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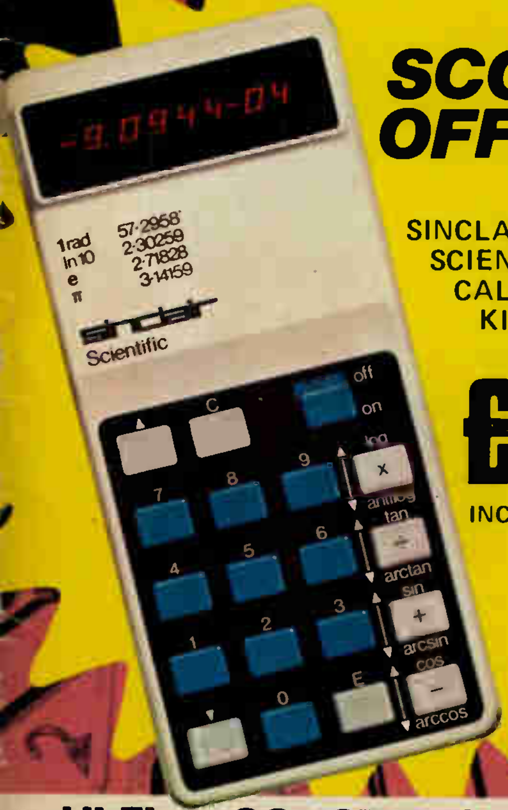

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OCTOBER 1974 Vol. 3. No.10

main features

projects

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news & information

Cover: Moαern Magazine's 'burglar' is 'caught' in this photograph using a simulated infra-red technique. See Electronics in Crime starting on page 10.

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AF139	0.41	MAT121	0.25	2N1132	0.24
AF186	0.48	MJE340	0.47	2N1304	0.28
AF239	0.44	MJE520	0.63	2N1613	0.21
ASY27	0.33	MJE3055	0.77	2N1671	1.20
BA115	0.10	MJE2955	1.27	2N2147	0.78
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BC107	0.14	NKT404	0.66	2N2926	0.12
BC108	0.13	OA5	0.72	2N3053	0.16
BC109	0.14	OA81	0.18	2N3054	0.48
BC109C	0.16	OA200	0.08	2N3055	0.45
BC113	0.15	OA202	0.06	2N3440	0.58
BC147	0.10	OC28	0.66	2N3442	1.39
BC148	0.08	OC35	0.55	2N3525	0.91
BC149	0.10	OC36	0.60	2N3614	0.65
BC169C	0.15	OC44	0.20	2N3702	0.11
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BCY70	0.18	OC81	0.29	2N3819	0.38
BCY71	0.22	OC83	0.27	2N3886	0.72
BCY72	0.12	OC140	1.14	2N3903	0.15
BD124	0.86	OC170	0.30	2N4002	0.14
BD131	0.42	OC200	0.84	2N4126	0.15
BF115	0.20	OC202	0.90	2N4871	0.34
BF180	0.36	OCP71	1.20	2N5457	0.30
BF194	0.10	ORP12	0.60	2S303	0.60
BFX13	0.26	ORP60	0.56	40550	0.64
BFX34	0.70	P346A	0.18	40361	0.45
BFX88	0.24	TIL209	0.20	40362	0.40
BFY50	0.21	TIP29A	0.49	40408	0.50
BFY51	0.20	TIP30A	0.57	40486	0.85
BFY64	0.36	TIP31A	0.61	40636	1.00
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SC35E	1.30
6 Amp	
SC40A	0.88
SC40B	0.97
SC40D	1.20
SC40E	1.50
10 Amp	
SC45A	1.09
SC45B	1.12
SC45D	1.50
SC45E	1.65
15 Amp	
SC50A	1.46
SC50B	1.57
SC50D	1.80
SC50E	2.00
Also	
40430	0.85
40669	0.90
40486	0.85

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CRS1 40AF	0.50
CRS1 60AF	0.78
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CRS3 025AF	0.36
CRS3 10AF	0.48
CRS3/20AF	0.54
CRS3/40AF	0.65
CRS3/60AF	0.80
TO48 7 Amp	
CRS7/400	0.64
CRS7/600	1.14
TO48 16 Amp	
CRS16/100	0.78
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B1/05	0.20	B4/80	0.90
B1/10	0.21	**6 Amp**	
B1/20	0.24	B6/05	0.50
B1/60	0.25	B6 10	0.58
B1/100	0.30	B6 20	0.68
2 Amp		B6/40	0.75
B2/05	0.30	B6/60	0.87
B2 10	0.35	**1 Amp Tubular**	
B2/20	0.40	W005	0.27
B2/40	0.44	W01	0.29
B2/60	0.45	W02	0.30
B2 100	0.55	W06	0.33
4 Amp			
B4/05	0.45		

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709C	(TO5 or d.i.l.) op-amp	£0.39
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728C	(TO99 or d i l) reg	£0.45
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747C	(TO5 or d.i.l.) gen pur dual op-amp	£1.00
748C	Hi-Z op-amp	£0.61
LM309K	5V 1.6A reg	£2.00
TAA960	3 st filter (ultra's ic transd)	£1.75

CASH AND CARRY PRICES

for callers or by post

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5	T1406 4 station intercom	£12.50
6	TAIA 2 station telephones intercom	£13.50
7	W1 2 2 station wireless intercom	£18.20
8	DP303 door phone intercom	£7.00
9	PK3 ETCH your own printed circuits	£2.25
10	EA41 reverberation amplifier	£11.75
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525C	120 160MHz VHF tuner	11.31	220	Signal Injector	2.65
570S	LF generator 10Hz–1mHz	21.45	390	VOX	£13.62
575S	Sq wave generator 20Hz–20kHz	19.77	432	Testakit	21.83
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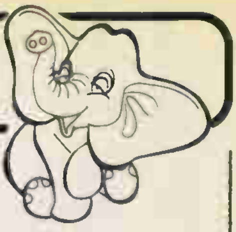

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104	9 volt	1 watt	o/p 8–10 ohm, 10mVi/p		£3.10
304	9 volt	3 watt	o/p 1–8 ohm, 10mVi/p		£3.95
555	12 volt	3 watt	o/p 8–16 ohm, 150mVi/p		£4.10
555ST	12 volt	1½ x 1½ watt	o/p 8 ohm, 150mVi/p	Stereo module	£5.95
E1208	12 volt	5 watt	o/p 4–16 ohm, 25–60mVi/p		£5.10
608	24 volt	10 watt	o/p 4–8 ohm, 30–50mVi/p		£4.95
410	28 volt	10 watt	o/p 8 ohm, 160mVi/p		£4.95
620	45 volt	30 watt	o/p 1–8 ohm, 150mVi/p		£9.95
Z40	30/35 volt	15 watt	o/p 1–8 ohm, 100mVi/p		£5.45
Z60	45/50 volt	25 watt	o/p 1–8 ohm, 100–250mVi/p		£6.95
SA6817	24 volt	6+6 watt	o/p 8 ohm, 100mVi/p	Stereo module	£10.20

Amplifiers with controls

E1210	12 volt 2½+2½ watts 8 ohms	Stereo	£8.25
R500	Mains 5 watts 4–16 ohms	Mono	£8.30
SAC14	Mains 7+7 watts 8 ohms	Stereo	£11.75
SAC30	Mains 15+15 watts 8 ohms	Stereo	£14.95
CA038	9 volt 1½+1½ watts 8 ohms	Stereo	£8.95
CA068	12 volt 3+3 watts 8 ohms	Stereo	£10.50

FM Modules

Mullard LP 1186 FM tuner (front end) with data 10.7MHz o/p	£4.85
Mullard LP 1185 10.7MHz IF unit	£4.50
Gorler Permability FM tuner (front end) 10.7MHz o/p	£4.20

FM and AM tuners and decoders

(All models fitted dials supplied with instructions)

FM 5231 (tu 2) 6 volt FM tuner	£7.95
TU3 12 volt version (FM use with decoder)	£7.95
SD4912 Stereo Decoder for Tu 3 12 volt	£7.95
SP62H 6 volt stereo FM tuner	£14.95
A1007 9 volt MW–AM tuner	£4.80
Sinclair 12 45 volt FM tuner stereo recorder for above	£7.45
A1018 9 volt FM tuner in cabinet	£13.95
A1005M (S) 9–12 volt stereo decoder FM for above	£7.50
106Z 12 volt stereo decoder General purpose	£6.50

Preamplifiers

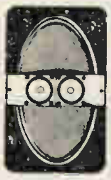
Sinclair	Stereo 60 Preamplifier	With Controls	£8.75
E1300	CART/TAPE/MIC INPUTS 9 volt	Module	£2.85
E1310	Stereo 3–30mV mal cart 9 volt		£4.75
FF3	Stereo 3mV tape head 9 volt		£4.95
3042	Stereo 5–20mV Mag. cart. mains		£5.95
EQ25	Mono 3–250mV Tape/cart/flat. 9 volt		£1.95

Power Supplies Mains input (*chassis-rest cased)

470C 6/7½/gear 300mA with adaptors	£2.25
P500 9 volt 500mA	£3.20
HC244R 3/6/7½/9 volt 400mA stabilised	£5.50
*P11 24 volt ½ amp 3 30 *P15 28 volt ½ amp	£3.30
*P1080 12 volt 1A 4 70 *P1081 45 volt 0 9A	£7.80
P12 4½–12 volt 0 4–1 amp	£7.15
SK01A 3/6/8/12 volt 1 amp stabilised	£12.75
P1076 3/4½/6/7½/9/12 volt ½ amp	£4.20
Sk800A 1–15 volt 0–½A stabilised	£17.50

EMI SPEAKERS

Special Purchase



13 x 8 chassis speakers (carr packing 30p each or 50p pr)
★150 TC 10 watt 8 ohm twin cone **£2.20**
★450 10 watt 4, 8, 15 ohm with twin tweeters and crossover **£3.85** each
FW 15 watt 8 ohm with tweeter **£5.25**
350 20 watt 8, 15 ohm with tweeter **£7.80** each
*Polished wood cabinet **£4.80** carr., etc., 35p each or 50p pair

EXCLUSIVE 5 WATT IC AMPLIFIERS

Special purchase 5 watt output 8–16 ohm load, 30 volt max DC operation complete with data.
Price **£1.50** ea.
or 2 for **£2.85**.

UHF TV TUNERS

625-line receiver UHF transistorised tuners FM. UK operation. Brand new.
(Post/packing 25p each)
TYPE A Geared variable as illustrated **£2.50**
TYPE B 4-button push-button (adjustable) **£3.50**

SPECIAL EQUIPMENT

Brand new ex-WD portable radiation detectors 0–10r complete with power unit, haversack and probe (CV2247) PRICE **£9.97** carr packing £1.00.
Brand new seal photo multiplier units (designed FM fuel tank fire detective) **£3.50.**

QUALITY CASSETTE TAPES

"Living Sound" made specially for Henry's by EMP Tapes Ltd.
5 screw type with library case. Post paid (GB)

	3 for	6 for	10 for	25 for
C60	£1.10	£2.00	£3.15	£7.50
C90	£1.47	£2.85	£4.65	£11.37
C120	£1.83	£3.54	£5.60	£14.00

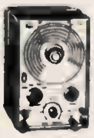
SPECIAL OFFER Cassette Storage

Rotating unit up to 32 cassettes stackable **£3.60** pp 15p
Car unit with bracket for 10 cassettes **£2.80** pp 10p

TEST EQUIPMENT

MULTIMETERS

(carr/packing 35p)



U4324 20KV with case	£8.25
U435 20KV with steel case	£8.75
U4313 20KV with steel case	£12.50
U4317 20KV with case	£16.50
U4341 33KV plus transistor tester steel case	£10.00
U4323 20KV plus IKHzd 465KHz OSC with case	£7.70
ITI-2 20KV slim type	£5.95
THL33D (L33DX) 2KV robust	£7.50
TP5SN 10KV (Case £2.00)	£8.25
AF105 50KV De-luxe (Case £1.80)	£12.50
S100TR 100KV plus transistor tester	£22.50

General Test Equipment

(* carr/packing 30p † carr/packing 50p) unless stated

† 3100 IMA strip chart recorder	£44.00
† Tk40 AC multivoltmeter	£18.75
† Tk15 Grid dip meter 440KHz–28MHz	£18.50
† Tk65 28 range valve voltmeter	£22.50
† Tk200 RF generator 120KHz–500MHz	£18.95
† Tk220 AF generator 20Hz–200KHz	£19.95
• HM350 In circuit transistor tester	£18.50
• C3025 Compact transistor tester	£6.95
• TT145 De-luxe meter 1–300 MHz	£14.75
† 63-36 R/C osc 20Hz–200KHz	£18.75
• C3042 SWR Meter	£5.75
• SE350A De-luxe signal tracer	£12.95
• SE400 Mini lab all in one tester	£15.50
C1–5 Scope 500,000KHz (carr £1.00)	£43.00
• C3043 5 CH F/A meter 1–300MHz	£5.75
Resistance sub box (Post etc 20p)	£2.40
Capacitator (Post etc 20p)	£2.10
2 amp variable transformers (carr £1)	£8.55
Radio activity counter 0–10r (carr £1)	£8.97
Mains unit for above (carr 50p)	£3.75

JOSTY KITS IN STOCK

(Post, etc., 15p each)

AF20	Mono transistor amplifier	£4.80
AF25	Mixer	£3.60
AF30	Mono transistor pre amp	£2.61
AF35	Emmitor amplifier	£2.27
AF80	Small 0.5W amplifier for mic	£4.22
AF305	Intercom	£8.62
AF310/2	Mono amplifier (for stereo use two)	£6.87
M160	Multivibrator	£1.71
M1302	Transistor tester	£8.45
M191	Vu-Meter	£4.58
M192	Stereo balance meter	£4.97
LF360	Quadraphonic device	£11.30
AT60	Psychedelic light control single channel	£7.80
AT65	Psychedelic light control, 3 channel	£14.56
AT25	Window wiper robot	£5.82
AT30	Photo cell switching unit	£5.70
AT50	400w Triac light dimmer speed control	£4.80
AT56	2 200w Triac light dimmer speed control	£8.90
AT5	Automatic light control	£2.50
GU330	Tremolo unit for guitars, etc	£7.50
HF61	Diode detector	£3.32
HF65	Frequency modulated FM transmitter	£2.70
HF75	FM transistor receiver	£2.87
HF310	FM tuner unit	£15.81
HF325	De-luxe FM tuner unit	£24.12
HF330	Stereo decoder for use with HF310/325	£8.96
GP310	Stereo pre-amp for use with 2 AF 310	£21.27
GP312	Basis circuit board	£11.45
GP304	Basis circuit board	£4.94
HF380	Aerial amplifier for LW to VHF	£4.94
HF395	Broadband aerial amplifier	£1.77
NT10	Power supply 100m/a 9v stab and 12v unstab	£8.15
NT300	Professional stab power supply	£12.51
NT310	Power pack 2 x 15 volt 2A	£5.71
NT305	Voltage converter	£4.50
NT330	Power pack AF310/GP304	£8.97
NT315	P/S 240v a c to 4 5 – 15v d c 500m/a	£8.67
AE1	Output stage 100mW	£1.50
AE2	Pre-amplifier	£1.15
AE3	Diode receiver	£1.82
AE4	Flasher	£0.99
AE5	A stable multivibrator	£0.95
AE6	Monostable multivibrator	£0.83
AE7	RC generator	£0.87
AE8	Bassfilter	£0.90
AE9	Treblefilter	£0.90
AE10	CCIR—filter	£0.90

AMATEUR ELECTRONICS by Josty Kit, the professional book for this amateur covers the subject from basic principals to advanced electronic techniques Complete with circuit board for AE1 to AE10 (see above) PRICE £3.30 (no VAT)

SINCLAIR MODULES AND KITS

Sinclair Project 80

ST80 stereo pre-amplifier	£11.95
Audio filter unit	£6.95
Z40 15 watt amplifier	£5.45
Z60 25 watt amplifier	£6.95
PZ5 power supplies for 1 or 2 Z40	£4.98
PZ6 power supplies (S. Tab) for 1 or 2 Z40	£7.98
PZ8 power supplies (S. Tab) for 1 or 2 Z60	£7.98
Transformer for PZ8	£3.95
FM tuner	£11.95
Stereo decoder	£7.45

All above post paid (GB only).

PACKAGE DEALS (Carriage/packing 35p)

2 x Z40, S780, PZ5	£25.00
2 x Z60, S780, PZ8	£27.75
2 x Z60, S780, PZ8 + Trans	£34.40

Sinclair Special Purchases

- Project 80 stereo preamplifier £8.75 post 20p
- Project 605 kit £18.95 post 25p
- Cambridge calculator kit £13.59 post 15p

SINCLAIR CALCULATOR KIT

Complete kit NOW **£13.59** + VAT

Also built **£19.95** + VAT

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354/6 Edgware Rd. W2	01-402 5854
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372 Edgware Rd. W2	01-402 8140
120 Shaftesbury Ave. W1	01-437 9692
230 Tottenham Court Rd. W1	01-580 1785
144 Burnt Oak B'way, Burnt Oak, Edgware	01-952 7402
190/4 Station Rd. Harrow, Middlesex	01-863 7788

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256 Banbury Rd. Summertown, Oxford	(0865) 54181
55 Gloucester Rd. Bristol 7	(0272) 45791

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No 36 Transistors/valves/semiconductors.
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No 17 Hi-Fi, TV-tape equipment.
Send large stamped addressed envelope with all enquiries.

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309 PA-Disco-Lighting High Power Sound 01-723 6963
303 Special offers and bargains store
All mail to 303 Edgware Road, London W2 1BW

Hi Fi and Electronics Centres Open 9 am - 6 pm

Prices correct at time of preparation. Subject to change without notice E.&O.E.

news digest

COMPONENTS SUPPLY POSITION EXPECTED TO EASE

For a variety of reasons, the components shortage that has dominated the list of problems of the electronics industry, especially the smaller companies, could well take a dramatic turn in the near future.

From Japan comes a report that the serious economic problems in that country will stagnate domestic demand which will encourage the surplus to be exported.

Once components are seen to be available, companies will start to use up the stock that they felt obliged to hoard during the shortage. Figures are hard to come by but many small companies have admitted to ETI that they now have such large stocks that they are looking forward to running these down.

The Spring Budget imposed serious cash-flow problems on most companies and running down previously hoarded stock must be very tempting.

The combined effects of these measures could lead to almost a components glut but there are few indications that this will result in a price fall. One example of price rises is that Japanese components have risen by an average of 30% in the last nine months.

£5 COMPUTER BY 1980?

Before 1980 general-purpose micro-computer complete with central processor and internal working memory will be available on a single chip for a cost of between 50p and £5. Magnetic bubble technology is expected to bring the cost of memory from the present 0.5p a bit to 0.05p per bit.

These and other similar predictions were made by L.S. Coles and J.M. Tenebaum of Stanford Research Institute, and O. Firschein and M.A. Fischler of Lockheed Research at New York's recent IEEE Intercon.

In their paper entitled 'Forecasting and assessing the impact of artificial intelligence on society', the authors considered the social implications of 21 postulated commercial products based on artificial intelligence technology.

One of their most startling forecasts is that of single chip computers capable of handling 20 million instructions per second with an internal 65,000 bit memory selling for less than 50p. This, say the authors, should happen before the end of this century.

MORE SOLAR CELLS

In recent News Digests we have given details of the increasing development work and interest in solar cells. The latest company to release details of their work in this field is Ferranti.

The company is aiming to produce a solar cell panel designed to recharge a 12V battery. The panels will measure 12" x 10" and will typically supply 250mA; greater capacity would of course be available by connecting panels together.

Ferranti's research centred on two types: thin-film cadmium sulphide and single crystal silicon types. It is the latter which has shown most promise and which will be used.

If the demand is proven the initial selling price is in the £100 region, perhaps falling to £30. Under U.K. conditions about 20W/hours per week are expected.

Envisaged uses are remote and inaccessible instrumentation, navigation and telecommunication links.

LASER WEAPON CONFIRMED

The long-rumoured laser gun now seems to be for real. The U.S. Navy have just confirmed previously unofficial reports that they are just about to undertake sea trials of a ship-borne anti-missile laser weapon. As the project is totally classified no other details can be published.

BOMB SNIFFER

A new and very welcome use has been found for gas leak detectors supplied by Leybold Heraeus of London, SE10. Normally these detectors are used by industry for detecting halogen gas which in turn is used to find leaks in pipes and vacuum systems. The electronic detectors are sensitive to a few parts per million.

The same detectors are now used in Ulster for sniffing out gelignite to which the detector is even more sensitive. So sensitive is the unit that it will show up anyone who has handled gelignite even 30 minutes beforehand and a car which has carried the explosive for two hours afterwards.

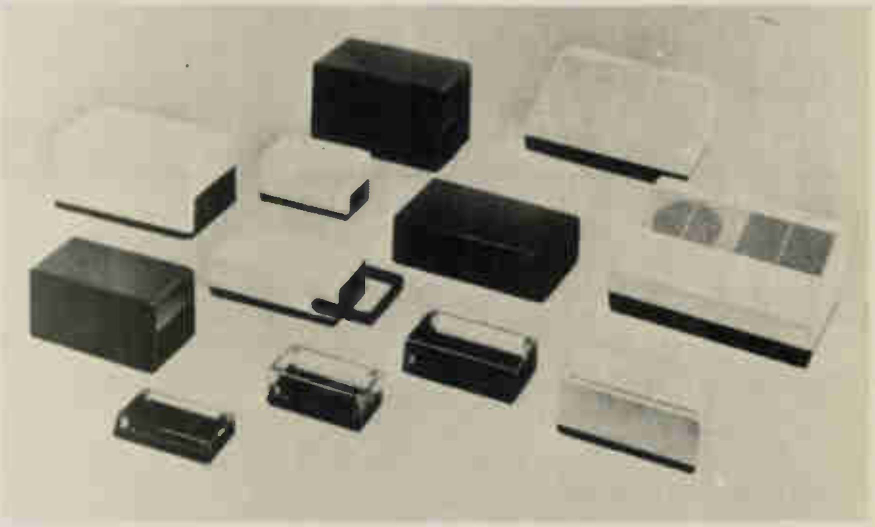
Apart from Halogen and Gelignite the detector only reacts to three or four chemicals but these are being kept secret to prevent attempts to mask the system.

BATTERY STATUS INDICATOR

New from Litronix is the RLC-400 battery indicator, a miniature-sized LED lamp with red diffused lens, incorporating a voltage-sensing I.C.

Designed to indicate battery state in small portable equipment, such as calculators and cameras, the RLC-400 features a sharp turn-on characteristic, having zero luminous intensity at 2.0V and bright output at 3.0V. Maximum forward voltage is 5.0V. *Litronix, Bevan House, Bancroft Court, Hitchin, Herts.*

PROJECT BOXES



One of the major problems confronting the constructor is in providing an attractive housing for the electronics. For those who take a pride in the final appearance of their projects, the availability of a new range of plastic boxes must be very welcome.

As shown by the photograph, the boxes are available in several sizes and styles – some with carrying/support handles. All are made of high impact polystyrene. The suppliers are Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hants.

HP-70 CALCULATOR

More details are now available on Hewlett-Packard's new low-cost pre-programmed business calculator. The price of £140 + VAT is somewhat higher than the information we were given but still represents excellent value-for-money.

The calculator has of course the usual four functions (+,–,x,÷) but in addition can handle 21 of the most common equations used in business and finance. These include accrued interest, future value of a compound amount, effective rate of a mortgage, effective rate of return for compounded amounts, percentage difference, percentage calculations and discounted cash flow.

A major advantage for the user of the HP-70 is that the financial data of any problem can be entered in any sequence and changed without having to re-enter the complete problem. The HP-70 also features a 4-memory operational stack as well as two independent memories for intermediate storage and accumulation of numbers.

DORAM ALL READY TO GO

The first item in last month's News Digest gave readers the first news on Doram, the new subsidiary of R.S. Components, which is entering the components field in a big way.

Doram are making their catalogue available this month and the photograph above gives some idea of the range which is going to be stocked – it shows just a tiny part of the 7,500 square foot warehouse in Leeds.

COMPUTERISED LIFTS

Cynical readers may say that the lifts in modern high-rise offices have been thinking for themselves for some time .....you can wait for ages only to be presented with a choice of three lifts to take since they arrive together.

For some years multiple lift systems have had some form of control but a new lift control system announced by Marryat and Scott Ltd is claimed to be five years ahead of its competitors. Apart from the obvious interest, the techniques demonstrate well the way that computers are affecting even the mundane aspects of our life.

The lift control system uses a minicomputer to control the operation of a group of lifts to cut down waiting time and make maximum use of the equipment.

Passenger demand for particular journeys is updated ten times a second – this makes maximum use of the cars. A light beam controls the doors so that stay-open time depends on the numbers entering or leaving. The doors even open as the lift approaches the landing to cut time still further.

When lifts are not in use they can be arranged to 'park' on those floors which are likely to need most service for particular times of the day: ground floor in the mornings, canteen floors at meal times, etc.

The control system even has built-in facilities to frustrate those nuisance callers who press all buttons and those who enjoy their conversations while holding open the doors!

The unit will even provide a print-out of the operation recording waiting times etc in order that the programme can be updated depending on experience.

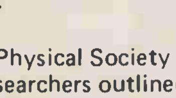
MOLECULE – ULTIMATE MICROCIRCUIT

What must surely be the ultimate in micro-miniature circuitry was proposed recently by Avi Aviram of IBM and Mark Ratner of New York University.

Speaking at a meeting of the American Physical Society recently the two researchers outlined a technique for designing individual molecules as functioning electronic devices. Presented to the conference was a blueprint for constructing a hypothetical rectifier in molecular form – along with quantum mechanical evidence of the scheme's feasibility!

SELF-ADHESIVE WIRING CLIPS

We were recently sent samples of an ingenious new wiring clip. These are supplied in a long row and individual clips are broken off. A backing paper is then removed enabling the clip to be stuck in position. Soft aluminium claws can then be bent over holding the wires firmly and neatly in position. The sketch illustrates the principle.



Although intended mainly for large quantity industrial use, we contacted the suppliers, *Special Products Distributors Limited, 81 Piccadilly, London W1V 0HL,* who told us they were happy to supply small quantities at 28p for 20 plus 10p postage and packing for quantities up to 250 staples.

The company are anxious to hear from retailers and other potential users.

news digest

The photograph shows David Metcalfe (left) Instrument Group Sales Manager of Hewlett-Packard and Halvor Moorshead, Editor of ETI (right) presenting an HP-970A Digital VOM to Charles Khoury of Bodmin, Cornwall, who was the winner of the competition held earlier this year.

Mr. Khoury is not new to Hewlett-Packard products as he already owns one of the company's HP-35 calculators.

TANDY'S EXPANSION

The first Tandy store opened less than a year ago but the number has now topped the fifty mark with new ones opening weekly.

For those who have not yet heard of or come across these stores they are a chain of high street audio/component stores. The Tandy Corporation originates from the U.S. where they have 2000 outlets and a turnover of £200 million.

Each outlet issues an identical 96-page free catalogue (very well produced, incidentally) which gives full details of the company's products. Quite a proportion is devoted to Hi-Fi equipment but the range of components - though not completely comprehensive - is considerable and includes some items not easily found elsewhere (one small example: heat shrinkable tubing).

Unlike the current trend towards mail order, Tandy is aiming for very wide coverage and hope to have 500 outlets within three years.

In addition to components, the Tandy stores market a number of electronic kits under the "Science Fair" brand name and a wide range of test gear.

Until recently the company have undertaken relatively little publicity but with the number of outlets growing rapidly it is a name we will all get to know a lot better.

GOULD TAKE-OVER BID FOR ADVANCE

The American Gould company is making a takeover bid for the Essex-based Advance Electronics Limited. The U.K. company employ about 1,800 people and have plants in Essex, Hertfordshire, Wales and Germany. Sales last year were £8 million.

Chicago-based Gould Inc. had sales of over £300 million largely in electronics and batteries.

TAPE REFERENCE BOOK UPDATED

'Tape Questions - Tape Answers', the popular tape reference paperback written by BASF tape specialist Heinz Ritter, has been updated by the addition of a supplement on (a) the Dolby System, (b) chromium dioxide tape, (c) Special Mechanics, and (d) Dynamic Noise Limiter (DNL).

The paperback was first published in 1971 and was an easy-to-follow, comprehensive guide to all aspects of tape from selecting the right tape software and hardware to operating techniques and maintenance. However, in the fast moving tape industry it soon became out-of-date as manufacturers, including BASF, introduced one tape development after another.

As an interim measure while a new edition is printed, a slip-in six-page explanation of the most important advances since 1971 will be available with all copies of the first edition.

'Tape Questions - Tape Answers' is available from Alan Patch, BASF (United Kingdom) Limited, Knightsbridge House, 197 Knightsbridge, London, S.W.7., priced 40p (post and packing included). The supplement is available free to anyone already possessing the first edition and wishing to update it.

FLUORESCENT LIGHT KIT

Recently announced by Electronic Design Associates is a 12V fluorescent light kit at £3.19 including VAT and postage.

The system drives an 8W tube and consequently draws only about two-thirds of an amp from a battery.

The kit is complete including a ready-built p.c. board, ready drilled metal-work, clips etc. A diffuser is also available for 59p inclusive (12p postage if ordered separately).

Electronic Design Associates, 82 Bath Street, Walsall, WS1 3DE.

NEW COLOUR TV DISPLAY

The first colour TV experiments mostly were based on a sequential system, bringing a coloured filter in front of a normal monochrome picture. The CBS experiments in the late 1940's and early 1950's are perhaps the best known. The disadvantages were the enormous wheel rotating at high speed - and the non-compatability of the system.

Serious work on this was dropped as a result of the development of the shadow-mask tube.

This principle however may not be dead. From no less a place than the Royal Radar Establishment comes news of work in an advanced state on a modern equivalent. The colour filter is placed over a B & W tube and is made of liquid crystals which are switched electronically. The eye does not notice the changing colours.

If it proves practical, the system could bring about a dramatic fall in the cost of colour TV's (£100 is suggested) as well as resulting in a far, far brighter display as the system is not subjected to the inefficiencies of the shadow-mask.

The system is due to be unveiled officially at the European Solid State Device Research Conference at the University of Nottingham (to be held at the time this issue appears).

We hope to carry more details when they are available.

R.S. OPEN BIRMINGHAM DEPOT

A new regional depot has been opened by R.S. Components for their customers in the Midlands. This is now operational. Address is P.O. Box 253, Saltby Trading Estate, Birmingham B8 1BQ. Telephone 021-328 0233.

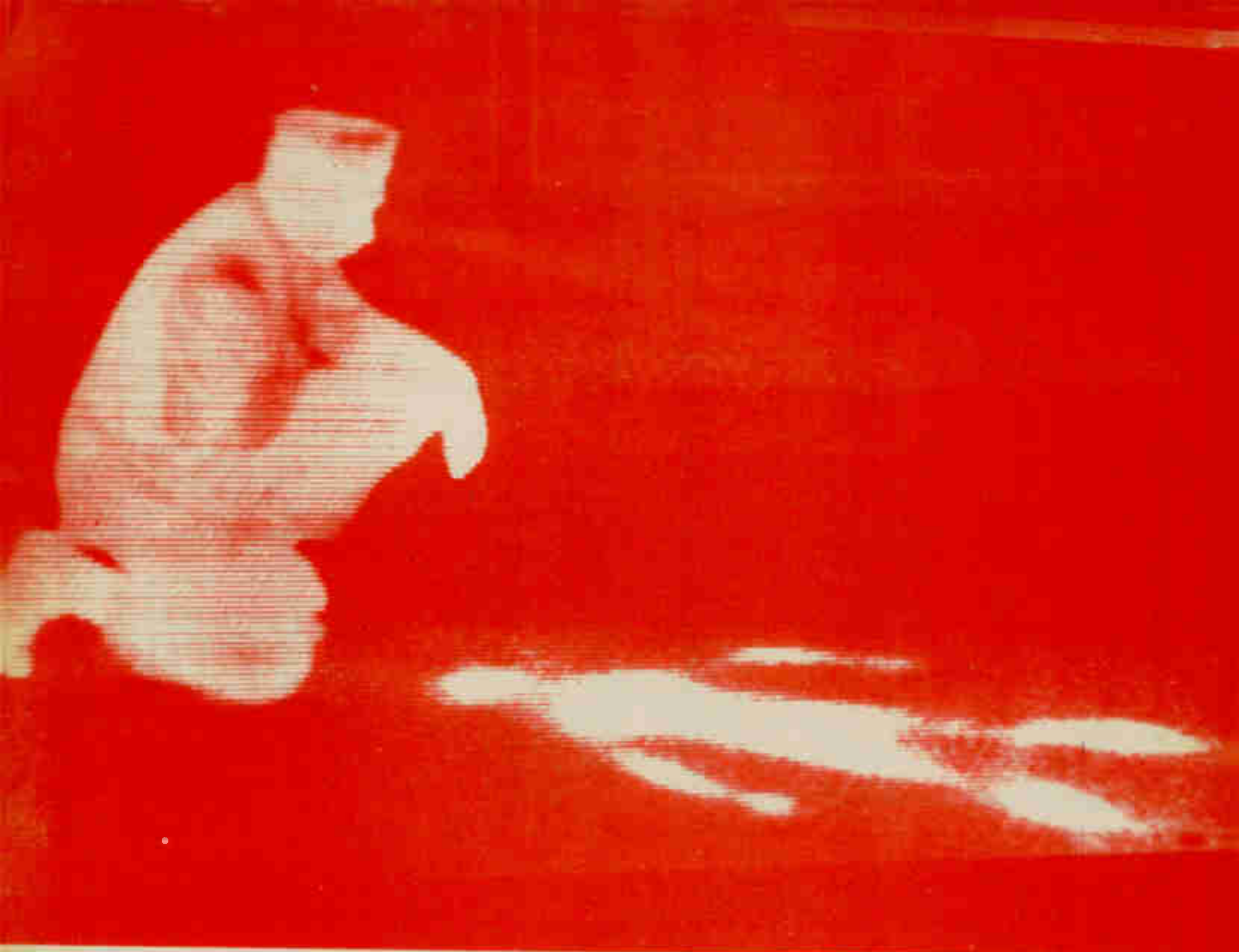
£10,000 PRIZE FOR NEW COMPANY

A recently held competition run by Barclay's Bank and the North of England Development Council has been won by John Jessop for his entry describing the establishment of a company to produce thick film micro-circuits on ceramic bases.

The competition, with a £10,000 prize, entitled 'Build Your Own Business', was to encourage anyone who had the vision and drive to set up a new business in the North of England. The project could describe a manufacturing or service industry and was not limited to electronics.

J. J. Electronic Components Limited has now been established and will operate from Cramlington, Northumberland.

Continued on page 68



ELECTRONICS IN CRIME

▲ *Hours after the murderer has moved his victim's body, a heat-sensing camera produces this thermogram showing exactly how and where his victim lay. The camera has reconstructed a scene — that the detective (left) can see only as a bare rug.*

In the battle against crime — *both* sides are using increasingly sophisticated techniques. Electronics Today reports —

HOURS after a murderer has moved his victim's body a thermographic (heat-sensing) scanner can clearly delineate the exact manner in which the victim first lay.

A person's movements can be plotted — hours after his presence — using holographic pictures to show up microscopic (elastic) deformation of the area where he has been.

It is electronics that has made this possible — together with other equally impressive instruments for a multiplicity of purposes — from infra-red image converters used for night vision to laser eavesdropping devices; from sophisticated devices for hidden weapon detection to units for finding long-since buried bodies.

IT'S A TWO-WAY GAME

Needless to say, since the devices used in surveillance and detection are of a 'passively aggressive' nature there have as a result evolved complementary devices used to neutralise or counteract the originals.

Many of the devices described in this series operate in conditions that are, at best, on the ragged edge of legality or sometimes in contradiction of it. One can readily foresee that the future battle against crime will be one in which *both* sides use electronic devices and counterdevices.

Already there are instances where this has happened. Recently a radio operator tuning across the 27 MHz band overheard bank robbers using walkie talkies during an actual felony.

The police unsuccessfully tried to locate the crime when notified. Unfortunately, it being a weekend,

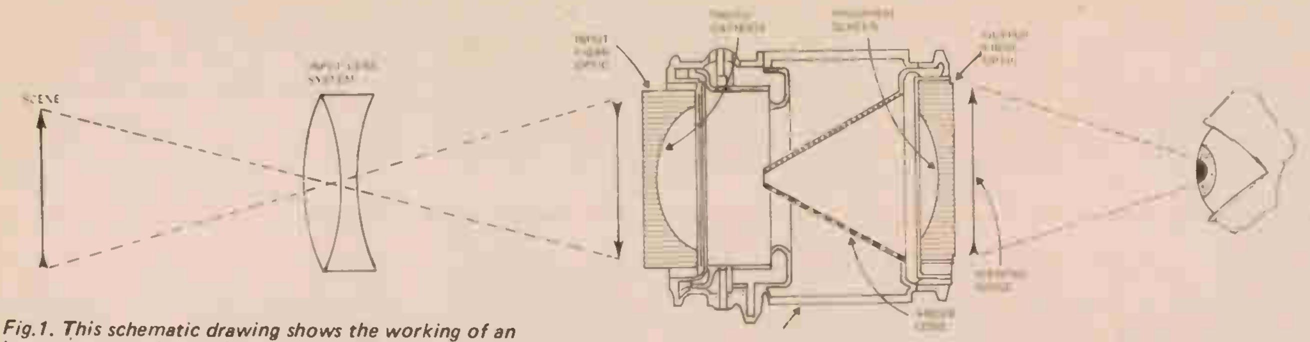


Fig.1. This schematic drawing shows the working of an image converter/intensifier.

