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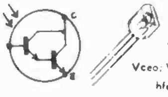

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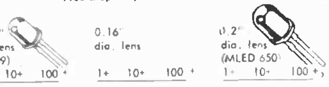

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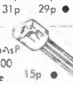

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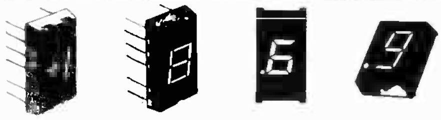

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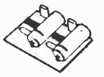
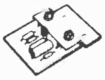
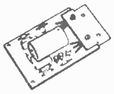


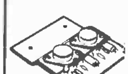
SS103-3
Stereo version of above (two I.C.s) **£3·25**



NEW! SS105 Mk. 2
A compact all-purpose power amp. Can be run from 12V car battery. Size 3½in × 2in. Useful 5W output (mono) into 3Ω using 12V. Excellent value. **£2·25**



SS110 Mk. 2
Similar in size to SS105 but will give 10W output into 4Ω using 24V (mono). Two in stereo give first-class results, suitable for many domestic applications. **£2·75**



SS140
Beautifully designed. Will give up to 40W R.M.S. into 4Ω. Excellent S.N.R. and transient response. Fine for P.A., disco use, etc. Operates from 45V d.c. Two in bridge formation will give 80W R.M.S. into 8Ω. **£3·60***

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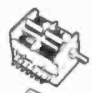

SS201
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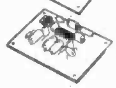
SS202
I.F. Stage (with I.C.). Designed to use with SS201 uses I.C. Carefully checked before despatch. **£5·25**



SS203
Stereo Decoder. Designed essentially for use with SS201 and SS202, this excellent decoder can also make a stereo tuner of almost any single channel FM tuner. Supplied ready aligned. A L.E.D. can easily be fitted. **£5·62**

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TP24 Twenty PNP Silicon, uncoded TO5. Similar to BFY64, 2N2904/5.

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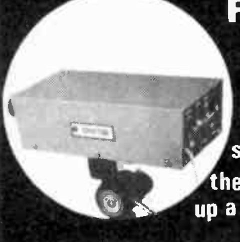

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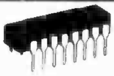

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4009A	41	4021A	98	4049A	42	4081A	19
4010A	38	4022A	78	4050A	42	4082A	25
4011A	21	4023A	18	4066A	63	4528A	1-14
4012A	18	4024A	63	4068A	31	4585A	1-49

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Gives instant changeover from "Sparkrite" ignition to conventional ignition for performance comparisons, static timing etc., and will also switch the ignition off completely as a security device. Includes: switch, connectors, mounting bracket and instructions. Cables excluded.

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100uA	£4.65	20V DC	£4.50
200uA	£4.60	50V DC	£4.50
500uA	£4.55	300V DC	£4.50
50-0-50uA	£4.65	15V DC	£4.60
100-0-100uA	£4.60	300V AC	£4.60
1mA	£4.50	VU Meter	£5.60
5mA	£4.50		
10mA	£4.60		
50mA	£4.50		
100mA	£4.50		
500mA	£4.60		
1A DC	£4.50		
5A DC	£4.50		
10A DC	£4.50		
5V DC	£4.50		

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Size: 80 x 80mm

50uA	£4.95
100uA	£4.90
500uA	£4.60
50-0-50uA	£4.80
100-0-100uA	£4.85
1mA	£4.60
1A DC	£4.60
5A DC	£4.60
20V DC	£4.60
50V DC	£4.60
300V DC	£4.60
300V AC	£4.75
VU Meter	£5.95

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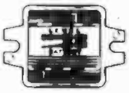

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18mm Panel mounting.
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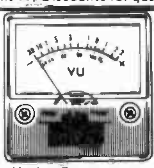

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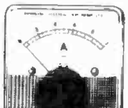
250uA Size: 33mm x 20mm.
£1.55 P/P & Ins 15p

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm



50uA	£3.55	15V AC	£3.40
100uA	£3.50	300V AC	£3.40
200uA	£3.45	5 Meter 1mA	£3.75
500uA	£3.30	VU Meter	£4.30
50-0-50uA	£3.50	1A AC	£3.25*
100-0-100uA	£3.45	5A AC	£3.25*
500-0-500uA	£3.25	10A AC	£3.25*
1mA	£3.25	20A AC	£3.25*
5mA	£3.25	30A AC	£3.25*
10mA	£3.25		
50mA	£3.25		
100mA	£3.25		
500mA	£3.25		
1A DC	£3.25		
5A DC	£3.25		
10V DC	£3.25		
20V DC	£3.25		
50V DC	£3.25		
300V DC	£3.25		

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm

50uA	£4.10	5 Meter 1mA	£4.20
100uA	£3.85	VU Meter	£4.85
500uA	£3.70	1A AC	£3.65*
50-0-50uA	£3.85	5A AC	£3.65*
100-0-100uA	£3.70	10A AC	£3.65*
1mA	£3.65	20A AC	£3.65*
5mA	£3.65	30A AC	£3.65*
10mA	£3.65		
50mA	£3.65		
100mA	£3.65		
500mA	£3.65		
1A DC	£3.65		
5A DC	£3.65		
10V DC	£3.65		
20V DC	£3.65		
50V DC	£3.65		
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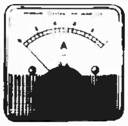
8A	£19.45	£1.50
10A	£23.75	£1.50
12A	£25.90	£1.50
20A	£60.45	£1.50
25A	£64.75	£1.50
40A	£73.40	£1.50

CLEAR PLASTIC MODEL SO640
Size: 85 x 64mm

50uA	£4.20	10V DC	£4.05
100uA	£4.15	20V DC	£4.05
200uA	£4.10	25V DC	£4.05
500uA	£4.05	50V DC	£4.05
50-0-50uA	£4.15	300V DC	£4.05
100-0-100uA	£4.10	15V AC	£4.15
1mA	£4.05	300V AC	£4.15
5mA	£4.05	VU Meter	£4.95
10mA	£4.05		
50mA	£4.05		
100mA	£4.05		
500mA	£4.05		
1A DC	£4.05		
5A DC	£4.05		
10A DC	£4.05		
5V DC	£4.05		

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm



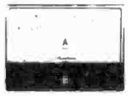
50uA	£3.45	10V DC	£3.05
100uA	£3.40	15V DC	£3.05
200uA	£3.30	20V DC	£3.05
500uA	£3.10	50V DC	£3.05
50-0-50uA	£3.40	100V DC	£3.05
100-0-100uA	£3.30	150V DC	£3.10
500-0-500uA	£3.05	300V DC	£3.10
1mA	£3.05	500V DC	£3.15
1-0-1mA	£3.05	750V DC	£3.15
2mA	£3.05	15V AC	£3.15
5mA	£3.05	50V AC	£3.15
10mA	£3.05	150V AC	£3.15
20mA	£3.05	300V AC	£3.15
50mA	£3.05	500V AC	£3.30
100mA	£3.05	5 Meter 1mA	£3.50
150mA	£3.05	VU Meter	£4.10
200mA	£3.05		
300mA	£3.05		
500mA	£3.05		
750mA	£3.05		
1A DC	£3.05		
2A DC	£3.05		
5A DC	£3.05		
10A DC	£3.05		
3V DC	£3.05		

BAKELITE MODEL MR 65 Size: 80 x 80mm

25uA	£5.80	300V DC	£3.95
50uA	£4.40	30V AC	£3.95*
100uA	£4.35	50V AC	£3.95*
500uA	£4.05	150V AC	£3.95*
50-0-50uA	£4.35	300V AC	£3.95*
100-0-100uA	£4.30	500V AC	£3.95*
500-0-500uA	£3.95	VU Meter	£5.20
1mA	£3.95	1A AC	£3.95*
1-0-1mA	£3.95	5A AC	£3.95*
5mA	£3.95	10A AC	£3.95*
10mA	£3.95	20A AC	£3.95*
50mA	£3.95	30A AC	£3.95*
100mA	£3.95	50A AC	£3.95*
500mA	£3.95	500mA AC	£3.95
1A DC	£3.95	50mV DC	£4.15
2A DC	£3.95	100mV DC	£4.15
5A DC	£3.95		
10A DC	£3.95		
15A DC	£3.95		
30A DC	£3.95		
50A DC	£4.20		
5V DC	£3.95		
10V DC	£3.95		
15V DC	£3.95		
20V DC	£3.95		
50V DC	£3.95		
150V DC	£3.95		

LASKYS make sense of Test Equipment

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm



50uA	£5.05	150V AC	£4.90
100uA	£4.95	300V AC	£4.90
500uA	£4.75	VU Meter	£6.25
50-0-50uA	£4.95		
100-0-100uA	£4.90		
1mA	£4.75		
1A DC	£4.75		
5A DC	£4.75		
20V DC	£4.75		
50V DC	£4.75		
300V DC	£4.75		

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Top value 1,000 opv pocket multi-meter. Ranges:—0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistance: 0/150k ohms. Decibels: −10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

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MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.

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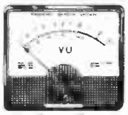
100uA	£8.70	50V DC	£8.40
50-0-50uA	£8.70	300V DC	£8.40
1mA	£8.40	500mA 5A DC	£9.50
1-0-1mA	£8.40	5V 50V DC	£9.50
1A DC	£8.40	5V 15V DC	£9.50
5A DC	£8.40	1A/15A DC	£9.50
5V DC	£8.40		
10V DC	£8.40		
15V DC	£8.40		

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm

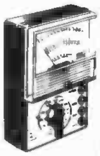


50uA	£6.00	50V DC	£5.75
100uA	£5.95	150V DC	£5.75
200uA	£5.90	300V DC	£5.75
500uA	£5.80	15V AC	£5.85
50-0-50uA	£5.95	300V AC	£5.85
100-0-100uA	£5.90	5 Meter 1mA	£6.65
500-0-500uA	£6.65	VU Meter	£7.10
1mA	£5.75	1A AC	£5.75*
1-0-1mA	£5.75	5A AC	£5.75*
5mA	£5.75	10A AC	£5.75*
10mA	£5.75	20A AC	£5.75*
50mA	£5.75	30A AC	£5.75*
100mA	£5.75		
500mA	£5.75		
1A DC	£5.75		
5A DC	£5.75		
15A DC	£5.75		
30A DC	£5.95		
10V DC	£5.75		
20V DC	£5.75		

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm

50uA	£4.35	300V DC	£4.10
100uA	£4.25	15V DC	£4.20
200uA	£4.20	50V AC	£4.20
500uA	£4.15	150V AC	£4.20
50-0-50uA	£4.25	300V AC	£4.20
100-0-100uA	£4.20	500V AC	£4.30
500-0-500uA	£4.10	5 Meter 1mA	£4.85
1mA	£4.10	VU Meter	£5.20
1-0-1mA	£4.10	1A AC	£4.10*
5mA	£4.10	5A AC	£4.10*
10mA	£4.10	10A AC	£4.10*
50mA	£4.10	20A AC	£4.10*
100mA	£4.10	30A AC	£4.10*
500mA	£4.10	50A AC	£4.10
1A DC	£4.10	50mA AC	£4.10*
5A DC	£4.10	100mA AC	£4.10*
10A DC	£4.10	200mA AC	£4.10*
15A DC	£4.10	500mA AC	£4.10*
20A DC	£4.20		
30A DC	£4.25		
50A DC	£4.10		
5V DC	£4.10		
10V DC	£4.10		
15V DC	£4.10		
20V DC	£4.10		
50V DC	£4.10		
150V DC	£4.10		

AUDIOTRONIC MODEL ATM5



Jewel movement, attractively moulded case with edgewise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv), 0-6/30/300/600V DC, (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. −10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

OUR PRICE £4.80 P/P & Ins 25p

CLEAR PLASTIC MODEL SO460
Size: 59 x 46mm

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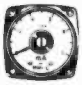
200uA	£3.75	20V DC	£3.65
500uA	£3.70	50V DC	£3.65
50-0-50uA	£3.80	300V DC	£3.55
100-0-100uA	£3.75	15V AC	£3.80
1mA	£3.65	300V AC	£3.80
5mA	£3.65	VU Meter	£4.65
10mA	£3.65		
50mA	£3.65		
100mA	£3.65		
500mA	£3.55		
1A DC	£3.65		
5A DC	£3.65		
10A DC	£3.65		

EDGWISE MODEL PE70
Size: 90 x 34mm

50uA	£4.55
100uA	£4.50
200uA	£4.45
500uA	£4.30
50-0-50uA	£4.50
100-0-100uA	£4.45
1mA	£4.25
10V DC	£4.25
300V DC	£4.35
VU Meter	£5.50

POSTAGE / PACKING & INSURANCE 15p

240° Wide Angle 1mA METERS



MW1-8 80 x 80mm
£7.45 P & P Ins 15p

ALL PRICES INCLUDE VAT

MODEL C7202EN

20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10/50/100/500/1000 V. AC. DC Resistance x 10, x 1000 (30Ω centre scale) DC Current 50uA/2·5mA/250mA. −20 to +68 dB.

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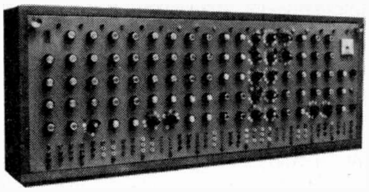

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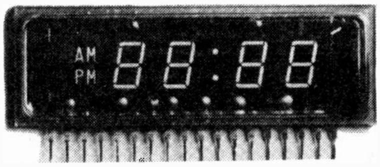

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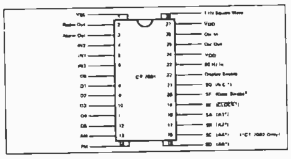

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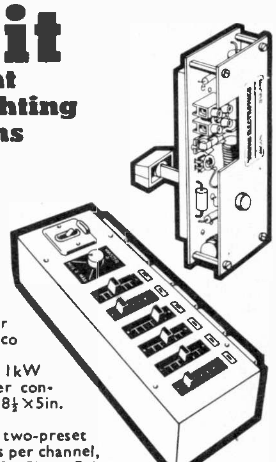

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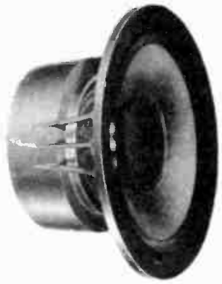

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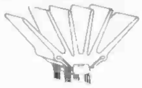

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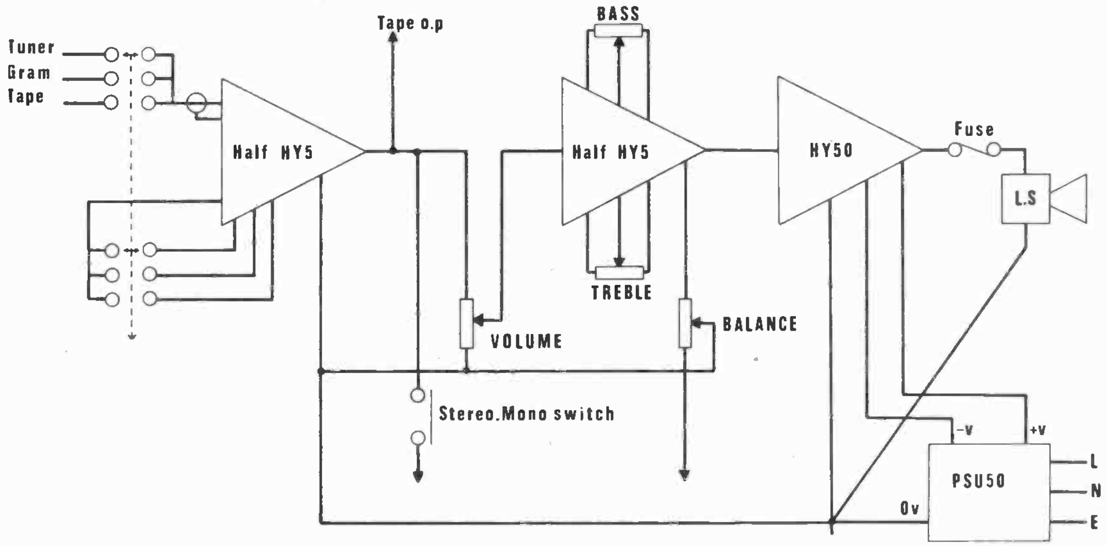
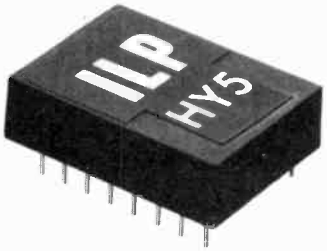
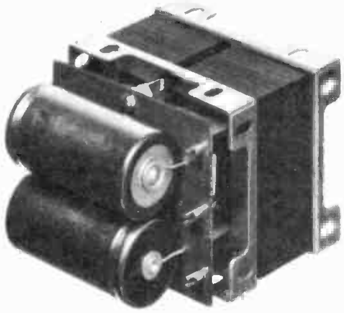


MONO ELECTRICAL CIRCUIT DIAGRAM WITH INTERCONNECTIONS FOR STEREO SHOWN





The HY5 is a complete mono hybrid preamplifier, ideally suited for both mono and stereo applications. Internally the device consists of two high quality amplifiers—the first contains frequency equalisation and gain correction, while the second caters for tone control and balance.

TECHNICAL SPECIFICATION
Inputs: Magnetic Pick-up 3mV RIAA; Ceramic Pick-up 30mV; Microphone 10mV; Tuner 100mV; Auxillary 3–100mV; Input/impedance 47kΩ at 1kHz. **Outputs:** Tape 100mV; Main output 0db (0·775V RMS). **Active Tone Controls:** Treble ±12db at 10kHz; Bass ±12db at 100Hz. **Distortion:** 0·5% at 1kHz. **Signal/Noise Ratio:** 68db. **Overload Capability:** 40db on most sensitive input. **Supply Voltage:** ±16–25V.

PRICE £4·75 +£1·19 VAT P. & P. free

The HY50 is a complete solid state hybrid Hi-Fi amplifier incorporating its own high conductivity heatsink hermetically sealed in black epoxy resin. Only five connections are provided, input, output, power lines and earth.

TECHNICAL SPECIFICATION
Output Power: 25W RMS into 8Ω. **Load Impedance:** 4–16Ω. **Input Sensitivity:** 0db (0–775V RMS). **Input Impedance:** 47kΩ. **Distortion:** Less than 0·1% at 25W typically 0·05%. **Signal/Noise Ratio:** Better than 75db. **Frequency Response:** 10Hz–50kHz ± 3db. **Supply Voltage:** ±25V. **Size:** 105 × 50 × 25mm

PRICE £6·20 +£1·55 VAT P. & P. free

The **PSU50** incorporates a specially designed transformer and can be used for either mono or stereo systems.

TECHNICAL SPECIFICATIONS
Output voltage: ±25V. **Input voltage:** 210–240V. **Size:** L.70. D.90. H.60mm.

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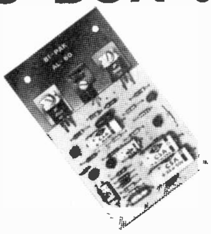
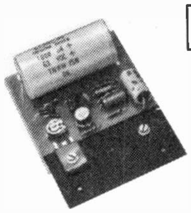


AL 60

ONLY £3·95

50W. PEAK (25W. R.M.S.)

● Max Heat Sink temp 90°C. ● Frequency Response 20Hz to 100kHz. ● Distortion better than 0·1 at 1kHz. ● Supply voltage 15-50V. ● Thermal Feedback. ● Latest Design Improvements. ● Load—3, 4, 5 or 16 ohms. ● Signal to noise ratio 80dB. ● Overall size 63mm × 105mm × 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.



STABILISED POWER MODULE SPM80

SPM80 is especially designed to power 2 of the AL60 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 BMT80, the unit will provide outputs of up to 1·5A at 35V. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including:—Disco Systems. Public Address Intercom Units, etc. Handbook available 10p.

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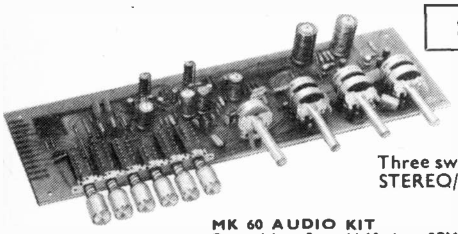

STEREO PRE-AMPLIFIER TYPE PA100

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.

PRICE £13·20

MK 60 AUDIO KIT
Comprising: 2 × AL60, 1 × SPM80, 1 × BTM80, 1 × PA100, 1 front panel, 1 kit of parts to include on-off switch, neon indicator, stereo headphone sockets plus instruction booklets.
COMPLETE PRICE: £27·55 plus 45p postage

TEAK 60 AUDIO KIT
Comprising: Teak veneered cabinet size 16¾" × 11½" × 3¾", other parts include aluminium chassis, heatsink and front panel bracket, plus back panel and appropriate sockets, etc.
KIT PRICE: £9·20 plus 45p postage

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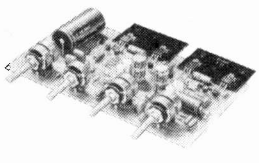

STEREO 30 COMPLETE AUDIO CHASSIS

7 + 7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This with only the addition of a transformer or overwind, will produce a high quality audio unit suitable for use with a wide range of inputs, i.e. high quality ceramic pickup, stereo tuner, stereo tape deck, etc.
Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, mains switch, fuse and fuse holder and universal mounting bracket, enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available.
Ideal for the beginner or advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty. (Can be installed in 30 mins.) PRICE: £15·75 plus 45p postage and packing.
TRANSFORMER: £2·45 plus 45p postage and packing. TEAK CASE: £3·65 plus 45p postage and packing.

AL 10/AL 20/AL 30

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. AL10 **£2·30**, AL20 **£2·65**, AL30 **£2·95**.

M.P.A. 38

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new BiPak M.P.A.30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. Used in the construction are 4 low noise, high gain, silicon-transistors. It is provided with a standard DIN input socket for ease of connection.
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GP96-1	100mv at 1cm/sec	£2·31
TTC		
J-2005	Crystal/Hi Output	97p
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J-2203	Magnetic 5mV/5cm/sec. including stylus	£4·78
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A COMPELLING FORCE

ELECTRONICS means many things to many people, as our post bag makes abundantly clear. Obviously the technology is a powerful force since it unites all manner of individuals who may have but little else in common. The powerful attraction offered by this highly technical and intellectual subject to vast numbers of persons who are not by trade or training "professionals" must be one of the more interesting and striking social phenomena of present times.

Particular areas of applied electronics have from time immemorial attracted their own devotees. These amateur enthusiasts have been easily identified as radio hams, audiophiles, radio control modellers or musical instrument builders. Outside such well defined areas the position is rather nebulous, the field is extremely wide and the applications too numerous for easy general classification. The equipments themselves are usually strictly functional and by and large fall within the definitions of sensing, measuring and controlling devices and systems. Highly valued for the duties they perform, they are installed and forgotten, or brought into use as a tool as the occasion demands. This is the comparatively new area of the hobby, and unlike the more traditional areas the end-products do not themselves directly foster any further creative or entertaining activities on the part of the owner.

As we all know this area is under constant exploration by the inventive minds. The probing into the vastness of this "application space" will continue, that's for sure, and will bring forth more and more rewarding discoveries. The enthusiast who pursues this kind of search may owe no allegiance to any well labelled group or sectional interest. He might be simply a devotee of electronics—just that; a member of a species that did not exist in any strength, outside the research laboratory, a couple of decades ago.

What should we call this free-ranging individual who respects no artificial bounds or limits in his pursuit of electronics in the common cause? The very universality of applied electronics gives the measure of the task. Frankly, we see no easy answer to our own question. But readers may think otherwise and may have their own ideas of an appropriate label.

Yet, as someone said, what's in a name? The bond of common interest in electronic circuitry and techniques is exceedingly strong and unites this huge band of enthusiasts, *at least so far as the means are concerned.* The *end* to which the technology is applied is entirely a personal affair. Here it must be admitted divergent views do sometimes emerge and even heated arguments can ensue between the various "specialists". But we should be tolerant in our approach to another man's uses or appropriations of electronics, and appreciate that the technology is free for all to apply and enjoy or benefit from, as they will.

F.E.B.

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THE tuning of keyboard instruments to the equal tempered scale is a task requiring considerable skill. The professional piano tuner uses a single tuning fork to obtain absolute pitch and then tunes all other notes by a system ascending tempered fifths and descending octaves.

The instrument described here uses two of the latest m.o.s. chips to produce 84 discrete tones from a single master oscillator. These tones can be used directly to tune any instrument by eliminating the beat frequency. Also included is a direct mixing input, which uses novel techniques to obtain the beat frequency. Also included is a direct mixing connection from an electronic organ, synthesiser, etc., or a microphone pick-up from any acoustic instrument, will produce visual beats via an l.e.d.

THE TEMPERED SCALE

Before describing the instrument, it may be helpful if we delve a little way into the theory behind the equal tempered scale. The scientifically orientated reader who has taken up a musical instrument may have been surprised by the distinct nonlinearity in the musical scale. This is particularly apparent on the guitar, for if the scale of C is played on a single string, there is a separation of only one fret (a semitone) between E, F and B, C whilst all other notes have a whole tone separation requiring double fret intervals. On keyboard instruments this irregularity is tidied up by arranging the black notes in the familiar groups of two and three.

Why then is the scale in this form, and why don't we notice it? We don't notice it largely because we are accustomed to it. The formation of our scale goes back to Pythagoras in the 6th Century B.C. who discovered that strings harmonised best when their lengths were in simple ratios to each other. Thus the most consonant arrangement was a ratio of 2:1, the octave, followed by the ratio 2:3 known as the fifth. The Pythagorean scale was based on just these intervals. In fact, there were several other scales in use until relatively recent times, but with the development of harmony (playing two or more notes together) most of these have become non-runners.

With the advent of keyboard instruments there was the requirement for playing in more than one key on a single instrument, without favouring a particular key. Clearly, the solution was to adopt a constant interval for the semitone. For this reason, the equal tempered scale was adopted in the 18th century, the only perfect intervals being the octaves and all semitone intervals equal to 1·0594, the twelfth root of two.

ELECTRONIC

TUNING

What all this means as far as we are concerned is that the traditional method of tuning a piano is not easy, for the professional will tune in ascending fifths flattened by just the required amount. Moreover, as far as our tuning aid is concerned, it means that we cannot derive digitally from a master source, the exact frequency we require; the notes are not in exact simple ratios. We can, however, produce a set of notes of sufficient accuracy if we start with a very high master frequency and divide it by a set of large number integers.