A MODERN IMAGE CONVERTER-INTENSIFIER SYSTEM

Passive night viewing devices depend upon the light amplification of the image intensifier.

The scene is very faintly illuminated from sources such as starlight or proximity to man made lights.

Conversely in an active system a source of infra-red light, such as a tungsten filament globe kept just below incandescence, is directed onto the scene. By using an infra-red filter over the "searchlight", the subject is not aware that he is being illuminated since infra-red rays are invisible to the human eye. The image converter tube is capable of "seeing" both visible and infra-red radiation.

The optical system focuses the reflected light onto the face of the input fibre optic plate on the image converter. The optical image is then transferred by the fibres to the interior concave surface where a high sensitivity photocathode transforms the photon image into an electron image. Photoelectrons are released in direct proportion to the light intensity at each spatial point of the image. These electrons are now accelerated and focussed electrostatically onto the phosphor screen of the output fibres optic plate by the potential applied between the anode cone and the photocathode.

The electrons striking the phosphor produce an image similarly to that on a cathode ray tube and so a radiant image is built up. The intensification factor depends on the accelerating voltage of the tube. For a voltage of 15 kV, the intensified image is typically 25 to 60 times brighter than the optical image formed at the photocathode. Apart from the refinement of fibre optics and higher bias voltage this unit is little different to the "Tabby" system (described in the main text).

all banks were locked making a total search impossible.

Major payroll robberies have been committed by 'bent' computer operators who not only programmed their machines to divert funds in their direction, but wrote deletion instructions into the programme as well — thus effectively covering up their tracks.

SURVEILLANCE

During the second world war a device was developed by the allies known as "Tabby", "cats eye" or "owl eye". Supplied mainly for tanks it enabled the tank-driver to "see" in the dark. Later versions giving greater definition were used as snipers appendages for night work. (See last month's ETI).

"Tabby" consisted of an orthodox optical system which brought the image to focus on the photocathode of an image converter tube. By applying a bias voltage an image was formed on a fluorescent screen at the rear of the converter. This image was intensified by the tube giving an improved brightness over the original picture. The bias was obtained from a then special type of battery called a "Zamboni pile." The image appeared on the fluorescent screen inside the converter. Image quality left something to be desired but the unit was adequate for the purpose of assisting night drivers.

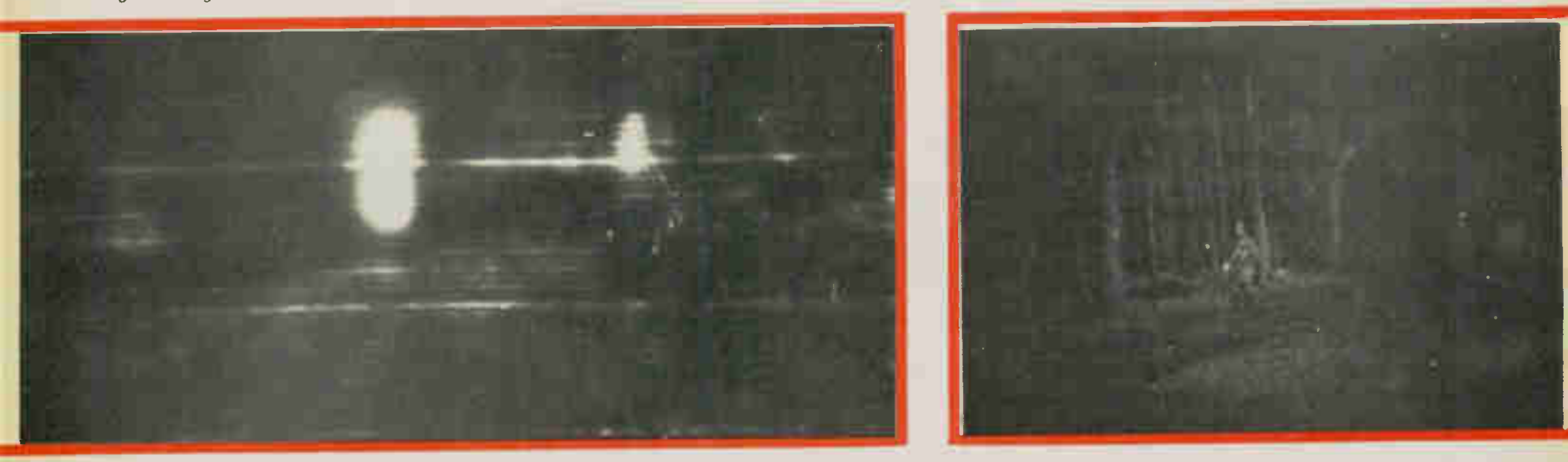
From these early instruments have evolved both active and passive image intensifiers and viewers as well as thermal imagers.

Thermal Imaging is an additional night vision technique which has certain advantages over intensifiers for the detection and observation of people and vehicles.

A human body (live) emits about 100 watts of heat energy in the form of long wave (far infra-red) light.

The average temperature of a man's head and his outer clothing is several

Fig.2. Thermal imaging (left) via image intensifier (right), both pictures are of a man walking along a path in open country on a dark night — (10^{-4} ft. candles). Using thermal imaging, the man could be clearly seen 1000 metres away, compared to the 100 metre or so maximum using the image intensifer.



degrees above the background temperature so although other objects around him are also giving off infra-red radiation the man stands out thermally from his background.

Over the past few years a number of thermal cameras have come into use. However most of these are intended for industrial rather than forensic use and their need for liquid nitrogen cooling of their indium-antimony IR detectors has rendered them too cumbersome for pólice use.

More recently details of a de-classified unit developed for the US army have become available. This unit is hand-held, has a thermoelectrically cooled detector and a 2.5 cm CRT display viewed through an eyepiece. Developed by Hughes in the USA the unit is energised by a 3 kg power pack and takes approximately 15 seconds to reach operational temperature.

Hughes have more recently announced a new portable unit called "Probeye". The unit weighs 3.1 kg and contains six InSb detectors cooled to 87°K by an argon gas cooler. Sensistivity is high and a small battery supplies the 1.5 watts required to operate the unit. Both battery and argon bottle have a life of four hours.

Latest work in the field comes from the English Electric Valve Co. where thermally sensitive TV tubes (pyroelectric vidicons) are being developed. Their main advantage is that they do not require cooling.

The two photographs on page 11 illustrate the different images obtainable by a light intensifying system via IR image converter as compared to a thermal image system.

The image intensifier system relies on the subject being illuminated by the surrounding faint light or by an infra-red source, whilst the thermal image is a heat picture which builds up an image from radiation emanating from the subject itself.

Thermal viewers form a valuable addition to night viewing equipment. Men and vehicles in most situations can be detected at twice the range obtainable using intensifiers and active IR systems.

Under certain conditions where the scene illumination makes observation with an intensifier difficult, (as in woods where little light enters from outside to illuminate the subject, or where there is a presence of strong lights in the field of view) then thermal viewers make detection and observation simple.

Cadaver Sniffing — A "Grave Operation"

A more macabre aspect of personnel detection is the detection of cadavers (dead bodies).

Searching for cadavers concealed in vegetation, buried or underwater often

"FALSE COLOUR" INFRA-RED COLOUR PHOTOGRAPHY

Infra-red can be used to take pictures in colour but the colour is what is known as false colour. Colours are sensations produced in the brain by certain wavelengths of visible light, that have entered the eye. Infra-red radiation produces no sensation because the human retina is not sensitive to it. But since certain photographic emulsions are sensitive to infra-red, it can be considered a colour and used to take pictures that show it as a colour when they are developed.

This is generally done by making invisible infra-red reveal itself as a red in the final photograph.

Like standard film that can take pictures in true colours, infra-red film has three superimposed emulsions, each sensitive to a different set of wavelengths — in this case infra-red, green and red.

These wavelengths form images on their respective layers, but when the film is developed, positive images in other colours appear.

False colour pictures are useful militarily because they make it even more difficult for an enemy to hide behind camouflage.

False colour has its civilian uses too. When an orange grove is photographed in false colour the healthy plants appear as a uniform reddish brown whilst trees attacked by fungi or pests are purplish or blue. Similarly landscape has its individual components brought out in full gamut of false but meaningful colours.

Amateurs have no great difficulty with false colour film and sometimes get surprising results that even experts cannot explain.

False colour film is available from the better known film manufacturers in standard 35 mm rolls for the would-be experimenter, as is manufacturers literature containing tips on how to use the film. (Kodak Ektachrome infra-red film to be used with orange filter).

Four graves, seven weeks old, normal colour.

Four graves, seven weeks old, false infra-red colour.

**It should be noted here that the monochrome print does not show as marked contrast as the original colour print.*

occupies large numbers of people for long periods. Nevertheless cadaver location, even if foul play is not suspected, is treated by the police with a high order of priority.

But it is often a long and difficult task, for the places of concealment and other circumstances, which determine the most effective search technique, are as wide as the environment in which man lives.

The Plessey Radar Research Centre have recently undertaken a study of various aspects of cadaver detection on behalf of the Home Office Police Scientific Research Development Branch. Plessey studied various search methods suitable for three well defined types of area. Large areas in open country, small areas in well defined boundaries such as back gardens; and areas of water such as canals, gravel pits, quarries, ponds, rivers or docks.

The study of the effluents of a living human body, including breath and vaporisation of odours from the body surface, have revealed that a broad number of chemicals are given off. The total organic emission is as high as 0.5 gms/hour.

Similarly a cadaver whether on or beneath the surface not only undergoes chemical changes and emmits organic matter into the atmosphere but also affects the surrounding soil and vegetation.

With these factors in mind electronic detectors of organic matter have been developed.

Most successful among these has been the body ammonia detector first used by the US army in Vietnam; continuous sampling monitored the air for ammonia together with carbon dioxide produced when the urea of sweat is broken down by bacterial action. This "sniffer" could detect the presence of humans, under jungle conditions and in the dark, even when concealed.

However, when searching for a cadaver over a large area it is more difficult and a combination of techniques has to be applied.

Photographic methods, using special film sensitive in the infra-red region, will pick up spectral anomalies of a grave where a body has been buried. In brief it constitutes a sensitive detector of recently disturbed vegetation and soil.

This technique has been used for detecting camouflage by the military with great success.

Evidence will be visually apparent with a fresh grave, but as the grave becomes overgrown other methods of detection must be used. For the first six months or so, the drop in soil moisture content above the cadaver will restrict vegetation growth. As decomposition products due to the cadaver's putrefaction seep up, thus enriching the soil, a lusher vegetation will appear (Ugh! — Ed). Some changes in the type and nature of the vegetation are also evident. Both these effects produce changes in the visible and near infra-red reflection spectra which are detectable on infra-red film.

Thermal imaging methods can also be used to detect thermal anomalies over a grave site. These occur for similar reasons as those causing spectral anomalies. It is to be noted that whereas the previous method measures the reflectivity of the soil and vegetation, thermal imaging measures the emissivity of the area.

Live humans have been observed from aircraft fitted with thermal imaging equipment even when concealed in trees.

During the rapid decomposition of the cadaver either on the surface or lightly buried, the surface temperature of the skin, clothing or even the soil, may be raised by the exothermic reactions set up inside the putrefying body. This effect could lead to a marked temperature anomaly which could make this type of system attractive.

Multispectral sensing is an experimental technique developed to improve on "false colour" infra-red photography. By this method a target is viewed using spectral bands by which it appears with maximum contrast against its background.

A special instrument called a "Telespectro-reflectometer" has been constructed. This is designed to scan a selected area of ground from an evaluation platform. It provides a very narrow spectral resolution of 0.005 μm over a broad wavelength range. The data are extracted on punched tape for computer analysis. Vegetation reflection spectra over graves are being investigated to see if a characteristic "fingerprint" of a grave for all conditions of weather, solar angle, age of burial and soil type, can be established. (Fig. 3).

Acoustics may also be used for cadaver location — and a single operator instrument is already in use.

Sound travels at different velocities through compacted soil as compared with less compacted fill. The more compacted the soil the higher the velocity and vice versa. Thus if the instrument is located over a grave the slower time of arrival of the shock wave at the sensor will be indicated by a time anomaly as compared with the surrounding more homogeneous terrain.

In the instrument shown (Fig 4) a hand-held striker generates a mechanical impulse which is transmitted into the ground and about five to 20 cm away a sensor picks up the vibrations transmitted by the soil and feeds it to the measuring unit. Tests have shown anomalies to be evident when over shallow test graves with pig carcasses in them.

VHF techniques have also been applied as a search medium. A

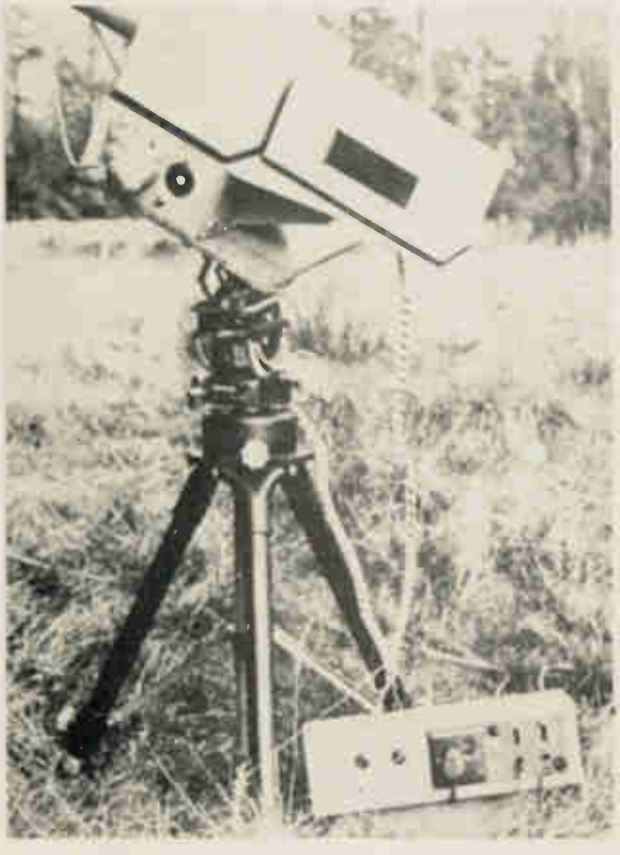


Fig.3. Telespectro-reflectometer.

ELECTRONICS IN CRIME

Fig.4. Experimental acoustic cadaver detector.

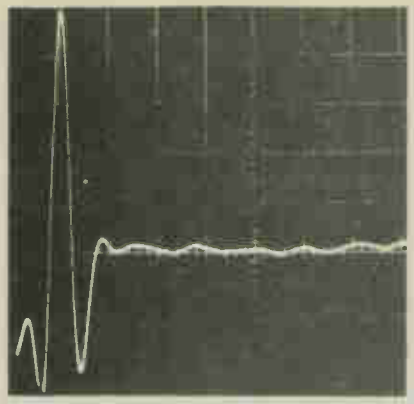


Fig.5. Soil surface radar return signal before burying dog.

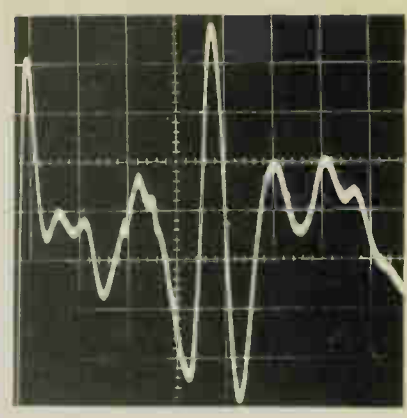


Fig.6. Signal obtained.

differential VHF cadaver detector has been developed. The search head for this unit consists of three equally spaced co-planar dipoles. The outer pair are used for transmission and the inner one for reception. The two transmitted signals are of equal amplitude and opposite phase so the received signal is zero when the search head is placed over a homogeneous medium such as undisturbed soil. If the head is swept towards an anomaly, the disturbance to the field of the nearer transmitting dipole will be greater than that to the field of the further dipole. The system thus becomes unbalanced and a signal appears at the receiving dipole.

The results obtained with this rig have been most encouraging. The detection of cadavers buried in soil to a depth of 15 cms has been achieved with soil moisture content of about 15% by weight.

Radar A more recent experimental method uses a short-pulse high resolution radar developed by Calspan Corp of Buffalo NY. Subsurface cadaver detection is accomplished by transmitting a very short pulse, receiving its (much weaker) reflection from the target and presenting the time delayed, changed pulse shape either for visual inspection by a human observer, or to suitable automatic recognition circuitry.

The transmitted signal must have a sufficiently large bandwidth to permit separation in time of the very strong soil surface return from the much weaker subsurface object return.

This experiment has demonstrated that a one-man-portable radar may be employed as a means of detecting buried objects. The holes made by disturbing the natural soil can also be detected, even though they have been filled and covered with an appreciable amount of soil fill. Animal bodies or cadavers may be easily detected.

By scanning the radar antenna laterally and longitudinally and noting corresponding signal response a fair estimate of the cavity size may be obtained.

Display of the signals obtained when a recently-dead dog was buried in a shallow grave are shown in Figs. 5 & 6.

Finally, the detection of bodies underwater. Turbid water can provide good transmission of ultrasonic energy up to 3 MHz. This is adequate for imaging objects of the size of cadavers, or even as small as hand weapons. There are nevertheless many engineering problems associated with generating a display which provides the operator with readily recognisable signals.

There are three main imaging systems.

1. Focused sonic image using refraction or reflection optics and an image converter.

2. Phased linear arrays of discrete pulse generating and receiving elements, which with suitable electronic processing can provide image displays.

3. Holographic techniques.

These are then a number of techniques which are available on an experimental basis. Further research and development is required before they can be put into general use.

Much research has been applied to techniques for detecting evidence of intrusion in some area or location. Recently a new technique of laser hologram interferometry has been applied with encouraging results.

The principle is that any surface which has had some force applied to it, such as the pressure of a human

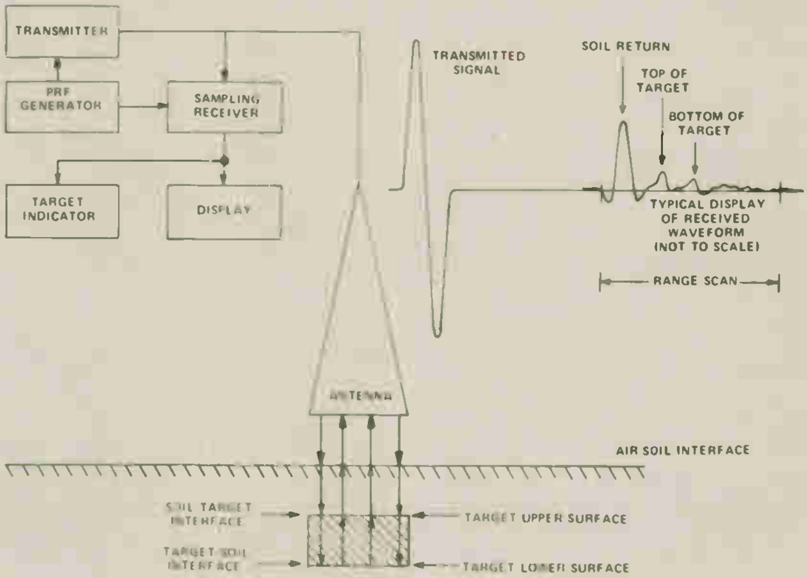


Fig.7. This is a black schematic of the Calspan radar system used for cadaver detection.

foot, elastically deforms around the pressure region. The elastically distorted area recovers rapidly at first — with about 90% return to original shape within seconds of removal of force, however further relaxation is progressively slower and detectable displacements persist for several hours.

This phenomenon is most marked with fibrous substances such as wood and textile materials.

If now, a method of comparing the surface shape of such a material at two instants during the slow recovery period is possible, it will provide the evidence of the earlier disturbance without the need for knowledge about the pre-disturbed state of the surface.

Through the use of holography this is possible. It must be noted here that such changes are of very low amplitude and the resolution of any measuring system used must be better than the minimum displacement of the material over the period of measurements taken. With a laser interferometer the resolution is at least half the wavelength of the light source (about 0.3 μm). This is of the order of magnitude required for detecting the minute changes of shape found by this technique.

Since interferograms are produced by taking photographs from the same location at successive intervals, absolute mechanical stability of the measuring system is essential. This requires a rather bulky set-up with a vibration-reducing platform if successful interferograms are to be obtained. Also motion of the object can mask localised variations.

Figure 8 shows that by locating a local reference mirror on the object surface, the motion of the object itself is compensated for. Any localised displacement due to elastic distortion by an external force will show up as interference fringes unmasked by the total motion of the object.

Figure 9 shows results from test set-ups using fixed-size samples of various materials which have been subjected to the force of a fixed weight for various intervals of time. The interferograms were taken at five minute intervals.

The illustration shows two identical hardboard samples. The weight on the upper one has been removed 15 minutes prior to making the hologram. The result indicates that the centre has moved 1.5 μm relative to the ends during the five minute sampling period. Each fringe corresponds to 0.34 μm. The lower "control" sample has shown no movement thus indicating the mechanical stability of the measuring system. After two hours the disturbed sample was still recovering at the rate of half a fringe per five minute interval. This dramatically demonstrates the order of magnitude of the measurements to be taken; measurements that were physically impossible prior to the development of the laser and holography.

Tests on rubber backed carpet underlay, where a footprint has been produced, yielded the fringe interferograms shown in Fig. 10. Photographs covering the time up to four hours after the event are shown.

These experiments have indicated the very high sensitivity of hologram interferometry in a stable environment. Where there are air currents, temperature changes and vibration, the technique can still be used with a pulsed laser and a local reference beam. The limits of sensitivity in an uncontrolled environment have not yet been established. The requirement of pulse to pulse frequency stability, coherence length and power requirement demand a somewhat bulky laser system at present. It is expected that future improvements in laser technology will overcome this disadvantage.

(These experiments were supported by the Police Scientific Development Branch of the Home Office and were implemented by EMI Electronics).

To be continued next month.

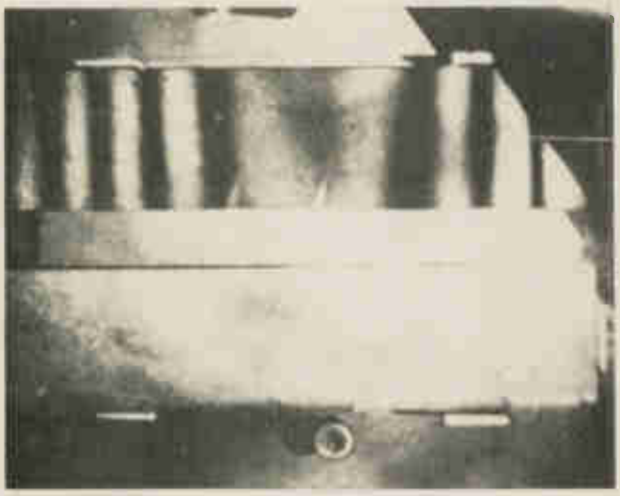


Fig.9. Interferogram showing movement in a hardboard sample. A second (control) sample is shown beneath the sample under test.

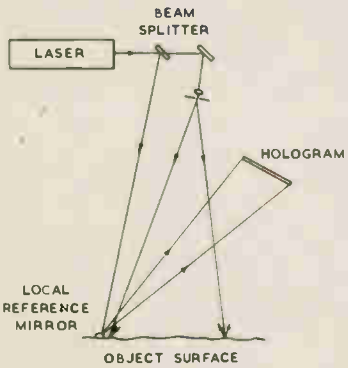


Fig.8. Local reference beam for object motion compensation. (See main text)

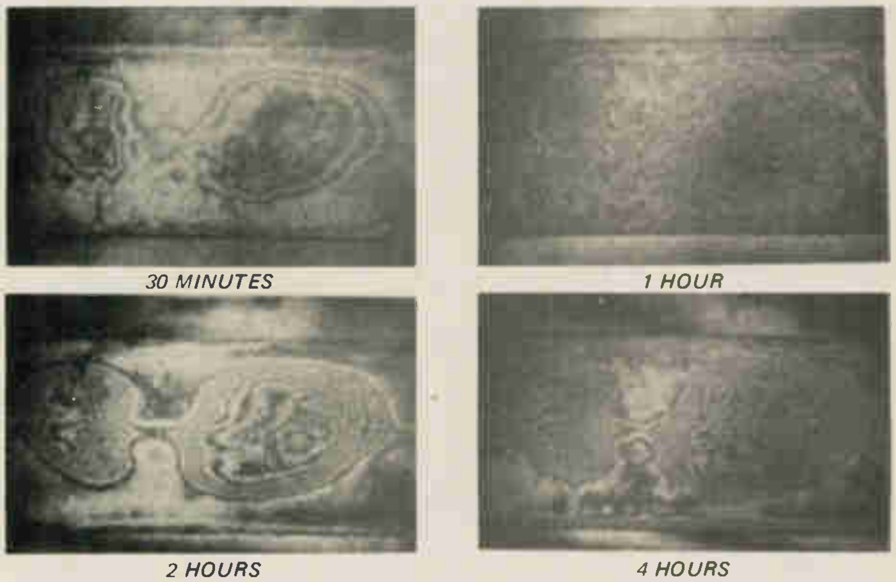
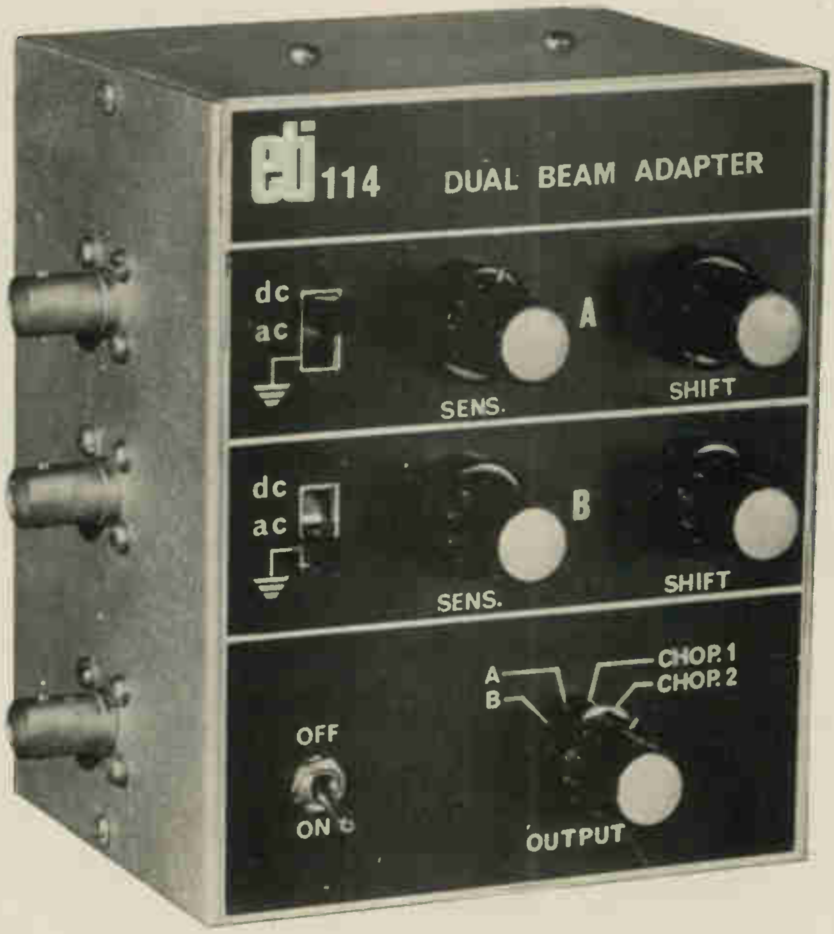


Fig.10. Sequence of 'live' fringe interferograms of footprint.

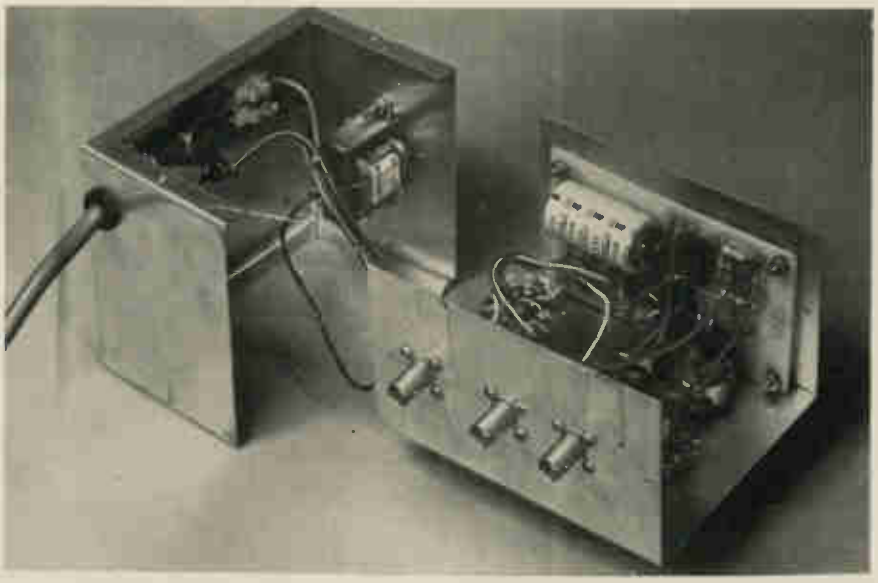
Goodbye to the long wait



PROJECT 114

DUAL BEAM ADAPTOR

Simple unit converts single beam CRO to dual beam operation.



THE oscilloscope, next to the multimeter, is perhaps the most useful test instrument. Indeed, for any serious experimental work an oscilloscope is indispensable. Unfortunately they are expensive beasts, and whilst an experimenter may well afford a simple, low-frequency single-beam type, a dual-beam version (at £100 or more) is usually beyond his means.

Nevertheless a dual-beam facility is most convenient, for it allows comparison of two different signals, for wave-shape or timing, and makes obvious, differences which otherwise would not be discernable.

The simple dual-beam adaptor described here, whilst not providing *all* the capabilities of an expensive dual-beam CRO, will however, cover most experimenter's requirements.

It is a low cost unit which allows two inputs of similar amplitude to be displayed simultaneously on separate traces. Frequency response of the unit is sufficient to allow observation of signals up to about 1 MHz.

CONSTRUCTION

Most of the components are mounted on a printed circuit board. However, if desired matrix or veroboard may be used.

Be careful to orientate the polarised components correctly, as shown on the component overlay. Wiring to the sockets and switches should be as short as possible. Note that C3 and C4 are mounted on the input switches and C5 is mounted on the output socket.

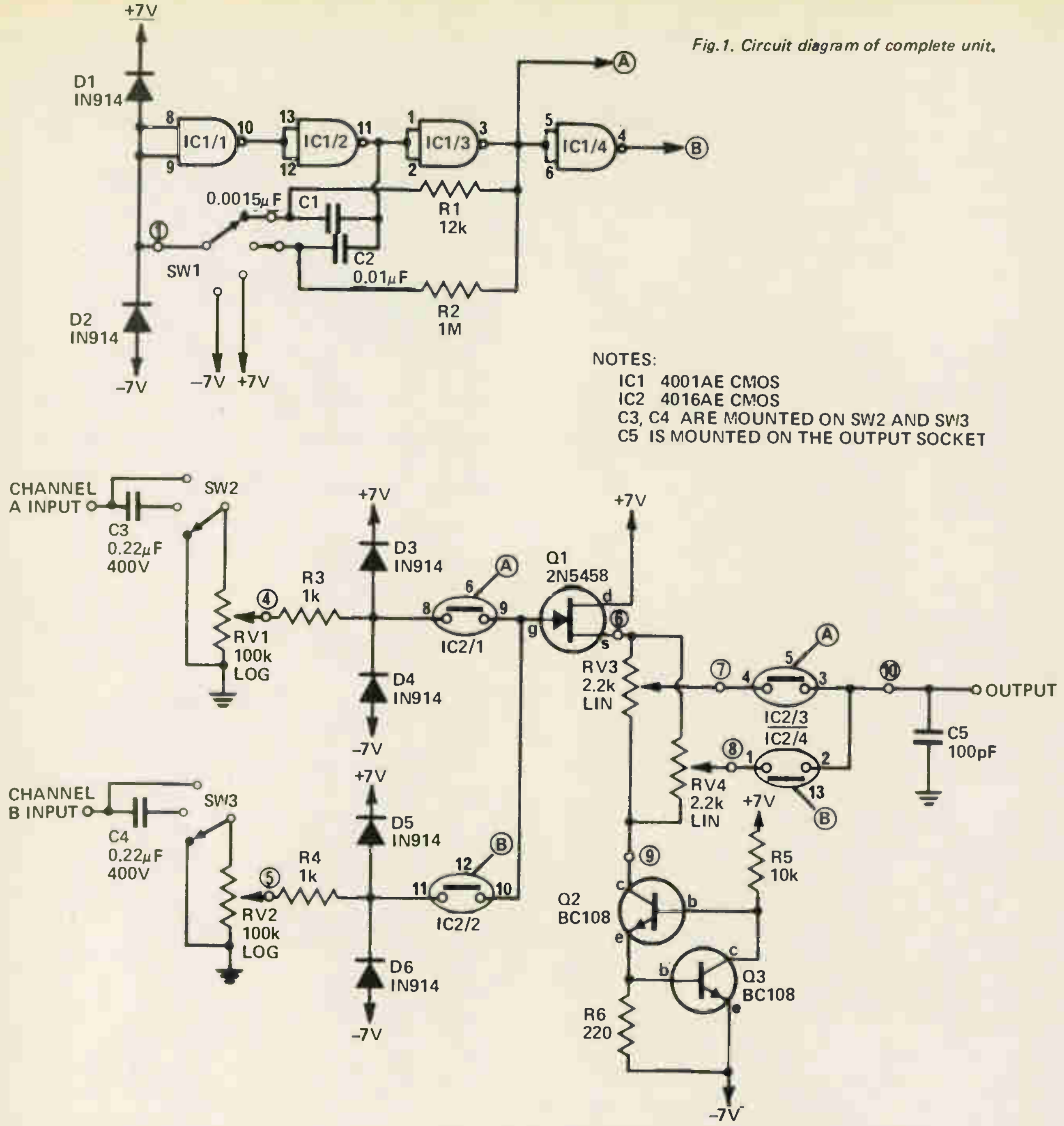
Our prototype was mounted in a small aluminium minibox as illustrated. As individual requirements will vary, details of front panel layout and metalwork only are supplied.

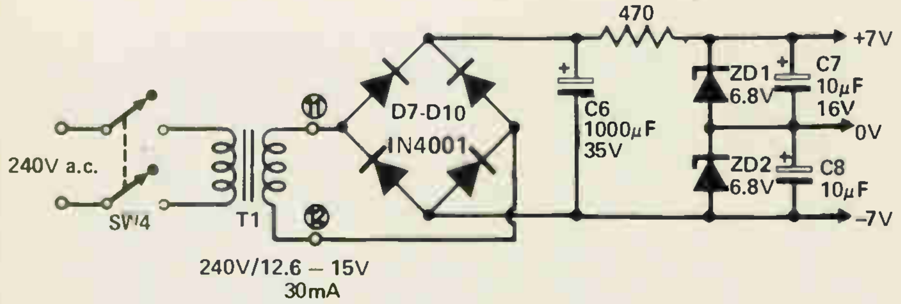
USING THE ADAPTOR

Connect the output of the adaptor to the input of the CRO. The two adaptor inputs now become A and B trace inputs to the CRO. A triggering signal should be applied direct to the trigger input of the CRO as otherwise the CRO will tend to synchronize to the chop frequency and not to either input signal.

It is preferable that the two input signals have approximately the same amplitude as there is no input amplifier or range selection provided

Fig. 1. Circuit diagram of complete unit.





on the adaptor. However there is an attenuator provided on each input so that some adjustment may be made.

If only one input is to be applied it is best to switch to that input only thus eliminating the second trace and any cross talk which may occur due to the high input impedances.

Two chopping frequencies are used, having widely different frequencies, so that if the input signal is a harmonic of the chopping frequency, (see Fig. 4) choosing the other chop mode will prevent the chop frequency being visible.

Normally CHOP 1 would be used for high frequency inputs, and CHOP 2 for low frequency inputs. An ALTERNATE mode has not been included (entails obtaining an output

SPECIFICATION

Input Level	
dc	± 4 volts max
ac	2 volts RMS max
dc insulation on ac	± 400 volts max
dc level shift	± 1.5 volts
Frequency Response	
– 3dB point > 1 MHz	
Chopping Frequencies	
A	60 Hz
B	35 kHz
Input Impedance	
	100 kHz

from the CRO of unknown level and availability) as the CHOP 1 mode is similar and almost as effective.

By means of the two shift controls traces A and B may be separated by up to ±1.5 volts.