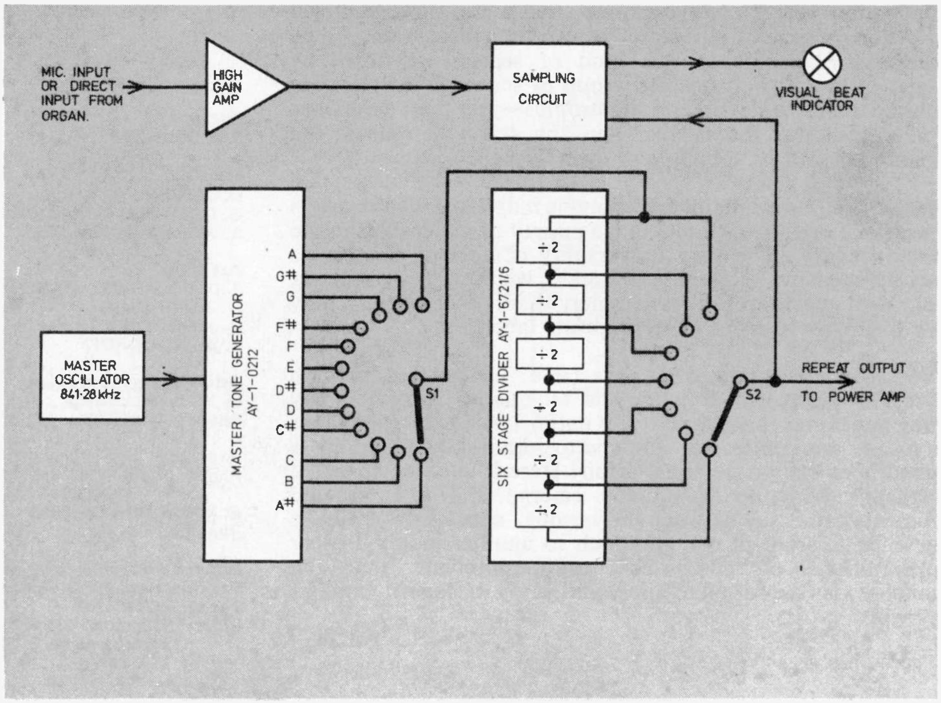


Fig. 1. Block schematic of Tuning Fork

The AY-1-0212 master tone generator was developed specifically for this purpose, its application being electronic organs of course. The block schematic is shown in Fig. 1; a frequency of 841·28kHz is produced by the master oscillator and fed directly to the tone generator chip. The outputs give directly the eleven notes of the highest octave. The lower octaves are produced by repeated division by two, a 6 stage divider chip AY-1-6721/6 being switched in directly.

Table 1 lists all the frequencies available from the instrument together with the pin number inputs for the master tone generator chip.

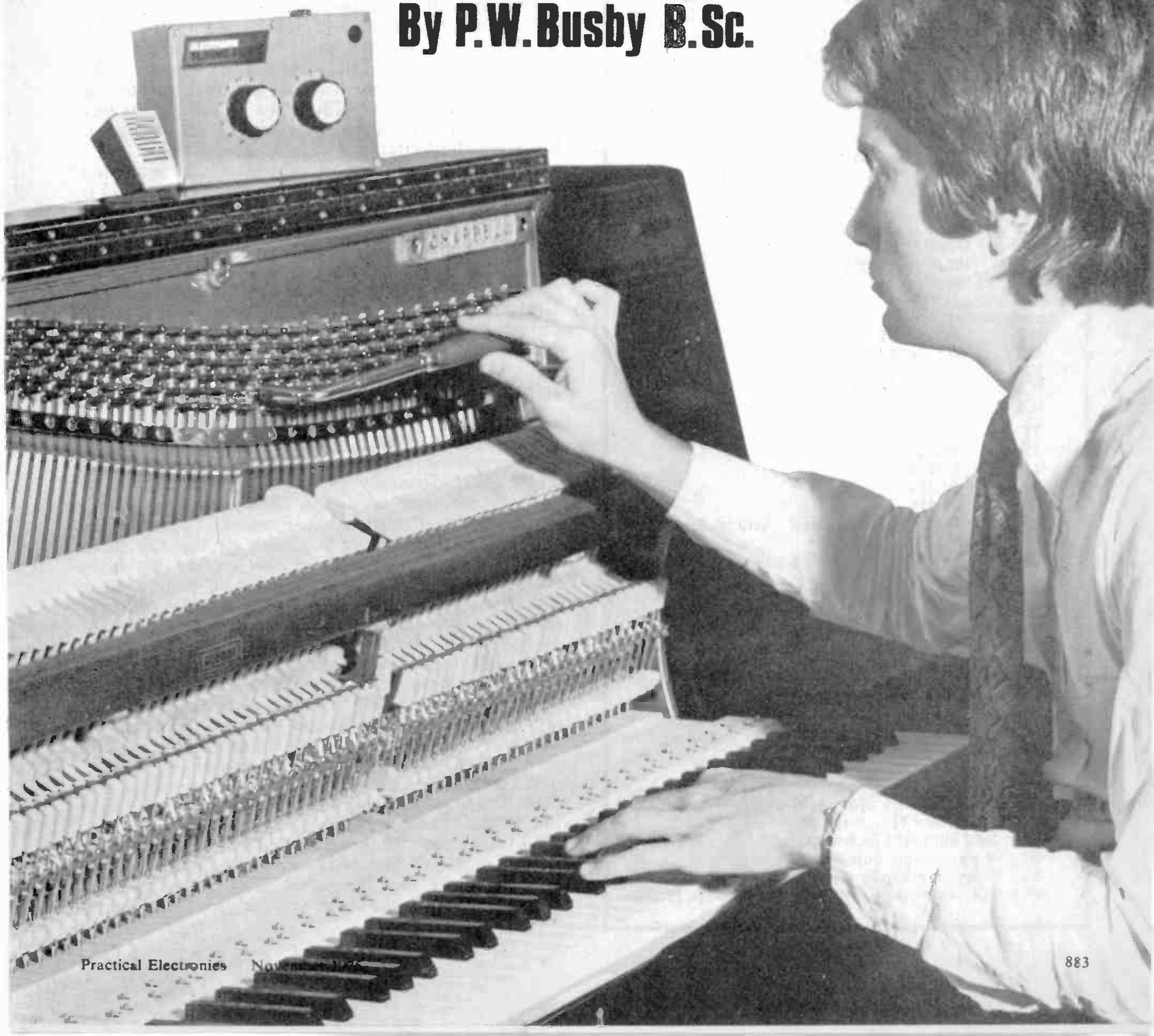
CIRCUIT DESCRIPTION

The circuit design for the basic tuning aid is shown in Fig. 2. The master oscillator feeding pin 2 of IC1 is basically a Colpitts oscillator with certain refinements. The additional capacitor C3 in series with the inductance L1 gives a substantial improvement in the frequency stability of the oscillator with respect to variations of the transistor parameters with temperature and supply voltage.

Also the ratio of C4 to C5 sets the tapping point for minimum tuned circuit loading and improves the circuit 'Q'. The use of an f.e.t. rather than a bipolar transistor further reduces the circuit loading. The inductor L1 is a standard single tuned

TUNING FORK

By P.W.Busby B.Sc.



COMPONENTS . . .

Resistors

R1	2·2MΩ	R21	4·7Ω
R2	3·3kΩ	R22	6·8kΩ
R3	6·8kΩ	R23	10kΩ 2%
R4	10kΩ	R24	4·7Ω 2%
R5	1kΩ	R25	3·9kΩ 2%
R6	1kΩ	R26	3·3kΩ 2%
R7	1MΩ		
R8	51Ω		
R9	1kΩ		
R10	100kΩ		
R11	1kΩ		
R12	1kΩ		
R13	10kΩ		
R14	330Ω		
R15	47kΩ		
R16	12kΩ		
R17	3·3kΩ		
R18	10kΩ		
R19	82Ω 1W		
R20	62Ω 1W		

All ¼W 5% carbon unless otherwise stated

Capacitors

C1, C2	0·22μF ceramic
C3	100pF silver mica
C4	220pF silver mica
C5	820pF
C6	82pF
C7	10pF
C8	100μF elect. 35V
C9	10nF
C10	220pF
C11	0·22μF ceramic
C12	100μF elect. 35V
C13	100pF
C14	100μF elect. 35V
C15	100pF

Semiconductors

IC1	AY-1-0212
IC2	AY-1-6721/6
IC3	709 14 pin d.i.l.
IC4, 5	741 8 pin d.i.l.
IC6, 7	723 14 pin d.i.l.
TR1	2N3823 f.e.t.
TR2	2N3823 f.e.t.
TR3	BC214
TR4	BC184
D1–D2	1N914
D3–D6	Miniature moulded bridge rectifier (400V 1A)
D7–D10	Miniature moulded bridge rectifier (400V 1A) (Both from R.S)
D11	TIL209

Transformer

T1 Min. mains transformer—Sec. 20V (2 windings) 3VA/winding (RS)

Inductor

L1 Denco IFT13 470kHz coil

Miscellaneous

Diecast box 73 8in × 4¾in × 2¼in
Veroboard 7in × 3¾in, 0·1in pitch
SK1, SK2 standard jack sockets
S1 12 way, single pole wafer switch
S2 7 way single pole wafer switch
14 pin i.c. sockets (4 off), 8 pin i.c. sockets (2 off)

470kHz i.f. transformer with the parallel capacitor removed.

The high input impedance of the m.o.s. chip IC1 allows it to be directly connected to the drain of TR1, eliminating the usual buffer transistor. The tone output from IC2 is taken through the attenuator R4, R5 which serves the dual purpose of reducing the 12V amplitude to a suitable power amplifier input level whilst protecting the output of IC2 from short circuits.

Referring to the circuit in Fig. 1, the incoming musical waveform, from a microphone say (SK1) is amplified by IC3 which has a gain of 1,000. The output from IC3 is a.c. coupled into IC4 which further amplifies it by a factor of 100. These two stages utilise operational amplifiers in standard configurations. The first stage, because of its very high gain, utilises a 709 with its attendant frequency compensation components. For the second stage we can manage with the limited bandwidth of a 741.

HIGH AMPLIFICATION

The reason for the high amplification of the signal is twofold. Firstly, it enables a magnetic pick-up or microphone with a sensitivity of a few millivolts to be used. Secondly, the over-amplification can be utilised to overcome the decay in amplitude, characteristic of stringed instruments. This is very important when tuning a piano, as the top notes decay very quickly; without this facility the beats would not be easily observed. There will be some initial squaring of the waveform, but this will not matter to us. The sampling circuit can cater for waveforms of any shape.

Passing on to the sample and hold circuit, a signal from the output of the tone generator (pole of S2) is amplified by TR3 to give a square wave of amplitude limited by the rail voltages. The leading edges of the square wave are differentiated by C10, R18 to give positive going pulses rising from −15·5V and rising to +12V. The diode D2 serves to suppress the negative going pulses generated at the trailing edge. These positive spikes turn on the f.e.t. TR2 and allow the hold capacitor C9 to store the output of IC4. The attenuator R11, R12 is necessary to ensure that the signal voltage on the drain of TR2 exceeds the gate voltage by the required 8V when TR2 is off.

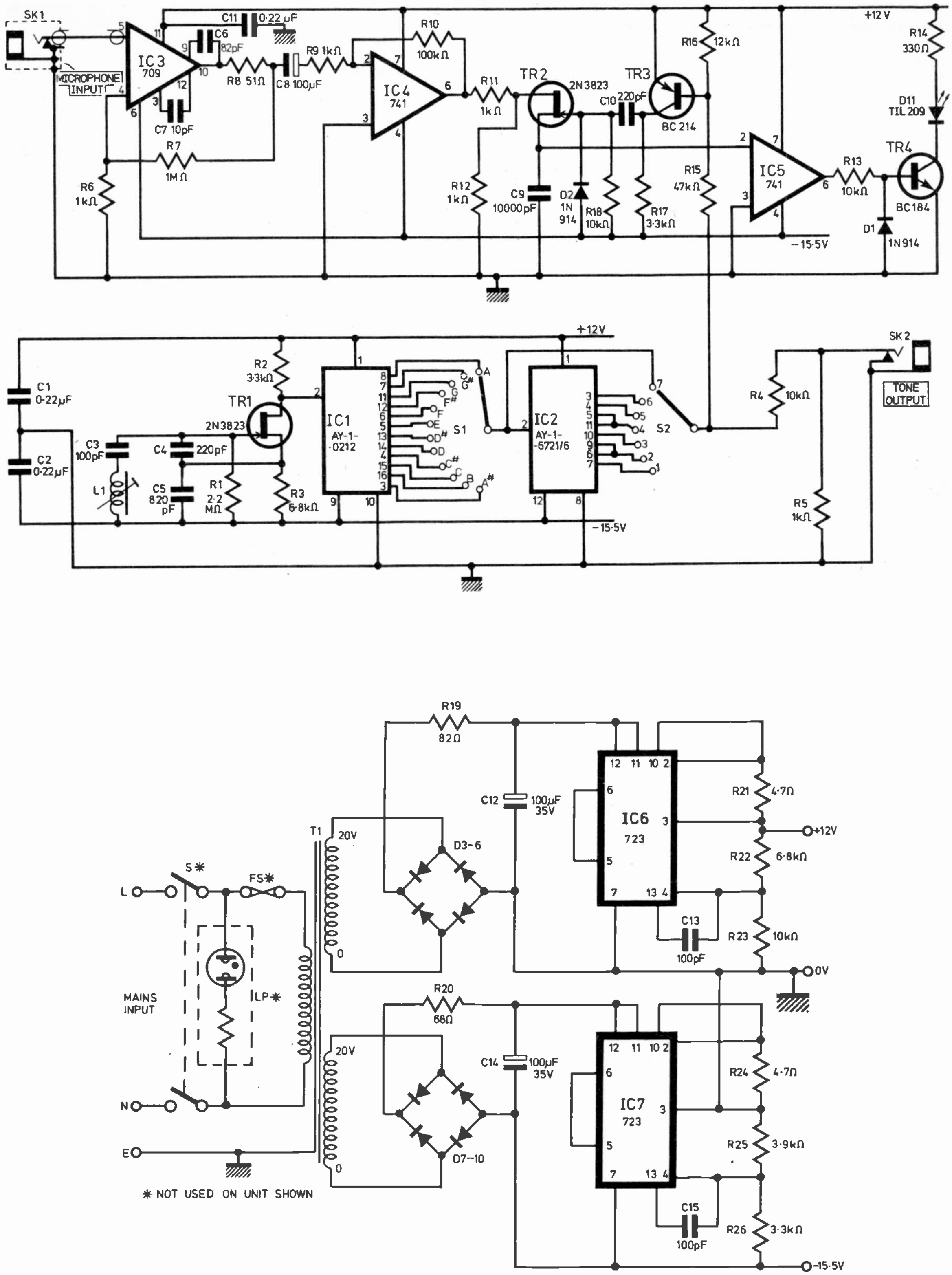


Fig. 2. The complete Tuning Fork circuit

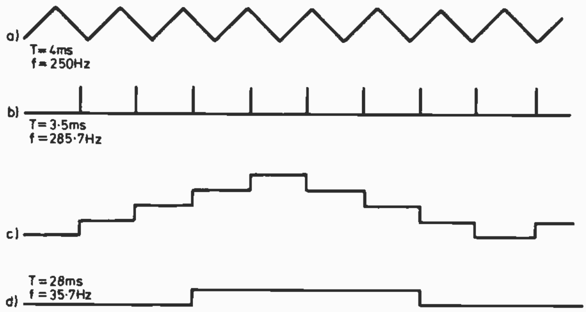


Fig. 3. Waveforms showing action of sampling circuit

SAMPLING WAVEFORMS

The action of the sampling circuit is depicted in Fig. 3. A simplified musical waveform (a) with period 4ms, frequency 250Hz is sampled by waveform (b) with period 3·5ms, frequency 285·7Hz. (c) is the output of the sample and hold circuit which corresponds in shape to the original waveform (a). (d) is formed from waveform (c) by the squaring circuit consisting of IC5 connected as a zero threshold comparator. The period of (c) and (d) is 28ms corresponding to a frequency of 35·7Hz. This is the beat frequency as 285·7−250=35·7Hz. Finally, the output of IC5 feeds directly to the l.e.d. driver TR4 providing a visual beat display.

CONSTRUCTION

The main circuit is built on a single piece of Vero stripboard as shown in the accompanying photographs.

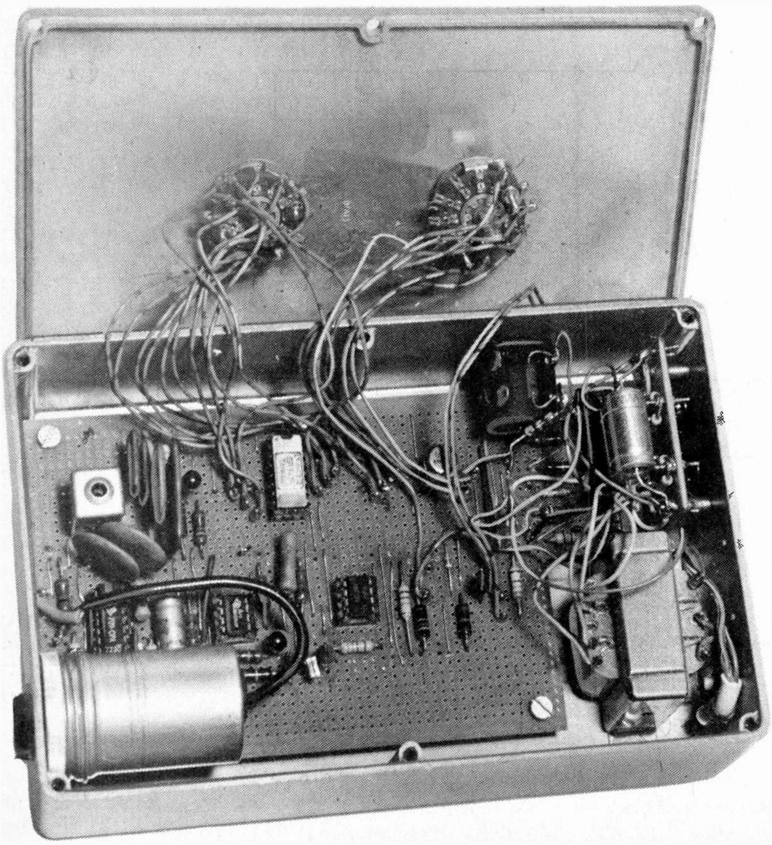
Note that the pin connections to the 723 refer to the 14 pin DIL package; if it is intended to use the 723 in a TO case, the pin numbering will be different and a different layout will be required.

When completed the output voltages should be measured. The tolerance on the supplies is ±1V on the +12V rail and +1·5V on the −15·5V rail. With 2 per cent resistors for the potential dividers R25, R26 and R22, R23 the outputs should be in tolerance. If, for any reason, the outputs require adjustment, these are the resistors to vary.

With the power supply working satisfactorily, the rest of the circuit can confidently be built. The layout conveniently splits in two, so that the oscillator and divider circuit can be built and tested first.

It is strongly recommended that the expensive master tone generator i.c. is mounted in a socket. The divider i.c. will have to be soldered indirectly as it is packaged in a TO case. As this is an m.o.s. device precautions should be taken whilst soldering it. The metal spring ring, which shorts the leads together in transit, should be left in place until soldering is complete.

Mount the decoupling capacitors C1 and C2 close to the oscillator components and ensure that the tracks around the oscillator are broken, thus preventing the high frequency oscillations being picked up in other parts of the circuit. The construction of the rest of the circuitry is straightforward.



Photograph of Fork interior showing board assemblies and ancillary wiring to control switches. Note the use of a film canister for screening the microphone socket.

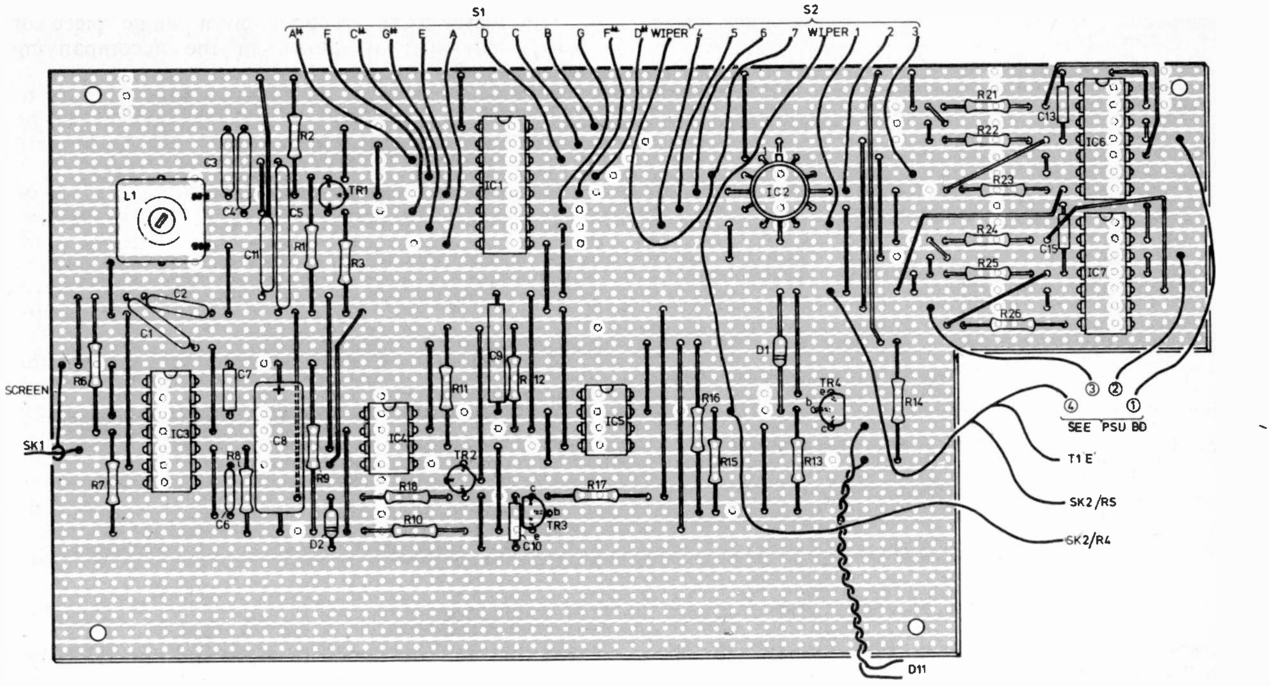


Fig. 4. Main board showing component assembly and copper track cuts required

As can be seen from Fig. 4 the p.s.u. regulators are mounted at the end of the main board.

The bridge rectifiers and smoothing capacitors are mounted on a small piece of board affixed to the side of the case as shown in Fig. 5 using countersunk screws and stand-off pillars.

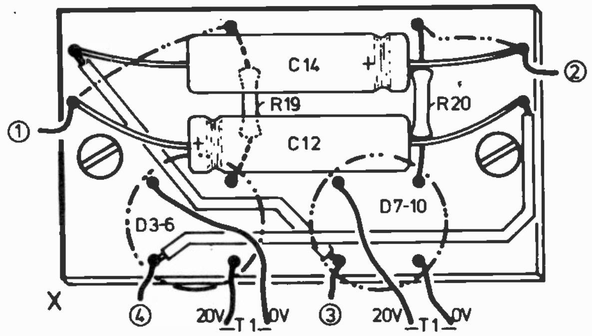


Fig. 5. Additional board for rectifiers and smoothing components

The complete instrument is housed in a diecast box. The microphone jack socket should be mounted close to the input connection to IC3. Also, shielding of this socket is necessary to prevent pick-up from the oscillator section. In the prototype, the complete socket was mounted inside a small aluminium canister and the connection to pin 5 of IC3 was made with screened lead.

TESTING

After carefully checking your wiring, plug the output into an audio amplifier and switch on. You should have 84 musical notes at your command. If you possess an oscilloscope you can ensure you have the correct input to IC1 by looking at the oscillator output (IC1 pin 2). This signal, which is not a sine wave, should have an amplitude which lies between the limits of +10V and +12V for the crest and +2V and −8V for the trough.

Before the visual beat circuitry can be tested, the instrument will have to be roughly calibrated against a known source; a musical instrument roughly in tune will suffice.

Select the note and octave required (middle C lies in range 4) and adjust the core of L1 for an audio beat frequency of about 1 beat per second.

Disconnect the audio output and connect a good quality magnetic microphone to the input jack; with the microphone in the vicinity of the musical instrument, the beat frequency should be clearly visible.

CALIBRATION AND USE

If you have access to a digital frequency counter, you will have no difficulty in calibration,

Table 1: AY-1-0212 Master Tone Generator

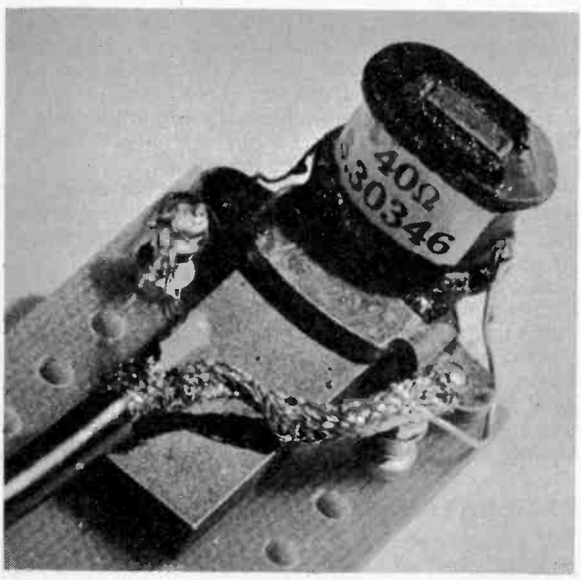
Pin No.	Note	Divisor	Frequency f Range 7	$f/2$ Range 6	$f/4$ Range 5	$f/8$ Range 4	$f/16$ Range 3	$f/32$ Range 2	$f/64$ Range 1	Correct frequency for $f/8$
8	A	239	3520	1760	880	440	220	110	55	440
7	G#	253	3325·22	1662·61	831·30	415·65	207·82	103·91	51·96	415·31
11	G	268	3139·1	1569·55	784·78	392·39	196·19	98·10	49·05	392·00
12	F#	284	2962·25	1481·12	740·56	370·28	185·14	92·57	46·29	369·99
6	F	301	2794	1397·48	698·74	349·37	174·68	87·34	43·67	349·23
5	E	319	2637·24	1318·62	659·62	329·66	164·83	82·41	41·21	329·68
13	D#	338	2488·99	1244·50	622·75	311·12	155·56	77·78	38·89	311·13
14	D	358	2349·94	1174·97	587·49	293·74	146·87	73·44	36·72	293·67
4	C#	379	2219·74	1109·87	554·93	277·47	138·73	69·37	34·68	277·18
15	C	402	2092·74	1046·37	523·18	261·59	130·80	65·40	32·70	261·62
16	B	426	1974·84	987·42	493·71	246·85	123·43	61·71	30·86	246·92
3	A#	451	1865·37	932·68	466·34	233·17	116·59	58·29	29·15	233·07
2	(f_0) input frequency=841·28kHz									
1	+12V supply									
9	−15·5V supply									
10	0V									

however, do not connect the counter to the oscillator output at pin 2 of IC1 as the loading effect will give a false reading. The best accuracy can be obtained by using the counter in the period timing mode with the instrument switched to the low frequency A of 55Hz.