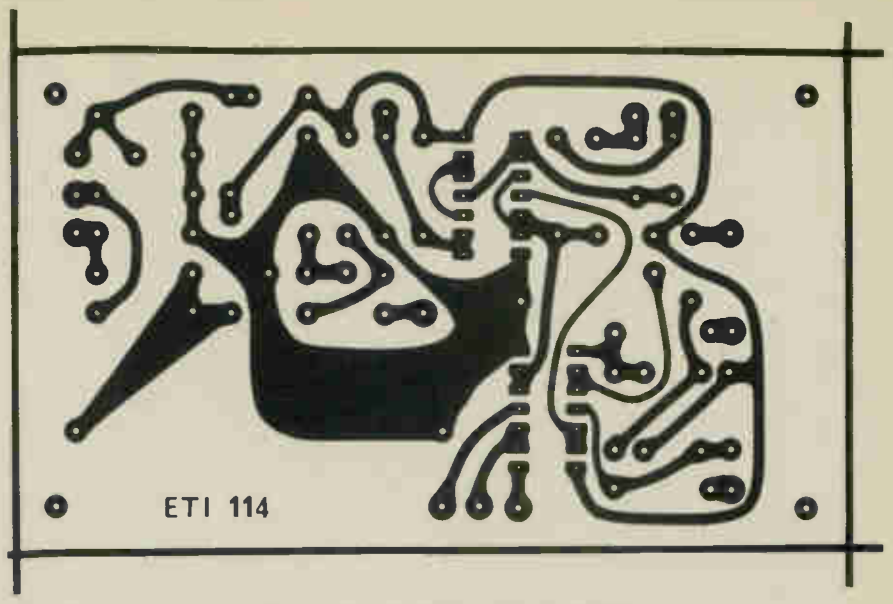


Fig.2. Printed circuit board pattern for the adaptor. (Shown fullsize).

HOW IT WORKS – ETI 114

Switches SW2 and SW3 select dc or ac coupling, or input shorted, for channel A and channel B inputs respectively. The signals are applied to the sensitivity potentiometers RV1 and RV2 and then passed to IC2/1 and IC2/2 which select one of the signals as an input to source follower Q1.

Transistor Q1 is supplied with a constant current (approximately 2.7 mA) by transistors Q2 and Q3. Hence, there is about 3 volts across RV3 and RV4, and this is unaffected by changes in input signal level. These potentiometers therefore provide a level-shift facility. When channel A is selected by IC2/1, IC2/3 selects RV3, and when channel B is selected by IC2/2, IC2/4 selects RV4. Thus as each signal has an independant level shift the two traces may be separated when chopped.

The CMOS gates of IC2 are driven by the outputs, A and B, the circuit·y associated with IC1. The drive circuit mode of operation is selected by SW1, a four position switch, such that channel A only, channel B only, A and B chopped at 60 Hz or, A and B chopped at 35 kHz may be selected. The operation is as follows.

Integrated circuit IC1 forms a multivibrator which can run at 60 Hz or 35 kHz, or be locked in A-high B-low, or A-low B-high output states. For example, if SW1 selects –7 volts, IC1 pin 10 will be at +7, IC1 pin 11 will be at –7, IC1 pin 3 will be at +7 and IC1 pin 4 will be at –7 volts. The CMOS switches of IC2 will be "on" if the control voltage is at +7 volts and "off" if the control voltage is at –7 volts. Thus when –7 volts is selected by SW1, "A" will be at +7 volts, and IC2/1 and IC2/3 will select channel A. Similarly if +7 volts is selected by SW1, IC2/2 and IC2/4 will select channel B.

If C2 and R2 are selected by SW1 the multivibrator will be free to run at 60 Hz and channels A and B will be alternately selected at this frequency. Similarly if C1 and R1 are selected, channels A and B will be alternately selected at 35 kHz.

The power supply is a simple full-wave bridge type which uses two Zeners to provide the +7 and –7 volt supplies required.

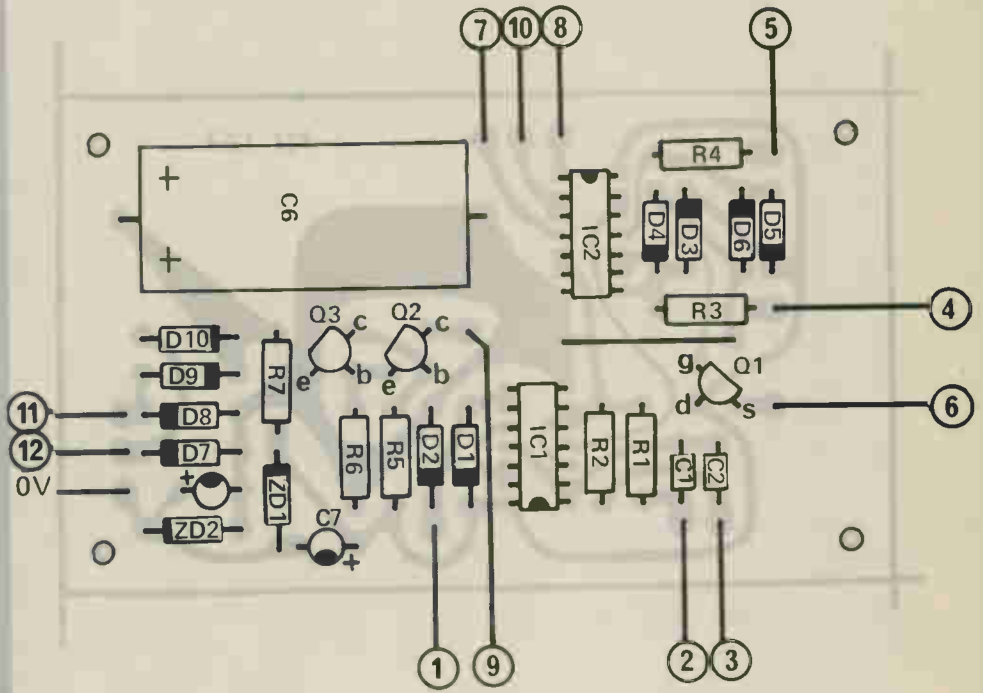


Fig.3. Component overlay.

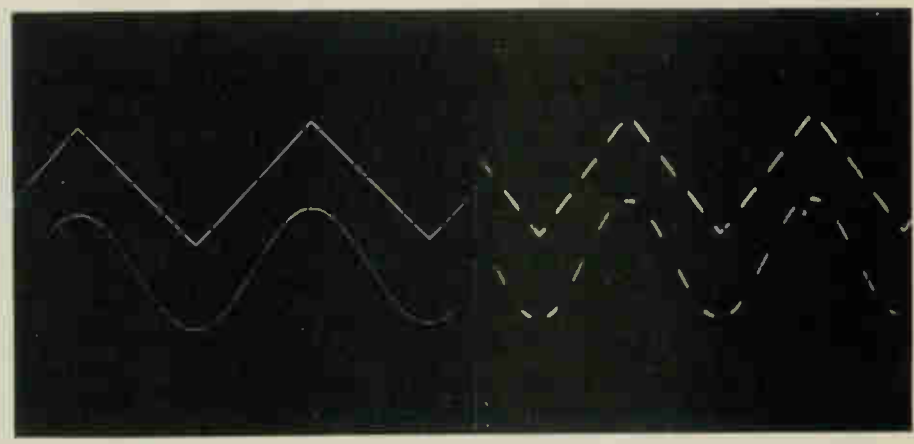
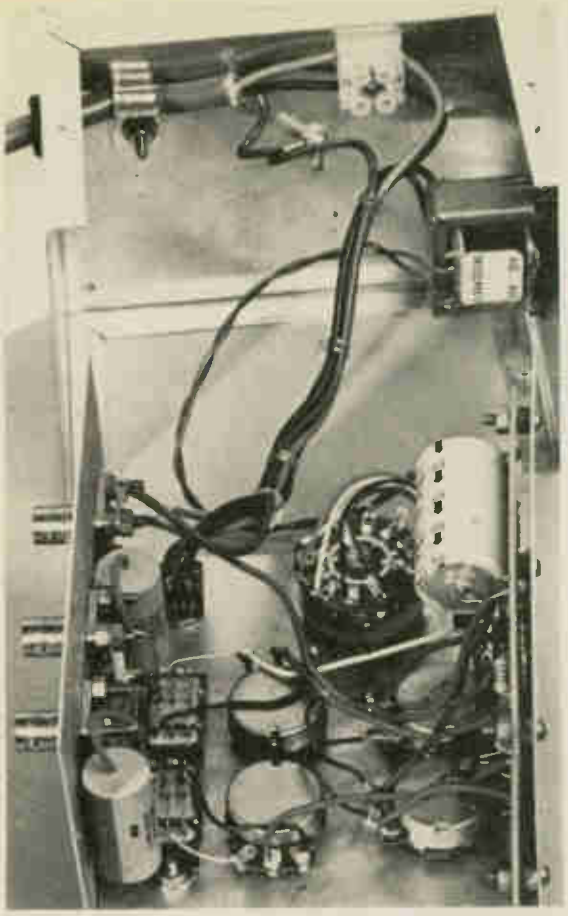


Fig.4a. Two signals, correctly displayed using the dual beam adaptor.

Fig.4b. Use of incorrect chopping frequency for a particular input signal (chop frequency a harmonic of signal) results in above effect. To cure use other chop frequency.



Layouts of components within the unit can be seen from this and accompanying photographs.

PARTS LIST—ETI 114

R6	Resistor	220	½W	5%
R7	"	470	½W	5%
R3,4	"	1k	½W	5%
R5	"	10k	½W	5%
R1	"	12k	½W	5%
R2	"	1M	½W	5%

RV1,2 Potentiometer 100k log rotary
RV3,4 Potentiometer 2.2k lin rotary

C5	Capacitor	100pF ceramic
C1	"	0.0015μF polyester
C2	"	0.01μF polyester
C3,4	"	0.22μF 400V poly.
C7,8	"	10μF 10V electrolytic
C6	"	1000μF 35V "

D1-D6 Diode IN914 or similar
D7-D10 " 1N4001 or similar
ZD1,ZD2 Zener Diode BZY88CV8 or similar

Q1 Transistor 2N 5458
Q2,Q3 " BC108,BC548 or similar

IC1 Integrated circuit 4001AE CMOS
IC2 Integrated circuit 4016AE CMOS

T1 transformer 12,6V–15V at 300mA
PC Board ETI 114
SW1 switch one pole 4 position rotary
SW2,3 switch 3-position slide switch
SW4 switch 2-pole on-off toggle 240V rated
Metal box 130mm x 105mm x 80mm
3 sockets to suit CRO leads
Knobs for front panel.

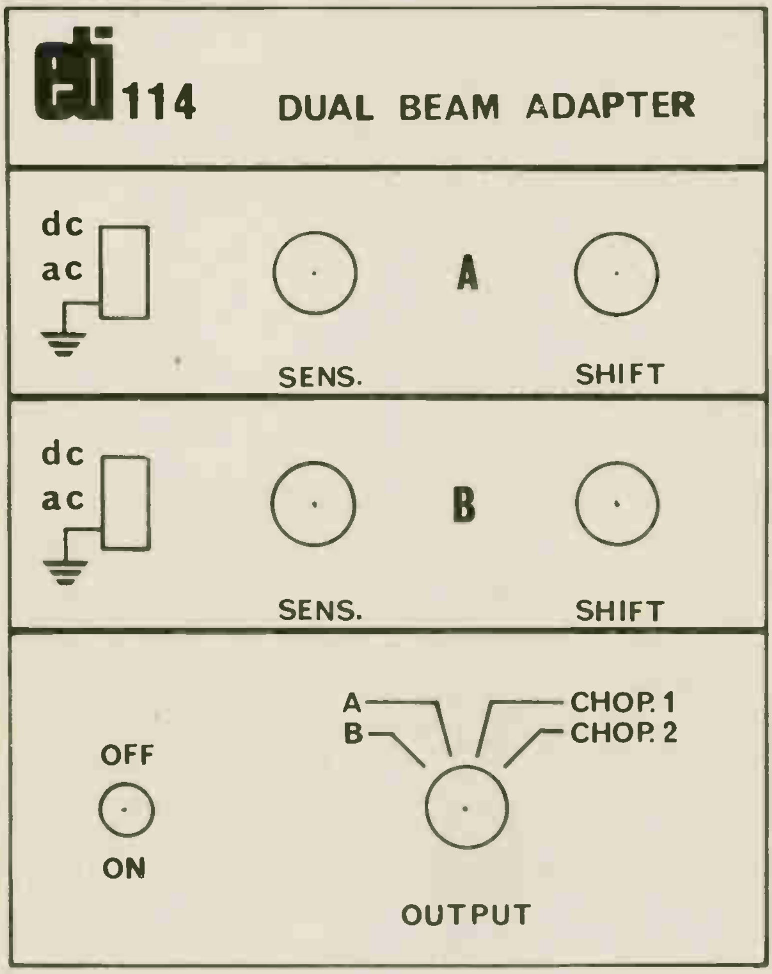


Fig.5. Artwork for front panel of the adaptor.

TIME CHECK FOR RADIOCARBON DATING

BEDEVILLED with the problems of establishing the true age of prehistoric remains, archaeology has been revolutionised in the past 20 years by the introduction of scientific methods of dating where previously there was mainly inspired guesswork. For organic remains such as wood and bone, the chief of these methods is radiocarbon dating. But this technique has been shown not always to give accurate results . . .

The principle of radiocarbon dating is that a fraction of the carbon dioxide in the atmosphere contains radioactive carbon-14 which is absorbed by plants during photosynthesis and by animals feeding on plants. When the plant or animal dies, the input of carbon stops and the carbon-14 gradually reverts to the common non-radioactive form, carbon-12. So the ratio of carbon-12 to carbon-14 in a dead plant or animal is a record of the time lapse since it died.

Radiocarbon dating is not accepted without reservations however. Where written records are occasionally available, as in Egyptology, the method is sometimes shown to be wrong by several hundred years. Probably the proportion of carbon-14 in the atmosphere in those times differed from today's value so that dates calculated using the present level have a built-in error. Therefore, the radiocarbon method itself needs checking.

A way of doing this has now been devised by Professor Colin Renfrew, an archaeologist at the University of Southampton, and a statistician from the University of Sheffield, R. M. Clark. They report that the radiocarbon method can be corrected to make it safely applicable to finds dating back to 5000 BC.

COMPARISON AVAILABLE

Clark and Renfrew looked at two geographical regions where alternative methods of dating happen to be available for comparison with the radiocarbon clock.

American scientists have found that high up in the White Mountains of California a tree, the Bristlecone Pine, survives to an incredible age – some are 4500 years old, making them the oldest living things – and the dry climate allows the preservation of still older dead trees. By counting the annual growth-rings the wood in the trees can be dated to within two or three years. That is a ready-made check on the radiocarbon method which shows that dates obtained by it are fairly accurate – back to 1500 BC, although they become seriously wrong for earlier times. For example, pine formed in 2500 BC gives a radiocarbon date of only 2100 BC, and wood known to have been formed about 5000 BC is given a date almost a thousand years younger.

Carbon dating is throwing new light on the Megalithic structures of Western Europe, such as Stonehenge.

But because of the uncertainty engendered by the imprecision of the radiocarbon clock, archaeologists are loth to rely on the Bristlecone Pine calibration. One fear is that the concentration of carbon-14 at the high altitudes where the pine grows might have been in some way unusual, making the radioactive basis in California not strictly comparable with that in Europe and the Middle East.

So, for a second check, Clark and Renfrew went back to the written records of ancient Egypt. From 1800 to 3000 BC these can be dated accurately by reference to the astronomical events they mention. Thus when-ever organic material is found in conjunction with written records a further check on the radiocarbon method is possible.

However, neither method can be used on its own as a calibration for the radiocarbon method – in the first case because the carbon-14 content of the trees may be in some way anomalous, and in the other because the Egyptian finds dated by the radiocarbon method may somehow have got mixed up with written material from an earlier or later time. So Clark and Renfrew used statistical techniques to compare the two methods of calibration. This is necessary to check whether any discrepancies that do occur are sufficiently small to have happened by chance, or whether they are serious enough to cast doubt on the validity of either scale.

It turns out that the two scales are compatible, and as the chance of each scale being in error by exactly the same amount is extremely small, the

Continued on page 29.

HEAR AND TELL UNIT

PROJECT

THE HEAR-AND-TELL does not fall into any neat category for description. Basically it will pick up any sound over a certain level and sound a bell or bring on a warning light. There are several uses for such a circuit. It has distinct advantages over, say, a microphone and amplifier in that background noise is absent.

Where a telephone is fitted in a room some distance from that normally used for watching TV for instance a call can easily remain unheard. This is avoided by having the Hear-And-Tell near the phone with an extension lead to an indicator lamp near the TV, or to a bell if preferred; there is no physical connection made to the phone.

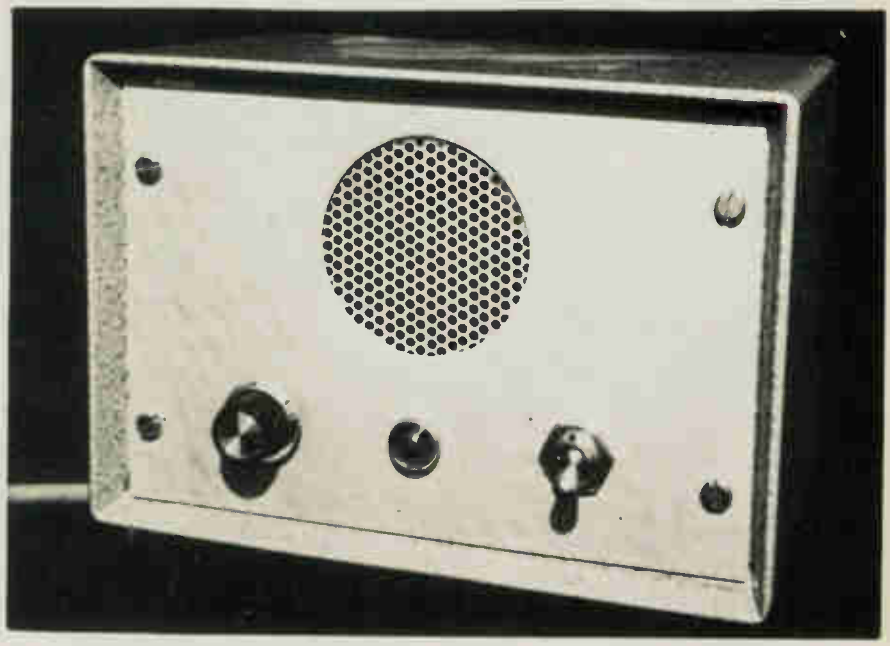
Similarly, a door bell which may not be readily heard in some part of the house can trigger the alarm. Where the Hear-And-Tell is operated from the sound of a door bell, the translation to a visual signal (indicator lamp) will prove of great aid for hard-of-hearing or deaf people.

The unit will also act as a baby-cry alarm, with audible or visual indication in any room to which the extension lead is run.

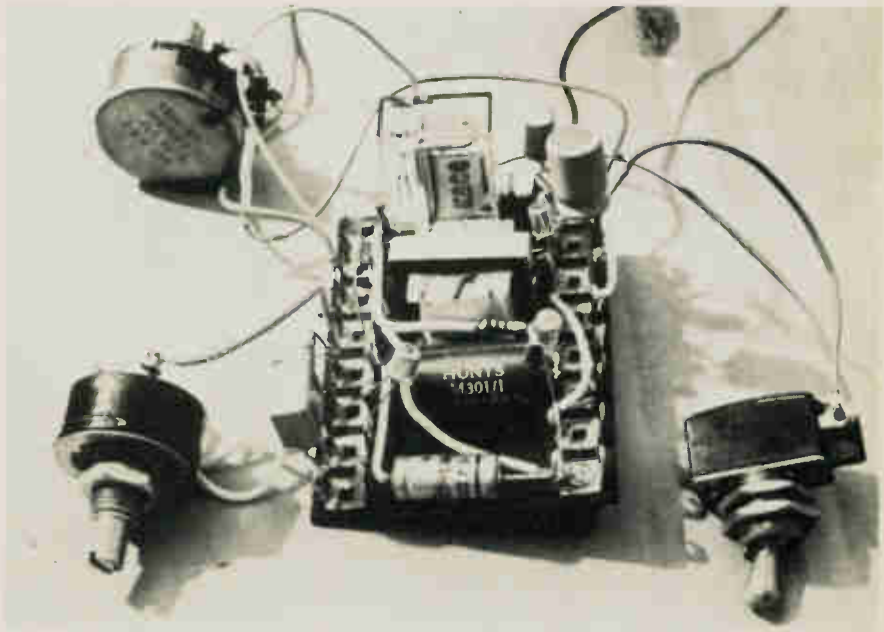
CIRCUIT

Figure 1 shows the circuit; this is for a.c. mains operation. A small high impedance speaker (30–100Ω) fitted in the case picks up sounds, which are amplified by Q1 and Q2. The manual control RV1 is the sensitivity control. If, for example, the unit is placed near a telephone, the sensitivity control is adjusted so that the circuit is operated by the phone bell but **not** by slight extraneous sounds.

When an audio signal is present, Q3 is driven into conduction, thereby moving the base of Q4 negative and increasing the current through the relay coil. RV2 is a pre-set, and is merely to allow the circuit to be set for best working with a change in supply voltage or in relay resistance.



The completed Hear-and-Tell master unit.



The tag-board, switches and controls.

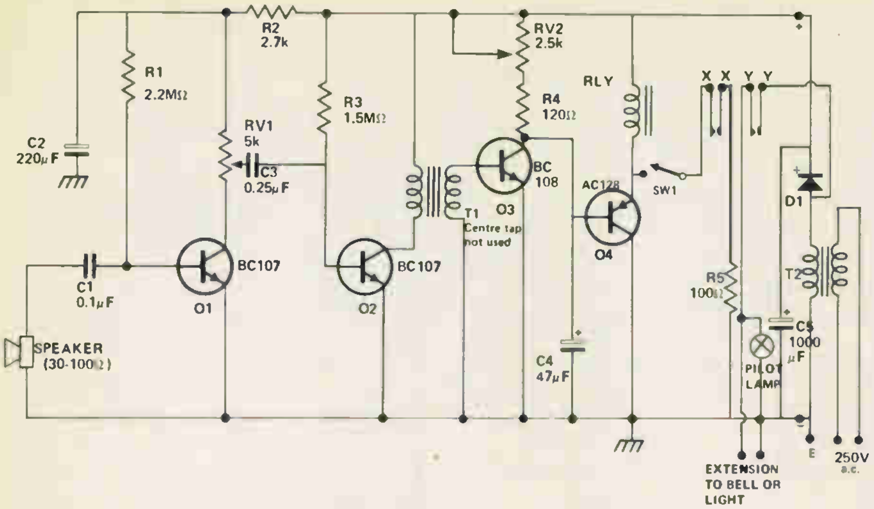


Fig. 1. Complete circuit of the Hear-and-Tell.

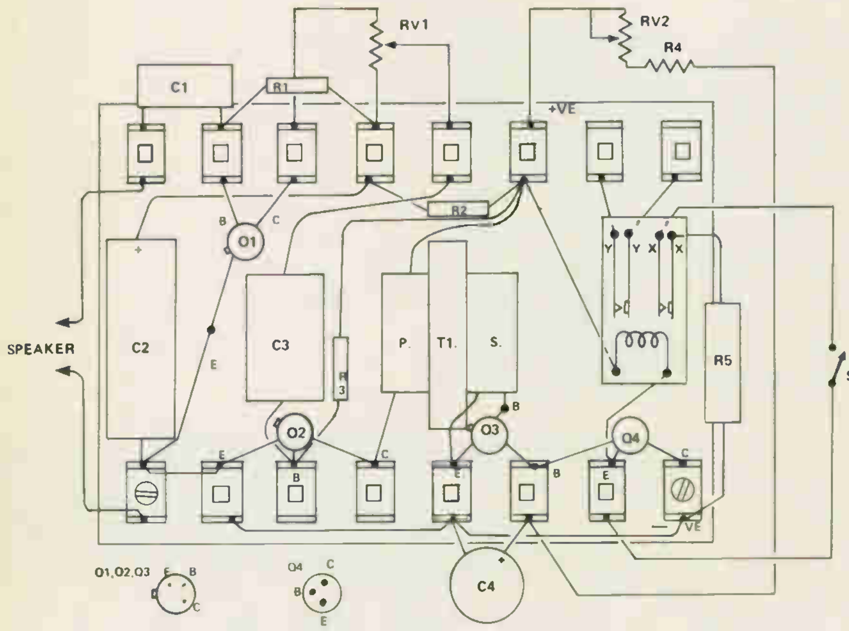


Fig. 2. The tag-board wiring.

PARTS LIST

R1	Resistor	2.2MΩ	¼W	5%
R2	"	2.7kΩ	¼W	5%
R3	"	1.5MΩ	¼W	5%
R4	"	120Ω	¼W	5%
R5	"	100Ω	½W	5%
RV1	Potentiometer	5kΩ log pot. (or 4.7kΩ)		
RV2	"	2.5kΩ pre-set pot.		
C1	Capacitor	0.1μF Mylar, polyester etc.		
C2	"	220μF 10V Electrolytic		
C3	"	0.25μF Mylar, polyester etc.		
C4	"	47μF 12V Electrolytic		
C5	"	1000μF 25V Electrolytic		
Q1	Transistor	BC107		
Q2	"	BC107		
Q3	"	BC108		
Q4	"	AC128		

T1 driver transformer (ratio approx. 3.5:1+1)
T2 mains transformer, 200/250V: 6.3V, 1A or 3/5/8V 1A secondary
D1 1A 50V silicon rectifier (1N4001 etc)
RLY 100Ω or similar 2-pole relay
PL1 6V, 100mA bulb.
75Ω 2½in. or similar speaker (can be 30-100Ω)
SW1 Toggle on-off switch (two required for battery operation)
Knob, sockets, tag-board and strip, case about 6 x 4½ x 4½in.

Contacts X-X and Y-Y of the relay are normally open. When the relay is energised, current flows through SW1, X-X and R5, thereby locking on the relay. At the same time contacts Y-Y close and current from the secondary of T2 is available at the extension lead sockets, to operate the remote bell or lamp.

If the lock-on switch SW1 is open, contacts Y-Y open when the sound ceases, and this is satisfactory if the warning lamp or bell is likely to receive immediate attention. The pilot lamp LP1 is of aid when setting the unit, as with SW1 open it will show at what sound level operation is being obtained.

For occasional use battery operation is possible by omitting the silicon rectifier D1, C5 and transformer T2. A 9V battery is connected to the positive and negative points shown, with an on-off switch in circuit. Quiescent current is about 6mA, which is not very heavy and will allow a long period of working from a PP9 or similar battery.

BOARD COMPONENTS

The components are readily assembled on a tag board (Fig. 2). T1 is of the usual push-pull driver type; the centre tap on the secondary is not used. Two bolts with extra nuts allow the tag board to be mounted in the case and also form the negative return to the case itself.

Leads are provided from the left-hand tags, to run to the speaker (acting here as a microphone). Also solder leads to tags 3, 4 and 5 of the top row, Fig. 2, to connect to RV1. These connections should not be too long, or be too near other leads. R4

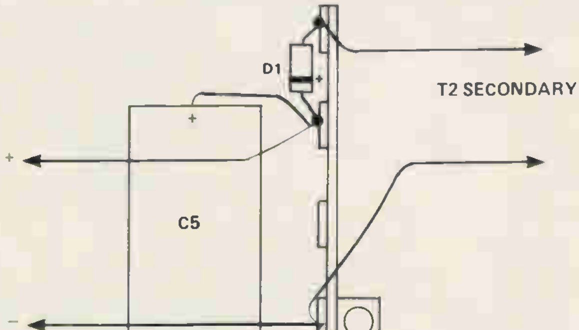


Fig. 3. Connection of the power supply components.

is soldered to RV2, and leads run to positive (top tag 6) and C4 (bottom tag 6). Fit flexible leads from one X contact on the relay and bottom tag 7, for SW1.

Run a red lead from top tag 6 (positive) and a black lead from bottom tag 8 (negative) for the board power supply. Components for the latter are assembled on a tag strip

(Fig. 3). If a battery is to be used instead, remember that an on-off switch is necessary in one battery lead.

TRANSFORMER T2

The common type of bell transformer (8V tapped at 3V and 5V) will be suitable, and connections from the secondary to relay contact Y can be arranged to provide 3V, 5V or 8V, depending on which is most suitable for the alarm device. A 6.3V transformer is also suitable. The core, one secondary terminal or tag, and the metal case are all joined together and connect to the earth lead of the mains cable. A 2A or other low rating fuse should be fitted in the plug.

The tag board, tag strip and transformer are bolted to the bottom of the case, with the pilot lamp holder, SW1 and RV1 on the front panel. RV2 and the extension circuit sockets are at the back.

ADJUSTMENTS

With SW1 open and RV1 at minimum gain position, adjust RV2 until the relay remains open. For battery use, RV2 can be set for minimum current, as shown by a meter in one battery lead, and consistent with reliable working.

RV1 is advanced until sounds of the required volume cause the relay to close. Where the extension bell or lamp is too far away for its indication to be known, observe the pilot lamp (this will go on when the relay switches).

If it is required for the warning bell or lamp to remain on once tripped, then SW1 should be left in the closed position. It is necessary either temporarily to turn back RV1 when closing SW1, or to have SW1 closed before current is switched on at the main socket outlet, since the sound of closing the switch will trigger the circuit and leave it locked on (shown by the lamp PL1 remaining lit).

Current required by the warning device should not exceed that available from T2. A 6V, 3 watt lamp will usually be ideal. ●

BACK NUMBERS

Back numbers are available for 25p each plus 7p postage on one, 10p on two. We are unable to supply the following:

April, May 1972
February, November 1973
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Orders should be sent to:

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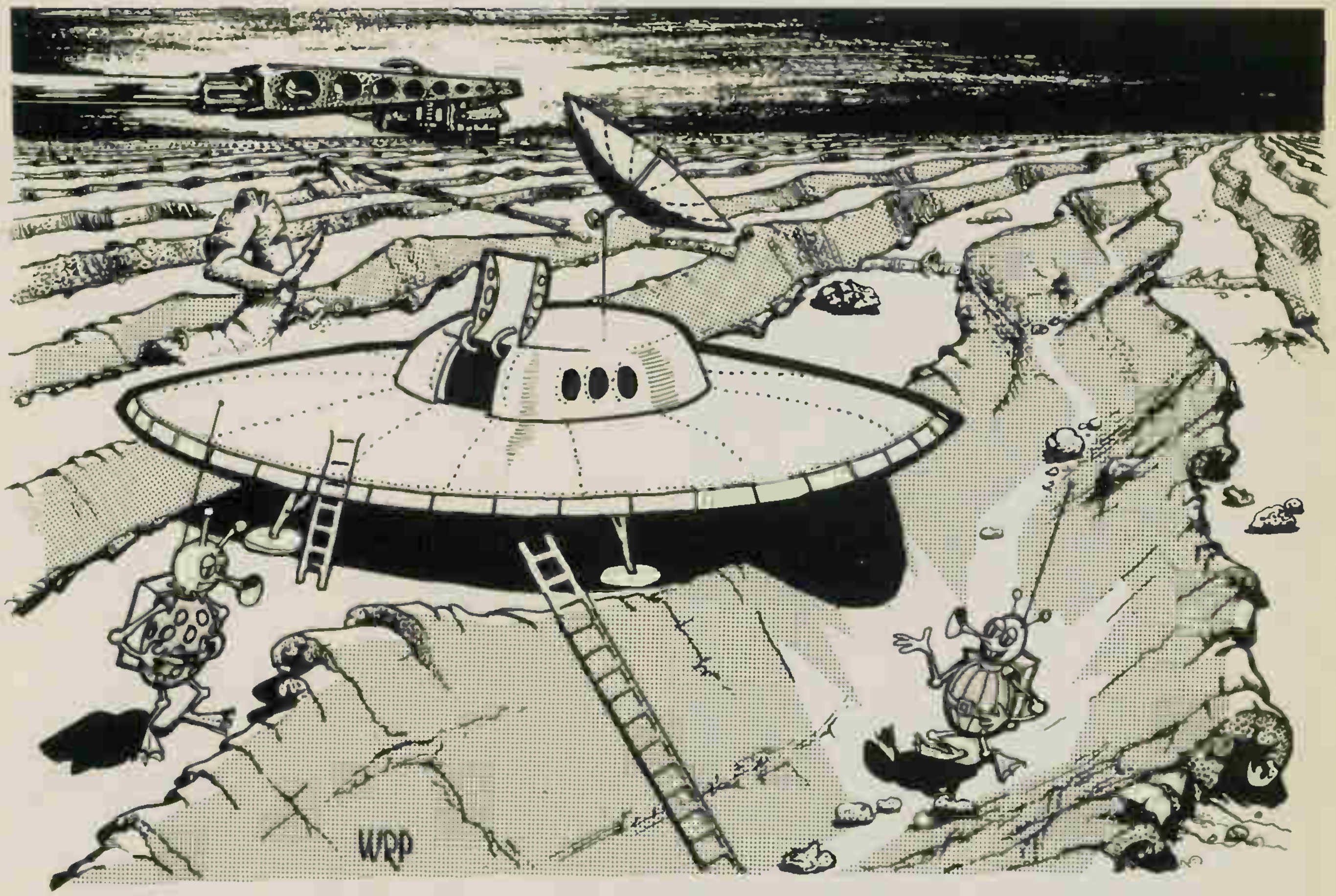

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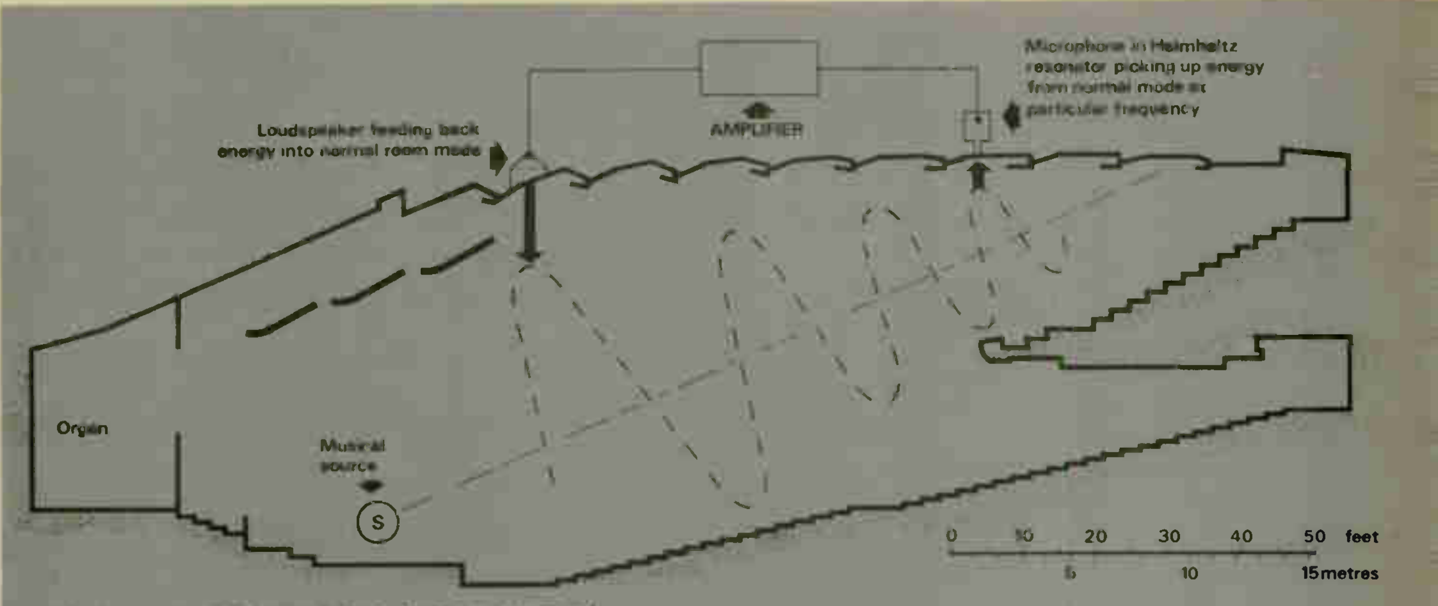


This diagram illustrates the principle of 'assisted resonance'.

Multi-channel sound optimizes concert-hall reverberation times.

'ASSISTED RESONANCE'

by P. H. Parkin, Building Research Station Watford.

MANY factors control the acoustics of a concert hall or theatre but the most important influence, and the only one under any control, is what is known as the reverberation time.

This is defined as the time taken for the sound in a room to decay to one-millionth of its original intensity after the source of sound has stopped. Roughly speaking, it is the time it takes for a moderately loud sound to die away to inaudibility.

In a furnished living room this time will be about a half-second, in a theatre about one second, in a concert hall between one and a half and two seconds, and in a cathedral five seconds or more.

The reverberation time of a room is determined by two things: the size of the room, and the amount of sound-absorbing material it contains. The sound can be visualised as travelling round and round the room after it has left the source, and each time it strikes a reflecting surface some of it is absorbed. Therefore the more absorbent each surface the quicker the sound is absorbed and the shorter the reverberation time. Also, the larger the room the farther the sound has to travel between each reflection, making the reverberation time longer. Nearly always the reverberation time is different at different frequencies because the sound absorption of all room surfaces, and of people, varies with the sound frequency.

MOST IMPORTANT FACTOR

Why the reverberation time should be such an important factor is not clear. It is probably not so much the time itself that matters as the fact that it is a measure of the *amount* of reverberant sound in the room. That is to say, it is a measure of the ratio of the sound that reaches a listener directly from a speaker or an orchestra to that which reaches him after being reflected from the room surfaces. But whatever the reason for its importance, it is the one factor we can measure and probably the most important influence on producing — so far as music is concerned — that elusive, desirable quality for concert halls known variously as 'warmth', 'resonance', 'fullness of tone', and many other similar terms.

As already mentioned, a theatre, or any room designed primarily for speech, will have a reverberation time of about one second. Anything shorter than this will cause the sound to seem 'dead', even for speech, and anything much longer will make speech rather difficult to hear. For music, however, a reverberation time of one second means that the sound will be very lifeless, one and a half seconds is generally reckoned to be about the minimum and two seconds about the optimum.

One obvious consequence is that there is an acoustical conflict when — as often happens — a room is to be used for both speech and music. A reasonable compromise reverberation time is one and a half seconds, but the effect is not very good for music and a little too reverberant for rapid speech.

This conflict has been realised for many years and various attempts have been made to overcome it. For example, rooms have been built with variable surfaces such as rotatable panels, one side of which is covered with sound-absorbing material so that when that side is facing into the room the reverberation time is shortened. On their other side these panels have a hard surface which when exposed inwards makes the reverberation time longer. This arrangement can be made to work reasonably well in studios, but in auditoria a large amount of sound absorption is due to the seats and audience. Therefore the change in reverberation due to the change in surfaces is limited. Further it is difficult to build reversible panels with different amounts of absorption on either side to deal with low sound-frequencies.

ELECTRONIC CONTROL

Because of the limitations of physical alterations, the idea of using some kind of electronic control in the auditorium has appealed to acousticians for many years. Several attempts have been made to devise an adequate electronic method of altering the reverberation time of an auditorium or, more precisely, to devise an electronic means of lengthening the reverberation time because no such method for shortening it has yet been evolved.

This article describes one of the more recent methods to be employed. It is known as 'assisted resonance' and was tried experimentally in the Royal Festival Hall in London in 1964 before being installed permanently. A simplified system has now been put into the Central Hall of York University.

The simple picture of sound travelling round a room is one way of visualising what happens, but another, more accurate, way is to think of the room's acoustic behaviour as a large number of resonances. The air in an organ pipe will resonate at one fundamental frequency with harmonics depending mainly on the length of the pipe. Similarly, the air in a room will resonate at various frequencies. But because a room has breadth and height as well as length, the number of resonances is enormous — several million in a large concert hall — so that they cannot normally be distinguished by ear.

What assisted resonance does is to select a large — but, of course, finite — number of these resonances, and 'assist' them as illustrated in the diagram.

A microphone connected by an amplifier to a loudspeaker forms what is known as a 'channel' and for each channel the microphone and the loudspeaker are positioned in the auditorium so that they respond more to one of the room resonances than to any other. Each channel puts some acoustic energy into the room whenever it is excited by the original source of sound, and the amount of that energy depends on the gain of the amplifier.

Obviously, this power compensates to a controllable extent for the power being lost at the room surfaces, and thus the reverberation time can be increased by controlling the gain. However, each channel is 'assisting' only one frequency, so it is necessary to have a large number of channels to cover the frequency range.

In the Royal Festival Hall there are 172 channels covering the frequency range 58 to 700 Hz. Using these channels it has been possible to increase the reverberation time from, for example, about one and a half seconds at 125 Hz to about two and a half seconds, and this time could be increased still further by increasing the gain of the amplifiers if desired.

OVERCOMING A CONFLICT

As already suggested, a more widespread use of the system could be to overcome conflict between speech and music. A hall would be designed with a reverberation time of about one second for speech and assisted resonance would be switched on to bring the reverberation time up to the region of two seconds for music. The cost of such a system would depend on the number of channels used, and the installation at York University was a development of the Festival Hall system to see (a) how few channels were needed, and (b) how much increase could be obtained in a hall which started off with a short reverberation time.

The York installation in fact consists of 72 channels and at the time of writing, has increased the reverberation time at the lower frequencies from about one second up to about 2.2 seconds and at the medium frequencies from about one second to 1.4 seconds. The number of channels used, and their spacing along the frequency range, was the best guess that could be make at the time of the installation.

Experience so far suggests that either a few more channels, up to a total number of perhaps 100, will be needed to make the hall *really* satisfactory for music or that some of the channels used for the lower frequencies might be switched to the medium frequencies.

To sum up then, the indication is that a maximum of 100 channels will increase the reverberation time of an auditorium at the lower frequencies by at least 100 per cent and at the medium frequencies by at least 60 per cent. Thus, a multi-purpose auditorium could start with a reverberation time of about 1.2 or 1.3 seconds — which is a little longer than used to be recommended for speech but which is now accepted, and the channel system used to bring the reverberation time at lower frequencies to about two and a half seconds and at medium frequencies to about 1.8 or 1.9 seconds, which should be adequate for music. ●

TIME CHECK FOR RADIOCARBON DATING.

Continued from page 22.

conclusion is that either can be used. But as the pine tree calibration is more detailed and covers a greater span of time it is used in preference to the Egyptian data.

SIGNIFICANCE OF RESULT

This result has great significance for archaeology. Our knowledge of European prehistory is being radically changed by radiocarbon dating so the greater confidence which should follow from Clark and Renfrew's work will be widely appreciated in scientific circles. Perhaps the most notable advance is that archaeologists are questioning the view that European culture originated in the ancient civilisations of the Near East, gradually fanned out through Europe and eventually reached the western coasts. This 'diffusion theory' arose long before scientific dating of individual finds became possible, and is founded on factors such as supposed similarities of style between tombs in western Europe and the Near East.

Carbon dating is causing a startling revision of these views. Megalithic structures in western Europe — for example, that remarkable and huge stone circle, Stonehenge, in England - are found to be older than structures in the Aegean which are supposed to have influenced them. By showing how the carbon-14 clock can be corrected Clark and Renfrew make these relationships much more distinct. On the 'diffusion' theory, megalithic tombs in western Europe are based on tombs built in Crete about 2500 BC which can be dated from Egyptian artifacts found with them. Yet the carbon-14 dates for the western tombs are 3000 to 3500 BC. Stonehenge was attributed to Aegean influences arriving in Britain around 1500 BC, but now it seems to have been built 500 years earlier.

Perhaps even more important, Clark and Renfrew greatly extend the potential of radiocarbon dating. Although strictly speaking their work applies only from 1800 to 3000 BC, it strongly suggests that the corrected method can be used to the limit of the Bristlecone pine tree data, 5000 BC approximately, with the possibility of going back a few thousand years earlier as even older pieces of wood turn up in California.

In principle the carbon-14 method, can date material as old as 50 000 years, but although an accurate calibration for the first 10 000 years is now within reach, there is still no way of knowing whether the method is accurate for the earlier period. ●

ELECTRONIC WINDOW CLEANER

How do you wash a glass roof, canted at 15º, too fragile to walk on, and several hundred square metres in area?

THE SYDNEY Opera House in Australia, despite some compromises in design and execution, has been acclaimed as one of the most incredible architectural achievements in the World.

As with most major projects of this type, innumerable problems arose during construction – and some extraordinarily ingenious techniques were devised for their solutions.

Typical of such problems was this: How do you wash the glass roof – canted as it is at the curious angle of 15º, too fragile for a man to walk on, and some hundreds of square metres in area?

Initially, it was planned to use a winch-operated buggy which would run up and down the roof on rubber tyres. However final stress analysis revealed that the glass roof was insufficiently strong to carry such a load.

Various other methods were considered before, finally , it was decided to use a small self-propelled cleaning vehicle, specifications of which were to be as follows:

All-up weight ∸ 43 kg
Brush span – 1 metre
Propulsion – pneumatic
Speed – 10 metres/minute.

Work commenced on the first prototype in September, 1972.

Problems soon mounted. The first of these was the bulk of the trailing hoses and control cables. In order to minimise the cost and complication, as well as the weight of these cables, radio control of the vehicle was considered. An Australian company, Silvertone Electronics, were called in to provide a suitable radio control link, and assist in the electrical installation of all the control solenoids and switches.

Work progressed swiftly and the actual site testing commenced in March 1973. From here on, problems compounded!

The wet, slippery glass roof, canted at even a moderate 15º, caused serious traction problems. The first vehicle was fitted with four large rubber tyred wheels, which slipped and slid all over the wet glass. One of the major causes of sliding was the weight of the water and air hoses, pulling the back wheels sideways, particularly when the vehicle was out in the middle of the roof with a long length of hose trailing. The use of radio control, by eliminating the need for control cables, reduced the magnitude of this problem.

The radio link worked well, considering the number of electronic devices in use on the Opera House site. No serious cases of interference were encountered, and the advantages of the use of radio control were demonstrated time and again, particularly in the freedom of movement of the operator.

The traction problem however, became more serious with each passing week. The little tractor was modified virtually daily, and at one time, the whole floor of the workshop was covered with wheels. Wheels with rubber tyres, plastic tyres, tyres with suction caps, slick tyres, rough tyres, skinny tyres and fat tyres. All to no avail. In desperation more wheels were added and finally even more weight. Nothing seemed to work. The sight of the 40 kg tractor sliding sideways out of control, heading for the harbour became a disconcerting, and all too familiar sight!

The successful solution came from the design engineer's son who pointed out that dragging a wet chamois cloth across a wet car was hard work . . .

The tractor was modified once more, and fitted with nylon caterpillar treads clad in chamois leather. The results were startling effective. Traction was excellent. Successful cleaning demonstrations resulted in an order for three tractors, (one for each roof and one spare) thus successfully completing a remarkably farsighted and difficult project.

The crawlers are powered by compressed air motors supplied by four separate compressors built onto the Opera House equipment bays. Outlets for air and water are available on the left and right wing of each foyer. The tractor cleans to the halfway point, and is moved across to the other wing to complete the last half of the roof.

Whilst the trailing hoses are a nuisance, weight and size considerations precluded a completely self- contained vehicle, however the final results achieved were more than satisfactory, despite the trailing cables. The prototype radio control link provided by Silvertone Electronics is basically a model aircraft control system especially modified to relay operation, in order to mate with the solenoid-operated air valves. The first unit now under development is a five channel pulse-position modulation system, controlling the four steering solenoids and a master failsafe solenoid. The latter is de-energised upon loss of radio contact or battery power to the receiver, thus placing the crawler into a failsafe mode.

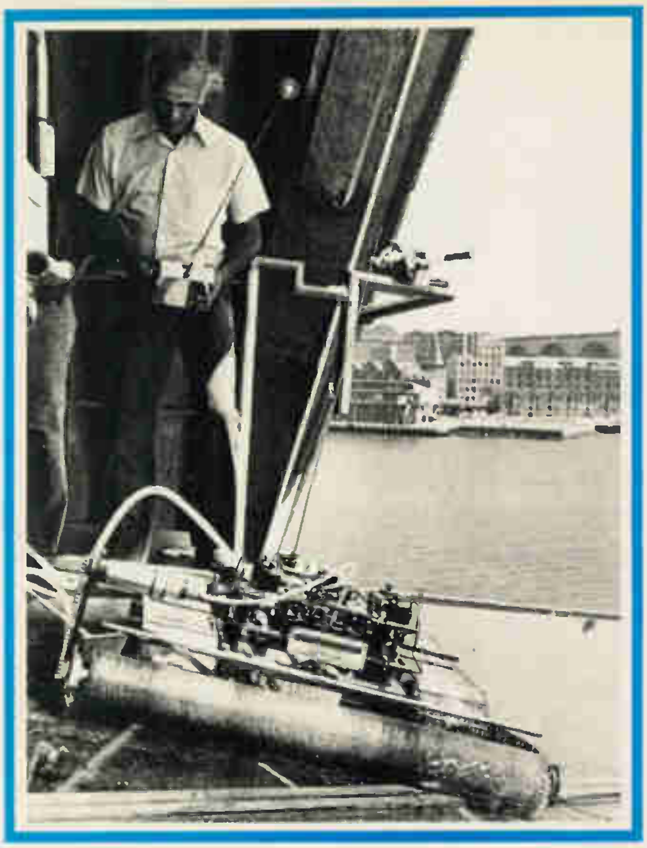
The prototype radio system operated on 26.960 MHz with 900 mW into the PA of the transmitter. No loss of control was evident, even when used on site with the 27 MHz paging system in operation.

Steering is achieved by the standard tracked vehicle method, of independent control over forward and reverse movement of each track.

The failsafe circuit simply shuts off the air supply to the main drive motors, thus preventing the vehicle from moving. The failsafe solenoid is held open by a missing pulse detector. Should the failsafe pulse disappear, or battery power be lost, the solenoid closes immediately. Forward speed is fixed at approximately 30 cm/second hence no speed control is required.

As anything up to three units may be used simultaneously, each transmitter is tuned to a different carrier frequency. A spacing of 15 kHz is adequate for safe operation, allowing up to 22 units operating simultaneously in the existing industrial control band, on any one site.

The use of P.P.M. results in a very flexible R/C link, capable of simultaneous, and independent control

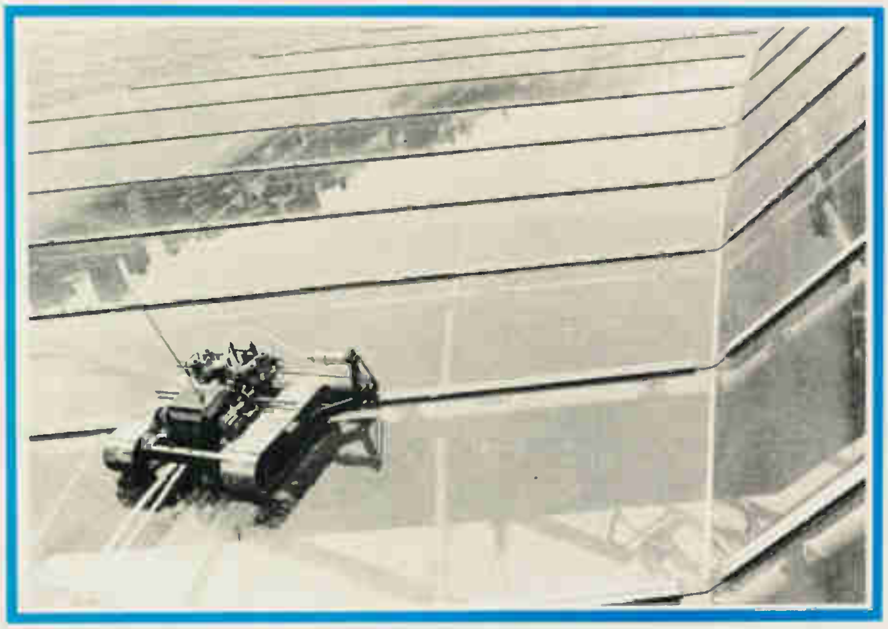


Here, the radio-controlled tractor is traversing one of the ribs used to support the massive glass sections.

of up to 50 separate command functions.

These may be either switched or proportional output type commands. The two types can also be mixed, resulting in a system, utilizing both switched and proportional output functions, however because the tractor moves very slowly, proportional control has not been used.

System resolution is better than ±½° for a typical closed loop feedback servo of approximately 8 kg static thrust. ●



The tractor is driven by compressed air motors controlled by pneumatic air valves via the radio link. A further air motor drives the cleaning roller – mounted on the front of the device.

BOOK REVIEWS

Reviewers: Brian Chapman, Andrew Pozniak

THYRISTOR CONTROL by F.F. Mazda. Published by Newnes-Butterworth 1973. Hard cover, 381 pages 215 x 135mm. Price £7.00.

Since its discovery in 1957, the thyristor has gained rapid acceptance by engineers as a device for the control of power and of motor speed. But in addition, a wealth of thyristor applications have been found in general electronics that considerable simplify the implementation of many useful, but previously too expensive devices.

In particular, the greater use of frequency converter, invertors, choppers and cycloconverters is directly attributable to the economic savings inherent in the use of thyristors to implement such equipment.

Most previous text books on thyristors have either been slanted towards the home experiment or towards the design engineer. Hence, as far as the student of electrical engineering is concerned, the former have been too basic, and the latter have incorporated mathematical treatments which tended to dismay rather than to illuminate.

This book has been written specifically with the degree or diploma student in mind. It assumes very little and discusses the entire subject in a clear and easily understood manner. Relevant mathematics are included, but these do not cloud the text as so often happens in the heavier works.

The whole gamut of thyristor applications is covered, including the newer electronics techniques mentioned earlier. Thus the book is not only suitable for students but should find acceptance by practising engineers. B.C.

THERMISTORS. By Professor F.J. Hyde, D.Sc., M.Sc., B.Sc. Published by Illife Books London 1971. Hard cover, 197 pages 215 x 135mm. Price £3.45p.

This is an elaborately researched book on thermistor devices. It is not a book for beginners, who would find it very heavy going indeed, nor does it purport to offer ready-designed circuits that can be extracted for a specific application.

It is a comprehensive text book that treats the subject in depth and from basic fundamentals. Mathematics is used extensively, including calculus and vector analysis, in developing design equations and in defining the behaviour of various devices.

In the sections dealing with practical applications, which comprise about half of the text, a very broad range of uses is covered, from the simple Wheatstone-bridge configuration thermometer, to the use of an indirectly-heated NTC thermistor as an ac/dc transfer standard. As elsewhere, design equations and behaviour parameters are given or developed from basic principles.

The long list of references to be found at the end of each chapter, and the comprehensive subject index, only enhance the impression of how thoroughly the late Professor Hyde had researched the subject.

This is a book that will find favour not only with students and engineers but also the research scientist involved with the detection, measurement or control of thermal parameters. A.P.

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We regret the offer only applies to the U.K. and Northern Ireland.

WHAT WILL IT DO?

The uncluttered keyboard of the Scientific may seem misleading. See the two keys in the picture with arrows pointing up and down? Using these give the keys on the right three functions each.

The instruction book supplied with the Scientific is detailed and clear and describes fully the method of useage and its only possible here to cover some of the facilities.

You can handle directly:

- Log_{10}, $Antilog_{10}$,
- Sine and Arcsine,
- Cosine and Arcosine,
- Tan and Arctan,
- Automatic Squaring,
- Automatic Doubling,
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- $\sqrt[y]{x}$ (any root)
- Addition, Subtraction,
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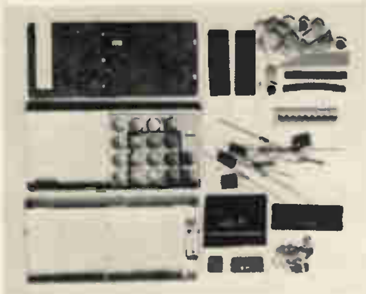
The marvellous facilities of the Scientific may lead you to believe that the kit will be a real challenge ... nothing of the sort; there are only about 25 components to solder and a really experienced constructor should take less than an hour. Only a soldering iron and wiresnips are needed.

Should you fail, there's the famous Sinclair guarantee and full back-up facilities.



[redacted]

What to look for in November's ETI

1 HEATHKIT COMPETITION
Solve our cross-number (like a cross word but with figures) and you could win for yourself one of the Heathkit range of products: there's a consolation even if you don't win — the latest Heathkit catalogue for every entrant!

2 READER OFFER—1
Forty 1N4001 silicon rectifiers: £1.00.
The 1N4001 (50V, 1A) is the sort of component you are always needing. Next month you can get them for the equivalent of 2.5p each — about one third of the usual price!

5 NEW SERIES: POCKET-MONEY PROJECT
In June's questionnaire many of you asked for more inexpensive, straight-forward projects. This new series is the result and the approach taken has been carefully thought out and is refreshingly new.

6 ELECTRONICS IN KNITTING
Sounds dull? Not a bit of it. Today computers are being used in conjunction with knitting machines to produce the complex patterns demanded by current fashion.

[redacted]R I.C. TESTER
[redacted]of the popular linear I.C.'s can be tested on [redacted]oject including types 301, 307, 308, 709, 741, [redacted]7 and 1456.

[redacted]IMER PROJECT
[redacted]m using 555's which can be set to give an [redacted] alarm for any time in the range ½ — 3½ [redacted]. Ideal for photographic printing, timing [redacted]ne calls or even as an egg-timer.

[redacted]ctronics

INTERNATIONAL

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If you have no trouble obtaining ETI from your newsagent, that's the obvious place to get it. However five out of the last six issues have been sell-outs and early analysis of the reader questionnaire has shown that one in three readers has trouble in buying ETI.

If you are one of those having trouble, why not take out a subscription? Normally you receive your copy a few days before our official publication. Note also that although the cover price of ETI is now 25p, we have not raised our subscription rates for the time being.

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eti product test

ADVANCE OS240 OSCILLOSCOPE

THE ADVANCE OS240 is one of two new low cost oscilloscopes designed for general use in laboratories, audio, radio and television production and servicing etc. and is also suitable for educational purposes. The OS240 is a dual trace instrument whereas the OS140, similar in appearance and function, is a single trace model. Each of these oscilloscopes has a 10MHz bandwidth and maximum input sensitivities of 5mV per division of the screen graticule.

Timebase speeds are from 1μSec to a little over 0.1 sec per division. The graticule over the screen has 8 x 10 divisions of 0.8cm each. Aside from its dual trace facility, the OS240 has an X - Y mode using the Y1 channel for X deflection and the Y2 channel for Y deflection, otherwise the performance of both models is identical.

These 'scopes are compact and very lightweight and therefore ideal for engineers who have to carry their test gear about.

FEATURES AND FACILITIES

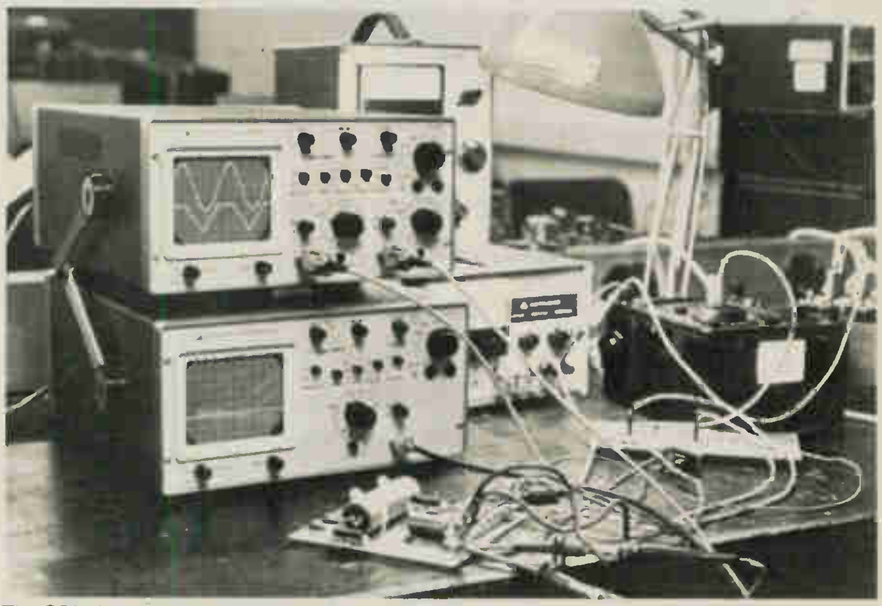
The c.r.t. screen is 4 inches in diameter but the escutcheon provides an 8 x 6.4cm viewing area with the graticule divisions already mentioned. The tube is a short persistence type and as the graticule is tinted (blue) the trace also appears as blue. A long persistence tube is available to order.

AMPLIFIERS

There are two main signal inputs, each taken through identical wideband amplifiers, Y1 and Y2, to which the input signals may be a.c. or d.c. coupled. Each amplifier responds to d.c. inputs and provides trace deflection accordingly. Input signals can be grounded by the input selector switch to enable trace reference to be set with the vertical shift controls. Input sensitivity is switch selected in steps from 5mV per graticule division (0.8cm) through to 20V per division, the sequence being 5, 10, 20mV and so on.

BEAM SWITCHING

Dual trace operation is achieved by beam switching in chopped or alternate trace modes which are selected automatically by the timebase switch.



The OS240 shown above with the single trace OS140 shown below.

At timebase speeds of 1mS per division, or slower, the chopped mode is used at approximately 150kHz. For 0.1mS per division, or faster, the trace is displayed alternately. Either trace can be independently shifted up or down or off the screen and operation can be reverted to single trace only with signals from the Y1 inputs. There is also provision for an X - Y mode display for Lissajou patterns etc., for which both amplifiers are brought into operation as described previously i.e., Y1 for X deflection and Y2 for Y deflection.

TIMEBASE RANGES

Timebase ranges cover from 1μSec to 0.1 sec per division in six decade switched ranges but there is a variable control providing a 10:1 reduction in selected sweep speed. A feature of the timebase circuitry is 'X' expansion times 2 or 5 which provides intermediate steps between ranges and allows close examination of any portion of the expanded timebase by using the X shift control. The timebase may be triggered from Y1 or Y2 inputs, or from external synchroniz-

ADVANCE OS240 PERFORMANCE SPECIFICATION

DISPLAY
4" flat faced c.r.t. with 8 x 10 division graticule, each division 0.8cm. EHT 1.5kV. Phosphor - P31, Long Persistence (P7) available as an option.

VERTICAL DEFLECTION
Two identical input channels, Y1 and Y2.
Bandwidth (—3db) d.c. — 10MHz.
Sensitivity 5mV/cm to 20V/cm in 1-2-5 sequence.
Accuracy ±5%
Input Impedance 1MΩ/approx. 28pF
Input coupling DC-GND-AC.
Protection 400V d.c. or pk a.c.

DISPLAY MODES
Single trace — Y1
Dual trace — Chopped or alternate modes automatically selected on timebase switch. 1ms/div and slower - chopped at approx. 250kHz 0.1ms/div and faster - alternate.
X - Y Mode with Y1 input giving X deflection Y2 input giving Y deflection. Bandwidth d.c. to 500kHz. <3° phase shift at 20kHz.

HORIZONTAL DEFLECTION
Timebase Ranges 1μs per division to 0.1s per division in six decade ranges.
Uncalibrated variable control give >10:1 reduction in sweep speed.
Accuracy ±5%
X Expansion X2 and X5 expansions give intermediate steps between ranges and a fastest speed of 200ns per division.
Accuracy ±5%

TRIGGER
Variable level control with option of bright line in absence of input.
Source Y1, Y2 or External.
Slope + or —
Coupling AC, AC fast, TV frame.
Sensitivity Internal <0.3 division 40Hz-2MHz approx. 1 division 8Hz-10MHz.
External <1.5V 40Hz-2MHz approx. 5V 8Hz-10MHz. External input impedance 100kΩ <10pF.

ADDITIONAL FACILITIES
Gate Output +20V Approx from 15kΩ
Z mod input a.c. coupled. Bandwidth 2Hz-10MHz 10V gives visible modulation.

SUPPLY
115V, 220V, 240V ±10% a.c. 45-440Hz.

DIMENSIONS
132x270x317mm (5¼"x10¾"x12½")

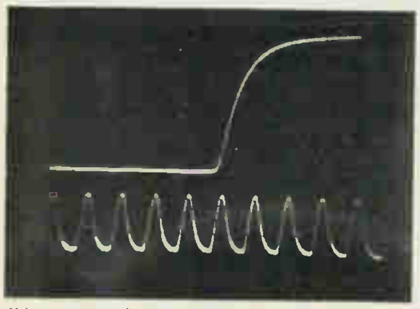
WEIGHT 5kg (11lbs) approx.

OPTIONAL ACCESSORIES
Probe Kit PB11. A passive probe kit with X1 and X10 attenuations. With X10 attenuation the input impedance is 10MΩ/13.5pf.

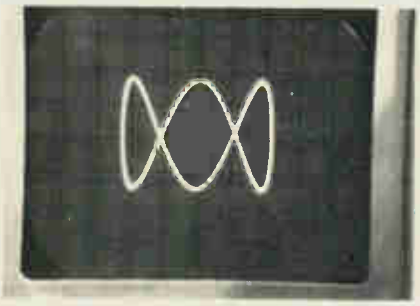
PRICE UK: OS240 £125.00 plus VAT. OS140 £115.00 plus VAT

Further Details: Advance Electronics Ltd., Roebuck Road, Hainalt, Essex.

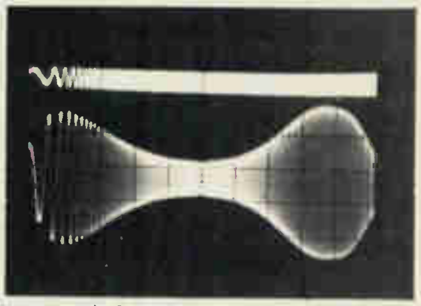
SUMMARY: Advance Electronics Limited have a long standing good reputation for top performance test equipment and with this oscilloscope has certainly met the need for an inexpensive yet versatile and remarkably accurate instrument.



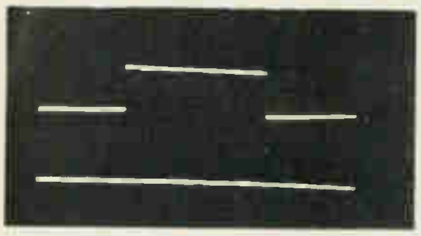
(Upper trace). Step waveform at approximately 0.3µS. (Lower trace). Waveform at 10MHz.



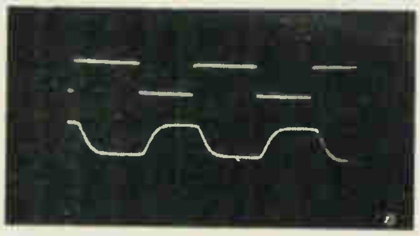
Three to one Lissajous pattern using the X-Y mode inputs and display. The 0.8cm/division graticule can be seen in this photo.



(Upper trace). Output from an audio frequency sweep generator L to R, 10 to 100Hz 0.1dB. (lower trace) Output from amplifier under test with bass and treble controls at maximum.



Square-wave at 15Hz via Y1 d.c. input (lower trace not used).



(Upper trace) 10,000Hz square-wave from generator. (Lower trace). Output from amplifier under test.

ing signals and from either the positive or negative going portion of any signal. However there is a panel switch marked 'Bright Line' that operates in conjunction with the triggering circuitry and which has two positions, ON and OFF. In the 'off' position the timebase will only trigger when the input signal passes through a predetermined level (set by the trigger level control). If there is insufficient trigger signal the timebase will not run. The bright line 'ON' condition gives identical performance when the trace is locked but when the trigger is set outside the range of the input signal the timebase free runs, thus giving a continuous trace under all conditions. The trigger input has coupling 'a.c.' signals (wide band mode for most signals), 'A.C. Fast' (includes a filter to reject unwanted low frequencies) and 'TVF' (includes a filter to reject high frequencies but the cut-off is chosen so that frame sync of a (TV) video waveform is accepted but the line frequency components are rejected.

EXTRA FACILITIES

On the rear panel is an a.c. coupled input for 'Z modulation' i.e., for brilliance modulation of the trace and there is also a 'gate' output (front panel) which provides a positive going square-wave of approximately 20V with repetition frequency dependent on the setting of the timebase switch. Provision has also been made for the use of a passive probe with very high input impedance (10Mohm) with 10:1 reduction in sensitivity. This is available as an optional extra, type PB11 at approximately £8.00. Connecting leads with plugs are provided and also a very comprehensive 26 page instruction and maintenance handbook complete with circuit diagrams and parts list. The carrying handle (supplied) folds under so that the 'scope can be set at a comfortable viewing angle on the bench.

PERFORMANCE

The OS240 supplied for review was checked throughout for performance generally in accordance with that specified and considerable attention was paid to its flexibility in use. It is not intended as a *precision* laboratory instrument but rather as a general purpose oscilloscope with an otherwise high grade performance, in fact a performance quite remarkable for the relatively low price.

Construction has been greatly simplified by the use of three main circuit boards, each connected by multi-pin plugs and sockets mounted directly on the boards so obviating the use of cable forms. The only wiring is that used between the mains transformer and the main circuit board and to the c.r.t., which incidentally is fully screened against magnetic fields.

A few practical applications possible with the OS240 are shown by the oscillograms above. These were taken with a Polaroid camera and these give some idea of the versatility varying from frequency comparison by the Lissajous pattern method to examination of fast step or pulse waveforms and even audio sweep frequency tests with an appropriate generator.

Performance parameters proved to be in accordance with those specified and no deviations of any consequence could be found. Drift on trace position (Y axis) was negligible after reasonable warm up time and triggering in the various modes found to be quite positive. The trace brilliance is good, even in strong light, with focus on dual or single trace displays quite sharp and there was virtually no astigmatism at full display amplitude or at any timebase speed, including expanded timebase. No hum (50Hz) modulation or deflection on traces could be detected with the Y amplifiers at full gain and the inputs grounded.

The OS240 would certainly fulfil all normal requirements for television, audio, radio and general electronics applications, particularly in servicing and production testing and it is doubtful whether improvement of any kind could be made without adding to the price. ●

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Model No.		Price
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UK145	Amplifier 1·5W	£ 4.37
UK220	Signal Injector	£ 3.13
UK230	AM/FM Antenna Amplifier	£ 3.88
UK275	Mike Pre-amplifier	£ 8.03
UK300	4-channel Radio Control Transmitter	£ 7.85
UK310	Radio Control Receiver	£ 3.93
UK325	'GCX2' Channel splitting unit 1,000 & 2,000 Hz	£ 9.44
UK330	'GCX2' Channel splitting unit 1,500 & 2,500 Hz	£ 9.44
UK000	Superhetrodyne Radio Control Receiver	£ 7.85
UK525	VHF Tuner 120 to 160 MHz	£14.93
UK555	Radio Control Field Strength Meter	£12.74
UK705	Windscreen Wiper timer	£ 8.98
UK710	4-Channel AF mixer	£14.68
UK780	Electronic Unit for Metal Detector	£12.74
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7401	0·18	0·17	0·16	7450	0·18	0·17	0·16	74123	£3·00	£2·90	£2·80
7402	0·18	0·17	0·16	7451	0·18	0·17	0·16	74141	0·85	0·82	0·79
7403	0·18	0·17	0·16	7453	0·18	0·17	0·16	74145	£1·65	£1·55	£1·45
7404	0·18	0·17	0·16	7454	0·18	0·17	0·16	74150	£2·90	£2·80	£2·70
7405	0·18	0·17	0·16	7460	0·18	0·17	0·16	74151	£1·10	£1·05	£1·00
7406	0·39	0·34	0·31	7470	0·32	0·29	0·27	74153	£1·30	£1·20	£1·10
7407	0·39	0·34	0·31	7472	0·32	0·29	0·27	74154	£1·98	£1·90	£1·75
7408	0·20	0·19	0·18	7473	0·41	0·39	0·35	74155	£1·50	£1·45	£1·35
7409	0·20	0·19	0·18	7474	0·41	0·39	0·35	74156	£1·50	£1·45	£1·35
7410	0·18	0·17	0·16	7475	0·50	0·48	0·46	74157	£2·00	£1·90	£1·80
7411	0·28	0·27	0·26	7476	0·44	0·43	0·42	74160	£2·10	£2·00	£1·90
7412	0·39	0·34	0·31	7480	0·74	0·71	0·64	74161	£2·10	£2·00	£1·90
7413	0·32	0·31	0·30	7481	£1·30	£1·25	£1·20	74162	£4·40	£4·15	£3·85
7416	0·48	0·44	0·42	7482	0·96	0·95	0·94	74163	£4·40	£4·15	£3·85
7417	0·48	0·44	0·42	7483	£1·20	£1·15	£1·05	74164	£2·20	£2·10	£2·00
7420	0·18	0·17	0·16	7484	£1·10	£1·05	£1·00	74165	£2·20	£2·10	£2·00
7422	0·55	0·53	0·50	7485	£3·50	£3·40	£3·30	74166	£3·20	£3·10	£3·00
7423	0·55	0·53	0·50	7486	0·35	0·34	0·33	74174	£2·50	£2·40	£2·30
7425	0·55	0·53	0·50	7489	£4·00	£3·75	£3·50	74175	£1·75	£1·65	£1·55
7426	0·50	0·46	0·44	7490	0·74	0·71	0·64	74176	£1·85	£1·75	£1·65
7427	0·50	0·46	0·44	7491	£1·10	£1·05	£1·00	74177	£1·85	£1·75	£1·65
7428	0·55	0·53	0·50	7492	0·74	0·71	0·64	74180	£1·50	£1·40	£1·30
7430	0·18	0·17	0·16	7493	0·74	0·71	0·64	74181	£5·00	£4·50	£4·00
7432	0·50	0·46	0·44	7494	0·85	0·82	0·75	74182	£2·00	£1·90	£1·75
7433	0·75	0·73	0·70	7495	0·85	0·82	0·75	74184	£3·20	£3·10	£3·00
7437	0·70	0·68	0·65	7496	0·96	0·93	0·86	74190	£2·15	£2·10	£2·00
7438	0·70	0·68	0·65	74100	£1·50	£1·45	£1·40	74191	£2·15	£2·10	£2·00
7440	0·18	0·17	0·16	74104	£1·07	£1·04	£1·00	74192	£2·15	£2·10	£2·00
7441	0·74	0·71	0·64	74105	£1·07	£1·04	£1·00	74193	£2·15	£2·10	£2·00
7442	0·74	0·71	0·64	74107	0·44	0·42	0·40	74194	£2·98	£2·86	£2·75
7443	£1·20	£1·15	£1·10	74110	0·60	0·55	0·50	74195	£2·00	£1·95	£1·90
7444	£1·20	£1·15	£1·10	74111	£1·38	£1·27	£1·21	74196	£1·95	£1·90	£1·85
7445	£1·98	£1·95	£1·90	74118	£1·10	£1·05	£1·00	74197	£1·95	£1·90	£1·85
7446	£1·20	£1·15	£1·10	74119	£1·50	£1·40	£1·30	74198	£5·00	£4·75	£4·50
7447	£1·10	£1·07	£1·05	74121	0·50	0·48	0·45	74199	£5·00	£4·75	£4·50

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- Distortion better than 1% at 1KHz
- Supply voltage 10–35 volts
- Thermal Feedback
- Latest Design Improvements
- Load – 3, 4, 8 or 16 ohms
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- Overall size 63mm x 105mm x 13mm

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

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STABILISED POWER MODULE SPM80 £3·25

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 63 mm x 105 mm x 20 mm. These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom Units, etc. Handbook available, 10p.