Alternatively, a tuning fork can be used—it may be worth purchasing one if the instrument is to be used a lot. Finally, if absolute pitch is not essential, the 50Hz mains frequency may be used.

Referring to Table 1 we see that the lowest note G has a frequency of 49·05Hz, in fact the correct frequency should be very near 49Hz. All that is required to pick up some mains hum, is a looped lead placed near the mains transformer. With the lowest G selected, tune L1 for 1 beat per second, check that you are tuning to 49Hz and not 51Hz by switching to the adjacent G# which should give approximately two beats per second.

Pick-up for steel stringed instrument



ELECTRO-MAGNETIC PICK-UP

An alternative pick-up for steel stringed instruments is a coil wound round a permanent magnet as used for electric guitars. This type of pick-up gives a superior performance to a microphone for the very low strings on a piano and has advantages for tuning in noisy environments. The device shown in the photograph was fashioned from an old telephone earpiece of 1936 vintage. One of the coils was removed, together with the pole-piece and magnet. The components were mounted on a suitable handle in much the same way as in the original earpiece.

CONCLUSION

The Electronic Tuning Fork has been used to tune several instruments, including a piano and a 37-string autoharp. The visible beat indicator proved to be a boon as it allowed piano tuning to proceed without switching off the sacred TV set! This particular piano, being a poor specimen, was incapable of holding its tune unless the tension on the strings was relieved by tuning about three semitones below concert pitch. This was easily facilitated by simply loosening the note select knob, and advancing it three semitones.

Finally, don't be put off by the fact that the instrument is not perfect, for if you wish to be fanatical about your tuning, the utmost precision can be obtained by tuning to a specific number of beats. Referring to Table 1, we see that for a perfect A, G has the largest error of 0·39Hz at a frequency of 392Hz. If the instrument is tuned for 39 beats in a period of 100 seconds, then it will be precise. This is not possible for a stringed instrument, as the note will decay too soon. However, it might be worthwhile for tuning a divider organ where there are only twelve master frequencies to adjust. ★

BY FRANK W. HYDE

ICE AGES

Talk of weather and ice ages has been increasing of late, so it is refreshing to have some new information on the subject. Recently, Professor McCrea, one of our most meticulous astronomers, has made certain suggestions regarding the advent of ice ages. He postulates that in the journey round the galaxy by the solar system, the Sun may pass through areas rich in dust. The infalling dust could reduce the effect of the Sun's output.

In McCrea's study, he did not attempt to explain how the changes occur, but looked at the evidence of the recurrence of ice ages related to the cosmic year. Support for this idea came from G. E. Williams of Australia, who quite independently made a detailed exami nation of the Sun's position during the cosmic year without offering any evidence of a link or mechanism for the ice ages.

These two approaches within a few weeks of each other has caused more attention to be given to a new model. In McCrea's calculations, orders of magnitude and estimates of the intervals were made. Williams, on the other hand, used geological evidence to an accuracy of a few tens of millions of years. This produced a fairly rigorous time scale for the glaciations.

In a summary, he indicates six principal occurrences. One of these has just been completed, one occurred in the Permo-Carboniferous period about 295 millions of years ago, another in the late Ordivician period some 450 millions of years ago and three in the late pre-Cambrian. That is 615, 770 and 940 millions of years ago. This reveals a gap at about 150 million years ago which was, however, a cool period.

From the evidence that Williams offers, a cosmic year for 303 millions emerges. This agrees with the impressions that the ice ages occur twice in the cosmic year. Williams offers the suggestion that this might be due to the bending of the galaxy due to the tides raised by the influence of the Magellanic clouds.

NEW PLANETS

The news recently released that Russian theoretical astronomy has examined a computerised experiment dealing with perturbations or orbits reveals the existence of one or maybe two planets beyond Pluto. There has always remained some doubt that all the corrections have not yet been made to the discrepancies in the Uranus predictions.

At the Institute of Theoretical Astronomy in Leningrad, this experiment has been carried out under the direction of Professor Chebotaryov, a specialist in celestial mechanics, who has been computing the effects on the comet 1862–3. The parameters of the orbit make it an enticing argument that a planetary body would produce the data to fit the observations.

The invisible planets would have positions way out beyond the Plutonian orbit. One would have a diameter of about 12,000 miles, which would give it a mass of about the same as that of the Earth, and would be 54 times as far away from the Sun as the Earth. The other would be twice as large as the Earth and at a distance of a hundred times that of the Earth from the Sun.

The ancients have always held that there were other planets; perhaps one of these will be called Lilith also, if and when they are optically observed. Is this perhaps a good argument for a very large telescope aboard an orbiting observatory.

SPACE BIOLOGY

The *Apollo–Soyuz* programme dealt with a number of joint biological tasks. One of these was concerned with fish embryonic development, with the object of discovering what effects weightlessness would have. Similar fish, Danyo Rerio, had been taken to outer space by *Soyuz 16*.

The main object was to study the vestibular apparatus. On the ground, living things learn from birth to distinguish the difference between up and down, by the use of this mechanism. In space these notions become non-existent and this seems to cause changes in the organ.

Another experiment concerned the growth of micro-organisms, since weightlessness had a considerable effect on the vital activity of mono-cellular life. The organisms chosen for the experiment were Chlamy Domonada, Flowers Crepsis, Araby-sopsis and Protea Vulgaris.

Two experiments with microbial exchange were made from the USA module and the Russian *Soyuz*. Exchange was made from the astronauts themselves also. These will be compared back on Earth to discover how the microflora has changed.

This was an important joint venture to discover the effects of mutual exchange between the astronauts. It could reveal the processes by which illness develops especially during the first few days of a mission. It would also be of value to determine conditions of cross-infection between the individuals on Earth. Thus another spin-off appears for the benefit of mankind.

COMET TO ASTEROID

A rare phenomenon, the transformation of a comet into an asteroid has been observed by Soviet astronomers.

A comet of the 15th magnitude is moving between Jupiter's orbit and the asteroid belt. The comet has been named Tamara Smirnova-Nikolai Chernkh, and was discovered in March this year.

Unlike most comets, this one does not follow the elongated elliptical orbit but moves in an almost circular one, its path close to the asteroids. It would seem, therefore, that the theory of capture obtains here as it does with other material particles.

If the comet has gathered enough material round its icy nucleus to attain a mass sufficient to make it also a minor planet, it may become another of the random bodies under the control of the gravitation of Jupiter or a lesser place in the asteroid belt.

POLES APART

It is calculated that the magnetic poles are changing position. This will necessitate considerable changes in charts towards the end of the century.

If the Soviet scientist Nikolai Medvedev is correct, the Earth has already entered a new epoch of magnetic inversion. When it attains a maximum, the north magnetic pole will be in the area of the Persian Gulf, with the Southern pole in the area of the Phillipines.

The theory is based on the fact that the poles drift with the migration of the Earth's nucleus which is known not to coincide with the geographical poles.

PART TWO

PE Engine Analyser

FOR ECONOMY MOTORING

By D. HALEY

LAST month the construction and wiring of circuits involving static tests, that is tests without the engine running, were described. The remaining circuits involve dynamic tests on the engine under normal running conditions, and the first of these, to be described this month, is the dwell and tachometer board. The dwell period is the portion of the ignition timing cycle during which the contacts are closed, and current is allowed to build up in the ignition coil primary. Too short dwell time will mean that, at high engine speeds, the current will not reach a sufficiently high value to produce a good spark and mis-firing will result.

Dwell is usually quoted in degrees of rotation of the distributor shaft. Since in one 360 degree rotation, the distributor connects once to each sparkplug, the distributor angle per contact breaker cycle is 360/N degrees, where N = number of cylinders. Hence, for a four-cylinder engine the maximum dwell angle is 90 degrees, for a six-cylinder 60 degrees and so on. On this instrument the meter scale for dwell has been calibrated 0 to 100 per cent of the maximum angle so that it applies to all engines. Of course, no engine will run with maximum dwell angle since the contacts would be closed all the time. The normal dwell angle for most cars is around 40 to 60 per cent of the total period.

INPUT WAVEFORM

Both r.p.m. and dwell time measurements make use of the pulses obtained from the contact breaker terminal on the ignition coil. Much of the circuit, shown in Fig. 2.1, is common to both measurements. The squared letters on the circuit diagram refer to the waveforms shown in Fig. 2.2 occurring at the points indicated. The waveforms and circuit are described relative to the negative terminal of the battery, normally connected to chassis. The signal obtained from the contact breaker is waveform A.

When the contacts are closed, the terminal of the contact breaker is connected to chassis. When the contacts open the terminal is connected through the low voltage section of the coil to the positive side of the battery. At the instant the contacts open the energy stored in the coil inductance, due to the current flowing in it, is converted into potential energy and produces a series of high voltage oscillations (waveform A) which last for about 3 milliseconds. It is these oscillations which generate the high voltage energy necessary to produce the spark.

CARS WITH POSITIVE EARTH

On cars which have the positive pole of the battery connected to the chassis, the c.b. terminal on the coil will go to minus 12 volts when the contacts open, and waveforms A and B of Fig. 2.2 will be inverted. One section of IC2 (4 NOR gates) is used as an inverter, brought into circuit by S2, so that the input presented to pin 5 of IC1 is the same as waveform B.

METER SIGNALS

At this point it is worth digressing to consider what signals are required to produce meter readings

SPECIFICATION • • •

Ignition timing	By strobe lamp fired from inductive coupling to No. 1 spark plug lead.
Tachometer	0 to 2500 r.p.m. on 1, 2, 4, 6 or 8 cylinder engines.
Dwell measurement	10 per cent to 80 per cent at 1000 r.p.m.
Ohmmeter	0 to 1000 ohms. 150 ohms centre scale.
Battery Charger	12 volt 4A (High rate) or 2A (Low rate) or 6 volt 4A (High rate) or 2A (Low rate).
Voltmeter	0 to 25 volts d.c. ±5 per cent f.s.d.
Condenser check	0·22 uF condenser is substituted across contact breaker.
Power input	240V a.c. at 50Hz or 12–16V d.c. at 1A.

proportional to engine speed and dwell time. If regular current pulses are passed through a meter, the meter will read current equal to the average value of the current pulses. Therefore, the meter

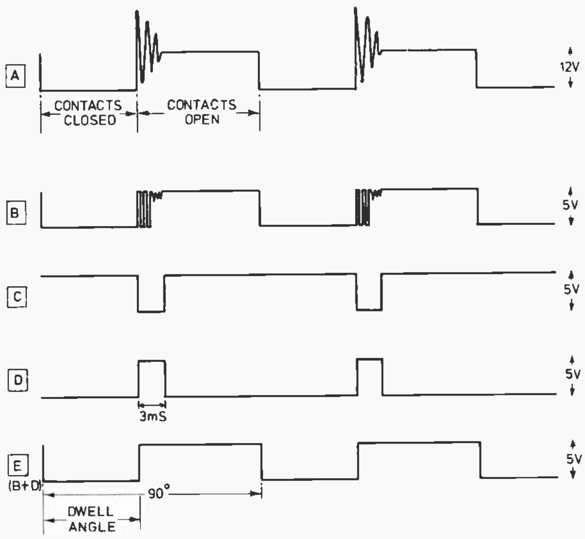
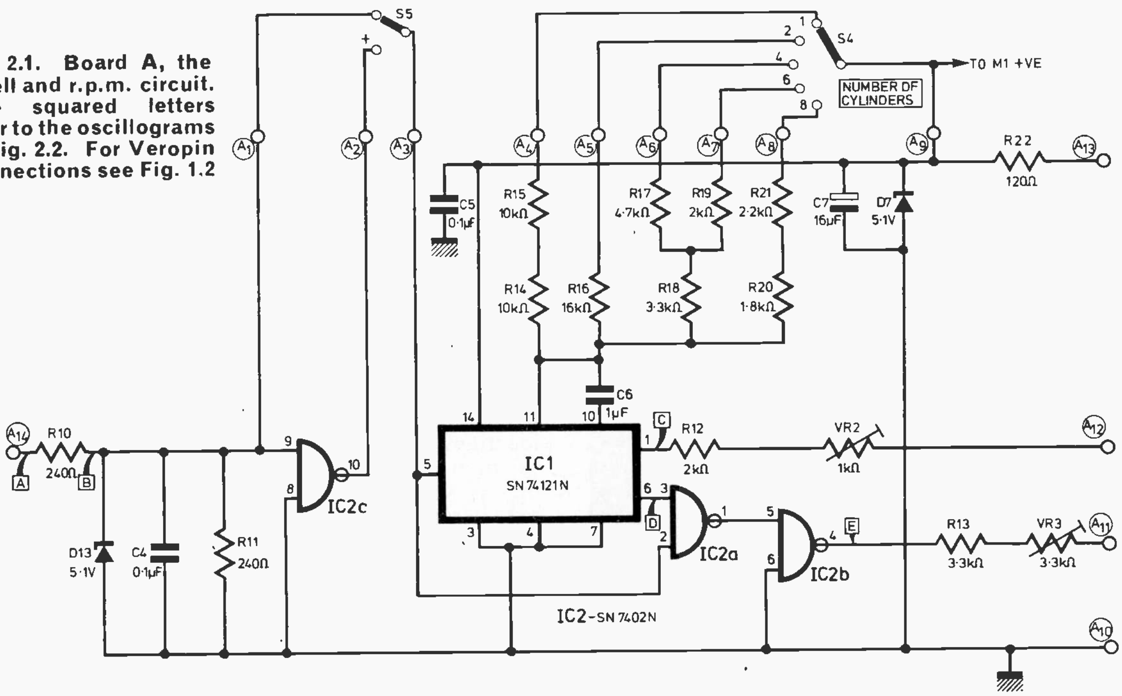


Fig. 2.2. The oscillograms to be found on test points of the dwell and r.p.m. circuit

reading will depend on the ratio of on to off time of these pulses. For instance, if current pulses of 1mA flow for 50 per cent of the time, the meter will read 0·5mA. Hence, considering waveform E of Fig. 2.2, it can be seen that if the dwell time is made the on part of the waveform, the meter will give a reading directly proportional to dwell angle. The 90 degree maximum dwell angle shown at E is for a four-cylinder engine. A six or eight-cylinder engine would have a maximum dwell angle of 60 degree and 45 degree respectively. If engine speed is varied,

TACHOMETER AND DWELL CIRCUIT

Fig. 2.1. Board A, the dwell and r.p.m. circuit. The squared letters refer to the oscillograms in Fig. 2.2. For Veropin connections see Fig. 1.2



both the on and off parts of the waveform will change proportionally, and the average meter indication (dwell angle) is independent of engine speed.

Waveform C, is a fixed length pulse, produced once every time the contacts open. Here, changing engine speed does not alter the on time, but makes the pulse occur more or less often, depending on whether engine speed is increased or decreased. Thus doubling engine speed will double the current through a meter. These pulses (waveform C) are used to give an indication of r.p.m.

CIRCUIT DESCRIPTION

Now to consider Fig. 2.1, the circuit required to produce these two trains of pulses in a form suitable to give the required indications on a 0–1mA meter. The contact breaker signal is clipped by a 5·1V Zener diode D13 so that it is at the correct level for use with standard 5V logic integrated circuits. This produces waveform B at the input to IC1 (pin 5). This integrated circuit is a monostable multivibrator with a level detecting trigger input. Once fired, it will ignore any further input triggering pulses occurring during the time constant of the timing components C6, R14—21.

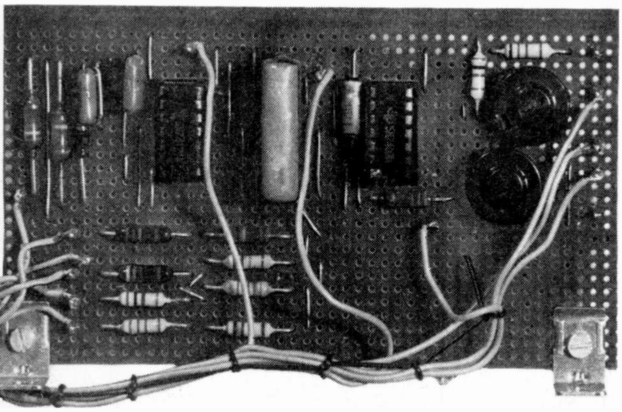
Thus the pulse chopping on waveform B caused by the coil ringing is ignored by the multivibrator, and the output at pin 1 of IC1 is waveform C. This signal is fed through series resistors R12 and VR2 to the meter, which will give a reading proportional to pulse repetition rate, i.e., r.p.m. The length of this pulse limits the maximum r.p.m. which can be measured, but if it is made too short there will be a risk of the i.c. double-firing and giving a false meter reading. About 3 milliseconds is the shortest pulse that can be safely tolerated. The integrated circuit has a maximum duty cycle of 60 per cent, which means that for 3 milliseconds on time, the total pulse period will be 5 milliseconds.

The formula for the maximum r.p.m. which can be measured with this circuit is given by

$$\frac{60 \times \text{max. duty cycle}}{\text{Pulse length} \times \frac{1}{2}\ \text{No. cylinders.}}$$

from which it will be seen that the greatest limitation will be on engines with the highest number of cylinders. For an eight-cylinder engine, the limit will be

$$\frac{1{,}000 \times 60 \times 0{\cdot}60}{3 \times 4} = 3{,}000 \text{ r.p.m.}$$



For ease of use and calibration it was decided to make the range the same (2,500 r.p.m.) for all types of engines and accordingly, the time constant associated with IC1 has been made switchable for a range of engines with differing number of cylinders from one to eight. This means that all carburettor adjustments are carried out with the r.p.m. meter reading near the centre of the scale, around 1,000 revolutions per minute.

As already described, dwell angle is measured by waveform E, which is a cleaned up version of B. The cleaning up is achieved by feeding waveform B and D into the two inputs of IC2a, or NOR gate A NOR gate produces "O" output when either of its inputs is a "1". Hence, since the positive going output of IC1 holds one input positive during the ringing on the other waveform, this ringing will be removed from the output. IC2b is a second NOR gate on the same i.c., used to invert the signal so that the correct portion of the waveform is in the on state to drive the meter positively.

From examination of waveform E it will be seen that 100 per cent dwell will be represented by constant zero voltage and zero dwell by constant positive level. This fact is made use of later in the calibration process.

The board is supplied from the 10V regulated supply which is further dropped to 5·1V for the integrated circuits by R22 and Zener diode D7.

CIRCUIT BOARD CONSTRUCTION

The circuit for r.p.m. and dwell angle measurement is constructed on a piece of 0·1in pitch Vero board measuring 4·8in long by 2·7in wide. Fig. 2.3 shows the layout of components on the top side of the board, and the points at which the printed circuit track should be cut.

Tags are inserted at all points where the circuits show connections to switches. If the constructor does not require all the facilities provided by the switching, links may be soldered between appropriate tags to set the circuits for one particular type of car, e.g. four-cylinder, negative earth. 14-pin d.i.l. sockets are recommended for the two i.c.s in preference to direct soldering to the board as there is a risk of damage by overheating with direct soldering. Both i.c.s are mounted with their orientation identity, i.e., pin 1, towards the top edge of the board. Two small angle brackets are fixed to the bottom corners of the board for bolting to the chassis, beside the power supply regulator board.

WIRING IN

There is quite a considerable amount of wiring associated with this board. Fig. 2.3 shows the pin identities on the board and should be used in conjunction with Fig. 1.2 in the first article when wiring in. As well as the supply connections, which are made from the 10V regulator board via the 150mA fuse, connections must be made to the meter function, positive/negative, and number of cylinder switches and to the contact breaker socket on the front panel. A lead having a banana plug on one end and a crocodile clip on the other should be made up for connection to the contact breaker terminal.

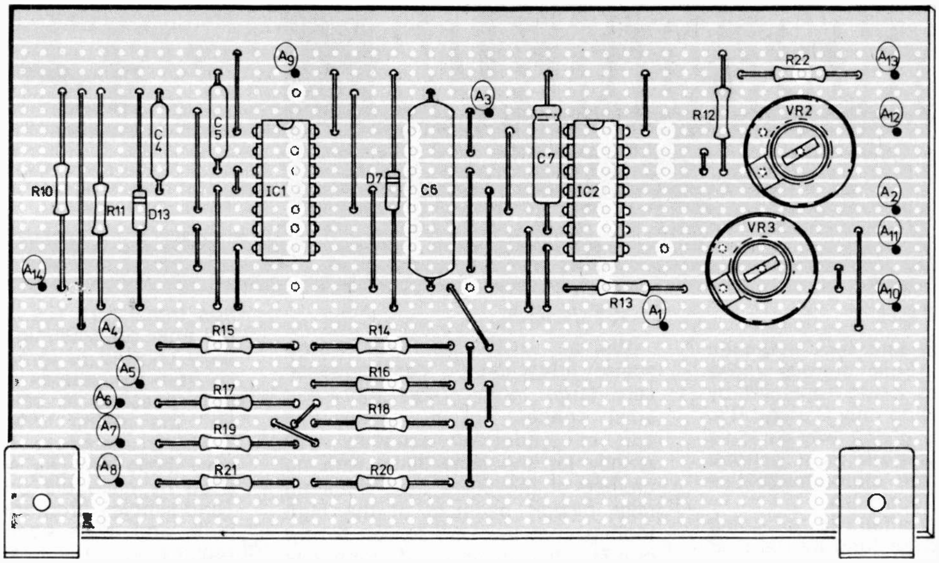


Fig. 2.3. Component layout and cutting details for Board A

TEST AND CALIBRATION

It only now remains to set the two calibration potentiometers VR2 and VR3 so that the meter indicates correct dwell and tachometer readings. It has already been noted that 100 per cent dwell is represented by contacts permanently closed. To set the dwell calibration, switch the meter to 'Dwell', Earth switch to negative and connect the contact breaker socket to supply negative. The meter should read approximately full scale. Adjust VR3 to set the meter reading to 100 per cent. Check that with contact breaker socket connected to +12V, the meter reading falls to zero. With the earth switch set to +ve, the readings should be reversed, i.e., 0 with c.b. socket connected to supply −ve and 100 per cent with c.b. socket connected to +12V.

To calibrate the tachometer scale, the 50Hz mains supply is used. The r.p.m. corresponding to 50Hz is $\frac{50 \times 60}{2} = 1{,}500$ r.p.m. for a four-cylinder engine. Set the function switch to r.p.m., the No. of cylinders switch to 4, and connect the c.b. lead to one 12V a.c. terminal of the bridge rectifier. Adjust VR2 to give a meter reading of 1,500 on the r.p.m. scale. Check that the reading falls to 1,000 r.p.m. on six-cylinders and 750 r.p.m. on eight cylinders.

DWELL MEASUREMENT

To make measurements of dwell angle, the lead from the c.b. socket is connected to the c.b. terminal on the coil. A lead should also be connected between instrument chassis and car chassis. From the foregoing description it will be seen that the pulse produced by IC1 forms part of the 'off' portion of the dwell waveform (E of Fig. 2.2). As the engine speed increases waveform E contracts to a shorter time scale.

This pulse therefore sets the upper limit of dwell which can be measured, since the off section of the waveform cannot be less than D. It should be noted that waveforms C and D are only 3 milliseconds for the eight-cylinder engine setting, being increased in width for less cylinders in order to maintain tachometer calibration. However, the period between sparks is also proportionally longer for less cylinders at a given engine speed, and waveform D will remain the same proportion of total period of waveform E for all engines, and will limit the maximum dwell measurement to the same percentage in each case. The following table should clarify this point.

Table 2.1.

No. of cylinders	Tach. pulse D	Period of E at 1,000 r.p.m.	Max. dwell at 1,000 r.p.m.
1	24 ms	120 ms	80 per cent
2	12 ,,	60 ,,	80 ,,
4	6 ,,	30 ,,	80 ,,
6	4 ,,	20 ,,	80 ,,
8	3 ,,	15 ,,	80 ,,

Increasing engine speed will reduce the maximum measurable dwell since it reduces the periodic time of waveform E. This limitation can be overcome to some extent, on less than eight-cylinder engines by leaving the "No. of Cylinders" switch on 8 for all dwell measurements. It must be remembered however, that the switch must be returned to its correct position when making tachometer readings.

SIX-VOLT SYSTEMS

In a 6V system the amplitude of the pulse obtained from the contact breaker will be only 6V instead of 12. It may therefore be necessary to reduce the value of R10 in Fig. 2.1 to around 50Ω. The full value of 240Ω must be used when setting the calibration of the tachometer and dwell scales, if this is done from 12V.

Next month: Strobe circuit and instructions for using the Analyser

SEMICONDUCTOR UPDATE... By R.W. COLES

ULN3006T
IM5200
DD10R

HALL SWITCH

We see less and less magnetic components in our circuits these days, coils are being replaced by active filters using only C's and R's, and relays are giving way to logic gates and thyristors in a general trend away from electromagnetics and towards electronics.

This state of affairs is not going to be tolerated for long by the ever loyal band of magnet-fanciers, and already they are launching a counter attack into the very heart of logic-land with a new device from Sprague called a Hall-Effect Switch.

Now for all you deviants who have forgotten what the Hall-Effect is, it goes something like this: If a current is made to flow from end to end of a bar shaped conductor, and a magnetic field is introduced perpendicular to the direction of current flow, then the effect of the field will be to deflect the end to end current flow, and to cause a small voltage to be developed across the width of the bar. This principle has been known for a long time, and has been put to good use in the past to measure the strength of particular magnetic fields.

The new use for the Hall-Effect is in a very small magnetically actuated switch with no moving parts, and the trick has been to integrate a Hall-sensor cell with a silicon integrated circuit and then to put the whole thing in a tiny three pin plastic package. The device code is **ULN3006T,** and providing that all the chips that come off the assembly line aren't gobbled up immediately by industry, this one could be a very useful addition to any amateur's component box.

The chip contains an amplifier which converts the tiny Hall voltage into a logic swing at the output. Switch ON point is about 500 Gauss, and switch OFF point is about 225 Gauss, making operation with any kind of magnet possible.