TRANSFORMER BMT80 £2·15 p. & p. 25p

INTEGRATED CIRCUIT PAKS

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

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00=12±7400	0·55	UIC46=5x7446	0·55	UIC90=5x7490	0·55
UIC01=12x7401	0·55	UIC48=5x7448	0·55	UIC91=5x7491	0·55
UIC02=12x7402	0·55	UIC50=12x7450	0·55	UIC92=5x7492	0·55
UIC03=12x7403	0·55	UI351=12x7451	0·55	UIC93=5x7493	0·55
UIC04=12x7404	0·55	UIC53=12x7453	0·55	UIC94=5x7494	0·55
UIC05=12x7405	0·55	UIC54=12x7454	0·55	UIC95=5x7495	0·55
UIC06=8x7406	0·55	UIC60=12x7460	0·55	UIC96=5x7496	0·55
UIC07=8x7407	0·55	UIC70=8x7470	0·55	UIC100=5x74100	0·55
UIC10=12x7410	0·55	UIC72=8x7472	0·55	UIC121=5x74121	0·55
UIC20=12x7420	0·55	UIC73=8x7473	0·55	UIC141=5x74141	0·55
UIC30=12x7430	0·55	UIC74=8x7474	0·55	UIC151=5x74151	0·55
UIC40=12x7440	0·55	UIC76=8x7476	0·55	UIC154=5x74154	0·55
UIC41=5x7441	0·55	UIC80=5x7480	0·55	UIC193=5x74193	0·55
UIC42=5x7442	0·55	UIC81=5x7481	0·55	UIC199=5x74199	0·55
UIC43=5x7443	0·55	UIC82=5x7482	0·55		
UIC44=5x7444	0·55	UIC83=5x7483	0·55	UICXI=25 Assorted 74's	1·55
UIC45=5x7445	0·55	UIC86=5x7486	0·55		

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

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION:

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

All input voltages are for an output of 250mV.
Tape and P.U. inputs equalised to RIAA curve within ±1dB from 20Hz to 20kHz.

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

only £13·15

LINEAR I.C's—FULL SPEC.

Type No.	Case		1	25	100+
72702	DIL	14	0.50	0.48	0.45
72709	DIL	14	0.35	0.33	0.30
72710	DIL	14	0.45	0.43	0.40
72741	DIL	14	0.40	0.38	0.35
72741C	TO-5	8	0.45	0.43	0.40
72741P	DIL	8	0.38	0.36	0.34
72748P	DIL	8	0.38	0.36	0.34
SL201C	TO-5	8	0.50	0.45	0.40
SL701C	TO-5	8	0.50	0.45	0.40
SL702C	TO-5	8	0.50	0.45	0.40
TAA263	TO-72	4	0.80	0.70	0.60
TAA293	TO-74	10	£1.00	0.95	0.90
TAA350A	TO-5	10	£1.85	£1.80	£1.70
µA703C	TO-5	6	0.28	0.26	0.24
µA709C	TO-5	8	0.35	0.33	0.30
µA711	TO-5	10	0.45	0.43	0.40
ZN414	TO-18	4	1.70		

DTL 930 SERIES LOGIC I.C's

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

DUAL IN LINE SOCKETS.

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

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

3 TERMINAL POSITIVE VOLTAGE REGULATORS

To3 Plastic Encapsulation O.P 1.5 Amps

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

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NUMERICAL INDICATOR TUBES

Type	Description	
9015E	Minitron 7 Segment Indicator	£1.50
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90
CD66	Side Viewing Nixie Type Tube 16 mm	£1.87
GR116	Side Viewing Nixie Type Tube 13 mm	£1.70

AL10/AL20/AL30 AUDIO AMPLIFIER MODULES

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

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

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

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

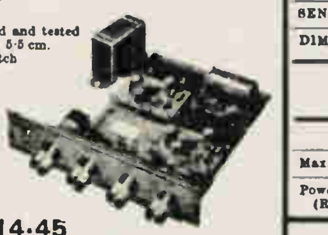
TEAK VENEERED CABINETS for:

STEREO, 20
TC 20. £3·95 p&p 30p.

MK 50 KIT
TC 100. £6·50 p&p 40p.

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

The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 60Hz typically 0·25% at 1 watt. Treble con. ±14dB at 14kHz.

£14·45

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

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·98 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

POWER SUPPLIES

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

PA 12. PRE-AMPLIFIER SPECIFICATION

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

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

FRONT PANEL FP12 with knobs £1·20.

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HEATHKIT'S DIGITAL FM TUNER

UNTIL RECENTLY it was the normal practice for state-of-the-art products to appear first from small, specialised companies at a premium price to be followed by the large manufacturers. Only after several years would the product become available as a kit for the enthusiast market.

The Heathkit AJ-1510 Digital FM Tuner has broken these rules: it incorporates so many 'firsts' that it goes right to the top of the list as far as sophistication is concerned and yet is available first as a kit from a large company.

FACILITIES

The various functions of the AJ-1510 can be best described in conjunction with the photograph of the front panel.

Firstly there is no conventional tuning scale: the frequency selected is displayed digitally. There are three methods of selecting a station.

1. Using the keyboard (shown below the readout) you can select the frequency of the station you require. This will be three figures (e.g. 9–3–5 for 93.5 MHz) in the U.K. as our FM band does not yet extend beyond 100MHz. (Tuning range is 88.1–107.9MHz). You get the station whose frequency you have selected and 93.5MHz lights up.

Inserting one of preprogrammed cards into its holder. This one represents 97.3MHz.

2. The tuner can be set for 'Auto-Sweep'. When this button is pressed, the readout starts at 107.9MHz and counts down: 107.7, 107.5 etc., and stops automatically on any station with a signal strength above a predetermined level. Stereo only stations can be selected in this mode. If you don't want the station you press a 'By-Pass' button and the count-down continues to the next station. When 88.1 is reached the readout switches to 107.9MHz and starts again.
3. The three central push-buttons on the dial are used to select one on three pre-programmed stations. *Not* by altering the varicap tuning diode's applied voltage as is usual but by going right back to the keyboard circuitry. A number of plastic cards are supplied (similar to a credit-card) which are cut for the frequency required. Up to three can be loaded into card-holders and selected.

CIRCUIT OPERATION

The use of digital tuning and frequency synthesiser together with the other techniques we will mention mean that the circuitry is extremely complex – more so than a colour TV set! There are over 50 I.C's – many of them multiple packages – plus about 50 discrete transistors.

The circuit operation is best understood by considering the unit in two sections: the "conventional" tuner part and the digital circuitry.

To refer to the tuner section as conventional is not strictly correct as it uses truly up-to-date techniques. To those who are familiar with modern FM tuner circuitry, many of the techniques will be known but they are rarely all found together.

The FM front end is a preassembled, prealigned unit which requires marginal 'tweaking' by the constructor. FET's are used for high sensitivity and for low cross-modulation. Tuning is by means of varicaps – now being well established. It is the control voltage applied to these that alters the tuning.

The i.f. requires no alignment – such tuned circuits as there are, are sealed units. Similarly the detector used has no conventional tuned circuits: it is a digital frequency discriminator which counts the pulses.

The stereo decoder is a Phase Locked Loop – the only adjustment required for this being a preset potentiometer.

DIGITAL CIRCUITRY

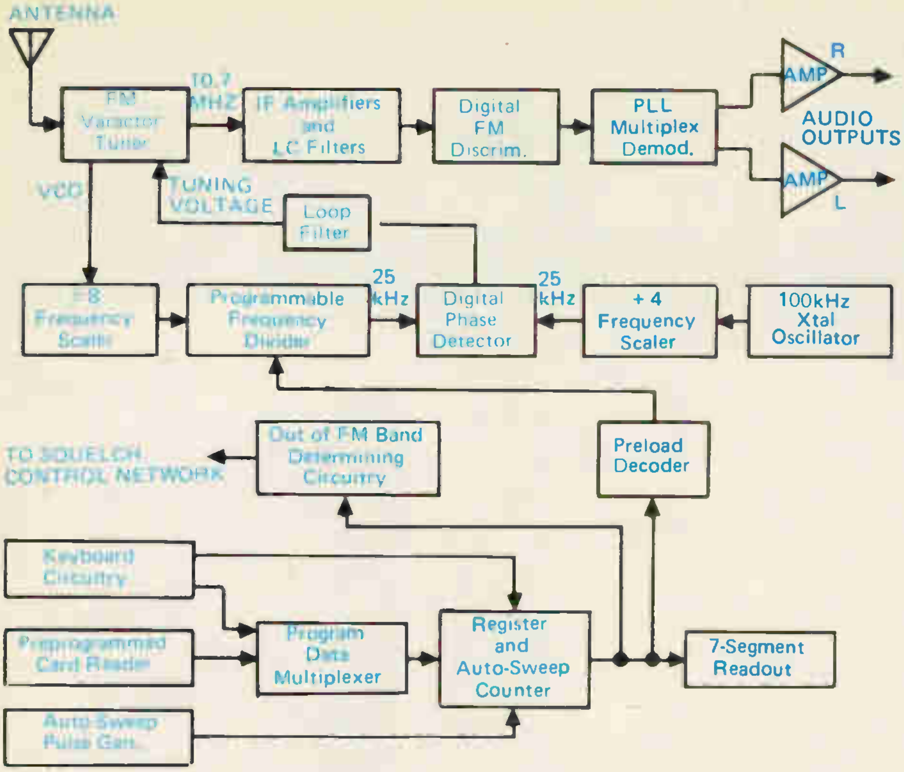
The reference oscillator is a 100kHz crystal which is fed to a divide-by-four circuit giving 25kHz. This frequency is highly stable at ±0.005%. This frequency is used as a reference for the digital phase detector.

Going back to the 'front-end', part of the oscillator signal (which is the received frequency plus 10.7MHz, thus for 93.5MHz this equals 104.2 MHz) is connected via a buffer to a divide-by-eight circuit which in turn is fed to a programmable frequency divider. This circuit is controlled by the programming circuitry to divide between 494 and 593, always giving a 25kHz output which is fed to the other input of the digital phase detector. If there is any frequency difference a voltage is produced which, by being applied to the varicap tuning section, tunes the receiver.

PROGRAMMING SECTION

The various methods of programming described earlier have to be selected and converted into a form suitable for the programmable divider: that's just a simple explanation of what most of the remaining circuitry fulfils.

The AJ-1510 is an American originated kit and has been designed for U.S. conditions and systems. The tuning range goes up to the 107.9MHz point, much higher than necessary, but it will not tune below 88.1MHz (the European FM Band starts at



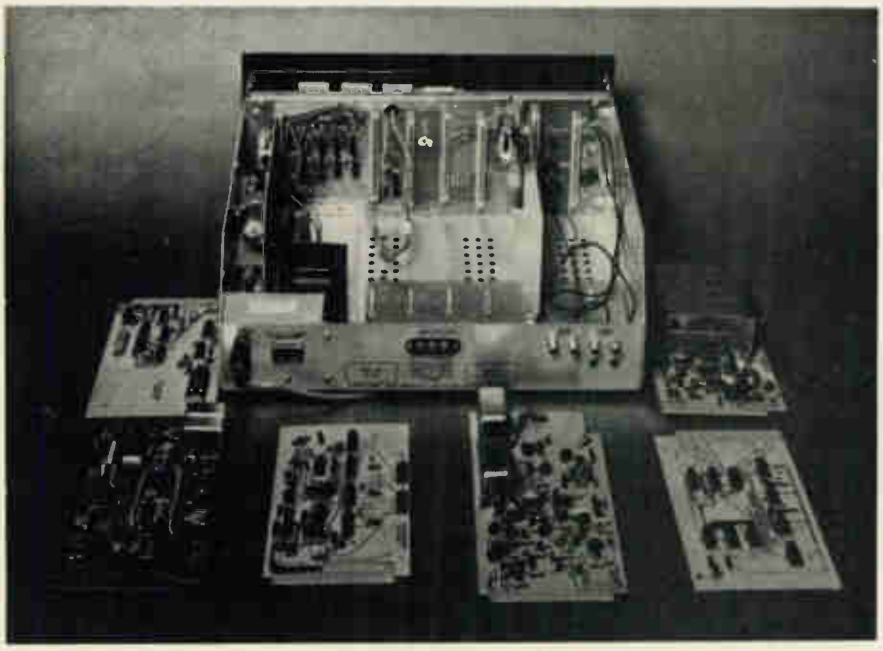
Block diagram (greatly simplified) of the circuit.

87.5MHz). This is no problem as we have no stations in the U.K. below 88.1.

The de-emphasis of the signal is for 75µS, not our 50µS, but when we asked Heathkit about this, they supplied us with two new resistors to get it right.

The major difference is that in the U.K. we have stations on the even frequencies (e.g. 91.6, 93.4) as well as on the odd frequencies used in the U.S. A modification kit *is* supplied but it is very much of a compromise and operates by capacitively loading the reference oscillator slightly, allowing odd frequency stations to be received. However the readout will be incorrect and the preprogrammed cards will have to be made up for a different frequency.

The Auto-Sweep is highly justified in the U.S.A. where in many areas there are over 50 stations within reasonable distance. About the maximum number in the U.K. is seven and this far smaller choice means that we all know the likely programmes of each station. However for the small band of FM DXers this facility is perfect. You can arrange for the Autosweep to pick-up stations above any predetermined strength and you can note their frequency immediately (as long as they are on odd channels!).



Rear view of the tuner with six of the circuit boards removed.

The completed kit with the cover removed.

BUILDING THE KIT

At first sight the kit is formidable. The instruction book alone comprises over 200 pages plus numerous fold-outs. Much of this however is a fault-finding section and circuit explanations.

The majority of the components are on computer-style plug-in boards or behind the front panel. A typical building time is not given: we took 20 hours before we got to the check-out stage, the only other person we know who has tackled the kit in this country took about 35 hours all-in.

We did have trouble - two I.C.'s supplied were duds - and the time it took to locate them was enormous. In fairness to Heathkit we have never come across, or heard of such a thing before with their kits, annoying though this was.

The tuning meter doubles as a 3-range testmeter measuring l5V, 50V and Ohms for checking out the circuit as you progress.

PERFORMANCE

We have not yet carried out objective tests but the specification indicates that most test equipment would be stretched to its limits to record such factors as distortion.

Subjectively the performance is superb - by far the best FM we have heard. This even applies using a dangled bit of wire for an aerial. We don't recommend using a tuner of this quality without a good aerial, only that we found it remarkably tolerant to say the least.

The Heathkit AJ-150 is a remarkable design, providing facilities second-to-none but it is not cheap at £300 for the kit and we did not like the 'even-frequency-stations' compromise bearing in mind the price. However, for those who want perhaps the ultimate FM tuner in kit form, the AJ-150 must leave the rest standing. ●

etī product test

GOODMANS' GOODWOOD MONITOR LOUDSPEAKER

GOODMANS' have, over many years, produced some of Britain's finest loudspeaker systems and the company pioneered many types of high-efficiency high-quality loudspeakers.

Fairly recently Goodmans were taken over by Thorn Industries and the Goodwood speaker system is the first new product, that we have had the pleasure of testing, which has been designed and produced by the new company.

The concept of this speaker has been based on the premise that listeners seek above average quality with minimum distortion and colouration but achieved with a price structure below that of true studio monitoring systems.

In appearance, the Goodwood system can best be described as of conservative British design. The enclosure is fabricated from veneered particle board approximately 1.5 cms thick, excepting the top and bottom panels which are made of a heavier board.

The method of fixing the front speaker grill is quite conventional, using four Velcro type fasteners. The grill cloth is a mixture of artificial fibres and wool. It has low flow resistance and an attractive appearance. The enclosure is approximately 46 litres (2.5 cf.) in volume and in theory should be able to provide a good frequency response over the major part of the audible spectrum.

Although conventional in appearance, the enclosures, do in fact have several unusual features. Firstly the woofer looks quite unlike any other Goodmans' woofer we have ever seen. It is 30 cms (12") high but only 26 cms (10") across. It should probably be best described as a 25 cm diameter loudspeaker.

Goodmans claim that this driver has been specifically developed to provide high power handling capacity.

Their approach to reducing harmonic distortion, which is generally frequency doubling or cone break up at low frequencies, has been to optimise the geometry of the flux distribution in the magnetic circuit. The woofer has a 3.6 cm diameter voice coil, and has a ceramic magnet clamped between steel pole pieces which are themselves fitted to a heavy and rather unusual die-cast housing. By making use of a heavy fibrous cone (which provides internal damping and dissipation of energy) together with a plastic coated diaphragm which is extended to provide an integral flexible surround, the manufacturers state that they significantly reduced unwanted resonances.

Goodmans have patented this design and, based on our measurements, have achieved what they claim.

The mid-range driver, which covers the range from 600 Hz to 4 kHz is a 10 cm cone type direct radiator. This speaker also uses a high-flux ceramic magnet and a rather unconventional rigid die-cast chassis. It bears a strong similarity to the woofer and also features a composite cone of plasticised polymer and conventional fibre cone to achieve excellent damping characteristics.

Goodmans claim that the wide angle of radiation of this speaker gives smooth power transfer over the operating range. Our measurements certainly confirm this.

The mid-range unit is located within its own separate enclosure. This has an internal volume of 3.7 litres and is lined with polyurethane foam.

The tweeter is a dome type radiator (2.5 cm diameter) which is moulded from synthetic fabric with a homogenous plastic coating. Again, it bears a very strong resemblance to the other two speakers. The dome tweeter is the only speaker of the three to bear a type number (DT3) and features a construction technique which is far less expensive than similar speakers Goodmans have produced in the past.

All three speakers are sealed into the enclosure with urethane foam strips, and internal damping is achieved by large blocks of 8 cm thick urethane foam. The speaker connections are unusual terminals at the bottom of the enclosure. These consist of a pair of screw terminals which flank a DIN type speaker socket, and the unit comes equipped with a seven metre long colour coded lead with a DIN plug at one end and a pair of spade lugs at the other.

The cross-over network is screwed

GOODMANS GOODWOOD DOMESTIC MONITOR SPEAKER

Frequency Response	± 8dB	35Hz—20kHz
Total Harmonic Distortion (for 90dB at 2 metres on axis)	100Hz	0.6%
	1kHz	0.2%
	6.3kHz	0.3%
Electro-Acoustic Efficiency (for 90dB at 2 metres on axis)	9W	
Measured Impedance	100Hz	5Ω
	1kHz	7Ω
	6.3kHz	8Ω
Cross-over Frequency	600Hz and 4000Hz	
Dimensions	76 x 36 x 27cm	
Weight	18.3kg	
Recommended Retail Price £60.50 + VAT.		

SUMMARY: Our overall subjective impressions of the Goodwood speakers are that they offer a very smooth response and clear uncoloured sound, but the bass end is not as good as we would expect from what is most probably the premium quality speaker system marketed by Goodmans.

The Goodwood speaker system is for purists who will primarily be listening to classical music, but will not really suit the man who wants to play heavy rock or some of the more modern styles of music.

into the back of the cabinet. It consists of four inductors and five capacitors connected as a three-way pye filter which proved to work quite well.

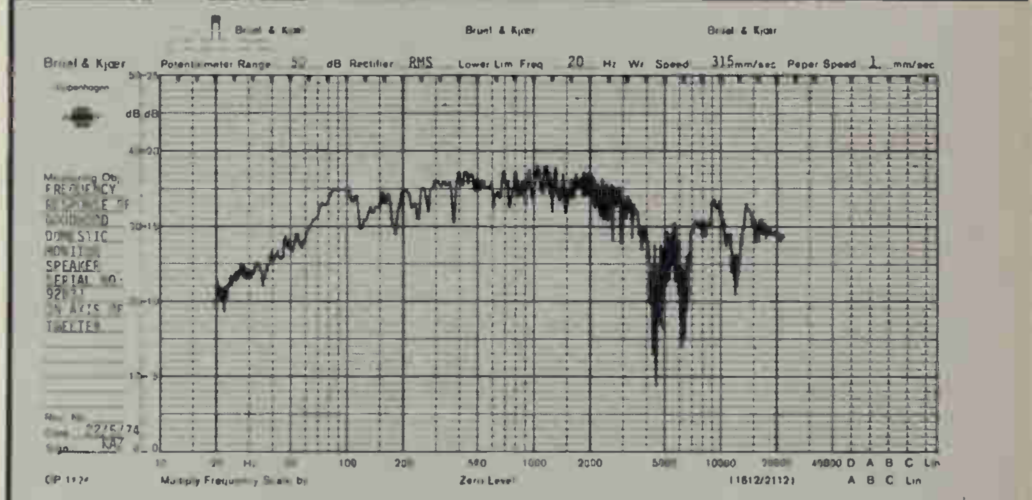
MEASURED PERFORMANCE

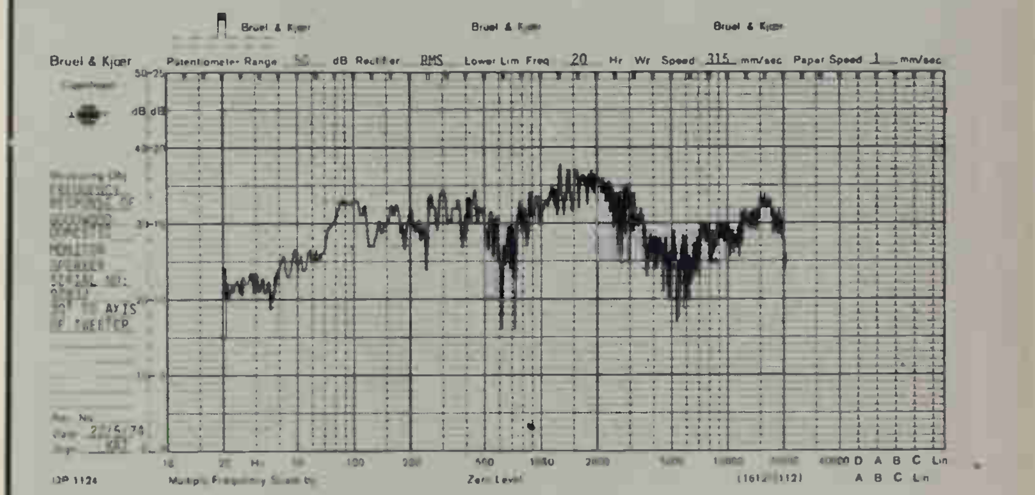
Our first test was to measure the frequency response on axis, and at 30° to axis, under anechoic conditions. The frequency response by and large (if one is prepared to ignore the predominant dips in the region of 4.5 to 6 kHz), was smooth, being ± 8 dB from 35 Hz to 20 kHz. Surprisingly, the frequency response at 30° off the main axis had fewer dips in the response than directly on axis.

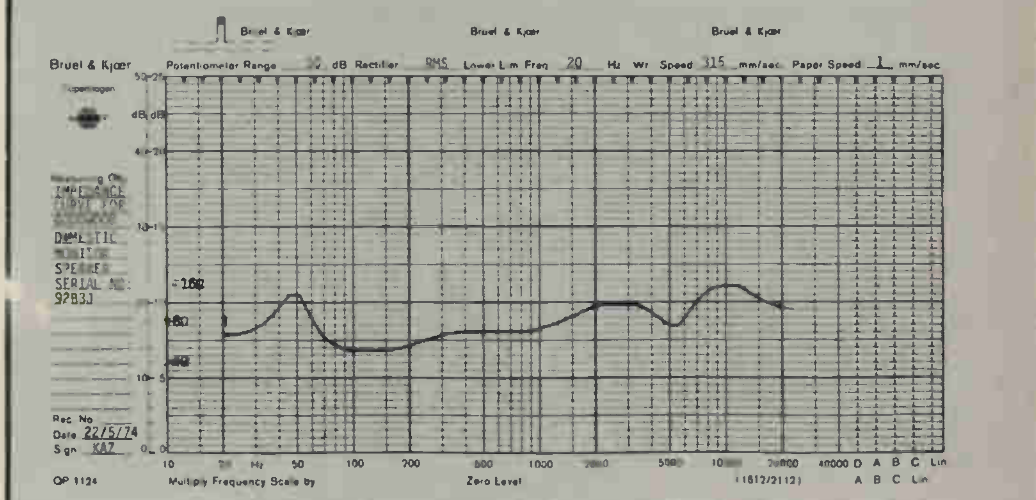
The impedance curve, likewise, was quite smooth with a minimum impedance of 5 Ω and a maximum impedance of 15 Ω.

The distortion characteristics at high signal levels were reasonably low. Far higher signal levels than we would have expected from this system were tolerated before the onset of frequency doubling.

Performance on music featuring deep bass such as EMI "Music of the Incas" SOXLP 7543, and CBS "Olatunji! Drums of Passion" was good, but not really up to the standards that we would have expected from a speaker system described as a monitor speaker system. In other respects though, the manufacturer's description is fair enough. The sound is definitely smooth and colouration is only very slight. ●

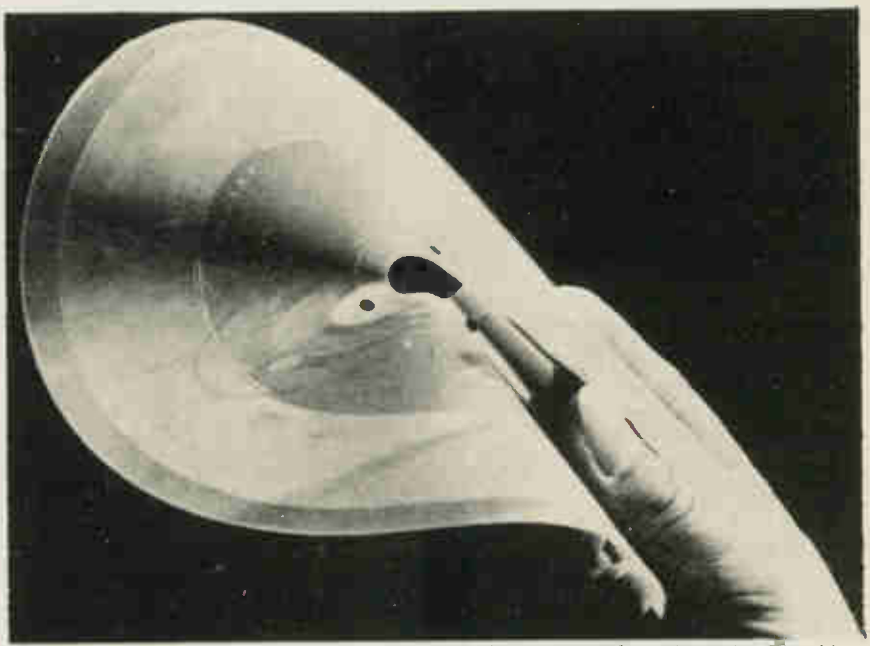






VIDEO-DISC COLOUR TV

Colour TV records this year — Decca-Telefunken's Teldec system now ready for production — here's how it works.



Both video and sound signals are in the extremely fine grooves of the video disc. The thin and flexible PVC foil used appears flimsy, but is actually quite tough and is said to be able to withstand 1000 playings without damage. Disc is driven by a high-speed keyed centre spindle; remainder floats on air cushion.

THE gramophone record is now a familiar enough object. So much so, that the technical achievement of translating complex musical sounds into mechanical variations in a groove and back again is taken for granted.

A measure of this achievement is the fact that on the inner grooves of an LP record the recorded wavelength of one cycle, near the upper (frequency) limit of hearing, is approximately 0.01 mm (about 0.005") in length.

Small wonder then that a stylus has difficulty in tracking a heavily modulated passage, or that pick-up designers are constantly seeking ways of reducing stylus mass and stiffness so that accurate tracking can be ensured with the minimum of wear.

In view of these problems, the thought of putting video signals of high definition on to disc, needing as they do frequencies of several megahertz has always seemed like a wild dream not worthy of serious consideration.

But, incredible though it may seem, it *is* possible, for a domestic video-disc player will be marketed this year that reproduces a full colour picture with 625-line definition plus sound.

The device, developed jointly by Decca and Telefunken, plugs into a conventional colour TV receiver and is no bigger than most record players.

The electronics involved are fairly complex, but, surprisingly, the mechanical arrangements for playing the discs are quite simple.

THE DISC

Unlike conventional long playing records, the video-disc is flexible. In this respect it is similar to the sampler discs that are sometimes freely distributed. The video-disc is 20 cm in diameter and carries about 5 cm radius of groove space. The grooves terminate some 5 cm from the centre.

Playing time is approximately 10 minutes. The video-disc is recorded on one side only, and is made from a specially toughened PVC material which is expected to have a life about the same as an ordinary LP.

The grooves are vertically modulated, in the manner of the old "hill-and-dale" sound recordings, instead of laterally. As there are no side-to-side excursions of the groove, more programme material can be accommodated in a given space.

A playing speed of 1500 rpm is required for the 625-line disc. This corresponds to 25 revolutions per second which is the same as TV frame frequency — there being two interlaced fields to each frame, thus one complete frame is contained in one revolution.

Video waveforms are not modulated directly on to the record grooves, but for reasons that will become clear later, are frequency modulated on a carrier having a deviation from 2.75 MHz to 3.75 MHz. A 1 MHz carrier is also frequency modulated with the sound channel, and a further sound channel could be accomodated if required to provide stereo, or sound in an alternative language.

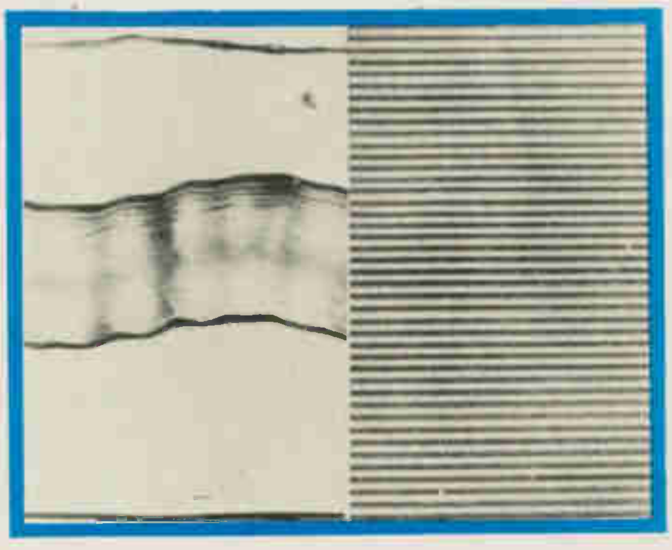


Fig. 1. Photomicrograph compares grooves of (left) standard long-play audio record, and, (right) Teldec video disc.

THE PLAYING DECK

At first glance something radical seems to be missing from the playing deck, it is the turntable! In its place is a small disc similar to the spool carriers used on open-reel tape-recorders, set into a hole in the deck-plate. The disc is smaller than the hole so that a gap exists around it. There is the normal spindle for the central record hole although it is larger than usual, and in addition there is an offset post on the disc which engages with one of the three holes near the centre of the record.

When stationary, the record just lies on the deck, but as it rotates at speed, air is drawn up through the gap around the centre disc, and is forced outward to escape at the rim of the record. It is thus supported on a cushion of air, the air-flow being maintained by the spinning action of the record.

The pickup arm differs from normal in that is is not pivoted at one end, instead, the cartridge is carried across the record by a transverse carriage.

As the groove spacing is constant the pickup can be driven at constant speed along the carriage, and still correctly track the groove on its inward journey.

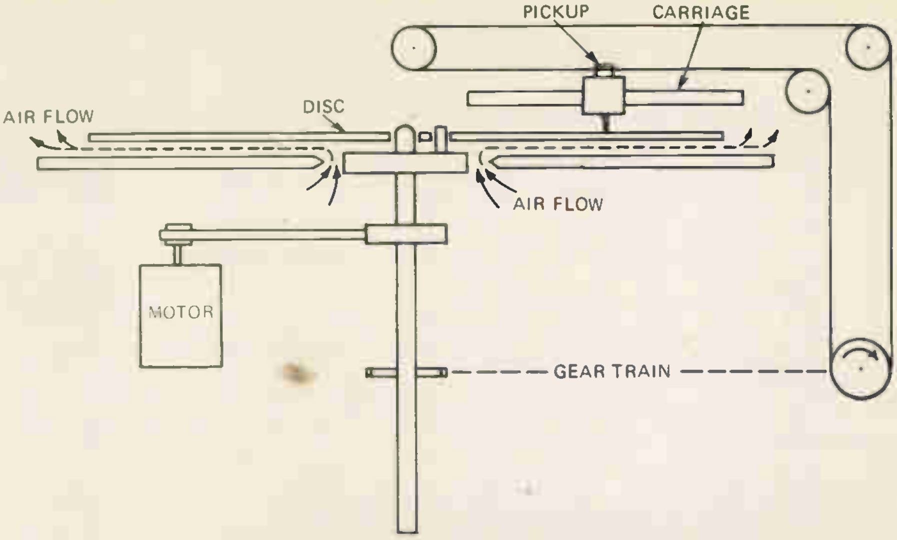
The drive is simply effected by means of drive-wire passing over pulley wheels, in the same manner as the dial-drive used in radio receivers. The wire is wound around a drive-drum which is driven through a gear chain from the record-disc spindle. By this means the pickup drive speed is directly related to the record speed.

Because the record is vertically modulated, the cartridge responds to vertical movements rather than lateral ones. It can thus be designed to accomodate lateral stylus displacement without ill-effect. Hence any departure from the mean tracking rate due for example to any eccentricity of the record, will not cause mistracking.

This characteristic has another application: if it is desired to repeat a few frames and thus 'freeze' the action, the drive to the pickup can be disengaged.

The stylus will then follow the groove for one or two revolutions until its compliance is overcome when it will jump the groove. It will keep doing this until the drive is re-engaged, and so as each groove carries one complete frame, a complete number of frames will be displayed at each jump thereby maintaining the sync. pulse timing.

This groove jumping will not damage the record because of its flexibility providing it is only continued for a reasonable time. The normal rate of progress of the pickup along the carriage is a little over 5 mm per minute.



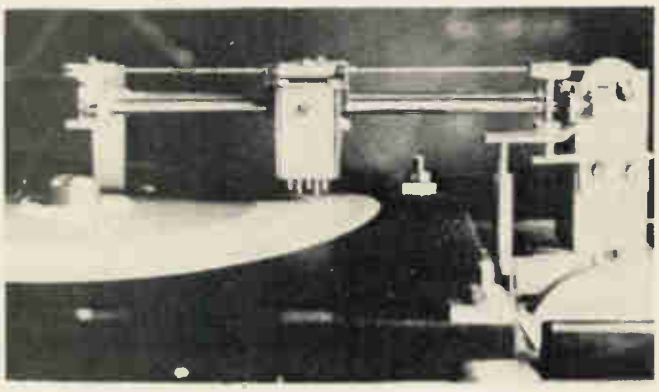


Fig. 2. This drawing shows the mechanical drive system of the Teldec recorder – compare this with the (inset) illustration of an actual (prototype) unit.

The basic player is thus quite straightforward, but in addition to the single-record player, it is planned to produce an autochanger, which is rather more complicated, A magazine, of up to 12 discs, can be inserted into the machine which feeds them automatically to the player with only a few seconds break between records. Each disc is returned to the magazine, or in the case of a single disc, to its sleeve after playing and the magazine is then ejected when all are finished. A programme of up to two hours can therefore be shown without handling the records, and the short breaks can be timed to coincide with scene-fades and natural breaks in the recorded material.

THE PICKUP AND STYLUS

It is this part of the equipment which usually arouses the greatest curiosity. Just how can a stylus faithfully follow modulations in the megahertz range? The short answer is that it doesn't! We remember that the modulations consist of a frequency modulated carrier. Now it doesn't really matter with an f.m. signal, whether the carrier is a pure sinewave, a square wave, saw-tooth or just pulses, as long as the frequency deviations are

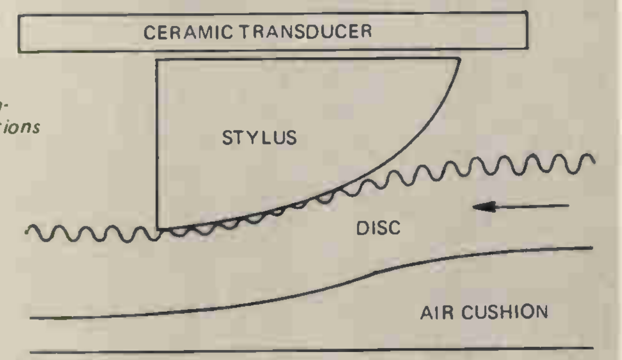


Fig.3. Stylus rests on a number of hill and dale modulations that are compressed under the stylus' curved leading edge. As each modulated 'hump' is released at the stylus' straight trailing edge it imparts a 'flip' to the stylus which thereby produces a pulse from the piezo-ceramic transducer to which it is attached.

VIDEO-DISC COLOUR TV

distinguishable. So as long as each hill-and-dale in the groove produces an electrical wave-form at the right time it matters not how severe the *amplitude* distortion may be.