The standard use for this device will be as a keyswitch for teletypewriters, where a small permanent magnet mounted in the key top will activate the sensor when the key is depressed, but, of course, other uses are limited only by your own imagination! And most readers are not short of this.

D.I.Y./L.S.I.

We all know that l.s.i. (large scale integration) can squeeze very large logic arrays into very small spaces, but up to now this sort of production economy was strictly for the specialists, with no chance of the small man dictating chip design because of the high tooling cost involved for each new circuit. One glimmer of hope has been present for a number of years in the form of PROMs, or Programmable Read Only Memories, which are factory produced arrays which can be content-programmed by the user.

An ingenious new chip from Intersil, the **IM5200,** may at last bring the benefits of custom l.s.i. to everyone because it is the first Field Programmable Logic Array (F.P.L.A.) ever produced. A sort of Programmable Logic Array has been available in the past, but with these early devices programming had to be carried out at the final manufacturing stage. These were a help, because instead of having to order a new device in thousands, you could order in hundreds, but the new F.P.L.A. takes this idea much further because it is now economic to make a new device in only one-off quantities, and not only that, because programming is done by the user, a ready programmed chip can be edited or modified at will.

The IM5200 has 14 logic inputs which are buffered and inverted internally and then fed to a programmable array of 48 AND gates which can each have any combination of the 14 input terms used as inputs.

The outputs of the AND gate array are fed to an OR gate array where each of eight OR gates can have any combination of AND terms as their inputs, and finally the eight OR ouptuts can be further programmed to give active high or active low outputs from the chip.

The secret of the new device lies in the A.I.M. (Avalanche Induced Migration) links used to hook-up the gate array when high current programming pulses are applied momentarily. As supplied, all A.I.M. links appear as open-base *npn* transistors (i.e. open circuits) but after programming a link is partially shorted to form a diode, and so from the outside of the package it is possible to selectively "wire-up" the gating arrays.

There seems to be no reason why these devices should not be used by amateurs once a suitable (and simple) programmer has been built, and since each F.P.L.A. can replace up to 250 t.t.l. packages, do-it-yourself will take on a new meaning!

TEN TO THE BAR

A modern trend is to replace all "old-fashioned" analogue displays with a trendy bunch of seven-segment l.e.d.s, to achieve a mathematically precise numerical readout. Of course, we all rather fancy a digital multimeter to replace the old faithful moving coil job, but in many circumstances the change to a digital type display actually decreases the amount, and clarity of available information; imagine for example the difficulties involved in reading a car speedo' which gave a digital output!

Now that the novelty of little flickering numbers is wearing off, the l.e.d. manufacturers are turning their skills to producing a new kind of analogue display, which, while being more suitable for use with today's advanced circuits than a moving coil meter, still gives a simple to read analogue information display which is not subject to misinterpretation.

An example of this practical thinking is the **DD10R** ten bar l.e.d. array from ITT which comes in a 20 pin d.i.l. package that can be stacked end to end to produce an array of light bars to any desired length. The anode and cathode of each of the ten l.e.d.s are individually accessible to ensure the utmost flexibility of application.

The usual way to display analogue variables such as speed, height, or depth on this sort of array is to illuminate more and more bars as the measured quantity increases, so as to give a variable length of column of light. Stacking several arrays alongside each other forms a histogram type display, and you can't do *that* with Nixie tubes!

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2N490	4·00	2N3055	0·75	2N5294	0·48	AF115	0·35	BC208	0·11	BF166	0·40	LM702C	0·75	OC71	0·17
2N491	4·38	2N3390	0·45	2N5295	0·43	AF116	0·35	BC212K	0·16	BF167	0·25	LM709		OC72	0·25
2N492	5·00	2N3391	0·28	2N5296	0·48	AF117	0·35	BC212L	0·16	BF173	0·27	TO99	0·48	OC81	0·25
2N493	5·20	2N3391A	0·29	2N5298	0·50	AF118	0·35	BC214L	0·18	BF177	0·29	8DIL	0·38	OC83	0·24
2N696	0·22	2N3392	0·15	2N5457	0·49	AF124	0·30	BC237	0·16	BF178	0·35	14DIL	0·40	ORP12	0·55
2N697	0·16	2N3393	0·15	2N5458	0·46	AF125	0·30	BC238	0·15	BF179	0·43	LM710	0·47	R53	1·80
2N698	0·82	2N3394	0·15	2N5459	0·49	AF126	0·28	BC239	0·15	BF180	0·35	LM723C	0·90	SL414A	1·80
2N699	0·59	2N3402	0·18	2N5492	0·58	AF127	0·28	BC251	0·25	BF181	0·36	LM741		SL610C	1·70
2N706	0·14	2N3403	0·19	2N5494	0·58	AF139	0·65	BC253	0·25	BF182	0·35	TO99	0·40	SL611C	1·70
2N706A	0·16	2N3414	0·20	2N5496	0·61	AF186	0·46	BC257	0·16	BF183	0·55	8DIL	0·40	SL612C	1·70
2N708	0·17	2N3415	0·21	2N5777	0·45	AF200	0·65	BC258	0·18	BF184	0·30	14DIL	0·38	SL620C	2·60
2N709	0·42	2N3416	0·24	2N6027	0·45	AF239	0·65	BC259	0·17	BF185	0·30	LM747	1·00	SL621C	2·60
2N711	0·50	2N3417	0·29	3N128	0·73	AF240	0·90	BC261	0·25	BF194	0·12	LM748		SL623	4·59
2N718	0·23	2N3440	0·59	3N139	1·42	AF279	0·70	BC262	0·25	BF195	0·12	8DIL	0·60	SL640C	3·10
2N718A	0·28	2N3441	0·97	3N140	1·00	AF280	0·79	BC263	0·25	BF196	0·13	14DIL	0·73	SL641C	3·10
2N720	0·57	2N3442	1·40	3N141	0·81	AL102	1·00	BC300	0·38	BF197	0·15	LM3900	0·70	SN76003N	2·92
2N914	0·39	2N3638	0·15	3N200	2·49	AL103	1·00	BC301	0·34	BF198	0·18	LM7805	2·00	SN76013N	1·95
2N916	0·28	2N3638A	0·15	40361	0·40	BC107	0·14	BC302	0·29	BF200	0·40	LM7812	2·50	SN76023N	1·80
2N918	0·32	2N3639	0·27	40362	0·45	BC108	0·14	BC303	0·54	BF225J	0·23	LM7815	2·50	SN76033N	2·92
2N929	0·37	2N3641	0·17	40363	0·88	BC109	0·14	BC307	0·17	BF244	0·21	LM7824	2·50	ST2	0·20
2N930	0·22	2N3702	0·12	40389	0·46	BC113	0·15	BC308A	0·15	BF245	0·45	MC1303	1·50	TAA263	1·10
2N1302	0·19	2N3703	0·13	40394	0·56	BC115	0·17	BC309C	0·20	BF246	0·58	MC1310	2·50	TAA300	1·80
2N1303	0·19	2N3704	0·15	40395	0·65	BC116	0·17	BC317	0·12	BF247	0·65	MC1330P	0·90	TAA350	2·10
2N1304	0·26	2N3705	0·15	40406	0·44	BC116A	0·38	BC318	0·12	BF254	0·19	MC1351P	0·80	TAA550	0·60
2N1305	0·24	2N3706	0·15	40407	0·35	BC117	0·21	BC337	0·20	BF255	0·19	MC1352P	0·80	TAA611C	2·18
2N1306	0·31	2N3707	0·18	40408	0·35	BC118	0·14	BC338	0·20	BF257	0·47	MC1466	3·50	TAA621	2·03
2N1307	0·30	2N3708	0·14	40409	0·52	BC119	0·29	BCY30	0·80	BF258	0·53	MC1469	2·75	TAA661B	1·32
2N1308	0·47	2N3709	0·15	40410	0·52	BC121	0·35	BCY31	0·85	BF259	0·55	ME0402	0·20	TBA641B	2·25
2N1309	0·47	2N3710	0·15	40411	2·00	BC125	0·16	BCY32	1·15	BFR39	0·24	ME0404	0·13	TBA651	1·69
2N1671	1·54	2N3711	0·15	40594	0·74	BC126	0·23	BCY33	0·85	BFR79	0·24	ME0412	0·18	TBA800	1·40
2N1671A	1·67	2N3712	1·20	40595	0·84	BC132	0·30	BCY34	0·79	BFS21A	2·30	ME4102	0·11	TBA810	1·40
2N1671B	1·85	2N3713	1·20	40601	0·67	BC134	0·13	BCY38	1·00	BFS28	1·36	ME4104	0·11	TBA820	1·15
2N1711	0·45	2N3714	1·38	40602	0·61	BC135	0·13	BCY39	1·50	BFS61	0·27	MJ480	0·95	TBA920	2·30
2N1907	5·50	2N3715	1·50	40603	0·58	BC136	0·17	BCY40	0·97	BFS98	0·25	MJ481	1·20	TIL209	0·30
2N2102	0·60	2N3716	1·80	40604	0·56	BC137	0·17	BCY42	0·28	BFX29	0·30	MJ490	1·05	TIP29A	0·49
2N2147	0·78	2N3771	2·20	40636	1·10	BC140	0·68	BCY58	0·30	BFX30	0·27	MJ491	1·45	TIP29C	0·80
2N2148	0·94	2N3772	1·80	40669	1·00	BC141	0·68	BCY59	0·32	BFX84	0·24	MJ2955	1·00	TIP30A	0·58
2N2160	0·90	2N3773	2·65	40673	0·73	BC142	0·23	BCY70	0·17	BFX85	0·30	MJE340	0·48	TIP30C	0·85
2N2218A	0·22	2N3789	2·06	AC126	0·20	BC143	0·25	BCY71	0·22	BFX87	0·28	MJE2955	1·20	TIP31A	0·62
2N2219	0·24	2N3790	2·40	AC127	0·20	BC147	0·14	BCY72	0·15	BFX88	0·25	MJE3055	0·75	TIP31C	1·00
2N2219A	0·26	2N3791	2·35	AC128	0·20	BC148	0·14	BD115	0·75	BFX89	0·90	MJE370	0·65	TIP32A	0·74
2N2220	0·25	2N3792	2·60	AC151V	0·27	BC149	0·15	BD116	0·75	BFY50	0·23	MJE371	0·75	TIP32C	1·25
2N2221	0·18	2N3794	0·24	AC152V	0·49	BC153	0·18	BD121	1·00	BFY51	0·23	MJE520	0·60	TIP33A	1·01
2N2221A	0·21	2N3819	0·37	AC153	0·35	BC154	0·18	BD123	0·82	BFY52	0·21	MJE521	0·70	TIP33C	1·45
2N2222	0·20	2N3820	0·64	AC153K	0·40	BC157	0·16	BD124	0·67	BFY53	0·18	MP8111	0·32	TIP34A	1·51
2N2222A	0·25	2N3823	0·78	AC154	0·25	BC158	0·16	BD131	0·40	BFY90	0·75	MP8112	0·40	TIP34C	2·60
2N2368	0·25	2N3904	0·27	AC176	0·30	BC160	0·60	BD132	0·50	BRY39	0·38	MP8113	0·47	TIP35A	2·90
2N2369	0·20	2N3906	0·27	AC176K	0·40	BC167B	0·15	BD135	0·43	BSX20	0·21	MPF102	0·39	TIP36A	3·70
2N2369A	0·22	2N4036	0·67	AC187K	0·35	BC168B	0·15	BD136	0·47	BSX21	0·29	MPSA05	0·25	TIP41A	0·79
2N2646	0·55	2N4037	0·42	AC188K	0·40	BC168C	0·15	BD137	0·55	BU104	2·00	MPSA06	0·31	TIP41C	1·40
2N2647	0·98	2N4058	0·18	ACY18	0·24	BC169B	0·15	BD138	0·63	BU105	2·25	MPSA12	0·35	TIP42A	0·90
2N2904	0·22	2N4059	0·15	ACY19	0·27	BC169C	0·15	BD139	0·71	C106D	0·65	MPSA55	0·25	TIP42C	1·60
2N2904A	0·24	2N4060	0·15	ACY20	0·22	BC170A	0·15	BD140	0·87	CA3018A	0·85	MPSA56	0·31	TIP49C	0·70
2N2905	0·25	2N4061	0·15	ACY21	0·26	BC171	0·16	BD529	0·80	CA3020A	1·80	MPSU05	0·53	TIP53	1·70
2N2905A	0·26	2N4062	0·15	ACY28	0·20	BC172	0·17	BD530	0·80	CA3028A	0·79	MPSU06	0·58	TIP2955	0·98
2N2906	0·19	2N4126	0·21	ACY30	0·28	BC177	0·28	BDY20	1·05	CA3035	1·37	MPSU55	0·63	TIP3055	0·50
2N2906A	0·21	2N4289	0·34	AD142	0·57	BC178	0·27	BF115	0·36	CA3046	0·70	MPSU56	0·80	TIY43	0·28
2N2907	0·22	2N4919	0·95	AD143	0·68	BC179	0·30	BF117	0·55	CA3048	2·11	NE555V	0·70	ZTX300	0·13
2N2907A	0·24	2N4920	1·10	AD149V	1·20	BC182	0·12	BF121	0·35	CA3052	1·62	NE556	1·30	ZTX301	0·13
2N2924	0·20	2N4921	0·83	AD150	1·15	BY182L	0·12	BF123	0·35	CA3089E	1·96	NE560	4·48	ZTX302	0·20
2N2925	0·20	2N4922	1·00	AD161	0·50	BC183	0·12	BF125	0·35	CA3090Q	4·23	NE561	4·48	ZTX500	0·15
2N2926		2N4923	1·00	AD162	0·50	BC183L	0·12	BF152	0·20	LM301A	0·48	NE565A	4·48	ZTX501	0·13
Green	0·12	2N5190	0·92	AD161 }	PR	BC184	0·13	BF153	0·25	LM308	2·50	OC23	1·35	ZTX502	0·18
Yellow	0·12	2N5191	0·96	AD162 }	1·20	BC184L	0·13	BF154	0·20	LM309K	1·88	OC28	0·76	ZTX530	0·23

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4008	1·63	4021	1·72	4043	1·80
4009	1·18	4022	1·66	4044	1·80
4010	1·18	4023	0·36	4045	2·65
4011	0·36	4024	1·24	4046	2·84
4012	0·36	4025	0·32	4047	1·65
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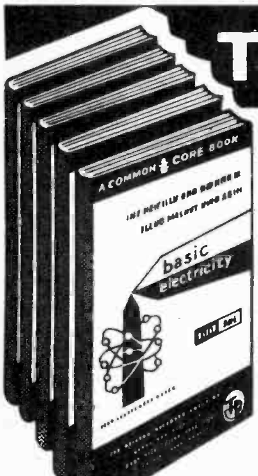

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MICROPROCESSORS

PART 2

By V. YATES*

LAST month we covered the fundamentals of the microprocessor, the hexidecimal coding system, and the function of some of the pins of the Motorola chip. This concluding article deals with the programming language used in the processor and the various types of memory.

THE LANGUAGE OF THE MPU

All instructions within an MPU system are in the form of binary words—more commonly referred to as machine code. However, the sequence of instructions which form a programme are normally first written in mnemonic form, using the list of instructions illustrated in Fig. 6, and are then converted into machine code.

A programme consists of a series of statements each comprising an instruction (mnemonic operator) and the operand. The operand can be a numerical value, an address, or an address where a numerical value can be found. Sometimes the operand is only present by implication. For instance, the instruction to add the contents of accumulator A to the contents of accumulator B and to place the result in accumulator A, represented by the mnemonic ABA, does not need an operand because it is obvious from the instruction that the operands must be in the accumulators.

Depending on the particular instruction an operand can be specified or located in a number of different ways:

Immediate: An example of immediate addressing is LDA A 05 (Load accumulator A with the number 05). In immediate addressing a programme statement comprises two bytes of machine code; in our example LDA A will form one byte and 05 the second. The machine code for LDA A in the immediate addressing mode is 86, so the whole statement becomes 86 05.

Direct: A statement using the direct form of addressing is a two byte statement comprising a single byte which specifies the instruction and a second byte which is the address where the operand will be found.

For example, the instruction LDA A 05 in the direct form of addressing would tell the MPU to load accumulator A with the content of memory location 00 05. In machine code this is 96 05.

The second byte of a statement employing the direct addressing mode forms the least significant eight bits of the address and the most significant eight bits are assumed to be 00. Therefore, with direct addressing it is possible to address the memory locations from 00 00 to 00 FF (the first 256 locations).

Extended: The only difference between extended and direct addressing is that three bytes instead of two are employed so that a full address can be incorporated in a statement. For example, LDA A 12 05 (load accumulator A with the contents of memory location 12 05 using extended addressing) becomes B6 12 05 in machine code.

Indexed: The MPU contained a register called the index register which is used in indexed addressing. The index register holds a two byte address which can be set to any value by the programmer. In indexed addressing the operand is found at the

Fig. 6: Microprocessor Instruction Set

ABA	Add Accumulators
ADC	Add with Carry
ADD	Add
AND	Logical And
ASL	Arithmetic Shift Left
ASR	Arithmetic Shift Right
BCC	Branch if Carry Clear
BCS	Branch if Carry Set
BEQ	Branch if Equal to Zero
BGE	Branch if Greater or Equal Zero
BGT	Branch if Greater than Zero
BHI	Branch if Higher
BIT	Bit Test
BLE	Branch if Less or Equal
BLS	Branch if Lower or Same
BLT	Branch if Less than Zero
BMI	Branch if Minus
BNE	Branch if Not Equal to Zero
BPL	Branch if Plus
BRA	Branch Always
BSR	Branch to Subroutine
BVC	Branch if Overflow Clear
BVS	Branch if Overflow Set
CBA	Compare Accumulators
CLC	Clear Carry
CLI	Clear Interrupt Mask
CLR	Clear
CLV	Clear Overflow
CMP	Compare
COM	Complement
CPX	Compare Index Register
DAA	Decimal Adjust
DEC	Decrement
DES	Decrement Stack Pointer
DEX	Decrement Index Register
EOR	Exclusive OR
INC	Increment
INS	Increment Stack Pointer
INX	Increment Index Register
JMP	Jump
JSR	Jump to Subroutine
LDA	Load Accumulator
LDS	Load Stack Pointer
LDX	Load Index Register
LSR	Logical Shift Right
NEG	Negate
NOP	No Operation
ORA	Inclusive OR Accumulator
PSH	Push Data
PUL	Pull Data
ROL	Rotate Left
ROR	Rotate Right
RTI	Return from Interrupt
RTS	Return from Subroutine
SBA	Subtract Accumulators
SBC	Subtract with Carry
SEC	Set Carry
SEI	Set Interrupt Mask
SEV	Set Overflow
STA	Store Accumulator
STS	Store Stack Register
STX	Store Index Register
SUB	Subtract
SWI	Software Interrupt
TAB	Transfer Accumulators
TAP	Transfer Accumulators to Condition Code Reg.
TBA	Transfer Accumulators
TPA	Transfer Condition Code Reg. to Accumulator
TST	Test
TSX	Transfer Stack Pointer to Index Register
TXS	Transfer Index Register to Stack Pointer
WAI	Wait for Interrupt

*Director, MOS Marketing, Europe. Motorola Inc.

address specified by the index register plus the number which is contained in the second byte of the instruction.

For example, the instruction LDA A +6 in the indexed mode would load accumulator A with the contents of the memory location which is six locations higher than the location which is addressed by the index register. In machine code this is represented by A6 06.

If the index register held the address 12 02, the instruction A6 06 would load accumulator A with the contents of memory location 12 02 +6 = 12 08.

Relative: Certain instructions, namely branch instructions, for the MPU employ the relative mode of addressing. These instructions enable the MPU to carry out an instruction which is not the next one in sequence. Consider the following instruction programme:

```
LOOP  DEC B
      BNE   LOOP
      NEXT INSTRUCTION
```

In this sequence DEC B causes a 1 to be subtracted from the content of accumulator B. Instruction BNE compares what is left in accumulator B with zero and causes the next instruction to be carried out if the result is zero. If the accumulator is not zero BNE causes the MPU to branch back to "LOOP" and again subtract 1 from the accumulator. In machine code this instruction sequence is represented by

0010	5A	(DEC B)
0011	26	(BNE)
0012	FD	(-3)
0013	Next instruction	

At memory location 00 11 the MPU encounters the instruction 26 (BNE). Memory location 00 12 contains the relative address of the next instruction should the conditions for a branch be met. If they are, the relative address (FD = −3) is added to the contents of the programme counter, so that the programme branches back to 0010 (DEC B): i.e. after reading the BNE instruction and the relative address the programme counter contains 00 13, to branch, the relative address is added to the programme counter; 00 13 + (−3) = 00 10.

Numerical information within the machine, as has been mentioned before, is represented in binary form. For relative addressing, and for some mathematical operation the numerical value is in the form of a signed two's complement number.

In signed two's complement representation the most significant bit (left hand bit) of a number is used to indicate the sign of the number: all numbers beginning with 1 are negative and all numbers beginning with 0 are positive. The remaining seven bits are used to indicate the value of the number.

Therefore while unsigned binary numbers of 8 bits can have any value from 0 to 255 (decimal), signed binary numbers can have values from +127 to −128.

To find the signed two's complement of a negative number three steps are necessary.

For example, what is the two's complement of −23? Forget about the sign and express the number in binary form: −23 = 00010111. Complement the number (change 0 to 1 and 1 to 0) so that it equals 11101000. Add 1 to the result, 11101000 + 1 = 11101001 and so −23 is equal to 11101001 or E9 (hexidecimal) in signed two's complement form.

The MPU can also operate on decimal numbers in binary coded form. As each decimal number requires four bits, each byte of binary code can represent two decimal numbers.

PROGRAMMING THE MPU

It is possible to programme the MPU directly in machine code, although this is rather a tedious and time consuming business. The industrialist who intends to use the MPU in an instrument, control system or in other equipment will use a "full-sized" computer to assist him in the preparation of his microprocessor programme.

Basically the process involves writing the microprocessor programme using the mnemonic instruction set (this is called the source programme), and then using the main computer to convert it into a sequence of machine coded instructions known as the object programme.

The whole conversion process is known as "assembly" and the programme which is run on the main computer to perform the conversion is called an assembler. The assembler, and some associated programmes, enable the source programme to be easily edited and manipulated by the programmer.

THE MEMORY

The MPU has, as we have seen, a 16-bit address bus for addressing locations in memory and input/output units (Peripherals). It has also been explained that a 16-bit binary word can have 65,536 different values, therefore the memory can have 65,536 locations.

Each 1,024 memory locations is referred to as 1K (it being generally accepted that in data processing 1K = 1,024, while in electronics 1k = 1,000) therefore, the memory for the Motorola MPU can have a capacity of up to 64K bytes.

This memory will normally be made up from RAMs (Random Access Memories), ROMs (Read Only Memories) and PROMs (Programmable Read Only Memories). All these memory devices are semiconductor integrated circuits.

RAMs: A RAM consists of a number of storage cells—each cell capable of storing one bit—together with the necessary control and addressing circuitry. The design of the cells and the control circuit allows information to be written into, or read from, the memory at will.

ROMs: Like the RAM a ROM comprises a number of memory cells complete with the addressing and control circuitry. However, the design of the cells in a ROM is fundamentally different. The content (a binary 1 or 0) is set during the final stages of manufacture of the device and can never be subsequently changed.

The actual binary content of the ROM is determined by the customer who usually sends the ROM manufacturer a paper tape, or a set of punched cards, which specifies the content of the ROM. ROMs are only economic when a large number with the same binary content have to be manufactured.

PROMs: The difference between a PROM and a ROM is that the content of the memory is entered electrically by the user. Once a PROM has been programmed the contents cannot be altered.

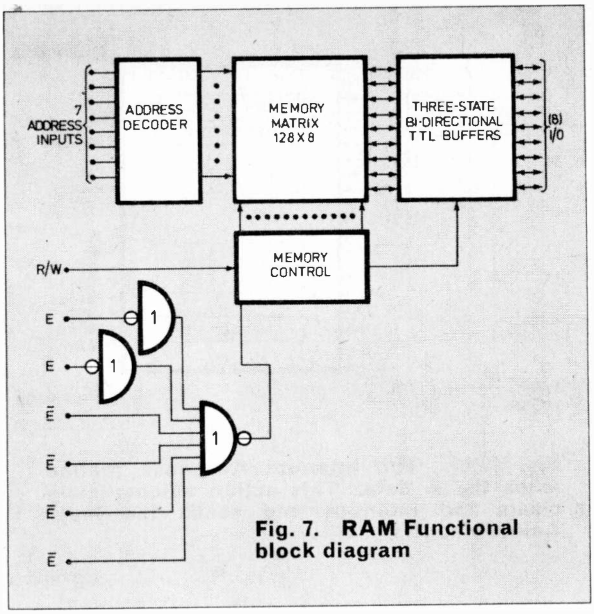


Fig. 7. RAM Functional block diagram

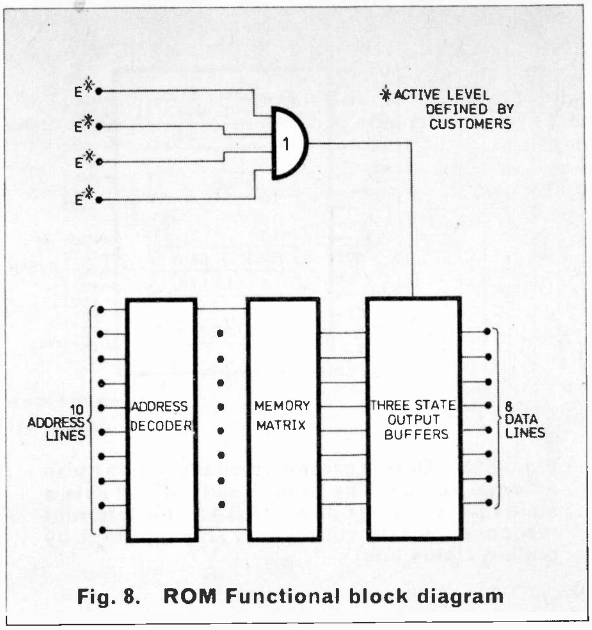


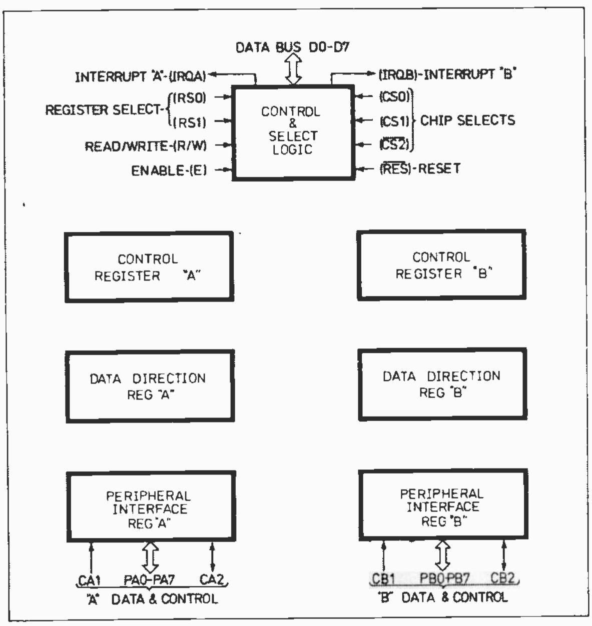
Fig. 8. ROM Functional block diagram

Most microprocessors will employ RAMs, together with some form of read only storage. The ROM section of the store is used to hold frequently used programmes.

The RAM in Motorola's microprocessor set is known as the MCM6810 and is shown in Fig. 7. It will store 128 bytes and has eight bi-directional buffers for connecting to the microprocessing system's data bus. The 128 memory locations necessitate seven address inputs in order that each location can be individually selected. In addition, the MCM6810 has six chip select (E) inputs to facilitate easy memory expansion.

The ROM intended for use in the Motorola microprocessor will store 1K bytes (1,024 8-bit words). It is known as the MCM6830 and, as shown in Fig. 8, it has four enable inputs and eight buffer stages for connection to the data bus.

Fig. 9. PIA Block diagram



THE OUTSIDE WORLD

A microprocessing system must be able to communicate with external equipment before it can be used. This equipment can take very many forms from simple relays to magnetic tape units, keyboards, video display units, printers and the like. Designing a circuit that will allow the microprocessing system to communicate with any or all of these is, to say the least, difficult.

In the Motorola microprocessor the problem is solved by a universal interface circuit known as the "Peripheral Interface Adaptor" (PIA) with the type number MC6820.

This is a complex LSI circuit of which a block diagram is given in Fig. 9. It is, as can be seen, divided into two sections; section A and section B. Connection to the microprocessor is made via the data highway (D_0 D_7), the address highway ($A_{0, 1, 2, 13 \text{ and } 14}$) and several control lines. The peripheral can be connected to the PIA by two bi-directional data highways (PA_{0-7} and PB_{0-7}) and four control lines.

Each individual line in the two peripheral data highways can be programmed to be either an input or an output by binary words held in the data direction registers. Binary words held in the control registers set the function performed by the various PIA control lines to adjust the function performed by the PIA to suit the peripheral to which it is connected.

PIA IN ACTION

Let us consider an actual example of the PIA in action, as graphically illustrated in Fig. 10.

(1) Fig. 10(a). The peripheral tells the PIA that it wishes to input data by taking the PIA input ready line to logic "1". This causes the left hand bit in the

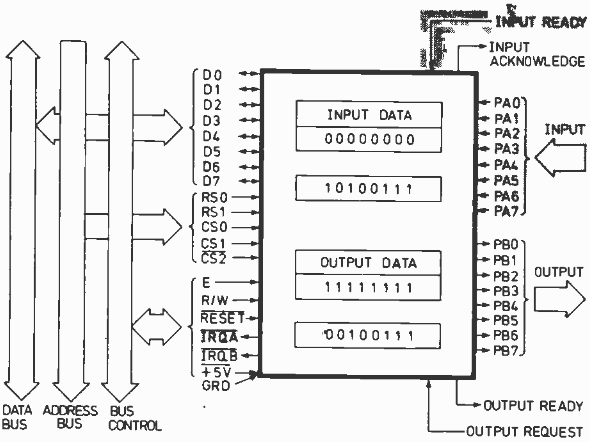


Fig. 10(a). Data is presented on the A side by an external device. The Input Ready signal sets a status bit and pulls down $\overline{\text{IRQA}}$. The Interrupt response routine will identify this interrupt by polling status bits

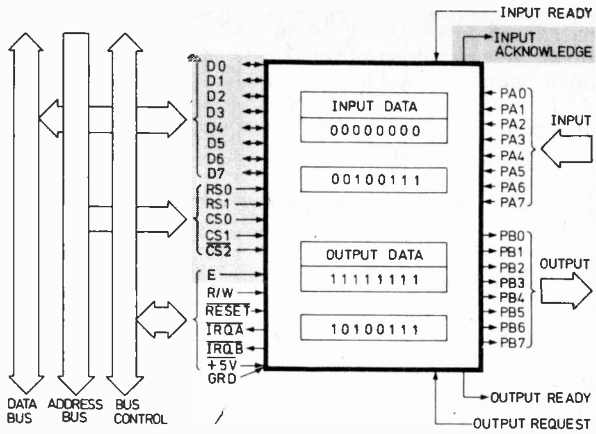


Fig. 10(b). The Interrupt Response routine reads the A data. This action automatically clears the interrupt and sends the Input Acknowledge signal

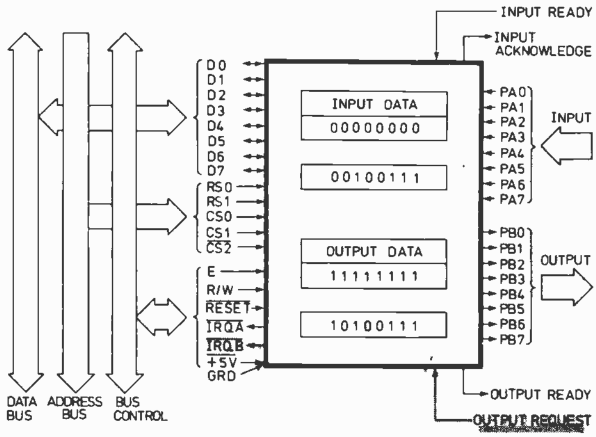


Fig. 10(c). An external device requests data on the B side with Output Request. This sets a status bit and pulls down $\overline{\text{IRQB}}$

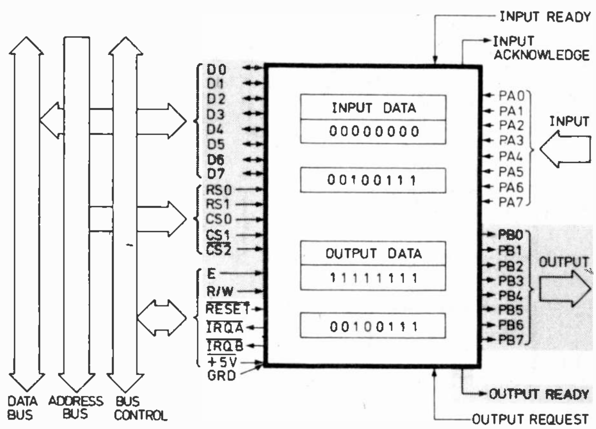


Fig. 10(d). The Interrupt Response routine identifies the interrupt by checking status bits. A read operation is used to clear the interrupt. Writing output data to the B side presents the data to the external device and automatically generates the output ready signal

A control register to be set to 1. This bit is called a "flag" bit.

(2) The flag bit forces the system's "$\overline{\text{Interrupt request}}$" ($\overline{\text{IRQ}}$) line to logic "0". Normally, all $\overline{\text{IRQ}}$ lines will be connected together (wire-OR), including the $\overline{\text{IRQ}}$ input to the MPU.

(3) The MPU will go into an interrupt request sequence as described earlier. After storing the contents of all its internal registers away in the stack, the MPU will set the interrupt mask bit in the condition code register before going to a known location within memory for the first instruction in the interrupt programme.

(4) This programme will cause the MPU to examine each flag bit in all units capable of causing an $\overline{\text{IRQ}}$ in turn (this is known as "Polling").

(5) Fig.10(b). The MPU "sees" the PIA A control register flag at logic 1 and instructs the PIA to write its data onto the data highway.

(6) This action resets the flag in the PIA control register. The $\overline{\text{IRQ}}$ line goes high, the MPU resets the interrupt mask bit to 0, recalls the content of the stack and proceeds with its normal programme.

The situation resulting from a request from a peripheral for data is illustrated in Figs. 10(c) and 10(d). The sequence starts with an "output request" from the peripheral. The reader should by now be able to trace the sequence without the assistance of the printed word.

The PIA can be used in many other ways apart from the one that has been described here.

Motorola have another interface device for use with their MPU which is called the Asynchronous Communications Interface Adapter (ACIA). This is another very complex device and it is not proposed to describe it in very great detail here. However, its function will be discussed in principle.

All information transfers discussed so far have been carried out in parallel (all eight bits at the same time). However, when data is to be transferred over a single line it has to be done serially (one bit at a time). The ACIA receives each input word one bit at a time (serially) from the reception line.

performs certain checks, then transmits the data in parallel (8 bits) over the data highway to the MPU. In the reverse direction the MPU sends all eight bits of a word simultaneously to the ACIA and the ACIA re-transmits each word one bit at a time over the serial transmission line to the remote equipment.

Information on the serial transmission line appears as a string of 1s and 0s in the form of electrical pulses and is carried out in accordance with rules which are internationally agreed. Pulses of different length to the data pulses are inserted to identify the beginning and end of each word transmitted. The ACIA performs in accordance with the agreed rules. If required, the ACIA can be used whenever it is necessary to interface the MPU with other equipment over a single pair of wires.

MORE MICROPROCESSORS

We have examined the Motorola microprocessors in some detail. It was mentioned at the start of this article that there are now some thirty different microprocessors available. While we do not intend to mention all of these, it would be worth while having a brief look at some of them.

All the microprocessors consist of a central processing unit, a memory and suitable arrangements for input/output operations. In some cases the MPU itself has to be programmed to carry out the necessary handshaking routines with peripheral devices.

FIRST TYPES

Intel were the first semiconductor company to produce a microprocessor. It consists of four integrated circuits which together made up a complete 4-bit processing unit, known as the 4004N. The basic four-chip set comprises the central processing unit (CPU), a RAM, a ROM and an I/O unit.

Using the basic building blocks a 4004 system can have up to 4K × 8-bit words in the ROM, 1280 4-bit words in the RAM and up to 128 I/O lines. With the addition of a few gates the system can be expanded to incorporate any combination of RAM and ROM up to 48 packages and to handle up to 192 I/O lines. The system has an instruction set comprising of 45 commands.

From the 4004 Intel progressed to the 8008, an 8-bit parallel central processing unit complete with associated integrated circuits. The 8008 was designed as a general purpose processing unit, which can directly address up to 16K bytes of memory.

The CPU unit itself comprises an 8-bit accumulator, two 8-bit temporary registers, four flag bits and eight 14-bit address registers. The instruction set consists of 48 commands which allow subroutine nesting up to seven levels. Asynchronous or synchronous operation with external memory and multiple interrupts are standard features.

THE 8080

The next development from Intel was a more powerful and faster 8-bit microprocessor which was designated the 8080.

The 8080 provides 74 basic processor instructions including decimal and binary arithmetic and can address up to 65K bytes of memory. Up to 256 input/output units can be interfaced directly with the single chip processor unit. A basic 8080 system consists of the CPU and seven other i.c. packages. A second 4-bit machine, known as the 4040, has been introduced by Intel. This is electrically identical to the 4004 but has an improved performance.

SERIES 3000

For applications where greater speed is required there is the series 3000. This employs Schottky bipolar circuitry throughout, and consists of a central processing element (3002), microprogramme control unit (3001) and seven other i.c.s including a look-ahead-carry generator and an interrupt control unit.

The main circuits are the 3001 and the 3002 which together form a 2-bit section of a high speed processing unit expandable up to 320 bits. One microprogramme control unit is required for every eight central processing elements. Each of the i.c.s within the system have multiple logic systems which can be rearranged by microprogramming.

MICROPROGRAMMING

Microprogramming is a technique which means that the function of the processor is determined by a series of short microprogrammes held in a ROM. The instruction set available is determined by the microprogramme and the user virtually chooses the instruction set he requires by writing the appropriate microprogrammes. Each instruction (called a micro-instruction), when implemented, calls up a microprogramme consisting of a series of micro-instructions. The time taken by the machines to perform a microinstruction is called a microcycle.

BCD OPERATION

Most microprocessors work in binary, following mainframe computer practice. However, a system has been introduced by Advance Electronics Ltd which operates in binary coded decimal (BCD). The decimal processor is contained on two LSI chips divided as follows: Chip 1—programme store (ROM) and input interface. Chip 2—arithmetic unit, data store (RAM) and output interface. The unit is intended for use in applications where fairly large quantities are required, as the ROM section has to be programmed by the manufacturers and, once programmed, cannot be altered.

CMP8

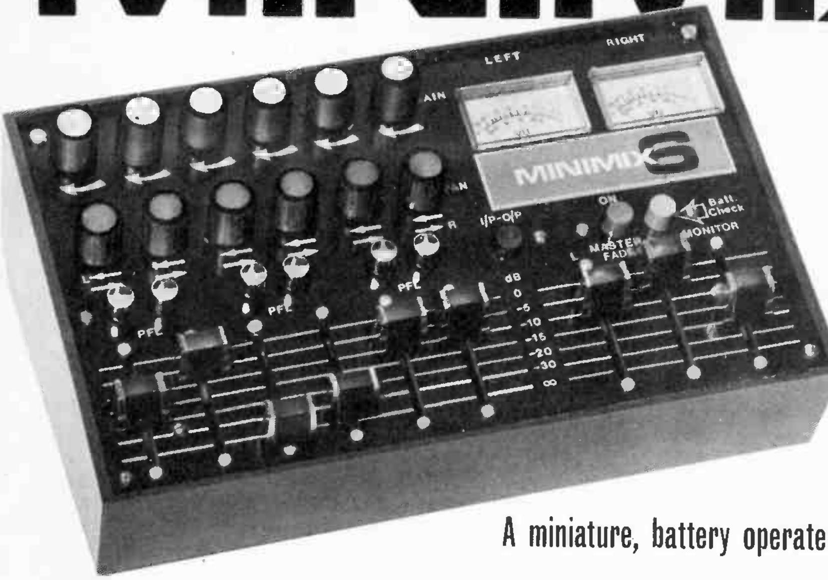
National Semiconductors have a fairly new microprocessor, designated CMP8, consisting of an 8-bit arithmetic and logic unit (ALU), two 16-bit index registers with auto increment/decrement plus four 8-bit registers. There are separate programme and address counters, a 16-bit stack pointer and direct memory access (DMA). It has the capability of directly addressing 65K bytes of memory, and comes in a 40-pin package.

Other microprocessor products available from National Semiconductors are designed around two p.m.o.s. l.s.i. chips which can be assembled in different combinations to form computer systems ranging from a simple 4-bit processor for elementary control functions upwards.

These two chips are the register, arithmetic and logic unit (RALU) and the control read-only

continued on page 916

MINIMIX 6



By G. D. SHAW

- *Panning between channels*
- *Twin VU meters for visual monitoring*
- *Headphone amplifiers for aural monitoring*
- *Switchable pre-fade monitoring offers a cueing facility*
- *Extension facilities enable extra channels to be added*

A miniature, battery operated, six-channel-into-two stereo mixer

SOUND mixing has, over the years, become more and more a part of the audio scene and is, of course, an essential prerequisite of the recording industry. Mixers of one form or another have always been in demand by the amateur constructor and find their place in p.a. work, discos, on stage live performances, and in the home studio. One of the difficulties has been to find a mixer which fits equally well into all these spheres of activity and which does not cost the earth to build.

Additionally the growth of interest in high fidelity reproduction and latterly, the boost given to interest in the creative manipulation of sound by the advent of instruments like the synthesiser has given rise to a fresh demand for sound mixers offering a little more than the "add or take away" requirement of a year or so ago.

It is with the synthesiser in mind, therefore, that the Minimix 6 has been designed but, at the same time, with the proviso that it should prove capable of employment in a diversity of applications.

USE OF THE 741

Essentially the Minimix 6 is a line mixer based on the ubiquitous 741 operational amplifier. However, the line preamplifiers have been given a gain range of up to +40dB and thus each line channel is capable of being operated satisfactorily by devices such as crystal pickups or crystal microphones. It is fairly generally recognised that the 741 operational amplifier is unsuitable for quality audio applications because the typical input noise figure of around 20μV creates problems particularly when any degree of gain is involved. A large proportion of the signal to noise problems can be overcome, however, by careful specification of signal levels and circuit layout.

The Minimix 6 provides unity gain as a true line mixer, i.e. for a 1V (0 V.U.) input the output is also 1V. In these circumstances, providing the input noise of the active units does not exceed 20μV then the theoretical signal/noise ratio is slightly less than −86dB. In practice the measured value on the prototype instrument proved to be −80dB, a figure which is likely to be more than adequate for the purposes specified. With a 10mV input, i.e. operating at maximum gain for a 1V output, the signal to noise ratio deteriorates to −70dB. Again, a figure which would be acceptable for most purposes.

SPECIFICATION . . .

Frequency Response (—3dB points)	
1V (0 V.U.) input	14Hz to 42kHz
0·1V input	14Hz to 16kHz
Signal to Noise Ratio (Input channels)	
0·1V input	−80dB
0·01V input	−70dB
Crosstalk	
100Hz	−43dB
1kHz	−40dB
10kHz	−23dB
Overload capacity	
Input Amplifiers	+14dB
Output Amplifiers	+14dB
Master Fader Rejection	−80dB

CROSSTALK

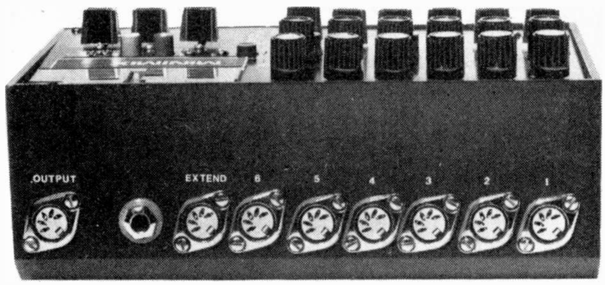
Crosstalk between channels is another problem, particularly when an attempt is made to compress all the necessary circuitry into a confined space. In the Minimix 6 the crosstalk at 100Hz is −43dB deteriorating to −23dB at 10kHz. Although the latter figure leaves much to be desired it compares favourably with the crosstalk in almost any stereo cartridge and in practice, with both channels driven there appears to be no discernible intrusion or interaction between channels. If only one channel is driven with a signal containing significant high audio-frequency elements the master fader rejection of −80dB ensures that the undriven output channel does not receive any unwanted signal.

BLOCK SCHEMATIC

A block schematic of the Minimix 6 is shown in Fig. 1. In all there are six input channels grouped in pairs as shown by channels one and two in the diagram. Signals from the input preamplifier are routed via the channel fader to the wiper of a pan-pot the ends of which are linked into the left and right pan busses. These are in fact virtual earth leads into the left and right group output mixer amplifiers. The group outputs are routed via the master faders into their respective output stages.

P.F.L. FACILITY

Cueing and monitoring facilities are often left out of home built mixers but are nevertheless frequently found to be useful, if not indispensible, in some circumstances. Aural and visual monitoring are provided in the Minimix 6 and may be switched so that the operator can monitor the outputs or any input irrespective of whether that input is actually driving into the group mixers. This latter facility is



known as Pre-Fade Listen (P.F.L.), and is extremely useful when setting up channel gains and signal levels prior to fading into the mix.

The monitoring of input signals is very much geared to the arrangement of the input channels which, as was explained above, are arranged into groups of two. For stereo operation the odd numbered channels 1, 3 and 5 are associated with the left output channel, while the even numbered channels 2, 4 and 6 are associated with the right output channel.

When a stereo signal is being mixed from a prerecorded source (a tape or disc) it would normally be expected that the pan controls would be hard over to left or right since the stereo imaging would have been carried out during the original recording.

When mixing mono signals to form stereo, however, the pan controls on each channel have to be adjusted in order to give a subjective spatial position for the individual mono signals in the final stereo image. In these circumstances the signal has to be monitored twice. Firstly the input channel has to be adjusted for gain and the subjective quality of the sound assessed.

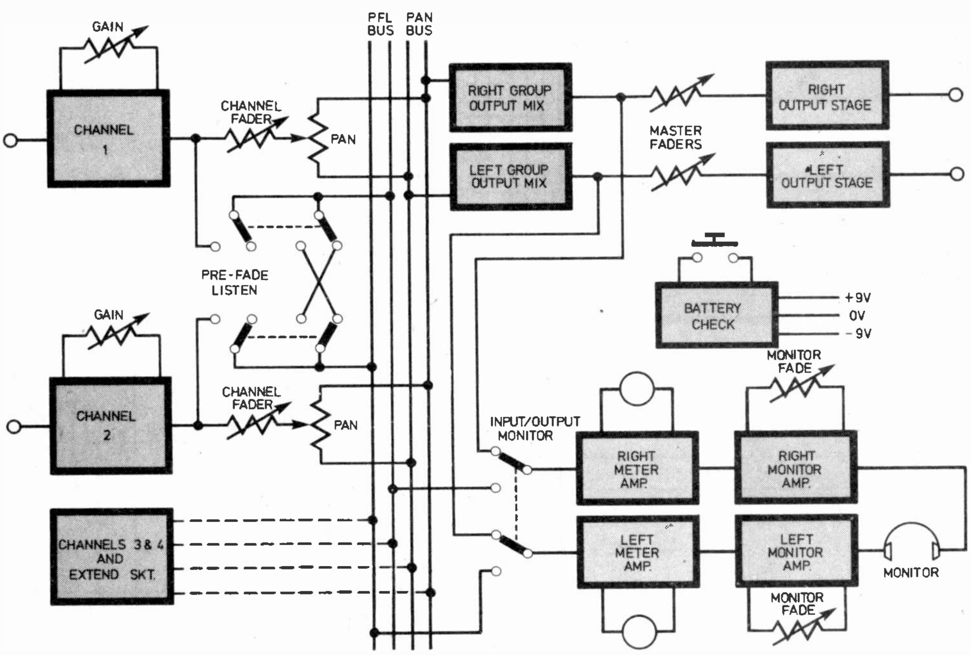


Fig. 1. Block schematic of the P.E. Minimix 6

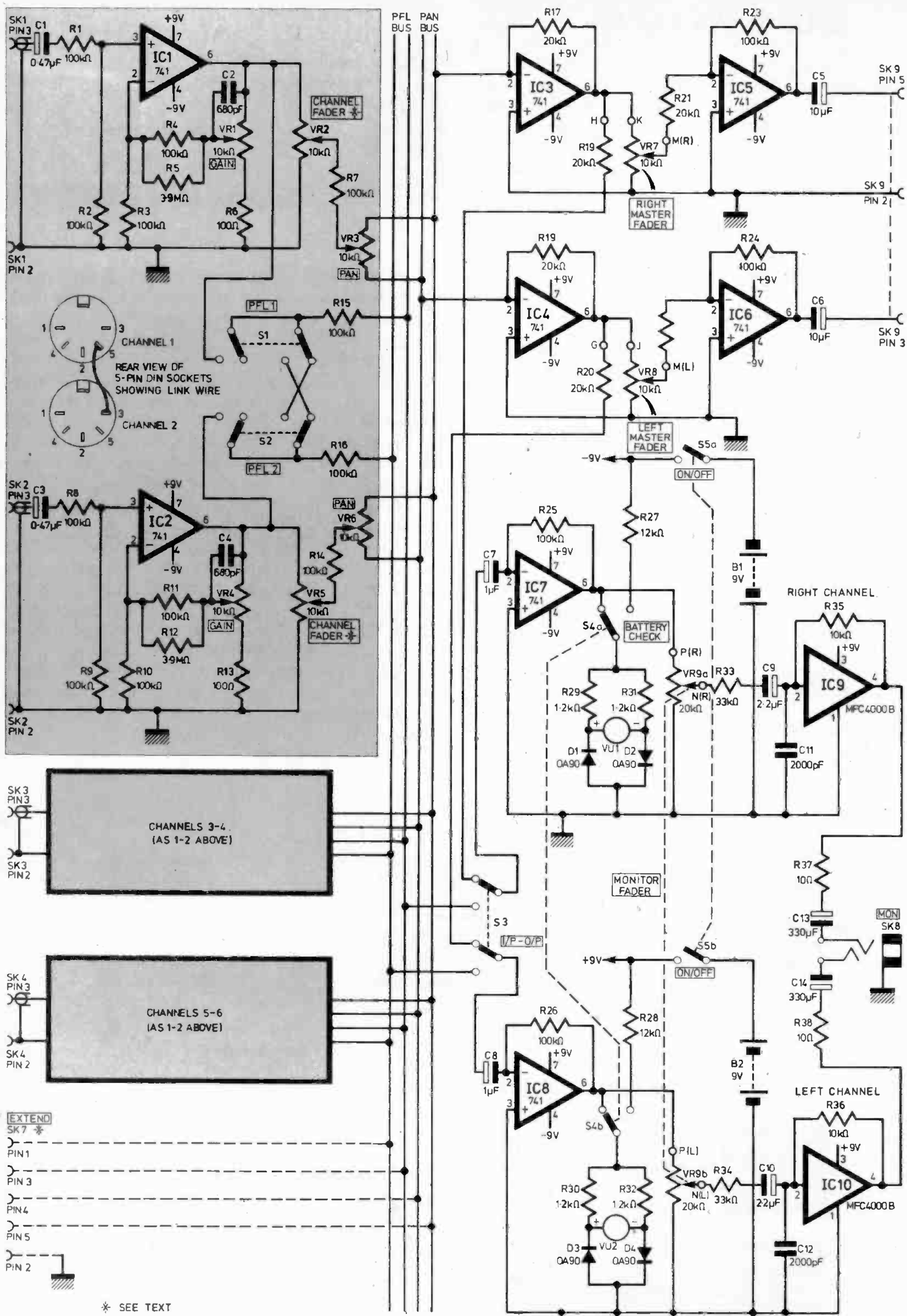


Fig. 2. Full circuit diagram of the P.E. Minimix 6. Note that channels 3-4 and 5-6 are identical to channels 1-2 (shaded areas)

BULK COMPONENTS

This list has been compiled to allow readers to take advantage of ordering all the components at once, and thus possibly obtain a quantity discount.