This greatly simplifies matters and in fact the diamond stylus, which is shaped rather like the bottom half of a capital D, actually lies across quite a number of modulations as it sits in the groove. Bearing in mind that the record is flexible as it rests on its cushion of air, the stylus causes a depression in the area of contact. The modulations pass under the curved portion of the stylus and are gradually compressed by the curvature. Upon reaching the straight trailing edge, each one is suddenly released whereupon it imparts a flip to the stylus. Thus the modulations produce a series of pulses from the transducer which are frequency modulated in accord with the recorded signal.

Hence the stylus does not, in fact could not, follow the contours of each modulation faithfully as is required of a lateral-cut audio disc.

As a series of pulses is all that is required, the carefully engineered cantilevers and stylus-mounting assemblies of the audio pickup are not needed. The stylus is cemented directly to a slice of ceramic material which has piezo-electric properties, (i.e. pressure applied to the material causes a voltage to be generated across it), and this generates the pulses.

Stylus pressure on the record is 0.2 grams, far lighter than even audio pickups, yet in spite of the minute size of the modulations, pulses of the order of 20 mV are obtained at the start of a record.

THE ELECTRONICS

The resolution of the video signal once it is demodulated is 250 horizontal lines, which corresponds to a bandwidth of about 3 MHz. This is less than the broadcast definition standard for 625 lines and is not wide enough to accept the normal PAL colour coding information. A further difficulty from the PAL viewpoint is speed stability which although good enough for monochrome video signals is not good enough for colour coding.

For these reasons, a modified colour-coding which is more tolerant of speed variations has been devised. This is known as "3-PAL". The colour components are sequentially modulated in a band up to 500 kHz. The luminance information, which requires higher definition — as the eye is more critical of luminance definition than colour, is modulated from 500 kHz to 3 MHz.

In order to achieve the sequential demodulation of the three colour components, two 64 µs line-period delay elements are used. These are connected in series so that a delay of one line for one colour appears at their junction, and a two-line delay for the third colour at their end. One colour is of course un-delayed.

The sound channel is modulated on a 1 MHz carrier, and the audio response extends up to 15 kHz. The sound carrier amplitude is −30 dB compared with that of the vision signal, yet a signal-to-noise ratio of −50 dB is maintained.

If we follow the signal as it leaves the pickup, it is applied first to two filters, one is a band-pass filter tuned to 1 MHz which separates out the sound carrier, and the other is a high-pass filter which allows only the higher-frequency vision carrier through. The two signals then pass through their own limiter, and demodulator stages to the audio and video amplifiers respectively.

The vision signal is then divided by a high and low-pass filter into the luminance and chrominance channels, the luminance signal passing directly to the output mixing and modulator stage. Chrominance information is processed through the delay lines and 3-PAL switch to the RGB matrix from where they are fed to the colour modulator along with a 4.43 MHz indent signal. Thus it emerges as a standard PAL signal and is passed to the UHF modulator along with the luminance and sound signals.

Output is the same as a received UHF colour transmission, so all that is necessary is to plug the unit into the aerial socket of a colour TV receiver, or of course it can be displayed on a monochrome set.

GENERAL FEATURES

Unlike tape video-recorders, the video-disc system cannot be used for home recording. It can only play back pre-recorded material. Some of the manufacturers of alternative recording systems regard this as a major drawback. However, in this respect it is no different from the gramophone disc, and no-one will claim that these are lacking in popularity! Obviously, those who wish to record their own video programmes will opt for video-tape just as those wishing to make their own audio recordings use a tape-recorder. There is room for both systems to suit individual requirements.

Cost of the discs compared with tape is well to the advantage of the discs. For a run of 5000 copies, the disc would cost about a fifth of the comparable length of tape. Smaller runs catering for minority interest programme material would cost more, but even then should show a decided advantage over tape. Actual cost should be little more than a top-priced LP record. The record-players should also show a price advantage over video-tape systems, owing to the simplicity of the mechanical section. They should be about twice the cost

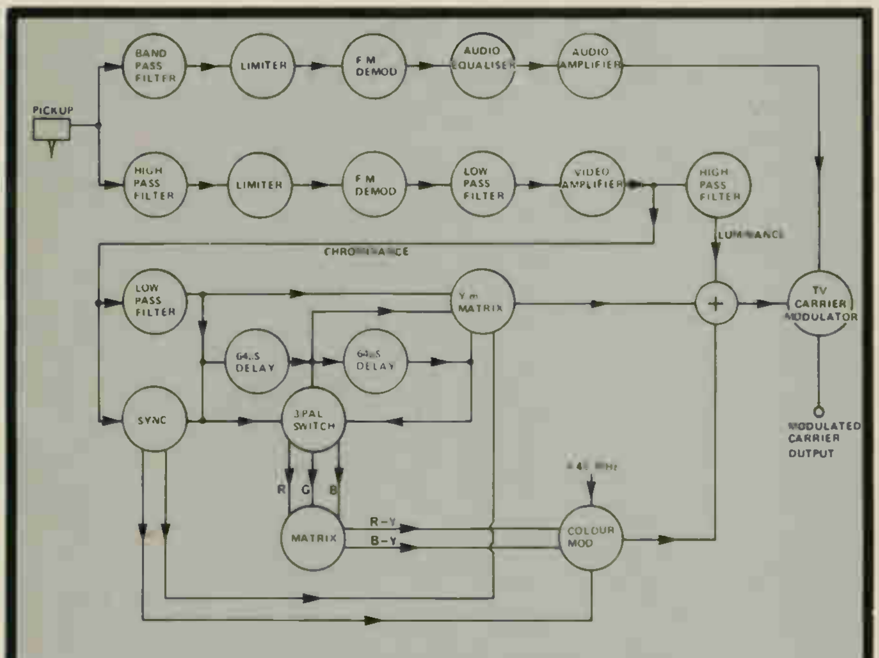


Fig. 4. Block diagram of complete player circuit (see text).

of a good quality audio record-player.

It is of interest to speculate on the nature of the records that may be issued.

It is in the field of instruction that the discs could come into their own. Enrolment in various adult education centres and the variety of subjects that now appear on the syllabus show the tremendous interest that exists in educational subjects. Students of home-decorating, cookery, dress-making, carpentry, golf, and a wide range of other subjects would greatly benefit from being able to see and hear experts give instruction, repeated as often as required, in their own home.

Coming back to technical considerations, the application of the system for purely audio recordings is intriguing. A much slower speed would be ample to record a low-frequency pair of FM carriers for a stereo programme, or even four carriers for discrete quad. If the higher carrier had an upper deviation frequency of 200 kHz which is some 15 times less than the 3 MHz or more upper limit of the video disc, it follows that the speed could be reduced by a similar amount and the playing time extended correspondingly. Thus some 2½ hours could be accommodated on a single 20 cm disc. Other advantages would be better stereo separation, elimination of tracking and tracing error, turntable rumble and harmonic distortion. There may be problems of maintaining the air cushion at slow speeds, but this could no doubt be overcome by mounting fan blades on the drive spindle beneath the deck.

Without doubt the video-disc is a remarkable achievement, and fascinating, proof that one must be wary of dismissing 'impossible' concepts totally out of hand! ●

COMING SOON . . .

Top Projects Book

A collection of the most popular ETI Projects published in the last 2½ years — all in one great volume. More details next month.

Here the tetrahedral microphone array used for ambisonic recording is used to capture the direct and reverberant sound field in St. Giles' Church, in the city of London.

Worldwide, interest is growing in this effective new way to obtain true 'surround sound'. Andrew Pozniak describes the latest developments.

AMBISONICS

In recent issues, contributors such as Dr. Farrimond and Prof. Fellgett have generally questioned what four-channel is all about and what its actual goals are. With this interest from both academic as well as commercial institutions some exciting developments are coming to light with the promise of more to come.

In this article a broad look is taken at the "Kernel" approach to "Surround-sound". Since these innovations are yet in their embryonic stages, little in the way of information other than of an academic or peripheral nature is available. Also patents already applied for, preclude much practical technical data being published.

As more information comes to light further articles will be published. A broad list of references is listed at the end of this article. To indicate how current this topic is, the last reference is to a paper given by M.A. Gerzon "Psychoacoustic criteria relative to the conception of matrix and discrete systems in tetraphonics". This was read at the International Festival of Sound in Paris earlier this year.

It is not without some renewed eagerness and anticipation that further developments from various sources are to be looked forward to, after the somewhat meandering start that quadraphonics has had.

"QUADRAPHONICS" has been with us for some time now, but, unlike the introduction of stereo about two decades ago, its acceptance by the public is far from accomplished.

The major reason for this is that in spite of much work by manufacturers on developing a viable system for this new dimension, none of these systems comes up with a "convincing" argument or sound in keeping with what is the basic purpose of the whole exercise.

A polyglot of systems has evolved (SQ,QS,RM,CD4,UMX etc.) all have a sound technological approach, however arguments for and against each method have been raging since their inception, especially by their innovators, each wishing to see their system adopted as the standard.

Unfortunately out of this "Babel" little has resulted except confused consumers, slow sales of already manufactured four-channel equipment and suitable records, and perhaps most important, non-emergence of any sort of standard throughout the industry.

Most vivid proof of this state of affairs is the growing number of positions one sees on the "mode" switch of currently manufactured four-channel amplifiers with inbuilt multiple decoders to cover every possible contingency.

A slight polarisation of thought in favour of the CD4 discrete system is in evidence, especially in the USA. However before even the adoption of *that* system takes place severe re-thinking of the whole approach is definitely merited. This last statement is prompted in the light of recent technical papers on the subject as well as experimental work being done both at academic institutions and by certain companies in various countries.

P. B. Fellgett, Professor of Cybernetics and Instrument Physics at

Reading University has teamed up with John Wright and, under the co-sponsorship of the National Research Development Council of Great Britain and the IMF company has been conducting research into a new concept for multi-channel sound recording and reproduction called "ambisonics".

As a result in 1971 a patent was taken out by NRDC arising from developments carried out at Reading University. At present experiments are mostly being carried out by IMF under Prof. Fellgett, John Wright and a more recent member of the team, Michael Gerzon, an Oxford University mathematician. Considerable help has been forthcoming from many parts of the audio industry from such companies as Dolby Laboratories and Calrec.

The first major public demonstration of Ambisonic sound was given at the recent Sonex '74 exhibition in London.

Unfortunately the demonstrators could hardly have picked a worse spot than the room they had allocated to them.

The acoustics of the room were completely unsuitable for the demonstration. In spite of the handicap one or two selections did give an idea of what an ambisonic system is capable. One particular piece of organ music produced a strong impression of the sound echoing inside a church. Some aspects of what "ambisonic" sound is, did come to light.

Professor Fellgett hopes to arrange a future demonstration in a more suitable location.

The new technique improves on present quadraphonic systems because of its ability to present natural sound images between front and rear pairs of speakers, and to reproduce sounds which seem to arise either between listener and loudspeaker or beyond.

So much so, that Mr. Gerzon believes that "Quadraphonics" as conceived widely at present, is a Dead End.

Unlike conventional quadraphonic approach, the new "ambisonic" system uses information from a multidirectional microphone array encoded onto just two channels. This means that the complexities of surround sound techniques are relegated to the recording studio and not the living room. It is envisaged that apart from two separate loudspeakers suitably in phase only a decoder will be necessary to convert an existing stereo system.

This new approach is not to be confused with the so-called matrix systems to date. In matrixing, information from conventional microphones is artificially blended to achieve synthetically the approximation of surround sound.

With ambisonics sound from every direction is picked up by a tetrahedral microphone array and is treated equally until the decoding operation.

In retrospect there have been two approaches to surround sound four-channel reproduction.

1. "Matrix" systems which aim to simulate discrete systems via less than four channels.

2. "Discrete" systems, which use four channels to create phantom inter-speaker images by feeding (panning) sounds only to the two adjacent speakers.

Now, with "Ambisonics" a new approach is emerging. This uses the "harmonic synthesis" or "Kernel" system. This new approach requires some explanation. The aim of a Kernel system is to convey through a finite number of channels an infinite number of directions (and thus an infinite number of channels). The mathematics used is not "Matrix" algebra but what is known as "Kernel" algebra (which is the corresponding mathematics used when one has an infinite continuum of variables).

"Kernel" systems start from the observation that the desirable effect is to produce a sound coming from an infinite number of directions around the listener. Such systems imagine a limited number of channels (two, three or four) being used to convey the sound to the listener, but are designed to create a continuous range of directions around the listener thus approximating the original. This re-creation may take place via (say) only four speakers. The signals fed to the speakers do not matter in themselves, only the directional effect of the sound field at the listener matters. (This philosophy is close to that expressed in Blumlein's famous 1931 stereo patent.)

Commercial examples of Kernel systems are the UMX family of systems of Nippon-Columbia, Japanese RM systems excluding Sansui's QS system which is only an approximation to RM., and also the British NRDC "ambisonic" system.

Work along similar lines is being done in Germany by Sennheiser.

All in all, it would appear that at long last some more rationalised approach, as to what four channel surround sound should really be, is being taken. Interestingly enough the impetus for this has come from the academics rather than commercial incentives.

Pop-gimmickry and special-effect records may offer the recording-engineer scope for juggling the controls. However, it is high time that the record makers realise that in general the serious listener likes music "au naturel" — as close as possible to the original. If this goal can be achieved by quadraphonics then let it be so; but unadulterated by synthetic (stereo or four channel) "pseudophonics".

It is obvious that the whole question of quadraphonics is in a state of ferment and movements in the right direction are being made. This year should see many interesting developments and further articles dealing with the topic will follow as information comes to hand.

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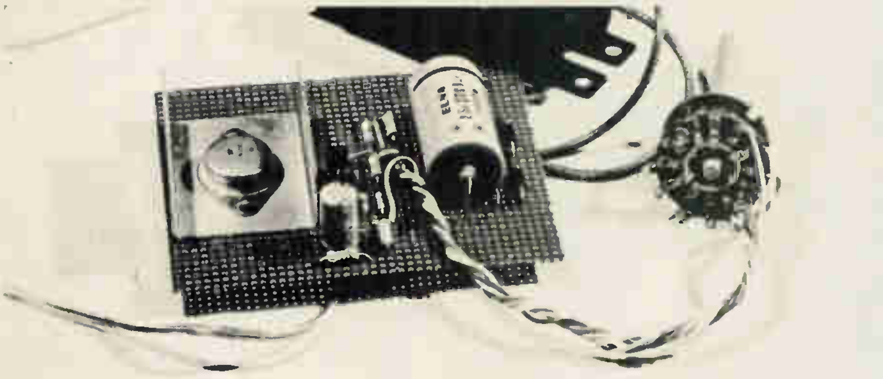
BASIC POWER SUPPLY

Simple regulated supply provides 4.5-12 volts at 400 mA maximum.



The power supply shown unmounted. Note the aluminium heat sink for the power transistor.

THIS little power supply provides a range of switch selectable output regulated voltages from 4.5 to 12 volts, selectable by a switch. The supply will provide up to 400 mA and the output can withstand a short circuit without damage. It is therefore ideal for the experimenter or for use with high drain appliances.

PARTS LIST
POWER SUPPLY ETI 221

R6	Resistor	1.5 ohms ½W 5% (2 x 1.5 ohms in parallel for organ)
R7	"	220 ohms ½W 5%
R3	"	820 " " "
R1, 8	"	1k " "
R4, 5	"	1.5k
R2	"	2.7k
Q1	Transistor	BC337 or similar
Q2	"	2N3055 "
Q3	"	BC327 "
D1-D4	Diode	1N4001 or similar
ZD1	Zenerdiode	BZY88C13 " (18V, 400mW)
T1	Transformer	240V/15V at 1A
SW1	DPST	240V switch
SW2	4 position single pole switch	
	heatsink for Q2	
C1	Capacitor	220μF 25V electrolytic
C2	"	100μF 16V "

Piece of matrix board.

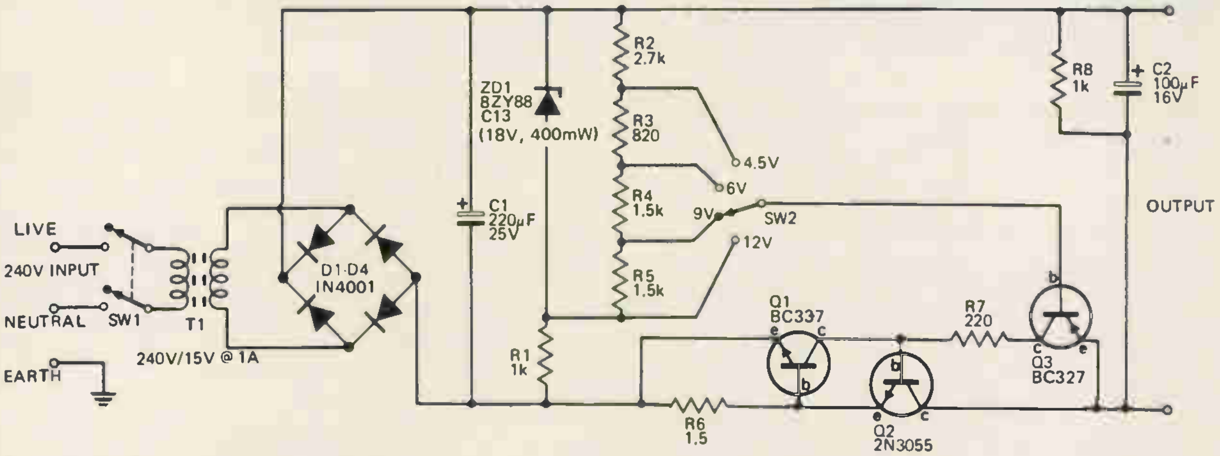


Fig. 1. Circuit diagram of the regulated power supply.

SPECIFICATION

Nominal output voltage 12V, 9V, 6V and 4.5V
Output current 0 – 400mA
Current limit approx. 500mA

HOW IT WORKS

The 240 V mains voltage is reduced to 15 volts by transformer T1, and this secondary voltage is then full-wave rectified by rectifier bridge D1-D4.

The output of the bridge rectifier is filtered by C1 to provide approximately 20 volts dc.

The series combination, of Zener diode ZD1 fed by resistor R1, provides a stabilized voltage of around 13 volts which is applied across the voltage divider R2, R3, R4 and R5. Thus a series of reference voltages are generated for the regulator, where the positive rail is fixed and the negative rail is the one that is varied.

Transistor Q3 is an emitter follower where the output (emitter) is about 0.6 V higher (more positive) than the base. The base voltage is selected by SW2 from one of the tappings on the reference-voltage divider. Since Q3 cannot handle the required output current, it drives Q2, a power transistor, which *can* handle the required load.

When the load exceeds 400 mA (approximately), the voltage drop across R6 forward biases Q1 which turns on and shunts current away from the base of Q2. Thus the regulator loses control and the output voltage falls, limiting the current to 400 mA. As the power dissipated in Q2 under short-circuit conditions is around 10 watts, Q2 must be fitted to a heatsink. Additionally, resistor R7 limits the current supplied by Q3 to a safe value (for Q3) under short circuit conditions.

If a fully variable supply is required, a 10 k potentiometer should be used in place of the voltage divider. The wiper of the potentiometer is then fed directly to the base of Q3.

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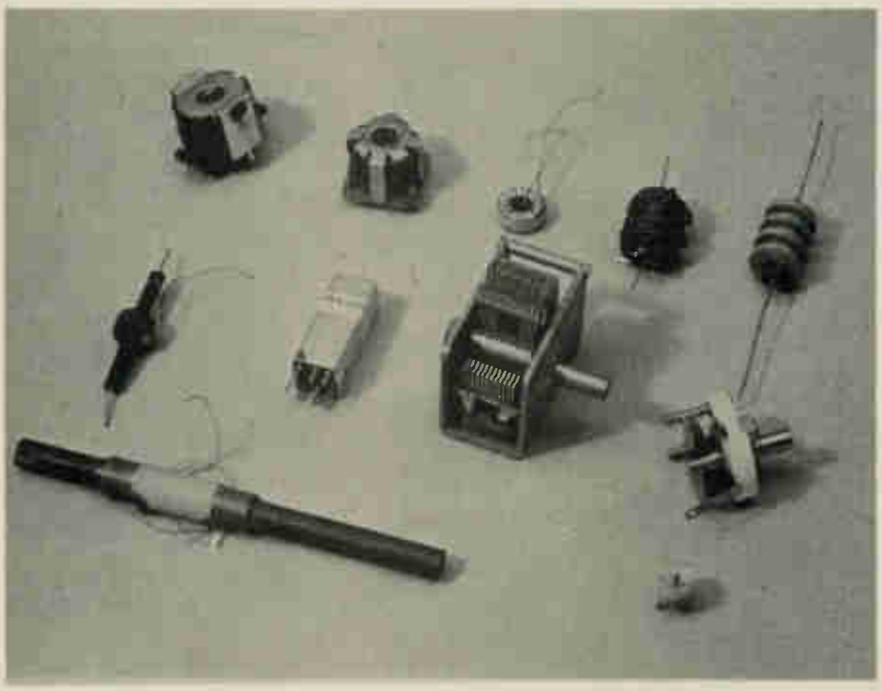
PART 9



The last of the heavy stuff! — the combinations of resistance, inductance and capacitance.

WE HAVE stressed throughout this course that a good solid understanding of basic electronics is essential if one hopes to understand complex devices.

It is not at all necessary to understand the extraordinarily complex physics going on inside our electronic black boxes. But we must know how these boxes behave in various circumstances and combination.

Hence the fairly solid material that we have presented so far.

Happily this part of the course is now virtually at an end and we are about to get into the more interesting stuff.

That, as they say, is the good news. Bad news is that this last theoretical section is fairly heavy. Do plough through it though — it really is important.

This part of the course deals with circuits that contain resistors in parallel with inductors or capacitors. It also covers the effect called resonance that occurs when inductors and capacitors are used together.

RESISTANCE AND INDUCTANCE IN PARALLEL

Vector diagrams may be used to study paralleled resistance and inductance. This is done much in the same way as series combinations.

In Fig. 1, the signal common to both components is the applied voltage (not current, as in series combinations). So the vector diagram uses a voltage vector as the horizontal reference. The current flowing in the resistor I_R is in phase with the voltage so it is drawn as shown, coincident with V. You will remember from previous theory that the current passing through an inductor lags the applied voltage by 90°. The current vector will therefore point downwards at 90° to the voltage vector.

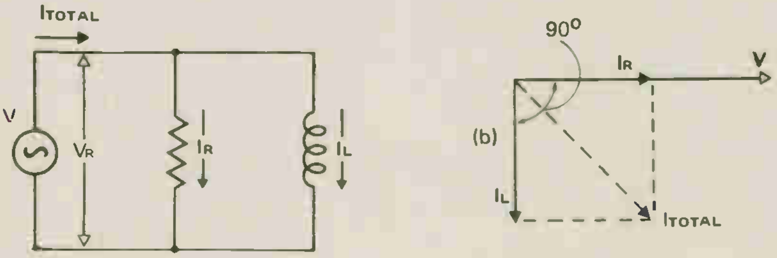


Fig.1. (a) The parallel resistor and inductor. (b). Vector diagram of circuit in Fig. 1 a.

To find the magnitude of the current drawn from the generator the diagram is added vectorially to produce I_{total}. This procedure is exactly the same as we used previously.

The Pythagoras rule also holds allowing us to compute I_{total} from I_R and I_L giving:—

$$I_{total} = \sqrt{I_R^2 + I_L^2}$$

Similarly the phase angle is found from:—

$$\tan\theta = \frac{I_L}{I_R}$$

A worked example is worth a thousand words, so let us consider the circuit given in Fig. 2a. Here the problem is to work out the current in each component and the magnitude and phase of the current drawn from the 10 V generator. (Remember V is common to both components so we can directly apply Ohm's law to each if we know their reactance values).

$$\text{Hence } I_R = \frac{V}{R} = \frac{10}{25} = 0.4 \text{ A}$$

$$\text{and } I_L = \frac{V}{X_L} = \frac{10}{33.3} = 0.3 \text{ A}$$

By calculation we get

$$I_{total} = \sqrt{0.4^2 + 0.3^2} = 0.5 \text{ A}$$

Alternatively, this result could have been reached by using an accurately drawn vector diagram (see Fig. 2b) in which I_R and I_L are the knowns that lead to I_{total} on completion of the parallelogram.

The tangent of the phase angle is:—

$$\tan\theta = \frac{0.3}{0.4} = 0.75$$

$$\text{Hence } \theta = 36^\circ\ 52'$$

and we know it is lagging as there are no capacitive elements present. The phase angle could also have been found by measuring the angle directly from the graphical vector diagram.

Calculation of current magnitudes and phase angle rarely needs better

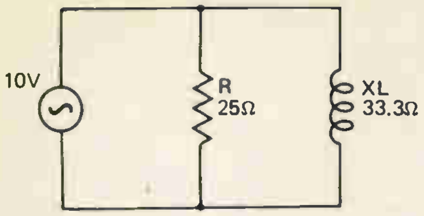
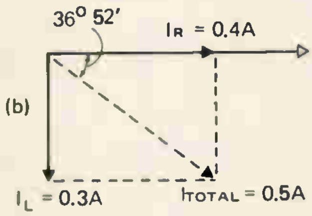


Fig. 2a. A practical example of parallel L and R.



(b) The vector solution.

than 1% accuracy; often 10% is quite adequate.

Indeed, the *majority* of electronic calculations require little precision. There is no point in making long and tedious tasks out of these, often arising, sums. What is more important is that the underlying principle is properly understood. Much of the electronic theory needed in practice is a case of mental arithmetic followed by final adjustment once the circuit is wired up.

RESISTANCE AND CAPACITANCE IN PARALLEL

Figure 3a is the circuit of paralleled resistance and capacitance. The magnitude and phase of the load current may be calculated in exactly the same way as for RL combinations. To check that you have understood the foregoing principles do the figures for yourself and draw the vector diagram as a second check. You should get the values shown in Fig. 3b. Remember, this time, that the current in the capacitor leads that in the resistor.

Now work out the total impedance represented by the two paralleled components — it should be 78.1 ohms. Remember Ohm's law applies to ac circuits provided the impedances are added vectorially to obtain the total — it is quite invalid to arithmetically add the values unless they are in phase (or if 180° out of phase, they can be directly subtracted).

To improve your understanding try it again using firstly, a resistor of 40 ohms with 2μF of capacitance and secondly, with 40 ohms and 0.1μF. Finally compare the three diagrams and results.

COMBINATIONS OF L AND C

Until now those circuits involving both a capacitor and an inductor have

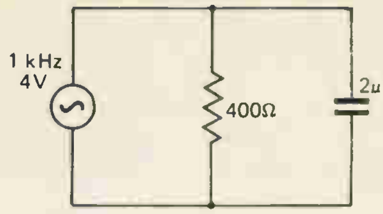
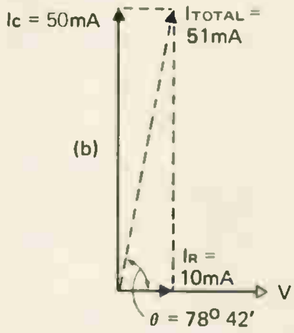


Fig.3a. Parallel combination of capacitance and resistance.



(3b) Vector solution of circuit.

purposely been ignored, for these can (under certain conditions), exhibit characteristics that are strikingly different to those seen so far in our discussion of storage elements.

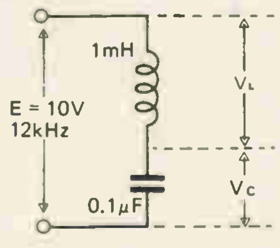
With the concepts of the vector diagram and the phase of signals behind us, it is now a reasonably straightforward task to gain an understanding of circuits that contain both inductance *and* capacitance.

SERIES COMBINATIONS

When two components are in series, the same current must flow through each, but, as we have previously seen, the voltage across an inductor must lead the current by 90° and the voltage across a capacitor always lags the current by 90°. Thus these voltages *always oppose each other* (180° out of phase) and the difference between them — is the input voltage! That is, either or both of the voltages across the reactances, may be larger than the input voltage.

To provide a better understanding of what happens in such circuits, let us calculate the current drawn from the supply and the voltages across the reactances in the circuit of Fig. 4a.

Firstly we must find the reactance of each component at the supply frequency of 12 kHz.



$X_L = 2\pi FL =$

$6.28 \times 12 \times 10^3 \times 1 \times 10^{-3} = 75.4$ ohms

$$X_C = \frac{1}{2\pi FC} = \frac{10^6}{6.28 \times 12 \times 10^3 \times 0.1}$$

$= 132.7$ ohms

To determine what the current through the series combination is, we must find the effective combined reactance. As the reactances have the opposite effect, this is simply obtained by subtracting capacitive from inductive reactance (capacitive reactance is always assumed to be negative by convention).

Thus $X_{comb} = X_L - X_C$

$= 75.4 - 132.7 = -57.3$ ohms

The negative sign indicates that the combined effect is that of a capacitive reactance of 57.3 ohms.

By Ohm's Law the current will thus be:—

$$I = \frac{E}{X_{comb}} = \frac{10}{57.3} = 174 \text{ mA}$$

Now that we know the current, we can go back and calculate the voltages across each component

$$V_L = X_L I =$$

$$75.4 \times 174 \times 10^{-3} = 13.1 \text{ volts}$$

$$V_C = X_C I =$$

$$132.7 \times 174 \times 10^{-3} = 23.1 \text{ volts}$$

Note particularly the magnitude of these voltages in relation to the input of 10 volts. In fact, due to the subtraction process, the input voltage is always smaller than that across the larger of the two reactances.

The vector diagram for the circuit is as shown in Fig. 4b. We will leave for the moment, the special case where the reactances are equal and study the parallel system.

PARALLEL COMBINATIONS

The parallel combination of L and C is shown in Fig. 5a. In this case the voltage will be common across both components, the current will lag the voltage by 90° in the inductor, and lead the voltage by 90° in the capacitor.

Thus, in this case, it is the two currents which are 180° out of phase so the total current is the difference between them.

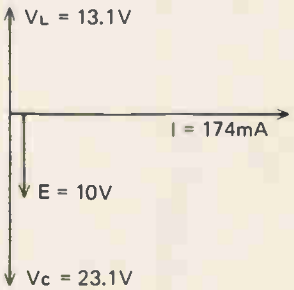


Fig.4a. A series inductor and capacitor combination. (4b) Vector solution.

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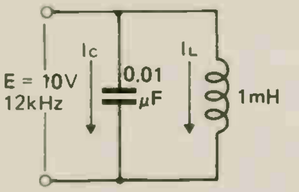


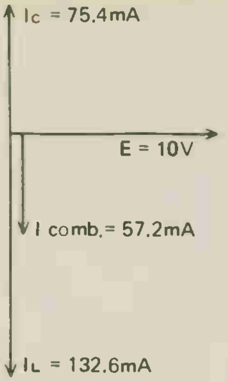


Fig.5a. A parallel combination of L and C. (5b) The vector solution.

Let us use the same values as for the series case

$X_L = 75.4$ ohms, $X_C = 132.7$ ohms

$$\text{Thus } I_L = \frac{10}{75.4} = 132.6 \text{ mA}$$

$$I_C = \frac{10}{132.7} = 75.4 \text{ mA}$$

$$\text{and } I_{comb} = I_L - I_C = 132.6 - 75.4\text{mA} = 57.2 \text{ mA}$$

Compare this current to the previous case. The combined reactance is now:–

$$X_{comb} = \frac{E}{I} = \frac{10}{57.2} = 174.8 \text{ ohms}$$

From this procedure we can deduce that, as the current from the supply is always smaller than the larger of the two reactive currents, the combined reactance, will *always be larger* than the larger of the two reactances. think about it for a while and you will see that this is so.

All practical LC circuits contain some resistance which modifies the behaviour of the circuit. The general circuit of a series LCR combination is given in Fig. 6 and a parallel combination in Fig. 7. These are the most common configurations but by no means the only ones.

In the series case the vector diagram shows how the difference between the reactive voltages is vectorially summed with the voltage across the resistor to obtain the magnitude and phase angle of the supply voltage. Alternatively we can use the Pythagoras rule again to find the input voltage:–

$$V_{in} = \sqrt{V_R^2 + (V_L - V_C)^2}$$

and the phase angle

$$\tan\theta = \frac{V_L - V_C}{V_R}$$

In the parallel case we look at currents instead of voltages. Remember the voltage must be the same across each component, and again a vector diagram of reactive and resistive currents will provide us with the magnitude and phase of the input current.

By Pythagoras:–

$$I_{in} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$\tan\theta = \frac{I_L - I_C}{I_R}$$

APPARENT POWER & POWER FACTOR

In a circuit containing both reactance and resistance, only the energy supplied to the resistor is dissipated. The energy supplied to the reactance is alternately stored in a field and then returned to the supply. Thus no energy is dissipated by the reactance.

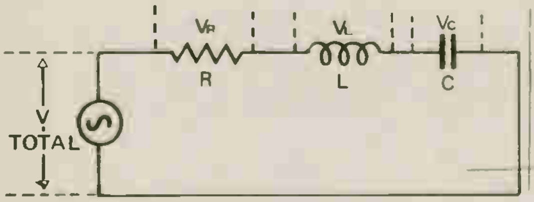
The energy supplied to the resistance is called 'REAL' power (because it does work) and is measured in watts. The energy shunted back and forth by the reactance is called APPARENT POWER and is simply equal to the input voltage times the current drawn. The apparent power is measured in terms of volt-amperes — often abbreviated to VA.

The ratio of the real power in watts to the volt-amperes is called the POWER FACTOR of a circuit.

Referring to Fig. 4b we can say that:–

real power in watts = $E_R I$
and apparent power VA = EI

$$\therefore \text{power factor} = \frac{E_R I}{EI} = \frac{E_R}{E} = \cos\theta$$



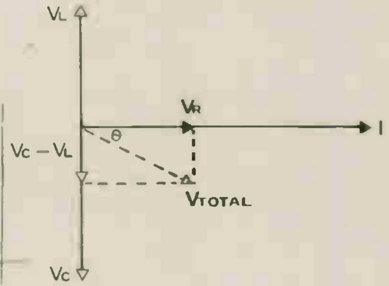


Fig.6a. Series combination of L, C and R. (6b) Vector diagram of the combination.

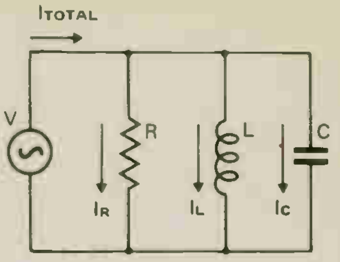
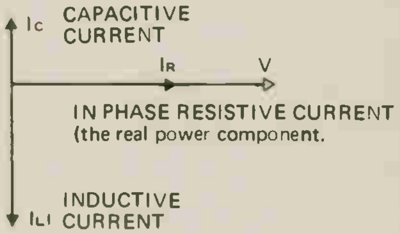
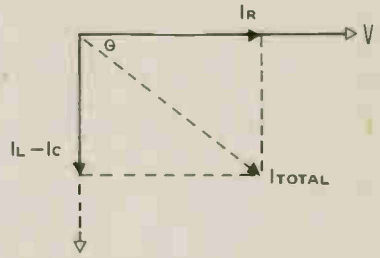


Fig.7a. A parallel combination of L, C and R.



(7b) The basic vector diagram.



(7c) The vector solution — the reactive components having been subtracted.

Thus the power factor in any circuit is equal to the cosine of the phase angle and the power actually dissipated in such a circuit is:–

$$P = EI\cos\theta$$

A PRACTICAL EXAMPLE

An excellent example of the use of reactances is found in fluorescent lights. A basic fluorescent light consists of a gas discharge lamp and a current limiting choke called a ballast as shown in Fig. 8.

Once lit, the complete light appears to the mains as an inductive load and, the current drawn from the mains will lag the voltage by a considerable amount.

The typical four-foot long lamp is rated at 40 watts but, when fed via the correct ballast-choke, draws 0.4 amps from the mains. Thus the VA will be 240 x 0.4 = 100VA approximately! As the consumer only pays for real power, this is of little concern to him, but the extra current drawn causes higher losses in the transmission line, which means the electricity supplier loses revenue. The suppliers therefore, in some areas, insist that large installations of fluorescent lights have suitable power-factor correction.

How is power-factor correction done? Quite easily — because all we need to do to cancel an inductive reactance, is add an equivalent

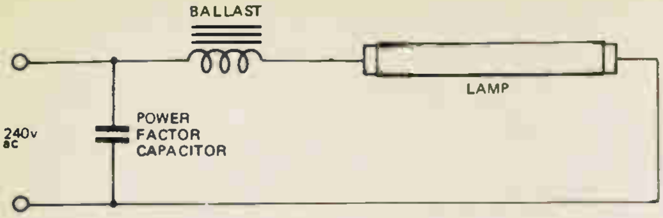


Fig.8. The circuit of a basic fluorescent light fitting (not including starting circuitry). This is an excellent industrial example of the uses of inductors and capacitors.

capacitive reactance in parallel (see section on parallel L and C). Thus a capacitor added across the input terminals will not affect the operation of the lamp but keeps the electricity supplier happy by reducing the input current from 400 mA to about 150 mA.

RESONANCE

As we vary the input frequency to an LC circuit the reactances of L and C change in different directions. That is, as frequency goes up, capacitive reactance goes down, (and inductive reactance goes up). At one particular frequency the reactances will be equal and, when this occurs, we find some very interesting effects — as we will see.

The frequency at which the reactances of L and C are equal is called the RESONANT FREQUENCY, and the circuit is said to be RESONANT at that frequency. Let us now look at the characteristics of series and parallel circuits at resonance.