Resistors

10Ω	2
100Ω	6
1·2kΩ	4
10kΩ	2
12kΩ	2
20kΩ	6
100kΩ	40
3·9MΩ	6

Capacitors

680pF Ceramic	2
2,000pF Ceramic	2
0·47μF 35V Tantalum	6
1·0μF 35V Tantalum	2
2·2μF 35V Tantalum	2
10μF 16V Tantalum	2
330μF 10V Elect.	2

Potentiometers

20kΩ log. Tocosa 35mm stereo slider controls	9
10kΩ log. miniature rotary pots (16mm dia.)	6
10kΩ lin. miniature rotary pots (16mm dia.)	6

Integrated Circuits

741 8 pin d.i.l.	12
MFC4000B 250mW power amplifiers	2

Semiconductors

OA80	4

Miscellaneous

PP6 type battery press studs	2 prs
Printed circuit board 200mm x 110mm	1
Case: Instrument case type 22 (R.S. components) *or* Vero case type 652523E (Vero Electronics)	1
Instrument case type 22	1
Rubber mounting feet, self-adhesive	4
5-way 180 DIN sockets	8
0·25in. stereo; jack socket	
Flush mounting V.U. meters type 3	2
Jean Renaud 2 pole changeover swtiches	9
10-way mounting frame	1
2-way mounting frame	1
Round push button (chrome finish)	6
Round push button (red, green, grey)	1 each
Control knobs for slider controls	9
Control knobs for rotary pots (4mm spindle)	12
Sundry 6BA nuts, bolts, washers	
2mm dia × 3·2mm spacers for mounting slider pots	18

This is done by closing the monitoring switch on the input channel in question and also by changing over the input/output monitor switch. In these circumstances the input signal is routed to both meter and monitoring amplifiers.

MONITORING ARRANGEMENT

Whilst it is not too important to have two visual indications of signal level, it is nevertheless very important to the overall assessment of the sound to have it heard by both ears rather than one alone. The arrangement of the monitoring or P.F.L. switches on paired channels is such that closure of either switch alone routes the input signal to both monitoring amplifiers, while closure of both switches routes the odd channel input signals to the left monitor amplifier and the even channel input signals to the right.

The second stage of stero monitoring consists of checking the signal level and balance between output channels. This is done by switching the monitoring amplifiers so that they are coupled directly to the left and right group output mixers and adjusting the channel faders and panning level and, equally as important, that the spatial positioning of the respective signals appears to be correct.

CIRCUIT DETAILS

The circuit diagram is shown in Fig. 2. It can be seen that, with the exception of the line inputs, each amplifier is connected in the inverting mode. This is quite important as far as the bus amplifiers. are concerned since the fact that the busses themselves are connected directly into the virtual earth points means that they are at very low impedance and therefore less likely to suffer from the induction of stray signals and/or hum.

The input channel or line amplifier has a variable gain and this would normally be set so that, with an input signal in the range 10mV to 1V, the output would be 1V. The bus or group mixer amplifiers have a gain of −14dB to allow for circumstances in which all channels might be routed at full level into one group amplifier and this is compensated for by the fact the output stage and output monitoring option have gains of +14dB. Thus with only one input signal per channel the output stage is still capable of producing a 1V signal.

BATTERY CHECK

The meter driving section incorporates a momentary action battery check switch in order that the battery condition may be conveniently monitored. With the values given a good battery will give a reading between 0V.U. and +1V.U. Below 0V.U. however the battery voltage is beginning to fall off and although the instrument will still operate satisfactorily with a reading of −1V.U. it would be imprudent to use the instrument on an important assignment with the batteries in this condition.

The headphone amplifiers are based on the MFC4000B and have an effective gain of −10dB thereby providing an output signal of around 300mV when the monitored channels are fully driven. This signal is quite sufficient to drive a pair of low impedance headphones to a listening level which is more than adequate.

Next month: Construction, testing and using the Minimix 6

PATENTS REVIEW...

PROTECTING IDEAS

Although this is essentially a patent column, concerned with new British patents for interesting electronic inventions, brief reference must now be made to an alternative approach to patenting. This is prophylactic, protective or defensive disclosure, by the deliberate publication of invention details, so as to block for ever the possibility of a patent on the idea.

The defensive disclosure approach is usually adopted by firms or individuals who can no longer afford to patent every development that they make, but are, understandably, worried over the possibility of a rival firm coincidentally coming up with the same idea, patenting it, and thereby securing a wide monopoly. Especially, now that the British Government is flying in the face of advice from the patent profession, industry and inventors, by raising the official fees payable on patents to unprecedented levels, the concept of deliberate disclosure may be of interest to readers.

Once details of a development have been published, for instance in these pages as a constructional article, it will be quite impossible for anyone (the author of the article included) to apply for a British patent to cover his idea. Because this magazine will find its way onto the shelves of libraries all round the world, such publication will likewise block the possibility of future patents in most civilised countries.

Only a fraction of the ideas conceived by inventors and research teams find their way into magazines, and it would be unwise for anyone to rely on such publication to defend their idea against patenting by others. It is far safer for an inventor who has taken a positive decision not to apply for a patent on a new idea to have brief details published as quickly as possible in some other manner.

One possibility open to firms with a house magazine is that a few pages of the magazine should regularly be set aside for the purpose of disclosure. As every single publication made in the United Kingdom (from children's comics to bus timetables to local borough council minutes) must be deposited with the British Library, and because the existence of a single copy of a document in a public library can constitute legal publication, details in a house magazine will carry heavy legal weight in the U.K. But house magazines may not find their way into foreign libraries, and thus foreign patents may not always be blocked.

To achieve reliable, widespread foreign blocking, it is necessary to ensure that published details are placed on the shelves of public libraries throughout the world. Research Disclosure, of Homewell, Havant, Hampshire, has a long-standing system of swiftly publishing (at a price, of course) details of any invention, on request of the inventor, and sending them automatically to strategic libraries in virtually every country of the world.

Inventors and small firms desperate over the continually increasing cost of patenting and the worry of what others may do, should at least consider the possibility of protective disclosure in all or some of the ways mentioned above.

FUSIBLE LINK — BP 1 395 971

A clever new type of fusible link for protecting circuitry against overheating is described by ITT Creed Ltd., in BP 1 395 971.

A circular wheel turns about a central pivot and has an inner wall and an outer wall which together define an annular cavity. Two pairs of contact pins protrude through the outer wall of the wheel into the cavity. One pair of contact pins at the top of the wheel engage fixed contact plates mounted outside and adjacent to the wheel. A solid slug of low melting point alloy bridges the ends of these pins where they protrude into the annular cavity.

The whole arrangement is mounted vertically and the power supply to the equipment under protection is passed through the electrical circuit formed by the series connection of these contacts and pins.

The wheel is in thermal contact with the equipment under protection, and if the latter overheats the alloy slug melts and falls under gravity to the bottom of the cavity. Here it solidifies again to bridge the gap between the other pair of contact pins. Thus, as the power supply connection between the first pins is broken, an alarm circuit connection between the second set of pins is made, for instance to ring a bell or light a warning lamp.

Once the fault has been corrected, the wheel is turned about its central pivot through 180 degrees, so that the slug bridging the bottom set of pins is moved to the top position to bridge the power supply contacts again. The isolated contacts are simultaneously moved into the alarm circuit at the bottom. Thus the link may be re-set as new after each fusing operation.

MOVE INDICATOR — BP 1 377 381

The Italian company Adriasud explains in BP 1 377 381 that problems arise in international bridge games, due to confusion at the moment of making a declaration. These problems are aggravated when the game is played by contestants speaking different languages.

The patent describes a circuit arrangement for enabling each contestant to positively indicate his declaration, with no possibility of thereafter altering it.

A series of indicator lights displaying the playing card numbers and symbols is shown in the patent. The lights are controlled using logic circuits, by a series of correspondingly marked switches. The circuitry is duplicated for each light and switch.

Each lamp is in series with a respective *npn* transistor across a supply line. The base of each transistor is connected via a resistor to the supply line and also via a diode to a bistable circuit. Initially a capacitor keeps the bistable supply briefly at zero so that all bistable circuits assume a start condition blocking their respective transistors and extinguishing all lights.

The patent goes on to describe in detail the effect of operating the keyswitches and how the circuit ensures that the first key operated has an inhibiting effect on all other keys in the same series of card symbol lights.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 33p each

All in the DECEMBER ISSUE!

GUITAR AMPLIFIER

IC50

A 50 watt r.m.s. two-channel mono amplifier for use in pop groups/bands. Suitable for lead and bass electric guitars, electronic organs and can also be used for P.A. work

- Fifty watts output into 8 ohms
- Two independent input channels
- Bass and treble controls on each channel
- Output short circuit protection
- Low distortion

CHRISTMAS LIGHTS FLASHER

A low power, interference free design for the random flashing of lights either for Christmas tree or shop window displays. Flash rate is completely controllable

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A temperature controller with a host of useful applications. Simple to build and easy to calibrate

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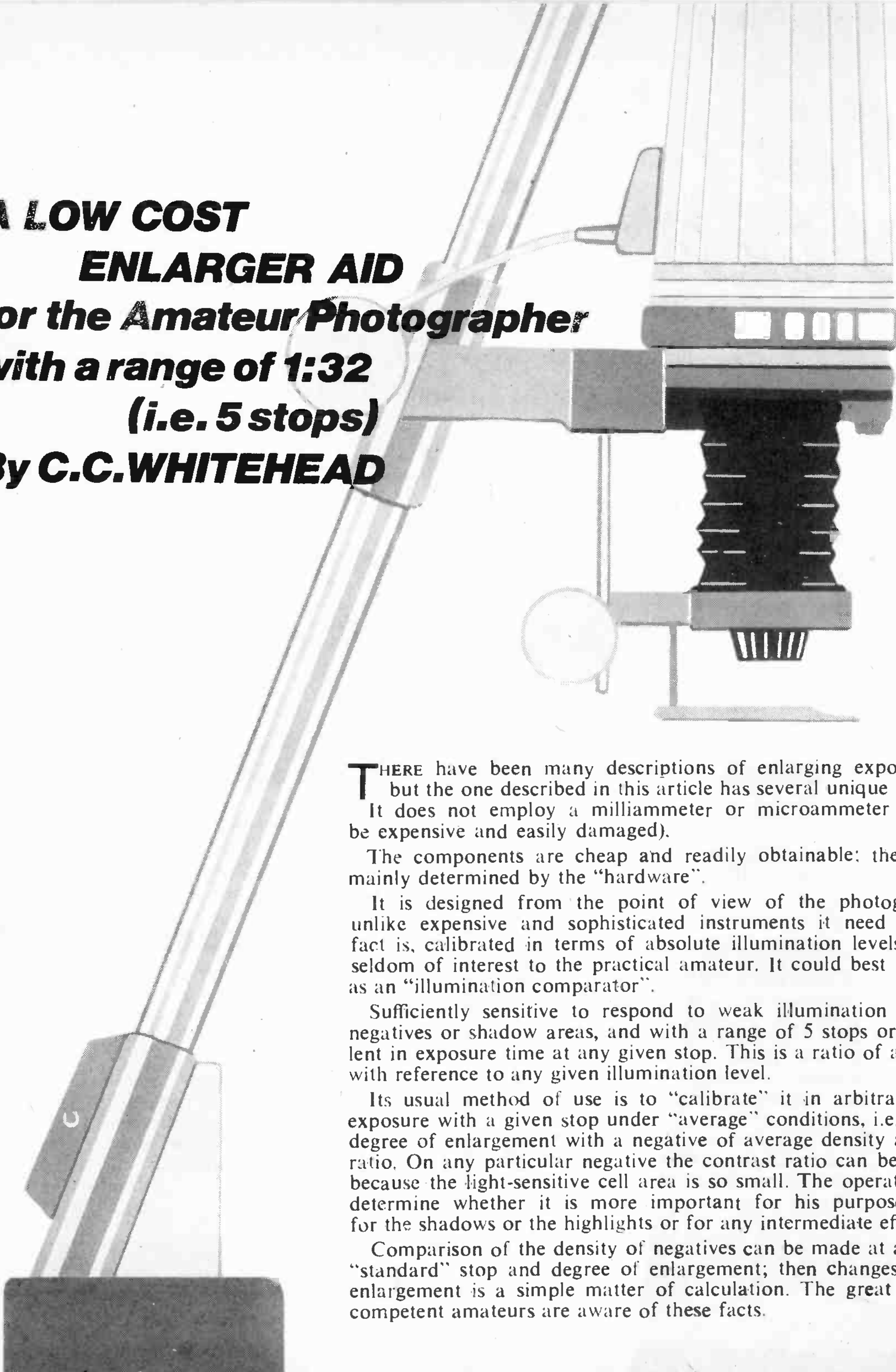


A LOW COST ENLARGER AID for the Amateur Photographer with a range of 1:32 (i.e. 5 stops)

By C.C.WHITEHEAD

THERE have been many descriptions of enlarging exposure-meters, but the one described in this article has several unique properties.

It does not employ a milliammeter or microammeter (which can be expensive and easily damaged).

The components are cheap and readily obtainable: the cost being mainly determined by the "hardware".

It is designed from the point of view of the photographer and unlike expensive and sophisticated instruments it need not, nor in fact is, calibrated in terms of absolute illumination levels, which are seldom of interest to the practical amateur. It could best be described as an "illumination comparator".

Sufficiently sensitive to respond to weak illumination from dense negatives or shadow areas, and with a range of 5 stops or the equivalent in exposure time at any given stop. This is a ratio of at least 32 : 1 with reference to any given illumination level.

Its usual method of use is to "calibrate" it in arbitrary terms of exposure with a given stop under "average" conditions, i.e. an average degree of enlargement with a negative of average density and contrast ratio. On any particular negative the contrast ratio can be determined because the light-sensitive cell area is so small. The operator can then determine whether it is more important for his purpose to expose for the shadows or the highlights or for any intermediate effect.

Comparison of the density of negatives can be made at a convenient "standard" stop and degree of enlargement; then changes in ratio of enlargement is a simple matter of calculation. The great majority of competent amateurs are aware of these facts.

SIMPLE LIGHT COMPARATOR

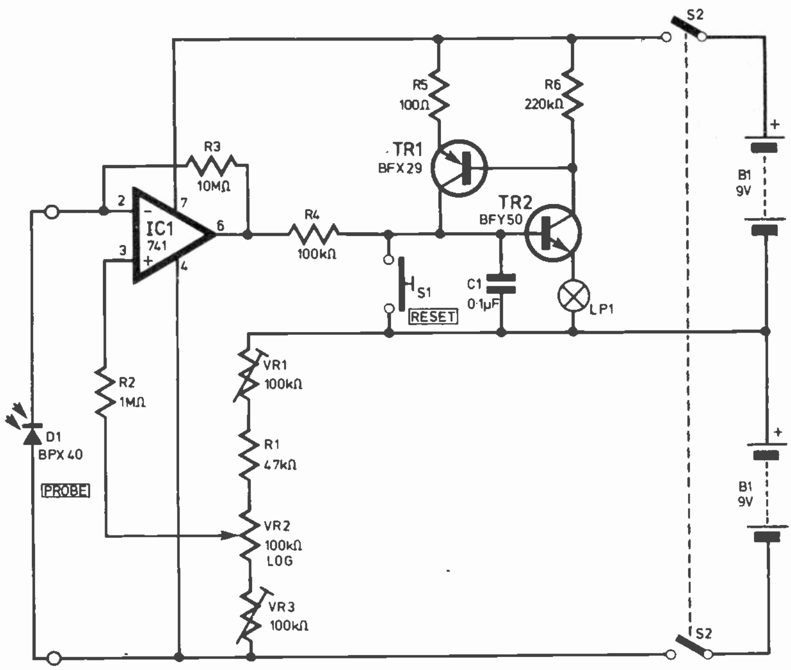


Fig. 1. Circuit diagram of the simple light comparator

The instrument is powered by small batteries (which in the writer's instrument are housed in the case) and which, owing to the very low power requirement, have practically "shelf life".

PHOTODIODE

Since one never obtains anything (except trouble!) for nothing, there is a price to pay for these advantages. As a very small photo diode (Mullard BPX90) is used (for "spot" readings) considerable amplification is required, which results in a limited range of light intensity readable. The range is 1:32, i.e. "5 stops". However, the intelligent photographer will know how to extend this range by operating procedure.

The circuit is shown in Fig. 1. The heart of the circuit is a 741 operating in the differential mode. In order to obtain a reasonably linear scale the potentiometer VR2 is logarithmic and used "backwards", i.e. with the high resistance end at the start of the reading. The preset potentiometers VR1 and VR3 are adjusted for best range and linearity of scale. It is not possible to obtain a close approximation to linearity, but this is not very important, having regard to the way in which the instrument is intended to be used.

TRIGGER CIRCUIT

The transistors TR1 and TR2, with resistors R5 and R6, form a "trigger-circuit" which operates abruptly when the potential at the base of TR2 is about 150mV with respect to 0V, and lights the lamp LP1.

The lamp used in the prototype is a 6V 0·04A cycle-lamp bulb, which is also under-run, to minimise the load on the battery. The lamp is normally on for only a few seconds at a time. Otherwise the current drain on the batteries is only of the order of a couple of milliamperes. The battery B1 is a PP6, since it has to supply the lamp current. B2 can be a PP3, since it only has to supply the photocell current and the negative feed to the amplifier.

COMPONENTS . . .

Resistors

R1 47k Ω
R2 1M Ω
R3 10M Ω
R4 100k Ω
R5 100 Ω
R6 220k Ω
All ¼W, 10% carbon

Potentiometers

VR1 100kΩ lin
VR2 100kΩ log
VR3 100kΩ lin

Semiconductors

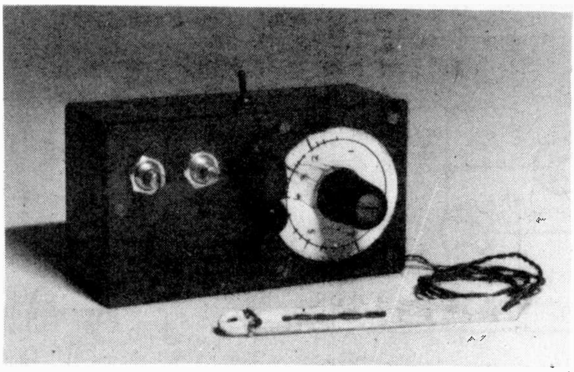
D1 BPX40 (Mullard Photodiode)
TR1 BFX29
TR2 BFY50

Integrated circuit

IC1 741

Miscellaneous

S1 Push to make non-locking switch
S2 2-pole single throw (min.)
LP1 6V 0·04A
Veroboard
C1 0·1μF



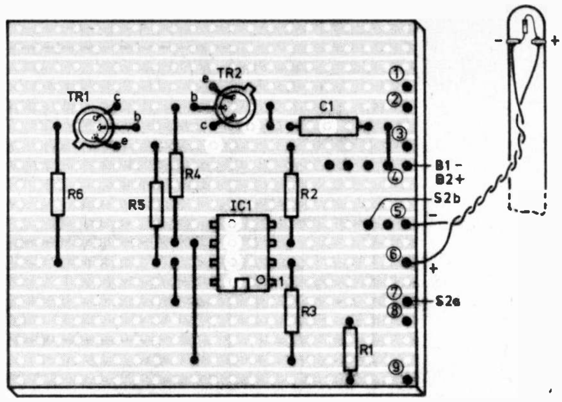


Fig. 2. Component layout and Veroboard cutting details

CONSTRUCTION

The potentiometer VR2 is provided with a blank scale and a good pointer (a slip of "celastine" or thin Perspex, with a scribed line filled with Indian ink makes an excellent index, mounted with a suitable adhesive on the underside of the knob). The photocell is mounted on the end of a "probe". A piece of wood (such as a lolly-stick) with a protective coating of varnish was used in the prototype with the photocell covered by a layer of stretch-and-seal film. The leads from the probe can be of any convenient length, preferably of very thin flexible wire such as gramophone pickup lead. Be careful not to put tension on the photocell leads, and anchor the attachment of the external leads securely. The probe is then quite robust.

The lamp is mounted close to the scale, and most of the bulb is blacked out with black enamel, except for a small clear portion to allow illumination of the scale. The circuit is constructed on a piece of Veroboard 2½in × 1½in (60 × 40mm) Fig. 2, and the whole instrument, including batteries, is contained in a plastic box with outside dimensions 5in × 2¾in × 1¾in (130 × 70 × 45mm).

CALIBRATION

Set up the enlarger in the darkroom. Place the probe in the centre of the image space. Have the enlarger lens at maximum aperture and only the enlarger light switched on. (Even the "safelight" should be off.) Set VR1 and VR2 at about half scale. Set VR1 (the indicating scale) at "maximum", i.e. fully clockwise.

Switch the instrument on by S1. The lamp will light. Press the "Reset" button S2. The lamp should go out. If it does not, raise the enlarger lamphouse (to reduce the illumination intensity on the easel) until when the reset button is pressed, the lamp goes out. It should be possible, with careful adjustment of the height of the lamphouse to cause the lamp to come on when the potentiometer is turned slightly anti-clockwise. Make a mark with a pencil on the scale. This is a trial datum. Stop the lens down one stop.

Press the reset button. The lamp should go out. Move the potentiometer slowly further anti-clockwise until the lamp again lights. Make another pencil mark on the scale here.

Repeat this procedure to five stops down. You will have six marks on the scale, at whole stop intervals. If the first and last marks don't come near the ends of the scale, repeat the procedure after adjusting VR1 and VR3, until the scale looks like Fig. 3. Having found the right values for these presets, they can be mounted inside the instrument and/or replaced by equivalent fixed resistors, and having finally obtained a convenient scale, make the markings permanent.

TIME SCALE

These markings (representing stop numbers) can now for convenience have an added time scale. One can either mark the whole scale in time values, or mark the individual stop spaces with interpolating marks, or both. This is a simple mathematical exercise. It is probably most convenient to mark the individual stop spaces, having regard to the uses to which the instrument will usually be put. Each individual stop space will then be marked as in Fig.

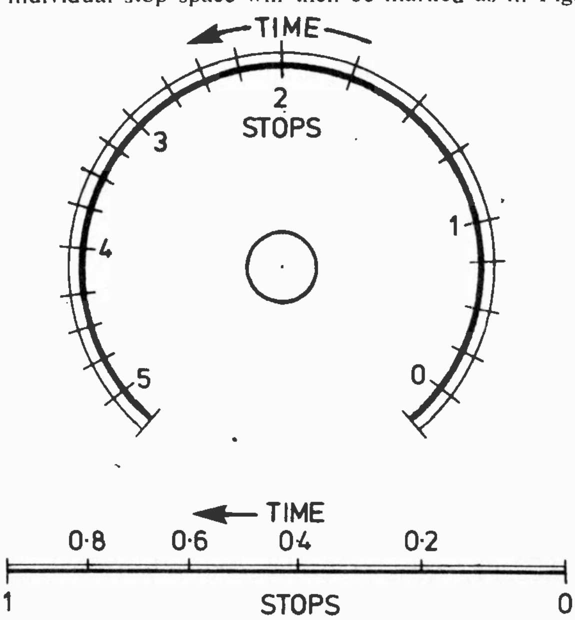


Fig. 3. Scale markings for the unit

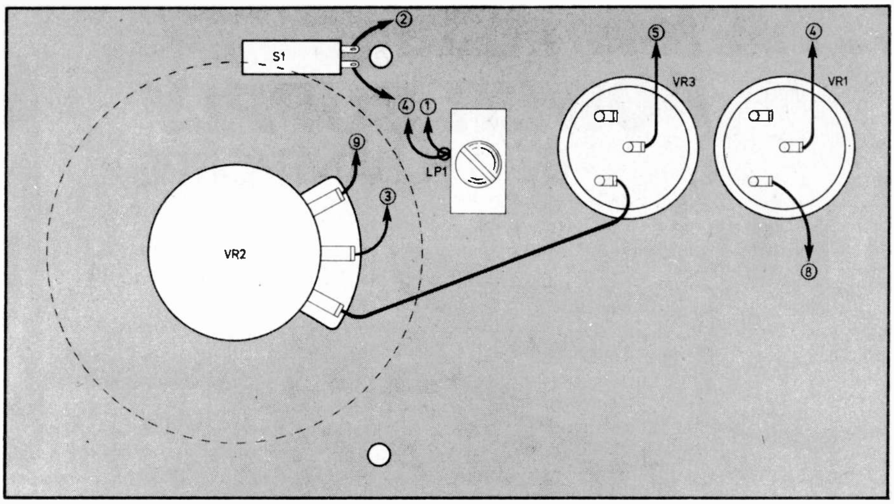


Fig. 4. Rear of front panel showing the interwiring between controls and leads to the circuit board

3. Each stop space gives a time ratio of 2:1. Reading from right to left from the stop mark, we have time ratios of 1:1·2, 1:1·4, 1:1·6, 1:1·8, 1:2 (next stop mark), each stop space being marked as in Fig. 3.

USE OF THE EXPOSURE METER

Now as to method of use. You select a negative from which you have made an entirely satisfactory enlargement (by the method of "test strips" or trial and error). With the negative in the enlarger, decide whether you intend to establish your datum on the shadows (the brightest part of the image) or the highlights (the dimmest part of the image) or intermediately. Place the probe to receive the light at the selected part of the image (making a permanent note of what part of the image you have selected). Also make a permanent note of the paper used and the exposure time when making an entirely satisfactory print. This is your "standard" for that particular paper. Make a permanent note of the meter reading under these conditions. This is your "standard" meter reading.

EXAMPLE

A standard meter reading is obtained as above (e.g. 2·2) and the standard exposure time is, say, 10 seconds. The conditions are then changed (but not the paper). For example, a larger or smaller degree of enlargement, denser or lighter negative, etc. One then chooses whether it is more important to expose for the highlights or the shadows. The probe cell is then placed at the most important point of the image and the reading taken. Say the reading obtained in this fashion is 3·4.

MULTIPLICATION FACTOR

The difference between this and the standard 2·2 is 1·2 stops. The exposure multiplying factor is therefore 2·4, i.e. mutiply by 2 for the one stop difference and by 1·2 of that value for the extra 0·2 of a stop. So one can either leave the stop unchanged and give 24 seconds exposure, or open the lens 1 stop and give 12 seconds, or close the lens 1 stop and give 48 seconds, according to choice.

If the reading goes the other way (due to a smaller degree of enlargement and/or a lighter negative, etc.) say to 1·6, there is a difference of one stop plus 0·4 in terms of time. The multiplication factor is then $\frac{1}{2}$ (for the one stop difference) which is 5 seconds, and then this is multiplied by 0·4 for the extra 0·4 of a stop, making 7 seconds.

This may look like a clumsy way of reckoning, but it is a simple way that avoids mistakes, and is the reason why the stop interpolations are not marked over the scale (each stop space being marked as shown in Fig. 3). This last reading of 7 seconds is of course with an unchanged stop. If the lens is stopped down 1 stop the time would become 14 seconds. If another reading is now taken (taking care to place the probe in exactly the same place on the image) a reading of 2·6 would be obtained; that is to say, 10 seconds, the standard exposure, multiplied by 1·4 making 14 seconds.

STANDARD READINGS

With a given enlarging paper, any set of conditions may be adopted as "standard". If a number of different makes and grades of paper are in use, it will be convenient to determine the standard exposure time and meter reading for each, making a permanent record. It would be a further convenience to arrange conditions so that either a convenient exposure time (say 10 seconds) or a convenient meter reading (say 2 or 3) is involved.

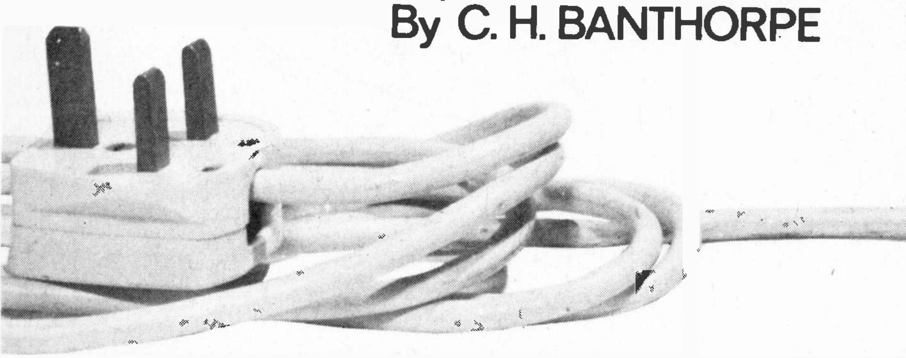
TEMPERATURE CONSIDERATIONS

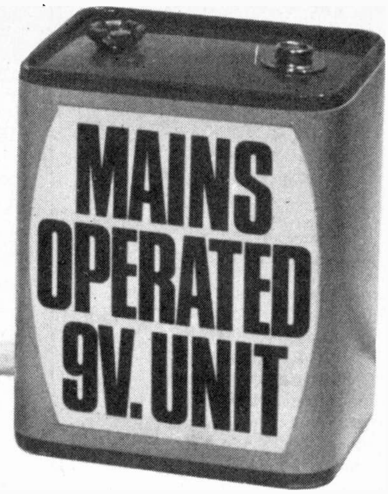
To minimise cost, no attempt has been made to design the instrument for use over a wide temperature range, but this is not usually important because darkrooms are usually occupied at normal room temperature for other reasons. If there is very strong light on the easel, the rise in temperature of the photocell may affect the reading, but this cannot occur at any light level that the instrument is capable of reading.

Other ways of using the instrument (e.g. classifying negatives with respect to density) will be obvious to the photographer. If the light level used during the exposure is below the range covered by the instrument, the datum can be established at a light level within the range and allowance made for the change in terms of stop settings. This is not so accurate as a direct reading, but is quicker than guesswork or the time taken to make test strips. ★

. . . A low voltage POWER SUPPLY

By C. H. BANTHORPE





THIS mains-powered unit was originally built to replace the battery in a transistor radio and thus solve the recurring problem of deciding when the sound distortion caused by the falling battery voltage was noticeable enough to justify throwing away a far from dead battery and replacing it by a new and increasingly more expensive one.

The unit is very simple and lighter than the battery it replaces and generates virtually no heat. It is also over-load proof and will suffer no harm if a short circuit is connected to its output indefinitely. It is therefore also a useful unit to use when doing repair or experimental work as accidental short circuits can easily occur at such times.

CURRENT LIMITING

The circuit consists of series capacitors C2/C3 which controls the output current, in this case approximately 40mA, followed by a bridge rectifier, smoothing capacitor, series resistor and Zener diode. Each rectifier is shunted by a capacitor to eliminate interference caused by the rapid switching on and off of each diode and a capacitor is also connected across the mains input to prevent mains wiring interference getting into the receiver (See Fig. 1).

If a lower or higher voltage output is required it can be obtained by changing the Zener diode to one with the desired voltage, but if higher, also change the electrolytic capacitor to one with a higher working voltage. The current will remain the same. For service work switched Zeners could be used, say 6V, 9V, 18V. If a higher current is required, C2/C3 must be changed to a larger value. The current output is roughly proportional to the capacity of C2/C3, doubling its value will provide approximately twice the output current. For example, in a unit needed for an output of about 70mA a 1μF capacitor was used. The Zener should also be changed to one of a higher current rating.

SAFETY PRECAUTIONS

It must be remembered that the output is connected to the mains via C2/C3 and the bridge rectifiers and it is therefore extremely important that safety precautions be taken. It would be unwise for instance to use the unit in a radio with exposed metal connected to the chassis. It is also safer to connect the live mains lead to C2/C3 as the current drawn from the mains is then at least limited to 40mA or so and a non-reversible mains connector should therefore always be used.

If the unit is used for service work it would normally be used on a mains supply from an isolating transformer and such safety problems would not arise.

COMPONENTS . . .

Resistor
R1 270Ω 1W

Capacitors

C1	4,700pF 400V polyester film
C2	0·15μF 400V polyester film
C3	0·47μF 400V polyester film
C4–C7	4,700pF polyester film
C8	1,000μF elect 25V

Diodes

D1–D4	BY127 (4 off)
D5	BZY88/C9V1

Miscellaneous
Mains lead and four self-tapping screws

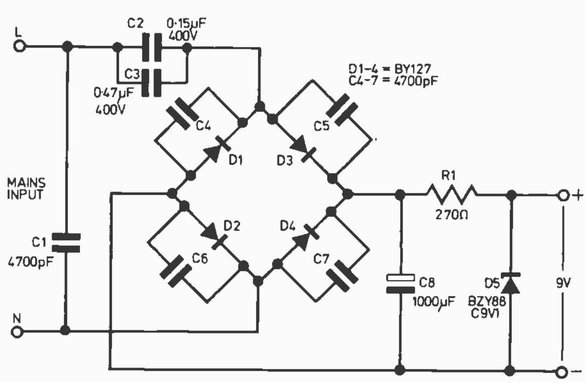


Fig. 1. Circuit of 9V p.s.u.

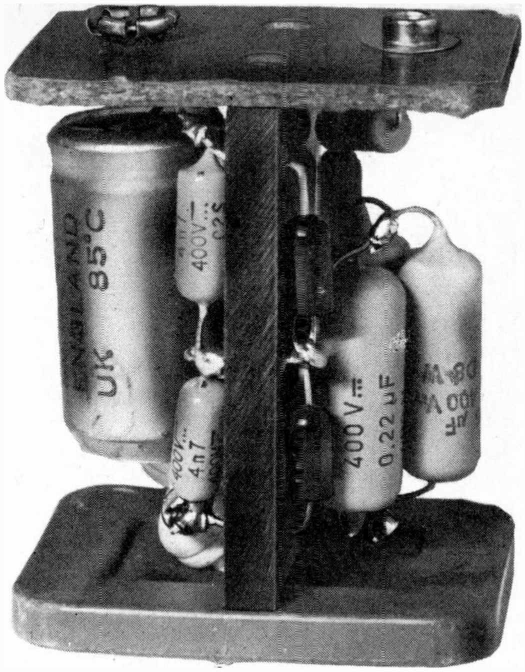
The circuit components are easily accommodated in the metal case of the battery it replaces. Remove the inside of the battery and retain the metal case and end pieces.

All the components of the unit can be mounted on a piece of insulated board cut and drilled as shown in Fig. 2. The wire ends of the components are pushed through small holes drilled in the board and after soldering is completed all components are self-secured. The two end pieces saved from the original battery are mounted on to the ends of the board by screws tapped into it. The Zener diode is soldered directly on to the two output connections, a small slot having been cut in the end of the insulating board to accommodate it. Make sure all components are well clear of the metal case.

COMPONENTS

As in all projects, if satisfactory and trouble free operation is required, good grade components operating within their limits must be used.

The writer has used Mullard polyester film capacitors in all positions, except the electrolytic, and they have proved to be satisfactory. C2/C3 is made up from one 0·47μF and one 0·15μF capacitor in parallel. They are subjected to approximately the peak of the mains voltage, about 350 volts, so 400 volt working voltage types were used. The same working voltage was also chosen for the other film capacitors. The voltage across the 1,000μF electrolytic is about 20 and a 25 volts working type was therefore chosen. It is probable that a smaller capacity would be satisfactory for most purposes so long as the working voltage is high enough.



If the unit is switched on and no current is taken from it then the full 40mA passes through the Zener diode. The Mullard type BZY88 is rated at 400mW up to an ambient temperature of 50°C. In this unit the 9 volts Zener passing 40mA will dissipate 360mW under no load; the worse conditions. As soon as a load is applied less current will flow through the Zener and its dissipation will reduce. It will therefore always be within, normally well within, its rating.

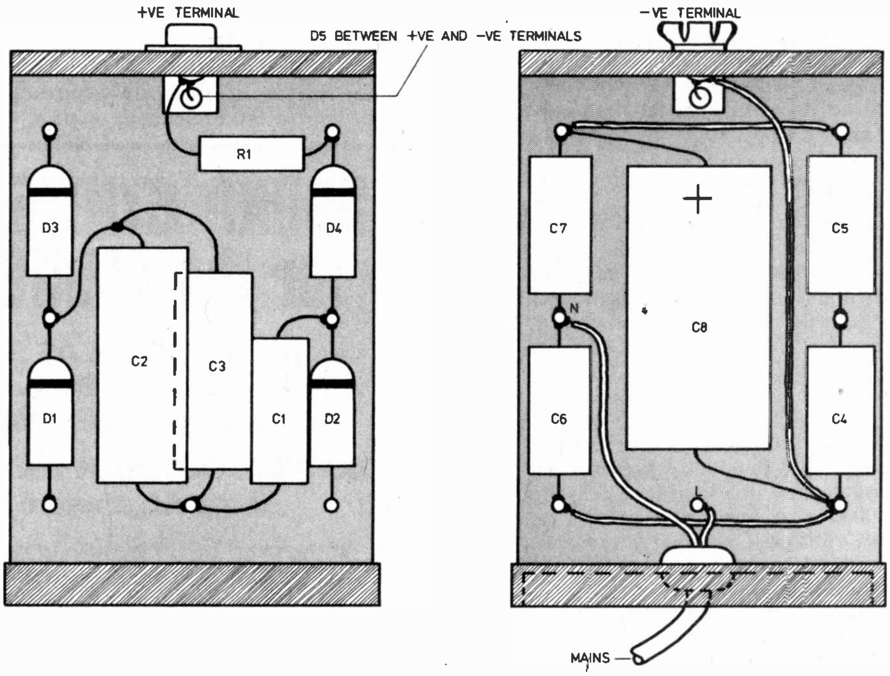


Fig. 2 Component assembly and board cutting details

The silicon diodes used are much better than necessary but are of proven reliability and easily available.

The current through the 270 ohm resistor remains at approximately 40mA regardless of the output load current as it merely divides between the Zener and the load. If the ouptut is short-circuited all the 40mA flows through the short circuit. If it is open-circuited all the current flows through the Zener. The power dissipated by the resistor is therefore just over 0·4 watts.

When the mains unit is completed and inserted into the metal case the metal can be swaged back over the bottom end pieces by lightly tapping with a small hammer. The unswaging and re-swaging of the metal case was found to be very much easier than expected and needs little skill.

USE AS A CHARGER

The circuit can also be used in other applications where its current-limiting feature is important, such as a charger for re-chargeable cells. A conventional charger supplies a high current into a discharged cell. This may be too high until the cell becomes charged, and before that overheating and damage could result. With this circuit the current is constant. Components for the charger can be chosen as outlined for the above unit.

The capacitor size to establish the current and the Zener diode should be a few volts higher than the fully charged voltage of the cell or cells to be charged. The purpose of the Zener in this case is to limit the output voltage if no load was applied to the charger while it was switched on. The electrolytic capacitor need not be included.

A number of the 9 volts units have been made up and used during the last two years and have performed satisfactorily. Hum is negligible, indicating that the 1,000μF electrolytic is probably larger than necessary. ★

MICROPROCESSORS

continued from page 903

memory (CROM). The design is such that one to four CROM's may be used to control a single RALU and yet one CROM may control up to eight RALU's. Therefore, there are many possible combinations.

RALU's

Within the RALU, which is a 4-bit wide slice of a processor, are seven general-purpose registers, a status flag register, a 16-word stack, an ALU, an I/O multiplexer, and three data buses. RALU's may be interconnected to form larger systems, by means of control lines. For example, when four are put together to form a 16-bit computer, they all receive an instruction in parallel and all carry out the requisite fetches and data manipulations in parallel at the full system word size with a carry bit being transferred from the most significant bit of one RALU) to the least significant bit of the next one where required.

The logic elements within the RALU are interconnected by the data buses, so that data may flow from any element into any other element. The RALU is completely general in design; the flow of data through the chip and, thus, the instruction set of the processor, is not fixed by the RALU at all, but is defined from outside by the second chip, the CROM.

The CROM is a form of ROM, coupled with some masking and sequencing logic. It contains the microprogramme control commands that direct the RALU's and define the instruction set of the system. National Semiconductors have available standard CROM's which contain the basic instruction set.

THE HOME CONSTRUCTOR AND MICROPROCESSORS

While difficult, these problems are not insurmountable. Likely applications home experimenters will have for microprocessors are electronic games, model railway control and television games. ★

INDUSTRY NOTEBOOK

By Nexus

WORLD-BEATER?

The Ferranti affair is now almost forgotten since, short of cash flow, it had some public money pumped in. In the face of bigger and more newsworthy commercial and industrial disasters such as British Leyland, Ferranti mercifully dropped into the background and keeping a comparatively low profile went quietly about its business.

Now Ferranti has popped up again in the news to let the world know that although the company might not have been very clever at holding down losses in the heavy power transformer division, it has some very bright people in the electronic component division and particularly in that area devoted to integrated circuits.

Their latest venture in l.s.i. has to be a winner. It uses the Collector Diffusion Isolation (CDI) technique which gives bipolar speeds with all the benefits of low-cost processing and small power consumption of unipolar devices. The particular device I have in mind is a single chip incorporating some 1,500 transistors which forms the central component of a whole range of modern digital instruments.

Initially, there are nine instruments of varying complexity in the range, each using the same chip which may be likened to a tiny central processor around which peripheral circuits may be added as required to provide various functions in the instrument. The chip includes circuits for input and output gating, the clock, decade counters, time base, plus all the associated logic circuits, and if all these circuits were realised with discrete components you would need something like a thousand.

The single-chip instrument is therefore less costly to assemble and should be far more reliable in service. Of course, such a chip costs a small fortune to develop and this has to be amortised over a long production run and so the instruments are not at greatly reduced prices though very competitive.

Co-sponsors of this project are Racal Instruments Ltd. who will, of course, have exclusive use of it. First showing of the instrument range was at Racalex '75 which opened in London on September 23. Racal Instruments is naturally delighted with the whole project and expect considerable export business as well as brisk home demand. Ferranti, too, has all the satisfaction of seeing another success for the CDI technique and a quickening of interest in its potentialities.

OPTICAL COMMUNICATIONS

Ten years ago research started on communications by light through optical fibres as a possible alternative to electrons through metallic conductors. When it all started nobody knew whether a fibre could be made with low enough losses, whether a fibre could be made economically in commercial quantities, whether if a fibre could be made it would be capable of being handled and jointed, and nobdy knew if l.e.d.s and lasers of suitable type would become available as the transmitting source or whether suitable photodiodes would be produced.

Now, at the IEE headquarters in London we have had the first full-scale international conference on the subject and although there are still problems ahead they are comparatively minor. A whole new industry seems to be in the build-up stage. Some modest systems are already in use, for example in warships and other military applications, but despite the considerable volume of experience that has been accumulated, especially in the last five years when research has accelerated sharply, it is unlikely that really big business in optical communications by fibre will start for another seven, possibly ten years. But when it comes it could be the biggest thing for the electronics industry since the electronic computer.

TANKER RISKS

Nobody likes to see disaster at sea but recent incidents involving supertankers do highlight the need for human navigating skills to be supplemented by the very bet electronic aids. Decca Radar has just announced that their Channel Approach Aid is now operational at the big oil terminal at Milford Haven after some two years of costly R and D and sea trials.

The Channel Approach Aid is portable and is taken on board by the ship's pilot. Working in conjunction with transponder beacons at shore sites, it provides the pilot with a digital read-out of ship's speed, a measurement of deviation from the channel centre line and distance-to-go to pre-determined points of turn.

Both the philosophy of the Channel Approach Aid and its engineering realisation are first class. It was developed by Decca in association with the Admiralty Surface Weapons Establishment and the Radar Research Establishment and so has an excellent pedigree. But I fear that despite all its abvious virtues it may not prove commercially successful, even after the fine example set by Milford Haven in installing the first system.

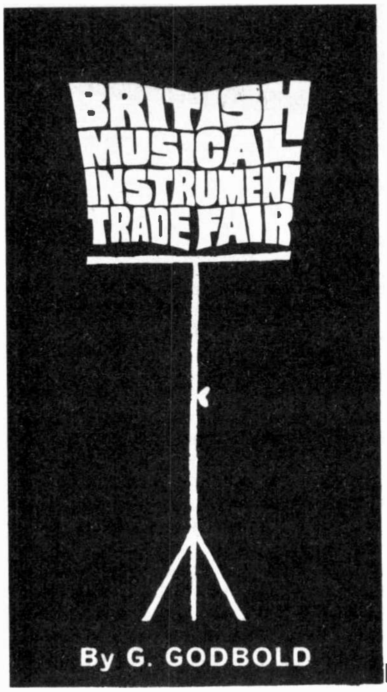
CMOS RELIABILITY

To kill rumours that CMOS plastic i.c.s are unreliable at supply voltages of 15V and above, Motorola has produced some remarkable figures on randomly selected devices tested at the higher end of the voltage range and at elevated temperatures. Military types operated at 18V and at 125 deg C survived with only four device failures in 1,200,000 device hours. Industrial quality circuits operated at 15V and at 85 deg C had eight failures in 5,819,500 device hours. The devices, say Motorola, were ordinary production items taken straight from the line.

CUTBACKS

Top spender in the industry is the Post Office as regular readers will already know. When the PO hiccups it reverberates all the way down the line and the PO with its unhappy financial situation is almost bound to trim its huge re-equipment programme regardless of urgency. GEC and Plessey are reported to have developed a nervous twitch at the prospect, while STC with the big TXE4 electronic exchange programme is reported as being fairly relaxed on the assumption that this prestige project will remain unharmed.

Of the trio, Plessey has a strong export business in cross-bar equipment and hopes to alleviate any home cut-backs by increasing overseas sales. But whichever way the cookie crumbles the Post Office must, in the end, have the equipment it so badly needs, the only trouble being that it will cost more later. Which could, of course, mean dearer telephone charges which could mean less subscribers with shorter and fewer calls which could put up unit costs which could . . . !



The Thomas Majestic Royale 1157. Features of this include "Preset" and "Memo Chord" tabs, with these an ensemble of voices in chosen chords can provide an automatic accompaniment in time with the rhythmn

We are all tired of the oft quoted words—depressed economy, setback, downward climb, gloomy times—most of these could be applied to the music industry when the imposition of VAT was applied. When I visited the British Musical Instrument Trade Fair (August 17-21) at Connaught Rooms, Bloomsbury Centre and Hotel Russell, I fully expected a reprise of last year's exhibits from a stagnant industry. No way—there was a lot of product range expansion notably at the low end of the organ market. Here, of course, electronics gimmickry, wizardry if you like, prevails.

It's an oft quoted fact that more than 90 per cent of the population do not own an instrument and for that matter cannot read music. With the range of "all singing all dancing" fun machines available and "at a glance" back up, music teaching software, the organ distributors have designs on reducing this statistic.

ANYONE CAN PLAY

The low end of the market consists mainly of instruments anyone can play. In the majority of cases this is true even if you are unfortunate enough to have one foot and two fingers. Usually what they have in *etceteras* they lack in voicing and balance.

An addition to the Philips range, the "Automagic", has none of these problems. This has a professional specification, and most appealing to the beginner, illuminated touch controls that enable rapid and easy switching of preset registration and automatic bass chords coupled to rhythm.

ORGAN INDUSTRY PIONEER

To the cognoscenti the name Hammond is synonymous with organ excellence both in product and sound produced. Over 40 years they have moved from tone wheel generation to the multiple derivative divider system still maintaining, arguably, that distinctive Hammond sound.

The tone wheel, in fact, pioneered the organ industry as we know it today.

In 1972 the incredible Concorde made its appearance combining l.s.i./m.d.d. technology with harmonic tone bar registration. The spin-off from this was evident in the Cougar and X2/X5 models. These offer tonebar performance, the latter being portable with a professional specification.

RHYTHM GENERATORS

Another development with roots in Concorde is the Autovari 64 which introduces almost lifelike realism to rhythm patterns. Completely different from the crashingly boring ryhthm units attached to most organs.

That there is a demand for this type of unit is evidenced by the singular selling success of the Powerhouse drum rhythm unit when introduced this year at the Frankfurt International Spring Fair.

This consists of eight pre-recorded double-track tapes from which it is possible to obtain up to 64 different drum rhythms. Again, the emphasis is on authentic sound with each rhythm having a 32 bar sequence Distributors for this unit are Benelux Musical Instruments Ltd.

Before leaving this subject one would have to mention the Farfisa "Super-partner". A rhythm box that allows the organist to augment rhythmic sequences. An extra facility makes this box rather remarkable. It adds a variety of instrumental accompaniments such as trumpet, guitar, trombone, etc. to the lower manual in conjunction with the selected rhythm. Different sounds either singly or in combination are predetermined by whichever rhythm is selected.

The unit is available with the new Farfisa Beresford and Buckingham, the latter being a clubland theatre organ.

SYNTHESISER ULTIMATE

Another extremely stylish clubland instrument, elegant in plastic and chrome, is the new EX42 from Yamaha. At £9,375 worthy of a mortgage but this paled into insignificance compared to its similarly clad companion, the £30,000 GX1 fully polyphonic synthesiser.

If you watched "Tomorrow's World" on the 11th of September you would have seen the American bandleader/arranger, George Fleury, give a commendable account of himself and the instrument. Orchestral instrument synthesis was convincing, particularly the big band brass *tuttis*. Unfortunately any one player can only skim the surface potential of this multi-million pound research development.

OTHER SYNTHESISERS

I was told that a derivative of the technology is the new SY-2 synthesiser which, like the ARP Pro-

Soloist, has a whole range of preset instrumental voices and effects. All of these can be modified with a variety of filters and shapers. Obviously, this type of synthesiser makes an excellent addition to an organ. Unless you are lucky enough to have a Wurlitzer with integrated Orbit.

Weighing in at 15lb and checking out at around £460 is the ARP Axxe. My introduction to this was the recreation of the unmistakable fired phasor and torpedo sounds from starship *Enterprise* by a dextrous Boosey and Hawkes demonstrator.

This is probably one of the simplest synthesisers to get to know; the fascia labelling and colour coded slide controls make this possible. An interface addition to the Axxe is "Little Brother" which can be slaved to provide extra effects. I was told that Little Brothers could be stacked endlessly, which promotes some speculation.

HOHNER KEYBOARDS

New Hohner keyboards shown by Hornby-Skewes included the Hi-Piano String. I find these string ensemble units hard to resist as the impression is of playing in a cathedral. A melody picked out with piano or harpsichord voicing seems to have a full reverberant orchestral backing.

P.A. GEAR

In P.A. equipment it seems that the old type column is out and the system column and bin box in. This usually consists of h.f. horns and mixed diameter speakers and h.f. and woofer horns for the bin.

The diminutive Min Bin from Carlsboro is representative of the genre measuring a mere 35 × 20 × 20in but capable of pushing out 100W.

This company also had on display the comparatively low priced 35W Scorpion combination amplifier. This is described as the most exciting innovation in the small amplifier market for years.

Marshall provided continuous demonstrations of their Lead 100, 100W transistor amplifier with guitarists Bert Kirby, Jim Wilmer and Steve Thomas.

The Yamaha SY-2 synthesiser complete with preset voices and a whole range of control facilities

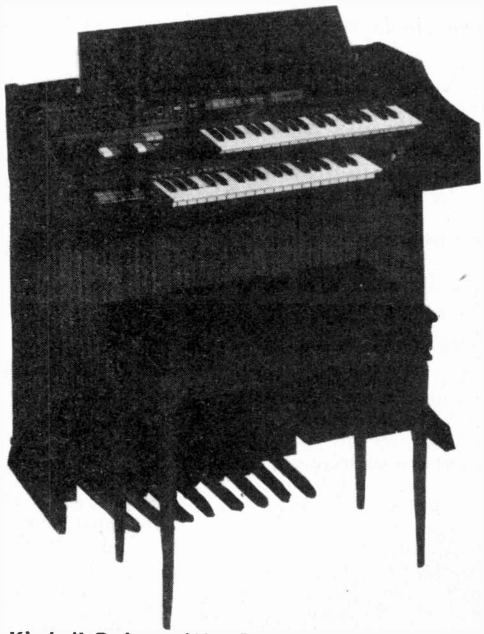
EFFECTS UNITS

Distortion is big business. Perhaps this is a harsh term for electronic effects; some purists might prefer colourisation. From reader reaction to this magazine we can tell where the interest lies and have provided many designs that rival commercial specifications.

One of the biggest producers of effects units is Solasound. New additions to their range are Chuck-a-Wah, an automatic wah-wah that is responsive to speed and dynamics in performance and Phase Pedal 4 for that way out rushing sound. An extension to this unit's capability is Supa Phaze which gives a passable Leslie imitation.

Increasingly popular is the foot controlled v.c.f. providing as it does an almost limitless range of tone colours in combination with voice or instrument. Two examples shown were the Univex Synthi Pedal and the Korg Traveler.

The Hohner Hi String, an electronic keyboard that synthesises the many sounds of a string orchestra



The Kimball Swinger 200. One of the new breed of two finger fun machines. One finger on the upper manual picks out the melody—one finger on the lower gives you rhythmic chords

A selection of readers suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

16 AND 14 PIN LOGIC CHECKER

No doubt P.E. readers will have noticed the "Logic Testers" that have come onto the market recently. Whilst being a worthwhile investment for laboratories etc., the price renders them unsuitable for amateurs with limited resources to fall back on.

The display being critical as regards both cost and acceptability, an oscilloscope display was adopted. This necessitates a Z-modulation facility in the 'scope being used. This is easily incorporated into 'scopes without this facility by simply coupling a one-valve grounded cathode stage to the c.r.t. cathode by a suitably high voltage capacitor of about 0·1uF.

IC4 and IC5 together with one NAND gate from IC3 form a sixteen-to-one line multiplexer, IC4 and 5 being alternately enabled by output D and the inverted output $\bar{D}$ of IC2. The input pins of the multiplexer are wired to a sixteen-pin d.i.l. i.c. test clip. When this is clipped onto an i.c., the multiplexer output will go low if the pin being addressed by the multiplexer is low or grounded.