PARALLEL RESONANCE

In a parallel reasonant circuit the individual currents flowing in the inductor and the capacitor depend upon the frequency at which the ciruit is operated and upon the size of the component (remember $X_L = 2\pi fL$ and $X_C = 1/2\pi fC$). These currents can be plotted as shown in Fig. 9b. The combined current is the direct difference of the two.

At low frequencies the circuit is predominately inductive. As the frequency is raised, more capacitive current flows: at the same time the inductive current reduces. A point is reached where the two are equal and, as they are of opposite sense, the circuit draws no current from the input. It behaves as though the generator is connected to nothing — as would occur if the load was an infinitely high resistance. This happens at the frequency known as the resonant frequency fr, for short. Above resonance the circuit becomes more and more capacitive as the effect of the capacitor becomes more dominant, and the input current gradually increases again.

It is often convenient to consider the impedance of such circuits instead of the currents. Variation of the impedance of a parallel resonant circuit is plotted in Fig. 10. Note the

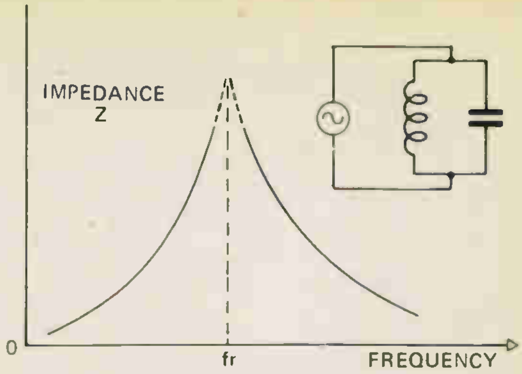


Fig.10. Variation of the impedance of a parallel tuned circuit as the frequency is varied.

theoretical impedance rises to an infinitely high value (zero current flow) at the resonant frequency. However, there is always some resistance in practical resonant circuits and this limits the rise and sharpness of the curve. This resistance is termed the DYNAMIC RESISTANCE.

Circuits capable of resonating in this manner are known as tuned circuits. Tuning is the procedure whereby any of the components is selected or carefully adjusted to achieve the resonant condition.

SERIES RESONANCE

A similar argument to the above can be used in the case where the two storage components are wired in series. The effective characteristics turn out

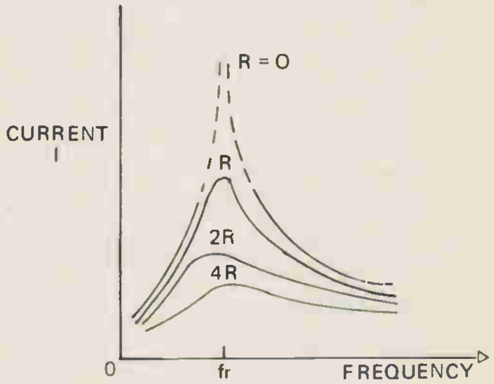


Fig.11a. The dynamic resistance of a series tuned circuit affects the sharpness of the resonant effect as shown.

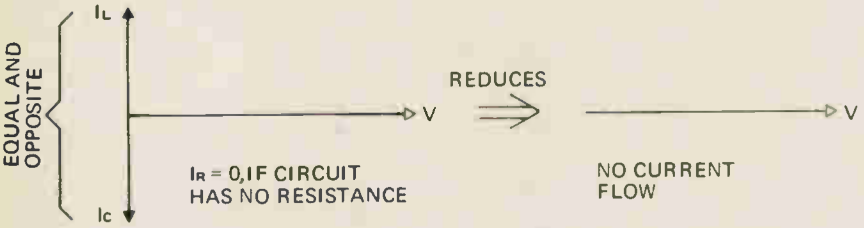


Fig.9a. Vector representation of the condition at resonance, when inductive and capacitive reactance are equal.

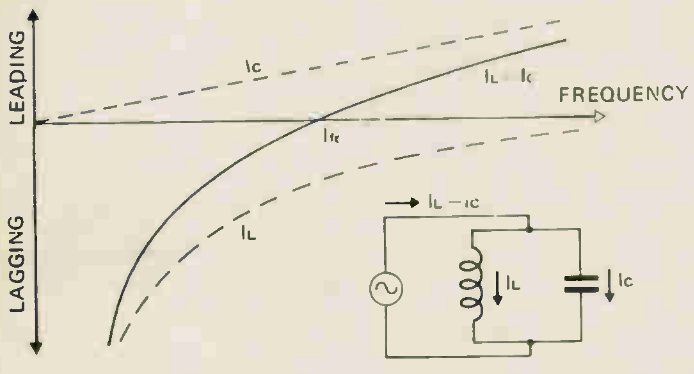


Fig 9b. Currents in the parallel tuned circuit as the frequency is varied.

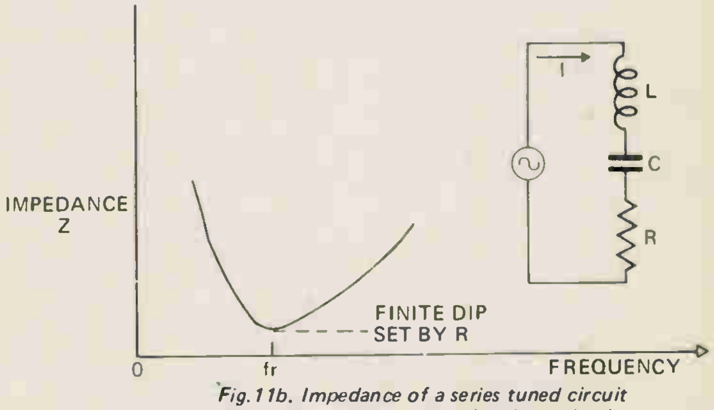


Fig.11b. Impedance of a series tuned circuit drops, at resonance, to a value determined by the dynamic resistance.

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to be the reverse of those of the parallel resonance case.

Here the current is common to both components so the typical vector diagram looks like that shown in Fig. 6. The case illustrated has the capactive voltage larger than the voltage across the inductor so the combination appears to be a circuit that has a value of capacitance smaller than that of the component actually in circuit.

It is when the two reactances are equal, at a particular frequency, that interesting things happen for there, the effect of the capacitor cancels that of the inductor and, the source sees only the resistance of the circuit. Ohms law tells us that the current drawn from the source is limited only by the value of the resistance, which in a typical tuned circuit is very small. Consequently the current could well be very large indeed. Fig. 11a shows how the current is limited by various values of dynamic resistance. Impedance variations for a series tuned circuit are given in Fig. 11b. The minimum of the dip is limited by the dynamic resistance.

QUALITY FACTOR OF TUNED CIRCUITS – THE Q

In the series tuned circuit the voltage across the resistor can never be greater than the applied voltage. On the other hand the voltage across the reactive components can rise to values many times that of the supply. The V_L and V_C values in Fig. 6 demonstrate how this occurs.

Consequently the series resonant circuit can be used to produce voltages considerably larger than those supplied to it. The magnification that occurs in this process is expressed as the 'Q', or quality factor of the circuit and is given by

$$Q = \frac{V_L}{V} = \frac{V_C}{V} \text{ (at resonance } V_L = V_C)$$

As the windings of the inductor are responsible for the majority of the resistance a good approximation for the Q factor is found using the realtionship

$$Q = \frac{X_L}{R}$$

introduced earlier in the course.

In parallel tuned circuits it is the current in the reactive components that is magnified, and again the same definition of Q can be used to express the goodness of the tuned circuit. Hence

$$Q = \frac{I_C}{I_R} = \frac{I_L}{I_R}$$

As currents are related to reactances by Ohms law, the Q can also be found from the ratio of the reactance and resistance as for series resonance.

RESONANT FREQUENCY

As pointed out earlier, the resonant frequency is that frequency where the inductive and capacitive reactances, of a series (or parallel) tuned circuit, are equal. That is:–

$$X_L = X_C$$

and hence $2\pi FL = \frac{1}{2\pi FC}$

By transposition we obtain resonant frequency $F_r = \frac{1}{2\pi\sqrt{LC}}$

The following examples will assist. Given a 100 mH inductor and a 0.4μF capacitor, find the frequency at which the two resonate.

$$F_r = \frac{1}{2\pi\sqrt{\frac{100 \times 4}{10^3 \times 10^7}}} = 800 \text{ Hz}$$

This is the frequency for series or parallel resonance of the two.

Often the need is to produce a resonant condition at a given frequency with one component supplied. For example, we may need a circuit resonant at 4 kHz, using a 160 mH choke. The capacitance needed will be:

$$F_r = \frac{1}{2\pi\sqrt{LC}}$$

from which $LC = (\frac{1}{2\pi F_r})^2$

or $C = \frac{1}{L} \times (\frac{1}{2\pi F_r})^2$

and putting figures for this example

$$C = \frac{1}{160 \times 10^{-3}} \times (\frac{1}{2\pi \times 4 \times 10^3})^2$$
$$= 0.1\mu F$$

Tuned circuits with zero resistance have the greatest magnification and the sharpest resonance peak. In practice there will always be some resistance present, for the inductor element needs to be as small and light as possible, these factors dictate that the wire used in the coil must be relatively fine in gauge, and hence will have a resistance value that may need to be taken into consideration. However, in systems-level discussions of electronic devices we can usually ignore the effect of the dynamic resistance, we only need to worry about that when actually designing circuits.

If careful measurements of the resonant frequency of a tuned circuit were made, it would be found that dynamic resistance does vary the resonance value by a small amount. In practice, most resonant combinations have an inbuilt variability that enables the capacitor of the inductor to be finely varied to peak up the response.

WHAT USE IS RESONANCE?

We have seen the series resonant circuit represents a large impedance when away from resonance but a very small resistance when tuned. The parallel configuration provides the reverse effect. These are summarised in Fig. 12. This way of looking at the resonant circuit is relevant to an understanding of how they are used to select certain frequencies out of a multiple frequency signal.

FREQUENCY SELECTION

Often the need arises to select a known frequency signal (or a narrow band of frequencies) from a wide spectrum. The most common example must be that found in radio transmission where many stations broadcast into the same medium, each at a slightly different frequency. The task of the radio receiver is to tune out the unwanted signals leaving only the required one.

The system to do this is depicted in Fig. 13. A series resonant circuit (Fig. 10a) will provide very little

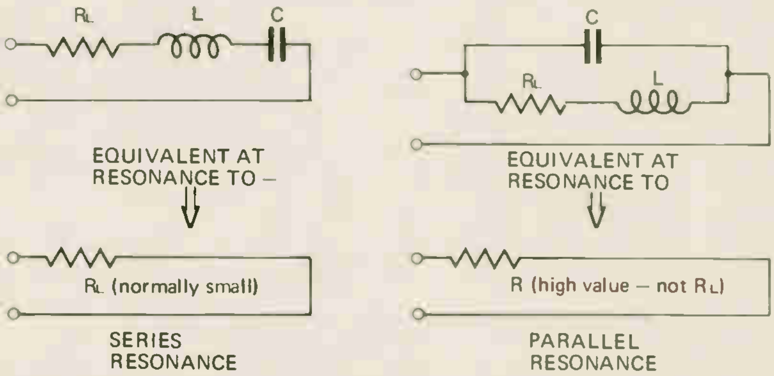


Fig.12. At resonance the two types of tuned circuit become purely resistive. The series circuit becomes a very small resistance and the parallel circuit becomes a very high resistance.

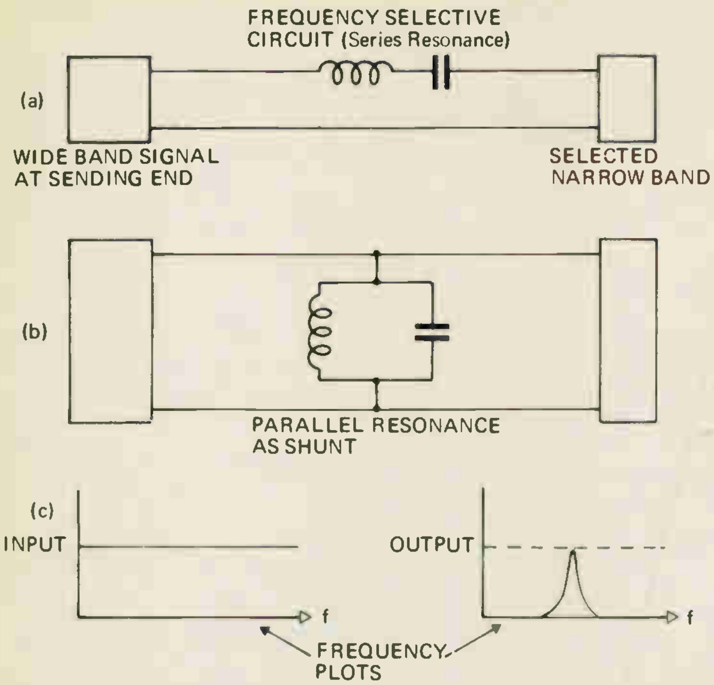


Fig.13. How coupling black boxes with tuned circuits provides frequency selection. (a) coupling by series tuned circuit. (b) coupling by parallel tuned circuit. (c) the input versus frequency compared to the output versus frequency.

attenuation to signals of the required frequency but will act as a larger resistor (actually as an inductive or capacitive reactance) away from the desired frequency. Thus, only those signals near to the resonant frequency of the combination are allowed through with any signal strength. Although series systems could be used, they seldom are in practice.

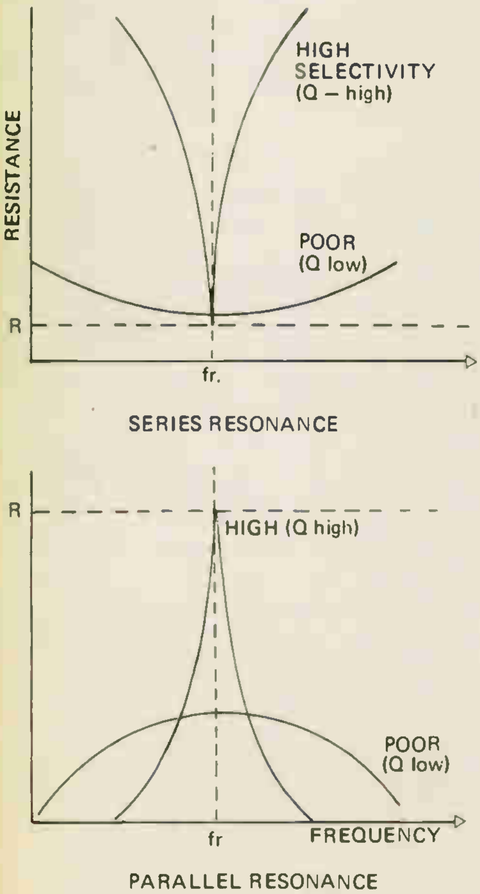


Fig.14. Summary of responses of the two types of tuned circuit with extremes of Q. (a) Series Resonance. (b) Parallel Resonance.

A similar effect can be produced by using the parallel resonant circuit as a shunt across the received output. All frequencies will be attenuated except those required. This form of selection is the one most used in radio work.

The sharpness of this tuning process is dependent upon the Q of the tuned circuit. A coil with a high Q will be more selective (better able to separate two close frequencies) but will of course produce a tuned circuit having a narrower bandwidth. If the signal to be selected is a single frequency all is fine, but most signals must cover a small bandwidth in order to convey information on a frequency as well as time basis. Fig. 14 sums up the various responses. To obtain a wider bandwidth the Q must be adequately low — sometimes resistance is added to spoil the Q to achieve the required compromise between selectivity and bandwidth.

Increased selectivity can be obtained by cascading tuned circuits. Filters used in telephony often consist of many pairs of components. The design of these is very specialised — it is more than merely adding stages one after the other.

When both high selectivity and wide bandwidth are needed, as is the case in radio programme reception, another arrangement is used. Effectively two tuned shunt circuits are used in cascade but with a difference. Each is tuned to a slightly different resonant frequency so that their characteristics overlap as shown in Fig. 15a. The resultant overall frequency response curve is one that has higher gain and a wider bandwidth. The small dip in the middle is not a problem provided the two central frequencies are not taken too far apart.

Rather than use two separate inductors it is, in practice, better to combine them into one component as a doubly-tuned transformer. A transformer is an inductive-coil assembly that can transform ac currents of voltages to smaller or larger values. This is based on the principle of mutual inductance, that is, windings linked by a common magnetic field have voltages induced in them in proportion to the number of turns in each coil.

In the tuned transformer, used in radios, the two windings are wound on a common former; this may be non-magnetic (ferrite, an iron powder material, is now commonly employed) depending on the frequency of operation. Tuning is achieved by screwing-in slugs of ferrite thus slightly altering the inductance. When the capacitance, rather than inductance, of the tuned circuit is to be varied to peak the circuit performance,

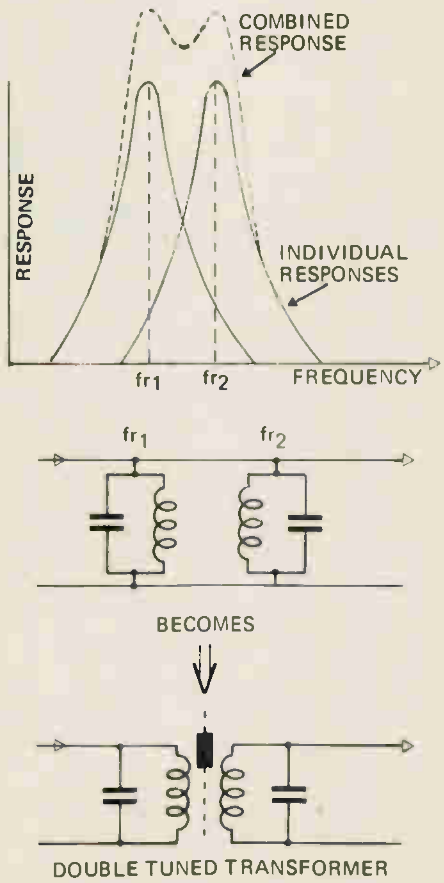


Fig.15. (a) Two tuned circuits may be used to obtain a better bandwidth/ selectivity compromise. (b) The two separate-tuned circuits may be combined into a single transformer. This construction is used extensively in radio receivers.

small-range variable capacitors are used. If the range needed is large – e.g. tuning across the AM radio band – the capacitor is invariably made of sets of blades that mesh into each other to vary the capacitance. A range of variable capacitors and transformers and chokes commonly encountered in electronics, is shown in the picture on page 54.

FREQUENCY GENERATION

If a resonant circuit arrangement is given a short impulse of energy – a short period of dc signal, for example – the energy put into the circuit oscillates back and forth between the magnetic field of the inductor and the electric field of the capacitor. This exchange of energy between reactances occurs at the resonant frequency. If the Q of the tuned circuit is high, this process will develop a reasonably pure sine-wave. If no more energy is added after the initial impulse the sine-wave will gradually die away as the energy is dissipated as heat in the coil resistance. If, however, an arrangement is made to add energy to the circuit every time the waveform rises to the same level and phase, the sine-wave will continue to run. High-power radio transmitters make use of this principle to obtain pure signals from highly distorted sources. It is, however, essential that the pulses are delivered to the system at the correct time. Pushing a child on a swing is a good example of pulsed excitation of a resonant system.

Electrically-operated clocks often use the energy pulse concept. The hair-spring and flywheel form the mechanical tuned circuit, and the flywheel rotates it makes a brief electrical contact with a small electromagnet that pulses the flywheel onward with an extra, small amount of energy. Pendulum clocks also often operate this way, gravity providing the restoring force for the mass of the pendulum. ●

ELECTRONICS - in practice

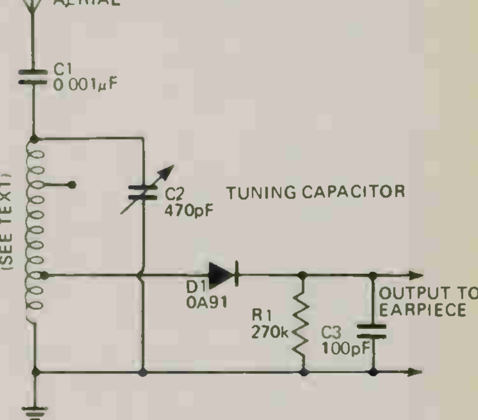


Fig.15. Circuit diagram of the crystal radio.

PARTS LIST — Crystal Radio ETI 227

R1 Resistor 270 k ½ watt 5%

C1 Capacitor 0.001μF
C2 " 100pF

D1 Diode OA91 or similar

L1 Coil see Table 1.

TC1 350pF-500pF tuning capacitor Robian or similar

Coil former piece of cardboard tubing (see Table 1).

TABLE 1
Winding details of air-cored coil (close wound).

COIL DIA.	NUMBER OF TURNS VERSUS WIRE GAUGE			
	22 SWG	24 SWG	26 SWG	28 SWG
1¼"				108
1½"			96	87
1¾"		88	77	70
2"	82	72	67	62
2¼"	71	64	58	54
2½"	61	56	52	49
2¾"	54	52	—	—

Note 1. Tap the coil every ten turns.
Note 2. For former sizes between those stated use an intermediate number of turns. This is not critical.
Note 3. Select the tap for the diode by determining which one gives best volume, whilst still adequately separating the stations.

CRYSTAL SETS were the latest thing in the 20's.

The schematic of the modern version of grandfather's pride and joy is given in Fig. 15. The term crystal-set was coined at the start, for early sets used a small piece of galena crystal which was touched by a fine piece of wire – the cat's whisker – to produce a rectifying contact, if and when you found the right place!

Today, that annoying variable is eliminated by using a germanium diode.

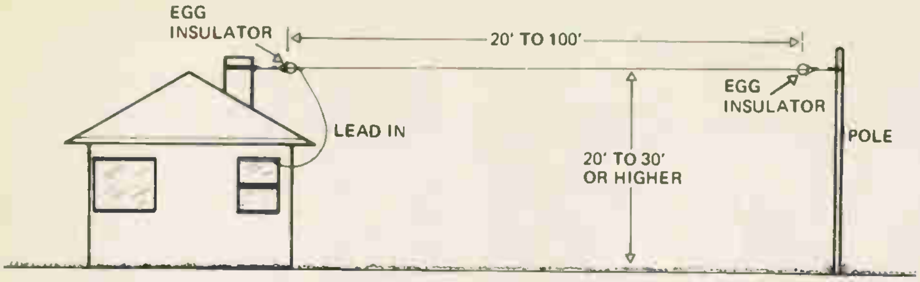
The aerial acts as a conductor in space and couples into the electromagnetic waves sent out by the broadcasting station; minute voltages are induced in it. These small signals, including those from unwanted stations as well, feed energy to the tuned coil and capacitor stage. Signals not at the resonant frequency of the tuned circuit do not excite it and, therefore, go undetected.

The detection and listening circuitry are connected to a tap on the coil, not across the entire inductor winding. This method is used to give the user the ability to make a compromise between signal strength and signal clarity, for the rest of the circuit acts as an unavoidable spoiling resistor that reduces the Q of the tuned circuit. Placed across the full winding the circuit reduces the Q, thus broadening the bandwidth, but reducing selectivity; placed across only a small part of the coil gives the highest Q (the best selectivity) but the smallest signal strength. In use, the taps are tried in turn to find that which gives the clearest signal with the best rejection of unwanted stations.

The diode (virtually any germanium diode can be used) rectifies the amplitude-modulated carrier.

The best headphones to use would be those with high impedance. Impedances of 2–4k are in the correct region. Crystal earpieces can also be tried if you are in a high signal strength area – you might be lucky.

Although this set is not to be compared with modern radios any experimenter who has not built one has missed out on a basic training exercise. It is a must.



This simple antenna is suitable for the crystal radio and may be used for the one transistor radio if required.

A LITTLE BETTER – THE ONE TRANSISTOR RADIO

Since the crystal-set days there have been many changes in radio detection. Apart from more efficient front-end aerials and coils these improvements all involve amplification with active amplifiers. We are not quite to the stage in this course where the operation of transistor amplifiers can be explained, but this simple circuit should present no constructional difficulties.

Note that the input stage is based on a standard modern radio antenna unit. The aerial couples into the tuned circuit by mutual inductance via its own quite separate winding. The resonating signal is taken from the tuned circuit by a second winding, an arrangement that enables a more optimum loading of the circuit to be achieved. It is, in fact, an inductor and transformer combined.

The transistor is used to amplify the signal and the radio frequency choke (R.F. choke) filters out the carrier. We will say no more about the rest of the circuit until the course has proceeded further.

Components for this radio are available from most component suppliers.

If radio receivers are your "thing" a good introductory book covering the practical assembly and operation of the above and more complex models is "Radio" by D. Gibson, Brockhampton Press, 1968. (Illustrated Teach Yourself Series). This inexpensive book is well illustrated and provides the constructional details of sets ranging from a crystal set through to quite advanced receivers. ●

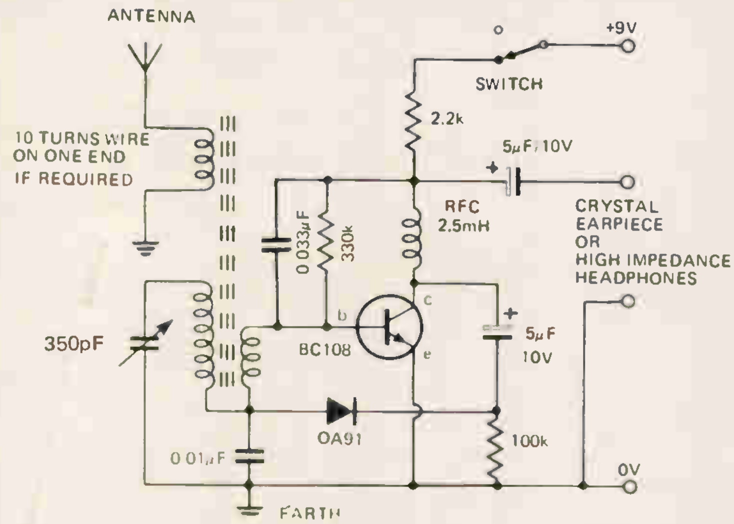


Fig.16. Circuit diagram.

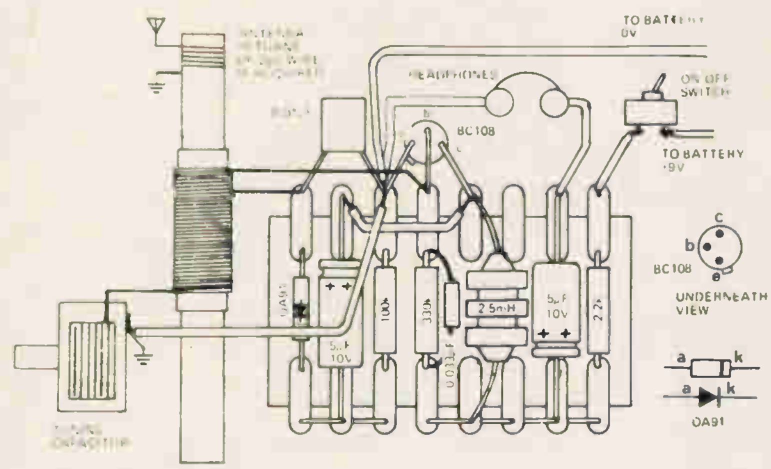
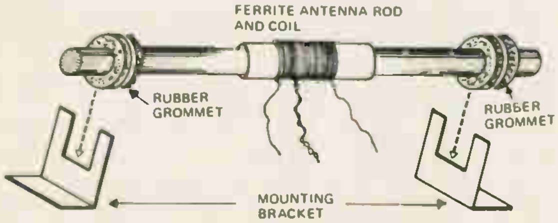


Fig.17. The receiver may be built on tag strips or a piece of circuit board.

PARTS LIST ETI 406 ONE TRANSISTOR RADIO

1 resistor 2.2k ½ Watt, 10%
1 resistor 330k ½ Watt, 10%
1 resistor 100k ½ Watt, 10%
2 capacitors 5μF 10 Volt electrolytic
1 capacitor .01μF
1 capacitor .033μF
1 transistor BC 108, BC 109, 2N3565 etc.
1 diode 0A 91 etc.
1 medium wave ferrite rod coil
1 tuning capacitor 350pF
1 nine volt battery and connectors
1 toggle switch — single pole single throw —
1 RF choke, 2.5 mH
1 crystal earpiece or high impedance headphones
1 pointer control knob
Rubber grommets, screws, plywood etc.



The ferrite antenna rod and coil can be supported by two grommets and small metal brackets.

DX MONITOR

Compiled by Alan Thompson

This month, as promised last time, the compilation consists of Part Two of our survey of African radio, country by country. Last month we took a safari from Algeria through to the Ivory Coast and (as confidently predicted by me!) radio engineers throughout the African continent rushed to change the frequencies of their stations just as soon as they learned the subject of DX MONITOR. If you can't manage to hear Radio Ghana on 4980kHz then there is nothing at all wrong with your radio or aerial, despite what I said! As I typed 4-9-8-0, GBC, having used that channel for at least 7 years, decided to move to 4825 – you just can't win. An added complication this month is that this round-up is being put together in mid-August and international stations around the world will be making their seasonal changes of frequency at 0100 GMT on 1st September, so I am mainly quoting "domestic" frequencies since they are rather less likely to change. With that caveat, here we go ....

KENYA: One of the easier African countries to hear! The National Service in Swahili is usually the dominant station on 4915kHz in early evening, signing-off around 2015. The General Service, in English, occupies 4805kHz until about the same time.

LIBERIA: The missionary radio station, ELWA, has an External Service in the international bands, with 11940 or 11950kHz being favourite channels. The English Home Service (HS) is a good signal on 4770kHz when interference from Communication stations allows it to be heard but most reports are of the service in Liberian vernaculars on 3227kHz which carries on until about 2245 GMT.

LIBYA: If you've been DXing for a few years you will not need reminding that this *was* an easy-to-hear country, with Tripoli using 100kW in the 25 metre band. Recently, Libya has curtailed its SW operations and it is now an irregular voice on SW: best prospect is the El Beida MW transmitter on 1124kHz, where its 1000kW can be heard most late evenings. If you are exclusively a SW-buff, you *might* catch it on either 6155 or the strange out-of-band channel of 8630kHz.

MALAGASY: Best bet is the International Service on 17730kHz from 1500-1600 daily, in English and French. If you hear French here at any other time then it is not Tananarive but ORTF Paris!

MALAWI: Not too difficult when the 90 metre band is open: 3380kHz gives good reception fairly often in the evening hours with programming in both English and Chichewa.

MALI: Radio Mali's HS is in French and local languages and can be located most evenings between 1800 and midnight on 4783, 4835 or (less frequently) 3380kHz.

MAURITANIA: One of the most regular African stations, Nouakchott has recently moved to 4845kHz where it may be heard in French, Arabic and local languages at any time of evening.

MAURITIUS: A really difficult one because the frequency varies from 4850 up to 4875 and back again: also, it is usually heard (in English and French which is some comfort) only between about 1800 and its 1830 sign-off. Last reported on 4871kHz a few weeks back.

MOROCCO: No real problem this one: usually dominates 11735kHz, in Arabic, throughout the evening hours.

MOZAMBIQUE: Radio Clube de Mocambique has a number of separate programmes and a wide range of channels – most usually reported are 4855 and 3210 throughout the evening, with the Beira regional station varying around 4890-4895kHz until about 2000 GMT when it signs-off. The language used on the above channels is Portuguese: English is sometimes heard over the "B" programme on 3265 and 4925kHz – that programme is all English but the channels are not the best, hence the "sometimes" caution.

NIGER: Not easy due to low-power transmitters (4kW): give 3260 or 5020kHz a try but expect to be disappointed! Programming is in French and local languages.

NIGERIA: Unless this one decides to move, 4990kHz ought to put this one in your log any evening after about 1900, through to 2305! It's mainly in English, too.

REUNION: You start trying for this island in the Indian Ocean on 4807kHz around 1800 when it is often audible until its scheduled sign-off at 1845. However, irregularly, it goes much later in the evening. Has the interesting sign-off ceremony of saying "Good-night" in half a dozen different languages, sending greetings to passing ships.

RHODESIA: Never easy, the RBC is most usually heard on 3396kHz during the mid-evening hours. However, care is needed in identification since Radio Nigeria also uses this channel and which one is received is an indication of propagation conditions at that time.

RWANDA: Deutsche Welle has a relay base at Kigali but that's the easy way to hear the country. More DX-ish, the HS of RRR is often very good in French and local languages on 6055 throughout the evening. Has, since early August, added a parallel channel of 3330kHz using a medium-power transmitter.

SENEGAL: A nice high-power transmitter uses 11895kHz until midnight, mainly in French. If you long for the noise of 60 metres, try 4890kHz.

SEYCHELLES: Until a few years back this one was on the "impossible" list - now, there is no difficulty in hearing the powerful voice of the Far East Broadcasting Association's transmitters if you can find the current channels. Latest recorded here are 15330 and 11890kHz for an English programme 1745-1800 daily.

SIERRA LEONE: You may be one of those who has tried for Freetown for years and years without any success. The only channel which has a chance of rising through the competing noise is 3316kHz and it only does so on rare occasions: when it does, it is often very good in the late evening, to 2330 close down. Worth trying for this over holidays, like Christmas, when the utility station which covers the channel is sometimes silent (or, at least, less active).

SOMALIA: One of the very difficult ones! At times when it may be heard in U.K. all programmes are in Somali and the channels used are all busy ones - 9585, 7120 and 6095kHz. Good luck - you'll need it.

SOUTH AFRICA: If you can't hear Radio RSA, the External Service, as you tune through the 41, 31 or 25 metre bands, around the hour, during the evening (in various European languages), then there is something amiss. The HS set-up has a programme in English, one in Afrikaans and a Commercial Service, as well as various other services carrying special features. Frequencies vary with time of year - try 3250, 3285, 3997, 4875 and 4965 (amongst others) in the 90 and 60 metre bands.

SUDAN: Winkle this one out of the pile-up on 5040kHz ± 2kHz, if you can! Irregularly has an English news during the evening but the time varies: otherwise in Arabic. Check your catch with the parallel 11835kHz, high-power transmitter.

TANZANIA: Another one where you should be able to do some cross-checks: 15435 and 4785 from 1600-2015 GMT. Currently, the HS is reported on 5050kHz until about 2000 GMT. R Tanzania Zanzibar on 3339kHz is sometimes a fair signal around 1900 GMT, in Swahili.

TOGO: In the fairly easy group, Radio Lomè on 5047 has an English news around 1950 (on most days): other times mostly in French.

TUNISIA: The very powerful station in Arabic on 11970kHz until about 2200 means you've captured the RTV Tunisienne transmitter at Sfax.

UGANDA: Two separate networks are operated in the HS of Radio Uganda - the Red Network on 4976 is the one most commonly heard in the evening: Blue Network on 5026 is a much rarer catch.

UPPER VOLTA: Radio Ouagadougou can sometimes be heard on 4815kHz in the evening hours but it's not the most powerful transmitter and the channel is a noisy one. The 41 m.b. outlet on 7230kHz may be heard in gaps between high-power European transmissions.

ZAIRE: Fairly easy on both 4880kHz and 15245kHz (varying up to 15262 at times), often with pleasant music programmes: language used is mostly French with periods in local languages.

ZAMBIA: Not at all an easy one! Best bet is 3346kHz which is not infrequently heard in the evening hours in English and vernaculars.

And that's the end of our African Safari. There are, as you may have noticed, other African countries which have not been mentioned. A few are "impossible" in the U.K. (e.g. St Helena and Tristan da Cunha); a few more are in the very difficult category and reception of them is really a question of being on the same channel at a favourable time day after day, until you get your catch (examples - Sao Tome, Lesotho and Swaziland).

Next month we shall be taking a look at the intriguing stations of Asia as the low-frequency DX season really gets under way, with (we hope) lots of good Far East openings in late afternoon and, again, in the late evening hours. DXers will be hoping that the winter of 1974-75 will be much better than the rather disappointing winters of the last two years in which good Far Eastern openings have been rare. ●

Electronics Tomorrow

by John Miller-Kirkpatrick

NOW THAT WE are on the wrong side of Summer 1974, King Arthur's table is shrinking ('the knights are closing in'?) and it is time to find something to build for those long boring winter evenings. Well, this month shows the start of the new components rush that tends to slow down during the summer months.

The electronics hobby market appears to be splitting into several defined groups: the all-out project where expense and time is no problem such as synthesisers, TV games and gigantic tuners; the mid-range bracket where the finished product has a functional use and the price is reasonable such as this month's Sinclair Scientific offer or last month's Digitronic offer; and the small, cheap project such as small amps or dice games etc. The problem for the constructor is whether it is better to build lots of small projects, thus getting experience over a wide range or to spend several months building a vast, all-singing, all-dancing, light-flashing thingamujig.

The first group tend to end up living in a house that visitors are scared to go into, with yodelling door chimes, electronic locks (that don't work during power cuts) and lights that flash whenever the temperature gets high or it rains or the dog wants to go out or even randomly.

The second group tends to take over a room with one corner for soldering, another for testing, a third for metalwork and the fourth for 'the project'. Whatever the project there is usually a small corner of a room from which come human (or semi-human) shrieks groans and grunts; mechanical or electronic ditto; and smells of overheating wire, burning insulation and/or skin. When next April comes around, you end up with either a collection of projects, some unfinished, some not working, or with one monolithic project which never seems to have exactly the same specification as was envisaged.

Very often the fact that the projects do not work is of no consequence, the fact that you have spent many "happy" and "satisfying" hours building it is. With this in mind, when you come to choose your project, do you build from square one or from modules?

Let us think of building a stereo tuner to fit onto your Hi-Fi, do you buy a Sinclair and finish the job in an hour, do you buy a tuner head, two I.C.'s and a few discretes and take a week, or do you buy FETs, filters, etc and spin the project out over a couple of months.

At one time you had no choice but to build from I.C.'s and modules. Valves have been, come and gone, only a few of the older constructors know how to use them and only a few shops carry a reasonable range (if any).

Even quite a few transistors have disappeared and RTL and DTL logic I.C.'s are now few and far between. I think that we can look forward to the day when BC108's come in fives in a 16 pin DIL or that 7490's are difficult to find in the shops.

I.C. manufacturers are producing new devices with multiple functions to replace several standard packages at the price of one of those packages. This is great for equipment manufacturers but not so good for some groups of amateurs that prefer to build to time or experience specs rather than cost or space. In this column we try to bring these new devices to your attention but don't rush out to buy them until you have decided whether you want to build your project the easy way or the hard way.

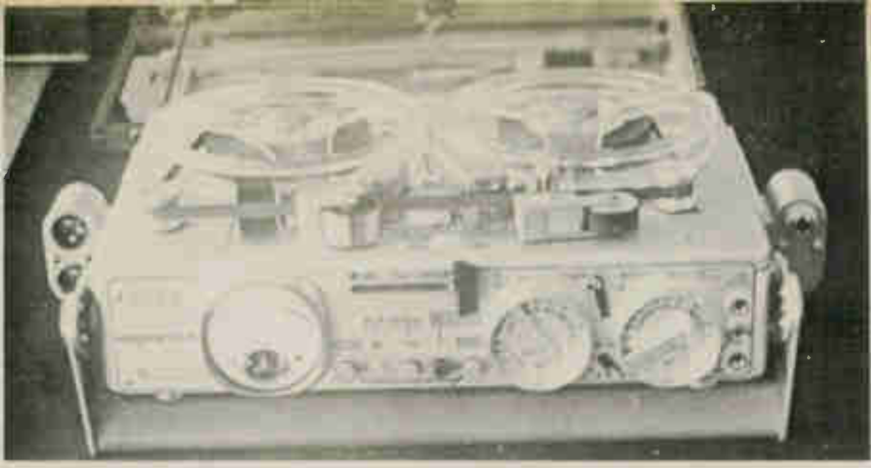
An example of this type of I.C. is a new addition to Motorola's rapidly expanding family of CMOS logic circuits. It is the MC14566 time base generator which consists of two pulse shapers, a divide-by-ten ripple counter, a divide-by-5 (or 6) ripple counter and a monostable multivibrator on a single chip. A single MC14566 can be connected to divide by 50 or 60 to produce one output pulse per second when fed with a 50Hz or 60Hz input frequency. In addition a BCD output indicating tenths of seconds is available. A second MC14566 can be connected to the first to provide a divide-by-60 with BCD outputs for seconds and tens of seconds. A third MC14566 connected similarly would give BCD outputs for minutes and tens of minutes and one output pulse per hour.

Although the devices can be used to construct digital clocks as shown in Fig 1, their main application is said to be to provide timing signals in industrial process control, data-logging and computing equipment working from 50 or 60Hz mains supply lines. Voltage requirements are 3-18V with a typical power dissipation of 25 nanowatts at 5V with a 1MHz input, package is a standard 16-pin DIL. Best people to contact for data or devices is likely to be *Jermyn Industries, Vestry Estate, Sevenoaks, Kent.*

Another useful I.C. from Motorola is the MC14553 which is a CMOS 3-digit counter/latch/multiplexer. Basically, it appears to be three decade counters with latches to provide a divide-by-1000 function with an output produced once per 1000 input pulses. The BCD outputs from the three counters are passed to the output pins in a multiplexed format together with digit enable outputs. Input pulses are shaped in a circuit which will accomodate extremely slow rising signals; this circuit also allows the input to be disabled by a control signal and prevents pulses from reaching the counters whilst they still retain their last count. The three counters feed three quad latches into which the contents of the counters are transferred when a pulse is fed to the latch enable input. A complete digital instrument for measuring any quantity that can be represented as a dc voltage can be built from one MC14553, one capacitor, a small amount of logic, a BCD to seven-segment decoder, three displays and three driver transistors. Also required is a simple VCO that will convert the voltage being measured into a pulse train. Again try Jermyn for data and devices.

A CALCULATOR/STOPWATCH

A new calculator is equipped with a mathematical stopwatch that is able to count time both forward and backward in continuous and discontinuous time intervals. What it does in fact is to add at 1/10th second intervals, so by adding 0.1 it will count in seconds. It will also cost telephone calls or business meetings, etc by entering a value per tenth of second (which can be worked out in calculator mode) and adding this each time. The calculator has auto-constant, floating DP, percentage, memory etc. all displayed on eight 0.2" LEDs. So before you dash off to buy a calculator think about having a digital stopwatch on it as well, for £44 plus VAT it seems to be quite a good buy. Available from *Imtech Products (Dept B), 35 Malden Way, New Malden, Surrey. Tel 01-949-2354.* ●



NEW NAGRA RECORDER

Kudelski to introduce three-motor recorder soon.

THE SWISS tape recorder manufacturer, Kudelski, has an outstanding reputation for producing high quality products.

Kudelski's Nagra recorder is in fact generally accepted as the best and most reliable machine of its type ever made.

Intended primarily for professional use, Nagra recorders range in price from $1500 to $3000 and have applications from producing synchronized sound tracks for film and TV productions and radio broadcast recording, to data aquisition, especially in sound and vibration engineering.

For many years the Nagra III tape recorder was the only true battery operated portable "high fidelity" tape recorder available, and it is worthwhile recounting that just after the mid-sixties an American corporation released pre-production information on their new tape recorder which had a specification performance equal to the Nagra III. Within weeks Kudelski unveiled the IV series Nagra – and the American Corporation shelved their production plans virtually overnight.

The Nagra deck is used as the basis for a large number of specialised recorders used for space, geophysical, military and scientific purposes, and Kudelski produces special stiffening frames to facilitate the fitting of multi-channel heads and wide tape reels.

The company have not yet entered the field of multi-channel tape recorders themselves (if one ignores the IV-SJ series recorder which is a true three-channel recorder) but it is obvious that they have set their eyes in that direction, for during a recent visit to the company's plant in Lausanne we came across the yet-unreleased Nagra 1S-D.

This new recorder is most probably the first three motor machine that Kudelski has produced. It is more than just an innovation or improvement on the basic portable Nagra, for the machine is obviously the first step that Kudelski is taking to develop a multi-track tape recorder system which will be the basis of a future incursion into the studio tape recorder market.

The Nagra 1S-D incorporates a push button operated mechanism which is a significant departure from the operational controls that have been a feature of all previous Kudelski tape recorders.

As can been seen from the illustration, the frontal appearance is typical of the BH-III series Kudelski Nagra with the exclusion of the operational controls in the top and bottom centre of the front panel.

The machine is significantly lighter than the Series IV machine and is claimed to have even better wow and flutter figures than those achieved by the series IV – which are most probably the best available in the industry at present.

Like the BH-III and early series IV machines, the input connectors are still designed for Cannon plugs, but the drive capstan system appears to be more rugged than that provided by the current series IV machines.

Kudelski is obviously delighted with this machine and although a release date was not available, it is clear that Kudelski will only release this machine because it offers distinct advantages in terms of improved performance from the series III and series IV Nagras.

It is now roughly six years since Kudelski released the series IV machines and excluding the improvements such as the two channel IV-S and IV-SJ released over the past two years, there have been no other new tape recorders released.

We expect that the 1S-D recorder will be even more in demand than the series IV and will become the obvious replacement for the series BH-III Nagras currently in use. ●

NAGRA PRODUCTION

The production facilities at the Lausanne factory are as modern as any in the world. From the production of their recording heads right through the machine and tool shops one gains a healthy respect for their excellence of production and quality control. The machine shops feature fully automatic numerically controlled lathes, and machines which produce the complex parts for the capstan supports on the one machine.

The technical staff are very proud of these facilities, and tell you so!

Each recorder is played with a continuous tape loop for twenty-four hours before final quality control testing is *even commenced*, and to see so many Nagra tape recorders undergoing this unusual pre-testing chore was really delightful. This run-in for each tape recorder provides not only a check of the quality of the head but also helps to provide a final honing of the head surface which is already mirror smooth from the automatic machining process.

Each machine undergoes a complete detailed acceptance test where all (not some) of the major system parameters are checked out to determine compliance of the machine with the published specification. This test includes record-to-replay frequency responses, wow and flutter, signal noise, channel separation, distortion, azimuth alignment and head linearity. All are carefully checked out, as is the degree of frequency response deviation in the critical 20-200Hz region.

An enlightening experience.

Tech–Tips

LM381 APPLICATIONS

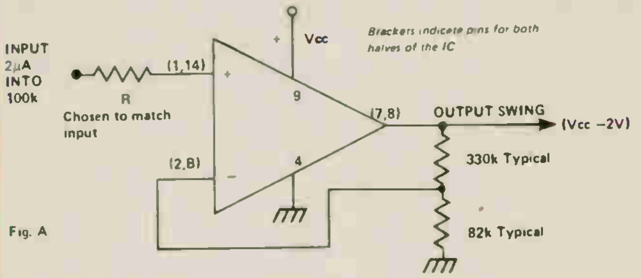


Fig. A

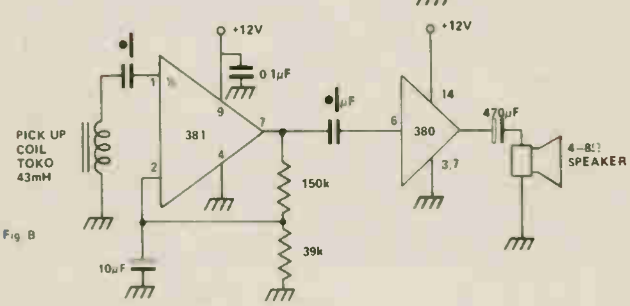


Fig. B

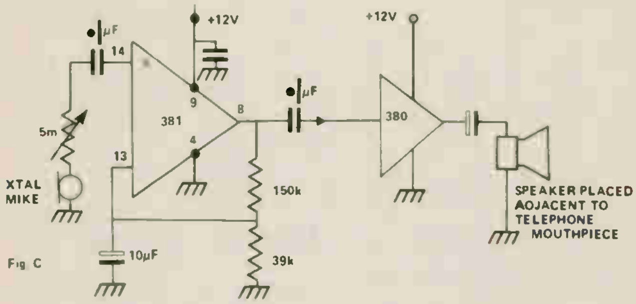


Fig. C

The LM381N dual op-amp has appeared several times in its usual guise as a low noise stereo audio preamplifier device. Indeed, it requires the very barest minimum of external components, since the function of the feedback resistors and capacitors is simply to determine the audio frequency response and gain.

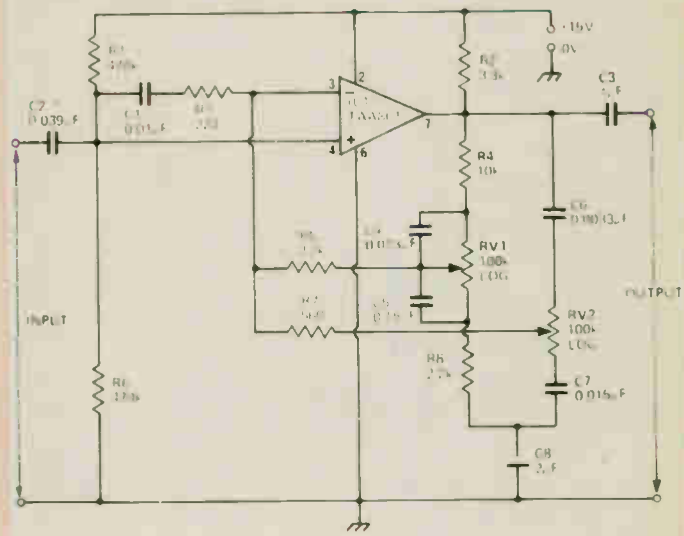
Because it is a dual op-amp, the LM381N can be used for most op-amp purposes where the many features can be used. The maximum voltage gain is 320,000 times, and the output voltage swing can be as great as the supply voltage less 2V. (Maximum supply voltage is 30V).

So the LM381N can be easily employed for instrumentation amplification, and the configuration for a basic DC amplifier is shown in Fig. A.

Figs. B and C are for a telephone pickup and speech amplifier. The pickup coil is placed near the earpiece while the speaker in C is placed adjacent to the mouthpiece. No electrical connections are made to the telephone.

The LM381N is available from Ambit International, 37 High Street, Brentwood, Essex CM14 4RH for £2.15 including VAT and postage and packing.

ACTIVE TONE CONTROL



The input signal is applied to the non-inverting input of the IC which is a Siemens TAA861 operational amplifier. Bass and treble boost and cut are controlled by the potentiometers RV1 and RV2 respectively.

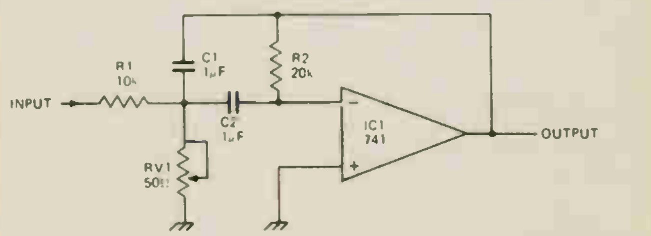
Control range is 20 dB of boost or cut at 50 Hz and 15 dB boost or 20 dB of cut at 12 kHz.

The overall gain of the circuit at 1 kHz is 15 dB and the input impedance is greater than 80 k ohm. Total harmonic distortion for 2.4 volts output is less than 0.5% and remains below 4% for up to 3.5 volts output.

Correct law for the potentiometer is antilog. This may be obtained by using slide potentiometers which are mounted in reverse (end-for-end) to normal.

Note that equalization is not incorporated in this preamplifier.

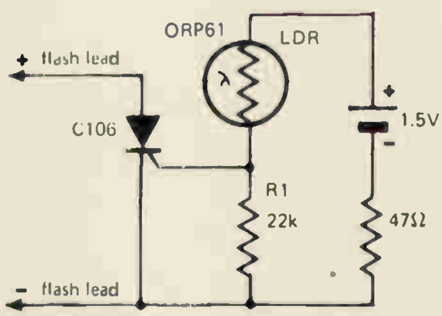
ACTIVE BAND PASS FILTER



This active filter has a gain of unity (0 dB) and is useful over the range 0.01 Hz to 3 kHz. The centre frequency of the passband is set by potentiometer RV1 and the bandwidth is determined by the values of R1, C1 and C2. The values shown in the circuit provide a bandwidth of about 15 Hz. With RV1 set to mid-position the centre frequency is approximately 220 Hz.

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

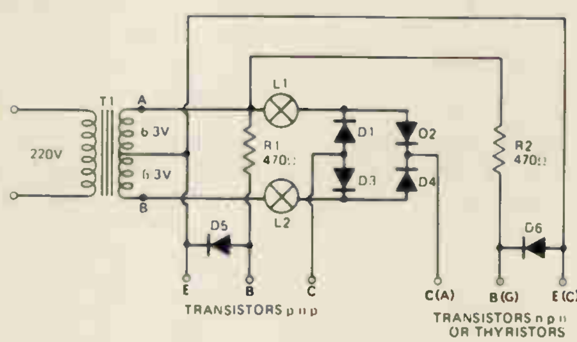
FLASH SLAVE DRIVER



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

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

SIMPLE TRANSISTOR/SCR TESTER

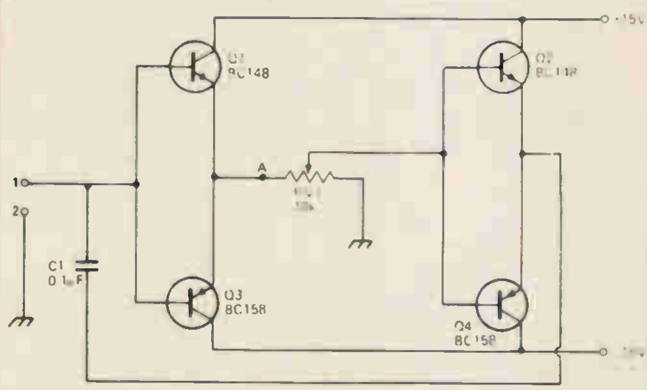


The 6.3-0-6.3V winding of T1 is bridge rectified by D1-D4, the two ac arms of the bridge being connected through L1 and L2 (75 mA maximum). The rectified waveform is applied to the collector of the transistor (or anode of SCR) under test.

The diodes D5 and D6 provide the correct drive polarity for the transistor base or SCR gate.

When testing a pnp transistor, for example, the collector and base are both driven negative when point A of the transformer swings negative. With a good transistor both functions will conduct, the transistor will saturate and L1 will be lit. If the base-collector junction is open circuit L1 will be off and if there is a collector-emitter short both lamps will be on.

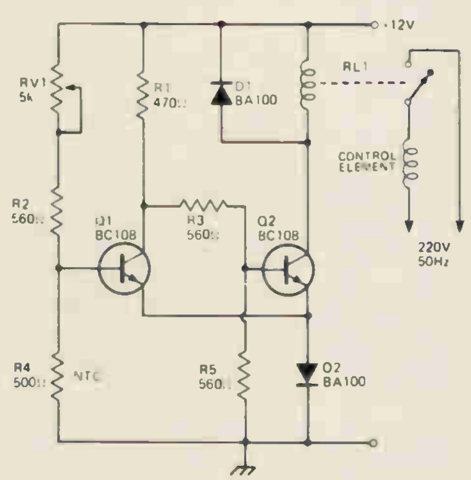
ELECTRONIC CAPACITOR



The value of capacitance existing between points 1 and 2 may be varied over a 1000 to 1 range by RV1.

The lower value of capacitance is due to C1, the transistor stages effectively multiply this capacitance, thus the total capacitance available from the circuit, as given, is 100μF.

It is possible to replace RV1 by a NTC or PTC resistor and thus the value of capacitance will depend on ambient temperature.



A negative temperature coefficient (NTC) resistor is used to sense temperature. Transistors Q1 and Q2 form a Schmitt trigger which switches when the voltage at the base of Q1 increases above 1.4 volts. Thus when the temperature falls below that set by RV1 the Schmitt changes state and the relay opens switching the heater 'ON'. Regulation accuracy is 1^{o} to 2^{o}C.

NEW RADIOTELEPHONE SYSTEM

A new radiotelephone system made by GEC-Marconi has recently started operating for the London Taxi Drivers' Association.

Until now the central station would put out a general call which could be answered by a number of drivers, often causing confusion. With the new system, the Taxi first sends automatically a sequential tone code which is picked up at the central station and displayed visually. If more than one cab replies the first caller can be identified and the message is passed to him.

The transmitter, near Marble Arch, has a 20-mile radius and is currently serving 250 Taxis but within 18 months a further 750 are hoped to be added.

Ernie Keates of the London Taxi Drivers' Association said the new system had cut down the wasted communications time by a half and that other radiotelephone users were showing interest due to the success of the scheme.

CABLE TRACER

Metrawatt (U.K.) Ltd. has introduced a battery-operated cable tracer designed to aid electrical engineers and D.I.Y. enthusiasts in the location of cables concealed under plastered walls and similar coverings and in troubleshooting for cable breaks and short circuits. The LS2 - which is priced at £27.50 - can also be used as a voltmeter for measuring a.c. voltages up to 400V.

In its cable tracing function, the LS2 has both capacitive and inductive search ranges. The capacitive search range permits the detection of cables connected to an a.c. voltage at 30cm while the inductive range indicates a.c. current carrying lines at 15cm. It has a 3" meter scale and a rotary range switch and sensitivity control. Plug-in and clip-on probes are provided for voltmeter applications.

D.A.T.A. SEMICONDUCTOR APPLICATION NOTES BOOK

The latest edition of the Semiconductor Application Notes D.A.T.A. Book is now available from *London Information (Rouse Muir) Ltd., Index House, Ascot, Berks, SL5 7EU.* The cost is £16.00 annual subscription (2 editions).

The publishers have extracted and tabulated in standardized format nearly 3500 circuit and device descriptions from manufacturers' literature. This is designed to give an overall picture for selection from existing designs. Notes from 55 international makers are set out in analogue and digital categories with sub-categories giving application details. Reader reply coupons are included so that the actual application notes can be ordered.

The book is available on a 30-day free trial offer, a refund will be made if returned within that period.

FLUORESCENT NUMERIC DISPLAY ONLY 5MM THICK

Incorporating all the advantages of fluorescent displays without the disadvantage of a large tubular glass envelope, a new fluorescent numerical readout only 5 mm thick (10 mm over connecting pins) is available from Walmore Electronics Ltd. The display, which is manufactured in America by Tung Sol, is fully compatible with modern MOS LSI integrated circuits and may be driven directly by them without any additional interface circuits.

Running from the nominal 25V d.c. (12 to 50 V) often required for MOS devices, the displays need an additional winding on the mains transformer to supply the 45mA at 1.5V required by the filament. Filament supply can be either a.c. or d.c.

Peak output occurs in the blue-green region although the output bandwidth embraces the whole visible spectrum. Many colours can be obtained with the use of filters.

With a 25V supply, a current per segment of 270µA is typical. The displays are available in single digit (22.3 x 12.7 x 5.1 mm) packages or in multiple digit units, e.g. a 12 hour clock with a.m. and p.m. indication. Single character packages can be mounted side by side to provide the same inter-digit spacing as the multiple digit units. The displayed characters, which measure 6.2 x 9.8 mm, are intended for mounting at 12.5 mm centres.

Walmore Electronics Ltd., 11-15 Betterton Street, London, WC2H 9BS.

CASE-HARDENING TESTS USING EDDY CURRENTS

One of the problems of case-hardening is the measurement of the depth of the case produced by the case-hardening process. This measurement is usually carried out by taking one or two sample products from each batch of work and, after sectioning, the depth of the case is physically measured.

During the past three years, Teledictor Limited have been investigating a method using a technique which will give a rapid and accurate indication of the depth of case without having to destroy products under test.

The method employs the Teledictor Type 936 Ferrous Segregator which can be used to measure the depth of case produced by any of the existing methods of case-hardening up to a maximum depth of 6mm (¼"). The system utilises the eddy current magnetic bridge principle and relates increases in case depth to decreases in magnetic permeability. These permeability differences are monitored to show as differences of scan on an oscilloscope.

Electronic thresholds are incorporated in the Segregator which can be pre-set to indicate satisfactory products by a green lamp signal, undercased products by a red lamp, and overcased by a yellow lamp signal. In a fully automated system using a Teledictor Type 940 Conveyor these signals are used to initiate the operation of a three-way sorting gate to channel products into their respective case depth groups.
Teledictor Ltd., Groveland Road, Tipton, West Midlands DY4 7XH.

COMPUTERS SUPERVISE TRAIN RUNNING

The railway network in the Munich area includes 400 route kilometers of S-Bahn and lines to the local towns and cities. Often the area has to cope with up to 150 moving trains simultaneously. In the face of such traffic volumes the previously used methods are no longer adequate. Almost all of the interlocking towers within a radius of 40km round Munich are of the modern pushbutton-operated type which lend themselves to data acquisition. Hence it was possible to build up a computerized system capable of handling this huge amount of data automatically and processing it for supervisory and control purposes.

The heart of the new control office at Munich is a data processing system incorporating Siemens process computers.
All the timetables of trains running in the Munich area and the actual deviations from the scheduled times are fed in to this system via ten data channels, six Siemens 304 computers, combined to form three duplex systems to improve reliability, receive from over 100 stations a continous flow of information on all important train movements. The system knows where any train is at any instant. By comparing the information for train supervision and later for train control.

The control office is subdivided into five zones each under a traffic controller with c.r.t. displays which enable him to call in sections up to 50 km long from the computer. The screen shows line and station tracks, train numbers and time delays.

In the event of any irregularities, the traffic controllers can set up a radio link between the station train controllers and the train drivers or speak to the train drivers themselves to ask them, for instance, to try to make up lost time when delays occur.

Since the c.r.t. displays cannot show all the 36 tracks of the main station, an information board 7.5m long and 2m high with 400 number displays is arranged in front of the controllers. This permits the train numbers and location to be given for all trains in the inner area of Munich. It operates independently of the computers.

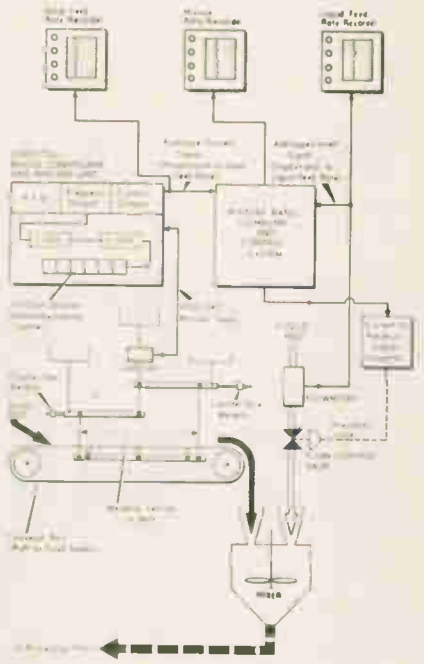
The computer system also makes possible the issue of spoken information on deviations from time tables. The station train controllers make their enquiries in digital form via telephones with twelve-number dials. First of all the system is rung up as a normal number on the railway telephone network, followed by the twelve as authorization code, the number of the train to which the enquiry is related and finally by the eleven to indicate the end of the enquiry. The computer then works out the answer, calls up corresponding speech syllables from a magnetic disc, composes a spoken announcement from them and switches them through to the caller.

Even the first stage of the new system has improved train services and made them more efficient. Fully automatic train operation will soon become a reality.

UNIQUE WEIGHING SYSTEM

Details of an ingenious conveyor belt weighing system have been released by Courtaulds who developed the system recently.

The basic problem was to measure the weight of a 'wild' feed of solid pulpy material so that it could be exactly ratioed with a controlled liquid feed to produce a mixture of precisely proportioned constitutents. The weighing system forms part of a continuous manufacturing process and already three installations are operational in a Courtaulds' factory.



One unusual feature of the weighing system is that two separate signals are derived from the output of the load cell (made by Transducers (CEL) Ltd). The first is a conventional 4-20 mA current signal that at any given moment is proportional to the weight of solid pulp (in either layered sheet or 'crumb' form) being fed onto the constant-speed conveyor belt and then into the mixer. This signal is compared with the analogue current signal derived from a flowmeter measuring the rate of liquid feed, so that the ratio of the two feed rates can be computed immediately. Any difference between this computed ratio value and the desired pre-set value generates a corrective feedback signal, which is used to adjust a liquid flow control valve and thus restore the solid/liquid proportion to the correct value at all times.

The second signal derived from the output of the load cell is a series of pulses, the total number of which is directly proportional to the weight of solid material that has been fed into the mixer. The system is calibrated so that one pulse is equivalent to 1 kg of solid feed, and the sequence of pulses is fed to an electromechanical totaliser in order that the total weight of solid feed delivered can be displayed digitally.

The signal conditioning and amplifier units provide three levels of damping to filter out unwanted noise from the system and thus ensure accuracy.

NEW ELECTRONIC TRANSMISSION CONTROL

A new electronically controlled transmission system, developed jointly by the Ford Motor Company and Ferranti for public service vehicles, is expected to make a significant contribution to road safety by reducing driver fatigue.

The system makes gear changing a finger-tip operation. Using a conventional gear lever in miniature the driver simply selects the gear he wants, the rest is left to the automatic system.

The control unit will eventually be much smaller than the prototype shown here.

The system is based on the use of a non-synchromesh ('crash') gearbox with a conventional clutch, but with hydraulic actuators controlled by electrically operated valves.

These valves are controlled by digital electronic circuits, so avoiding the drift problems of analogue controls. Once the driver has selected a gear, movements of clutch, gear shift mechanism, exhaust brake (to slow engine) and accelerator take place automatically, smoothly and in correct sequence.

Safety features are built into the control system to guard against the effects of driver error such as engagement of a low gear while travelling at high speeds.

The electronic equipment is light and can be located behind a seat. The Ferranti pre-production equipment, demonstrated recently at a motoring Press preview for the system at Ford's Dunton facility, comprises two small units — one being a power supply and the other the main control unit measuring some 11" x 9" x 5½" and housing approximately 300 IC's and other components. The final version will be even more compact; circuitry based on Ferranti CDI integrated circuits will be housed in a single unit weighing less than 5lb.

Tests of the new system have shown that wear on gearboxes and clutches is much reduced whilst gear changes can be made more quickly than can be achieved by skilled drivers using conventional controls. The system is much less expensive than hydraulic automatic transmissions using torque converters and is not subject to the associated power losses.

LASER DRY-CLEANERS NOW!

Many of Venice's medieval and renaissance buildings have been blackened and eroded by industrial smog. Even works of art housed within the public buildings and palazzi are under attack.

Conventional cleaning methods, such as chemical solvents or sand-blasting cause more damage than the disease itself.

Recent experiments show, however, that a laser beam can be used to remove pollutants and reveal the original natural beauty of the stone or wood beneath.

The work has been researched jointly by Dr. Ralph Wuerker of TRW (One Space Park, Redondo Beach, California, USA) and Dr. John Asmus of the University of California, San Diego.

A further, vaguely allied, project of the two research workers was to create holographic images of Venetian sculptures so that three-dimensional images of the works of art could be recreated anywhere in the world.

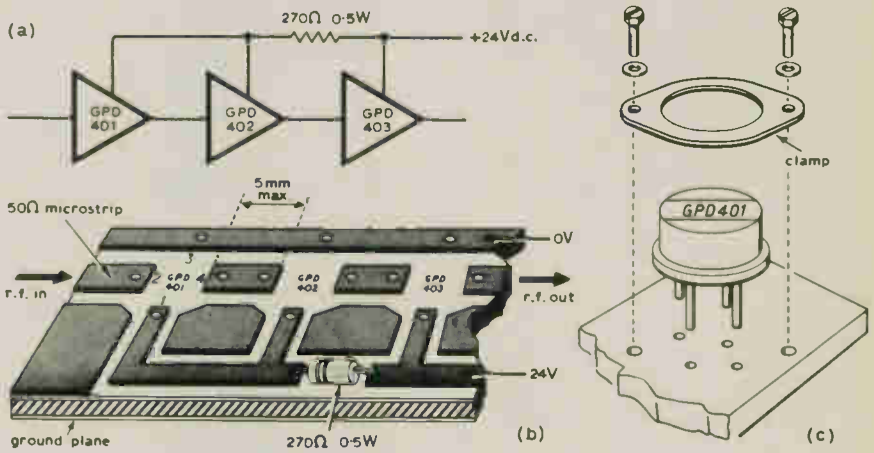
NEW STORAGE MEDIUM

A new information storage effect has just been announced by IBM. The effect, can handle phase and amplitude data over a band-width of $10^8 - 10^{10}$ Hz or higher.

The data is stored as a stable pattern of electrons trapped in a photo-sensitive piezo-electric crystal. The storage pattern is produced by interaction between two input signals — one electrical and one acoustical.

Read-out is obtained by applying a signal of the same frequency as the original input — this caused the stored data to radiate an 'echo'. Data is erased by shining a light onto the material.

5-400 MHZ AMPLIFIER USING FOUR COMPONENTS



This wideband r.f. amplifier will provide a gain (within 2dB) of 35dB from 5 to 400MHz. The noise figure will be about 4.7dB and the power output (into 50Ω) will be +14dBm.

Avantek have designed this universal r.f. amplifier for applications where it would be uneconomic for a company to design and develop their own. The result is the GPD 400 series - three basic r.f. amplifiers housed in transistor-style TO-12 packages. The three basic types are shown connected in cascade in the drawing. A suitable printed circuit board layout for the triple cascade amplifier is shown in the drawing at (b). The printed circuit board should be double-sided and have a low loss at the frequency of interest. The exact width of the input and output lines will depend on the dielectric constant of the board and should be such that the lines have a characteristic impedance of 50 ohms. For best performance in cascaded systems GPD amplifiers should not be mounted further than 5mm apart. The amplifiers themselves are held in physical contact with the ground place by a special clamp which is provided with each device (c).

The devices are available from Walmore Electronics Ltd, 11-15 Betterton Street, Drury Lane, London WC2.

AUTOMATIC TICKET BARRIER

A new electronic ticket barrier system has been introduced by Automatic Revenue Controls Limited.

The system consists of a basic two-way or one-way-only entry/exit gate to which can be added a series of facilities to suit exactly its application. In its simplest form, the gate accepts a magnetically encoded ticket from the passenger, checks it electronically and returns it to the passenger, releasing the barrier at the same time.

The gate will 'remember' up to four tickets in a row so that tickets presented by passengers before an earlier passenger has operated the barrier will not be rejected. (This has been found useful when a parent feeds in tickets for the family to pass through.)

The gate can be equipped to update multi-journey tickets each time they are presented, by deducting one journey from those recorded on the ticket's magnetic surface. A light shows the passenger how many journeys he has left. Exit gates can be programmed to retain multi-journey tickets reading nil.

Season tickets are similarly allowed for, although here only the validity of the date has to be checked and no amending of the ticket is necessary. If an expired season ticket is presented, the gate is normally designed to return it to the passenger without unlocking the barrier.

NEW SOUND ABSORBER

A new wall lining material, having the appearance of sandstone, has sound absorbing properties similar to acoustic lines.

The material based on resin coated foundry sand has been developed by British Industrial Sand in association with Sound Research Laboratories (Holbrook Hall, Sudbury, Suffolk).

Prototype material tested at SRL's laboratories show that the material has mid-frequency absorption of 0.8. This is similar to that obtained from a luxury-grade deep pile carpet laid on thick underfelt.

AUDIO-VIDEO LINKAGE

The picture shows the setting up of an audio-video linkage between buildings at HMS Mercury, the navy's signal school near Petersfield. This new opto-electronic linkage transmits across obstacles such as roads, railways and waterways using modulated infra-red radiation (900 nanometers). It carries picture and sound with a duplex telephone service channel.

There are applications in education, surveillance, heavy industry, civil engineering, radio-active areas and for relaying closed circuit television at conferences and exhibitions.

NOW THE VIDEO-CARD

A flat chromium oxide card no longer than a page from an average book can provide 10 minutes playback in colour plus full stereo sound.

The new video-card, devised by the Sony Corporation, was demonstrated at a recent International Magnetic Conference (May 16, 1974) in Toronto and also a few days earlier in Tokyo.

The technique — to be known as MAVICA — has substantial advantages over more conventional video-tape systems.

The Mavicard consists of two rectangular sheets of videotape-like material measuring about 16cm by 22cm. One sheet carries the audio signal, and has a claimed 38 dB signal/noise ratio. The second sheet provides the video signal — resolution of this, Sony claim, is almost as good as the U-Matic VTR. The sheets are automatically separated as they are fed into the player.

Recording costs should be a mere fraction of the cost of normal video-tape systems. The blank Mavicards cost only a few pence each in volume and recording is virtually a mass-duplicating process similar to printing — except that the programme material is transferred thermally.

'LOW-TEMPERATURE' LITHIUM CHLORINE BATTERY

A rechargeable lithium/chlorine battery that operates at 425°C — 225°C lower than previous lithium/chlorine batteries — has been developed by General Motors Research Laboratory.

The improvement is due to a special eutectic LiF/LiCl/KCl mixture that forms the electrolyte. Although the power of the battery (624 watts per kg) is satisfactory for vehicle propulsion, high-temperature corrosion problems must be solved for the battery to be commercially useful.

MINI-ADS

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The Proprietors of British Patent No. 992666 for "Discharge chamber with current lead-in" desire to enter into negotiations for the sale of the patent, or for the grant of licences thereunder. Further particulars may be obtained from MARKS & CLERK, 57-60 Lincoln's Inn Fields, London WC2A 3LS.

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Contain hundreds of resistors, switches, capacitors, pot (all new) + crystals, transistor panels and loads of odds and ends. Only £1.82 (40p).

VERSATILE POWER UNIT
Contains double insulated mains transformer, 2 amp thermal cut-out and bridge rectifier. Will give 1.7V–10.5V output with two extra capacitors (provided). Ideal for Nickel-Cad charger, 5V TTL supply, cassettes, radios, etc. Supplied complete with information 95p (20p). Also available as model garage woth lamp, switch, jack plug, etc. £1.35 (30p).

3W TAPE AMPLIFIERS
Polished wood cabinet 14 x 13 x 9" containing a sensitive (20μV) 4 valve amplifier with tone and volume controls, 3 watts output to the 7 x 4" 3 speaker. Also included is a non-standard tape deck. Supplied in good working condition with circuit Mains operated. £3.30 (£1.25). Amplifier chassis complete and tested (2xECC83, EL84, EZ80) and speaker £2.20 (45p).

COMPUTER PANELS
3lbs assorted panels £1.10 (30p) 7lbs £2.20 (40p). Pack containing at least 500 components including at least 50 transistors 66p (20p). 12 high quality panels with power transistors, trimpots, IC's, etc. £2.20 (30p) 100 for £13.00 (£1.00). Trade supplied.
ALL PRICES INCLUDE VAT; Carriage in brackets, SAE list, enquiries.

GREENWELD (ET2), 51 Shirley Park Road, Southampton, New Retail/Wholesale/Mail Order Premises. Tel. 0703 772501. Also Retail shop at 38 Lower Addiscombe Road, Croydon.

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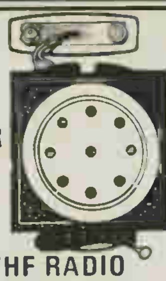

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