The resistors R2 to R4 together with IC2 from a staircase generator, which, when applied to the "X" amplifier of the oscilloscope forms a row of dots. Connecting the D output to the Y amplifier produces a double row of dots.

If the output of the multiplexer is now connected to the Z-modulation input, and if a given pin on the i.c. being checked is at logic O, then the dot being drawn in the corresponding position on the oscilloscope face will be extinguished, thus indicating the state of the pin.

As can be seen from the circuit diagram, one of the NAND gates is being used to decode 7 (0111) and 15 (1111). These points in the cycle correspond to pins 9 and 8 respectively. If S1 is closed then on 7 and 15 the Z output will be forced low through D1, thus extinguishing pins 8 and 9, and modifying the output format to 14 pin.

The display was found easier to read using badly-focussed dots, and has proved invaluable in diagnosing faults in digital circuits.

G. Butler, Hertford

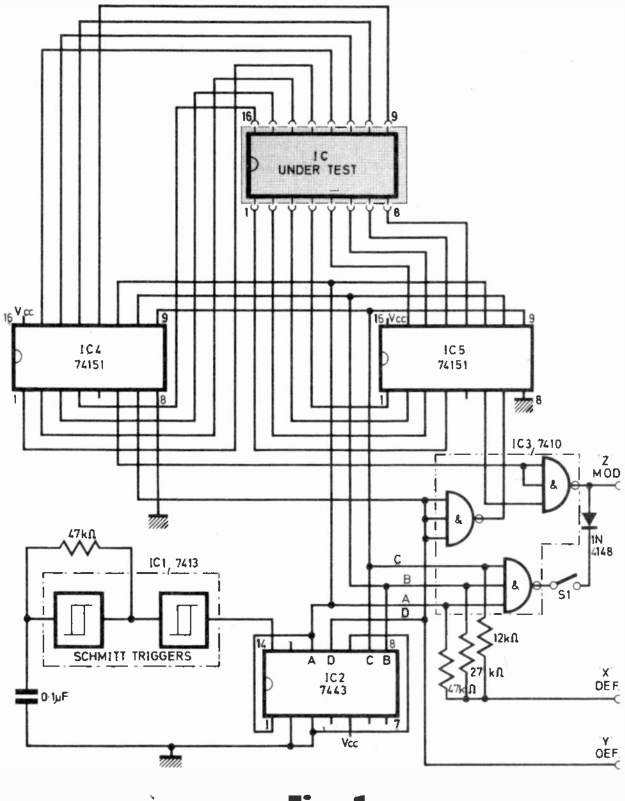


Fig. 1

TRIFFID POWER SUPPLY

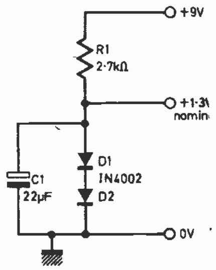


Fig. 1

A very simple circuit which can be used to provide the 1·3V necessary to power the ZN414 i.c. radio (as shown in P.E. Feb. 73) is shown in Fig. 1. Resistor R1 provides current to forward-bias the silicon diodes D1 and D2 to provide about 1·3V, and capacitor C1 decouples any noise to earth. The diodes can be any general purpose silicon types such as 1N4002, 1N4148, etc.

S. Newington-Bridges, Ampney Crucis.

SIMPLE ELECTROLYTIC COMPARATOR

A simple circuit which can be used to roughly determine the capacitance of an electrolytic capacitor is shown in Fig. 1.

A 555 timer in its monostable mode is used to provide a pulse, the duration of which being proportional to the unknown capacitor C4 and resistor R3. One simply times it with a capacitor of known value, the length of the pulse and compares Switch S1 commences the timing action.

A relay can be used instead of an l.e.d. which will make timing easier as one listens for the "click" of the relay dropping off whilst looking at a watch.

D. Lal, Amsterdam

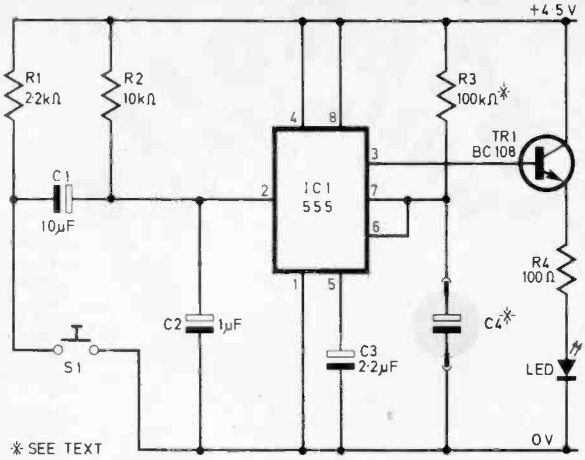


Fig. 1

MUSIC GENERATOR

THE circuit of Fig. 1 can be used to play either repeating tunes of 32 notes or random tunes. Although the notes in the sequence cannot be individually determined, they are determined by the settings of only five controls. This simplifies both the circuitry and the operation.

The output is produced by a unijunction transistor oscillator, whose emitter is connected through five potentiometers to the outputs and input of a 4-bit binary counter IC2, IC3. If pulses are applied to the input, 32 different states are obtained in sequence, and therefore 32 different notes. Diodes are connected in series with the potentiometers so that each potentiometer is isolated when the corresponding output is low.

The pulses for the counter can be produced either manually with a push button or automatically by a low-frequency astable consisting of TR1 and TR2, whose tempo can be controlled by two independent potentiometers. The sequence can either be fixed in a 32-note cycle or random. An AND gate (IC1) is used to select these four modes.

With the switch on "fixed", one input to the gate is permanently high, and the other is connected to the astable or push button. The output will be high when the input is high and low when it is low. With the switch on "random", one input is connected to an r.f. oscillator consisting of TR3 and TR4. When the other input, connected to the astable or push button, is high, the output is r.f. oscillation, and the counter counts at this frequency. When the voltage at this input drops, the counter will remain at the state at which it was before the voltage fell. Since the r.f. is much greater than the automatic pulsing frequency, this state cannot be predicted, and is therefore random.

J. Samson, Bishop's Stortford.

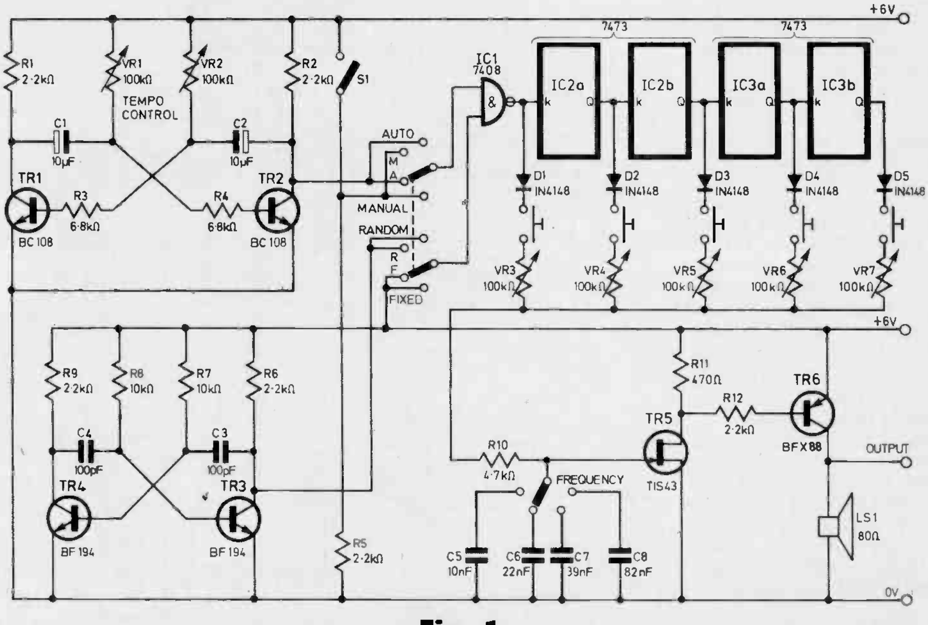
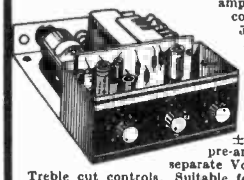


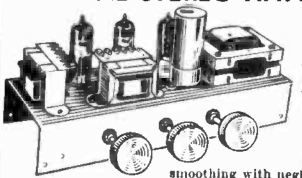
Fig. 1

SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistorsin push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £15·00. P. & P. 65p.

DE LUXE STEREO AMPLIFIER



A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line-up:-2 × ECL86 Triode Pentodes. 1 × EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w × 4"d. Overall height including valves 5". Ready built and tested to a high standard. £12·50. P. & P. 85p.

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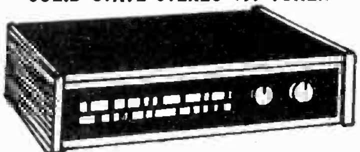

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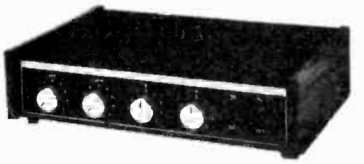

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Overall Size 12"w. × 8"d. × 2½"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	£15·00	P. & P. 50p
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Also available ready built and tested £32·50. Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.

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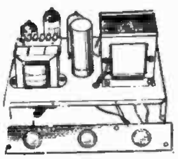

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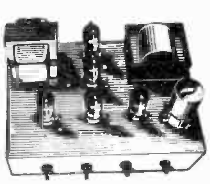
10/14 WATT HI-FI AMPLIFIER KIT



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Readout—

A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Bridge that gap

Sir—Gas ignitors of identical design to that featured in the July issue of PRACTICAL ELECTRONICS have been in commercial production for some considerable time now. During this time I have been called upon to repair quite a few. In most cases the spark gap component was not functioning.

As I was unable to obtain direct replacements for these components, I replaced them with 200V thyristors, which worked just as well. The thyristor was connected directly in place of the spark gap, anode to cathode of rectifier and cathode to output transformer primary. The gate was not connected and the lead was cut off. Although the P.E. article mentions that a current of "several tens of amps" may pass through the spark gap under pulse conditions, a 3A thyristor was found to suffice. This is probably due to the extremely short time for which the current flows.

I feel sure that this information may prove useful to some of your readers who wish to construct a gas ignitor from your design.

S. Champion,
King's Langley.

I have been aware of the technique of using a thyristor for some time but because of the difficulties outlined below, did not use it in our design. However, in case any readers encounter problems in using the technique, I feel that I should briefly outline the drawbacks.

Although this solution will work in particular cases, semiconductor manufacturers have informed me that there are two drawbacks to triggering thyristors by applying excess voltage between anode and cathode:

> Typically the excess voltage required between devices may vary from a few volts to twice the rated voltage of the device.
>
> The magnitude of excess voltage is temperature dependent.

Therefore, anybody contemplating using this technique may have to experiment to find a suitable device.

With regard to the current carrying capability of the device, Mr Champion is generally correct in stating that a 3A device is suitable because of the relatively short duration of the pulse.—R.D.B.

Highest reward

Sir—Having just completed building a £200 synthesiser using Dewtron modules and our own bits and pieces, I recommend the v.c.o., v.c.f., envelope shaper, etc. but warn people beware of gimmicks.

P.E. must be congratulated for stimulating interest in the field of musical synthesis; we think the patching used in both projects, i.e. plugs and sockets is unsatisfactory; we used slide switches along with slider potentiometers.

I think that the first project was too bulky and expensive; the "P.E. Minisonic" was good except for the use of a touchboard, which you yourself admitted leaves something to be desired. The actual choice of modules for Minisonic was good, the ring modulator, noise generator and v.c.f. are essential along with the sawtooth v.c.o.

The "Symbiosis" piece by Malcolm Pointon (June-July 1975) was very interesting and is the kind of use synthesisers should be put to. Synthesisers should explore new sounds rather than imitate conventional ones. I hope "Symbiosis" prompts other owners/composers to attempt their own recordings along these lines.

My synthesiser is designed for "experimental" sound exploration rather than conventional music and has virtually all patching routes possible, stereo output, noise, ring modulation, low frequency oscillator, v.c. phaser along with the more conventional modules I mentioned earlier.

Synthesisers give the highest reward from an involvement in electronics, a creative, artistic product, unlike some projects I could name.

R. D. Martin,
Congresbury,
Bristol.

Mr Martin raises some interesting points in his letter but I do feel that a number of them need some slight qualification.

I believe that synthesisers fall into two classifications. In the "live" performance area the instrument requires flexibility and yet has to be easy to play. In these circumstances some form of switch patching is ideal since it enables changeovers to be accomplished swiftly and accurately. The disadvantage to this method is that it provides a considerable restriction to the overall versatility of the instrument.

In the studio the requirement to achieve speed in patch changeover is not nearly so important and a method of patching can be adopted which allows the user to maximise on the interconnection options available. In these circumstances I strongly believe that a patch cord system is the ideal. In general terms the greater contact area and relatively wide spacing minimises noise and crosstalk problems and these are distinct advantages over the neater, but relatively costly, matrix patch boards now available.

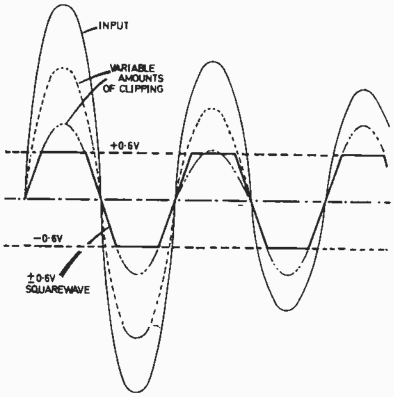
The P.E. Sound Synthesiser was an attempt to provide an introduction to both types of instrument. The modular system was essentially a studio instrument featuring cord patching while the Keyboard Unit was geared for live performance and required no patching at all other than the options of coupling it directly to external processing devices if required. In the case of the Minisonic it was the aim to provide a design, aimed particularly at the younger constructor, which would offer a maximum of flexibility with the lowest possible price. The "touch" keyboard simply provided a very economical way of getting the constructor off the ground and there is always the option of adding a conventional keyboard at a later date.

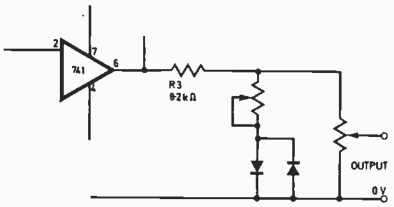
Finally, a word on the use of the synthesiser. Mr Martin feels that the instrument should be used in an imaginative sense rather than in an imitative one. To a certain extent I go along with this but I make the qualification that, because of its inherent versatility, the synthesiser is not an easy instrument to master. If it is used in an entirely imaginative way there is a danger that performances will become stilted, at best, or that the listening public will become frightened off by the unaccustomed and rather weird sounds which can be produced. I believe that imitative sound synthesis is an extremely good exercise in the use of the instrument and serves to train the user to exploit the full potential of the instrument in terms of dynamic range and register.—G.D.S.

Fuzz control

Sir—Mr Carter's fuzz effect circuit (see Ingenuity Unlimited, August) is similar to a design of my own, and readers may be interested in a few further ideas. Mr Carter's "Fuzz" control only effectively reduces the length of sustain, which in itself is a continuous ±0·6V square wave.

If a variable resistor is put in series with the diodes a very different range of effects is produced. At zero setting R = 0Ω, the effect is the same as Mr Carter's. However, if the resistance is increased the amount of clipping is reduced as the 8·2kΩ resistor and the variable resistor split the voltage between the amp output and the diode voltage.



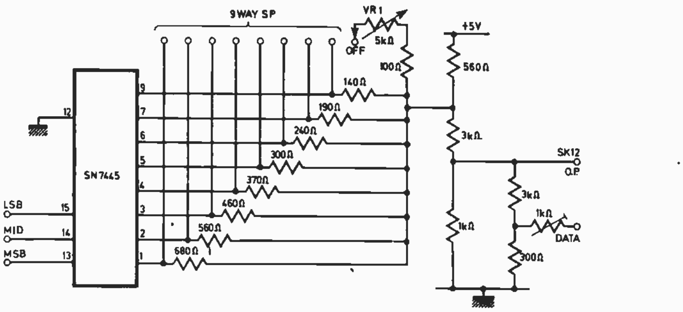


Modified Fuzz

If the potentiometer is around 100kΩ the effect will be variable from square wave to almost no fuzz at all. A log potentiometer is best wired so that half way = 10kΩ.

It now becomes necessary to look at another point; the amp is able under some signal conditions, to clip itself, which in the no fuzz mode, is undesirable. The important factor is the ratio between rail volts and diode volts. This ratio can easily be improved by increasing rail volts and/or easier still, using lower voltage diodes, germanium selenium or micro alloy.

G. C. Cleasby,
Reigate.



Suggested D/A converter improvement

Right beam

Sir—I must congratulate A. C. Ainslie on the 8-channel trace multiplier design in the August issue of P.E. The facilities provided by most reasonably priced oscilloscopes are inadequate when working with logic circuitry, and techniques like Trace Multiplying help to fill the gap.

May I suggest an improvement to the D/A converter of Fig. 3. In practice, it is essential to be able to compare any two traces by overlaying them at the same vertical position, particularly for well separated channels. The attached circuit permits this facility, by switching VR1 to the appropriate channel.

I would also like to point out the trend in commercial instruments towards presenting displays of the actual logic states of a circuit by strobing the states at an appropriate time, using units such as the Hewlett-Packard pattern analyser.

While such instruments are obviously outside the range of the amateur, the use of digital time-base generation does allow some fairly powerful circuit analysis methods to be used, if the time base is designed to be accessible. For example, the time-base counter inputs to the internal D/A converter can be replaced by inputs from up to five test points in the circuit under test. This will immediately show up any disallowed combinations of logic levels on the five inputs, since each combination corresponds to a particular X-defection.

Also, the response of another test point to the allowed combinations can be checked by connection to the Y-amp, or Z-mod. Such displays are simpler to interpret than timing diagrams in most cases.

Other advantages are the presentation of the correct display is often automatic, without any knob twiddling. The display is independent of changes in clock rate. Direct read-out of time (in terms of number of clock pulses) between events is feasible, for example on 7-segment l.e.d.'s.

The addition of a data selector i.c., e.g. a 74151 to the time base counter allows the states of up to eight test points to be shown in an easily readable format. The timing diagram display can be more difficult to decipher if the logic levels on the channels do not change during the sweep, particularly with the smaller sizes of display tube.

As a user of a combined trace multiplier and digital time-base unit for some time, I have found the trace multiplying section rarely preferable to the more direct methods indicated above.

J. R. Keneally,
Weymouth.

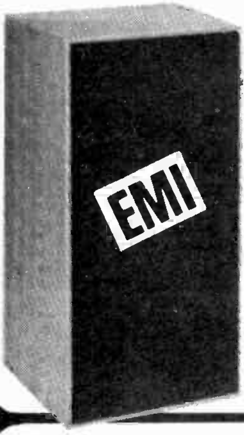
Mr Keneally's simple D/A Converter was of the type tried originally but which had to be scrapped because of poor pulse response. This would appear to be because there is no defined system impedance, whereas with the ladder network a characteristic impedance, *R* (the ladder being R, R2, R, etc.) can be chosen for optimum performance. This type of converter, however, does not lend itself to providing trace shifting.

Trace overlay is usually used to give more accurate comparison between times than is possible with a spaced display. However, should modern c.r.t.'s and internal graticules still leave one in doubt with a separated display, it is a simple matter to trigger from one of the signals under consideration, there then being no ambiguity as to which of the two channels is "in the lead". Modern high performance 'scopes with dual timebases and trace expansion also simplify comparison.

The instruments to which Mr Keneally refers using digital discrete step timebase are most useful and I have used one for several months from a commercial manufacturer. With little space it is not possible to go fully into their advantages but by using memories they allow complex and accurate investigation to be performed.

For the majority of uses, however, it is considered that a simple timing diagram display holds virtually "all the answers" in an unambiguous form, and it was for this reason that the Trace Multiplier was developed; to supplement, rather than replace, existing and costly digital instrumentation.—A.C.A.

RTVC FOR SPEAKERS AT FANTASTIC REDUCTIONS



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Specification – Size 33"×14"×16" approx. Impedance 8 ohms. Power handling 25W RMS. (Peak 50 watts.) Frequency range 35 Hz–20 KHz.

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System consists of a 13" × 8" approx. woofer with a 3" tweeter, crossover components and circuit diagram. Frequency response: 20 Hz to 20 KHz. Power handling 15 watts RMS into 8 ohms. (Peak 30 watts.)

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Complete with crossover Components and circuit diagram

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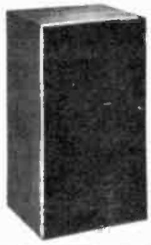
Easily put together with just a few basic tools.
Specification (each speaker): Impedance 8 ohms. Power handling 15 watts RMS (30 watts peak). Response 20–20,000 Hz. Size 20" × 11" × $9\frac{1}{2}$" approx. Comparable built units (EMI LE3) sold elsewhere for over £45 pair.



£22.00 pair complete +£5.20 p & p.

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System 1a. £69.00

The new 20+20 watt Stereo Amplifier incorporating the latest silicon transistor solid state circuitry, the RT-VC VISCOUNT IV gives you a powerful 20 watts RMS per channel into 8 ohms. Superb teak-finished cabinet, with anodised fascia to harmonise with any decor. Polished trim and knobs.
The VISCOUNT IV has a comprehensive range of controls – volume, bass, treble, balance, mono/stereo, mode selector, and scratch filter.
Front panel socket for stereo headphones. And a host of sockets at the rear – for left and right speakers, tape recorder, auxiliary, tuner, disc and microphone.
SPECIFICATION: 20 watts RMS per channel 40 watts peak. Suitable 8-15 ohms speakers. Total distortion @ 10 watts better than 0.2%. Six switched inputs: 1. Magnetic P.U. – 3 millivolts @ 47 K ohms (R.I.A.A.); 2. Crystal/ceramic P.U. – 50 millivolts @ 50 K ohms (R.I.A.A.); 3, 4, 6. Tape Tuner/Aux. – 140 millivolts @ 50 K ohms (flat frequency response); 5. Microphone – 3 millivolts @ 50 K ohms (flat frequency response).
CONTROLS: Push button ON/OFF, stereo/mono, scratch filter. 6 position rotary selector. Individual rotary controls for treble, bass, balance and volume. Headphone socket, tape out socket. Aux. mains output. **Frequency response**: 25 Hz to 25 KHz @ full rated output. **Signal to noise ratio**: better than –50 dB on all inputs. **Tone control range**: Bass ±15 dB @ 50 Hz; Treble ±12 dB @ 10 KHz. **Power requirements**: 200-250V A.C. mains @ 60 watts. **Approx. size**: $15\frac{1}{4}$" × 3" × 10".
MP60 type deck with magnetic cartridge, de luxe plinth and cover.
Two Duo Type IIa matched speakers – Enclosure size approx. $19\frac{1}{2}$" × $10\frac{3}{4}$" × $7\frac{1}{4}$" in simulated teak. Drive unit 13" × 8" with 3" tweeter. 15 watts handling. 30 watts peak.
Complete System with these speakers £69.00 +£6.50 p & p.

System 2. £85.00

Viscount IV amplifier (As System 1a)
MP60 type deck (As System 1a)
Two Duo Type III matched speakers – Enclosure size approx. 27" × 13" × $11\frac{1}{2}$". Finished in teak simulate. Drive units 13" × 8" bass driver, and two 3" (approx.) tweeters. 20 watts RMS, 8 ohms frequency range – 20 Hz to 18,000 Hz.
Complete System with these speakers £85.00 +£7.60 p & p.

PRICES: SYSTEM Ia
Viscount IV R103 amplifier £27.50+£1.90 p & p.
2 Duo Type IIa speakers £30.00+£6.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover £22.00+£3.30 p & p.
Total if purchased separately: £79.50
Available complete for only: **£69.00** +£6.50 p & p.

PRICES: SYSTEM 2
Viscount IV R103 amplifier £27.50+£1.90 p & p.
2 Duo Type III speakers £46.00+£7.50 p & p.
MP60 type deck with Mag. cartridge de luxe plinth and cover £22.00+£3.30 p & p.
Total if purchased separately: £95.50
Available complete for only **£85.00** +£7.60 p & p.

20x20 SYSTEM

Scotland and the Orkneys P & P Surcharge
System 1a £1.75 System 2 £3.50

PUSH BUTTON CAR RADIO KIT— THE TOURIST TT*

NO SOLDERING REQUIRED

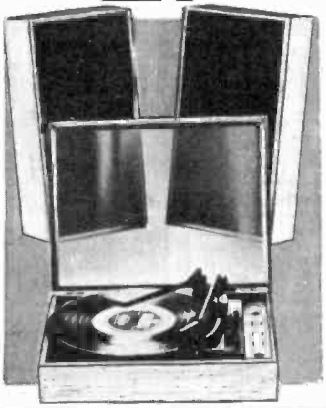
NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO

Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly. Fine tuning push button mechanism is fully built and tested to mate with printed circuit board. **TECHNICAL SPECIFICATION: (1) Output** 4 watts RMS output. For 12 volt operation on negative or positive earth. (2) **Integrated circuit** output stage, pre-built three stage IF Module.

Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size chassis 7" wide 2" high and 4¾" deep approx. **£9.50**+£1.05 p & p. Speaker including baffle and fixing strip £2.00 +45p p & p. Car Aerial Recommended — fully retractable £1.60+40p p & p.

The Tourist I Kit For the experienced constructor. If you can solder on a printed circuit board you can build this model. Same technical specification as Tourist TT. **Price £8.20**+£1.05 p & p.

*STEREO 21 QUALITY SOUND FOR LESS THAN £24.00



Stereo 21, easy to assemble audio system kit. No soldering required.
The unit is finished in white P.V.C. and the acrylic top presents an unusually interesting variation on the modern deck plinth.
Includes — **BSR 3 speed deck**, automatic, manual facilities together with stereo cartridge.
Two speakers with cabinets.
Amplifier module. Ready built with control panel, speaker leads and full, easy to follow assembly instructions.
Specifications — For the technically minded:
Input sensitivity 600mV. Aux. input sensitivity 120mV. Power output 2.7 watts per channel. Output impedance 8—15 ohms. Stereo headphone socket with automatic speaker cutout. Provision for auxiliary inputs — radio, tape, etc., and outputs for taping discs.
Overall Dimensions. Speakers approx 15½"×8"×4". Complete deck and cover in closed position approx. 15½"×12"×6".

Complete only £23.20 +£3.00 p & p.

Extras if required. Optional Diamond Styli £1.60.
Specially selected pair of stereo headphones with individual level controls and padded earpieces to give optimum performance £5.80.

*DISCO AMPLIFIER

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties. Output 20 watts RMS into 8 ohms (suitable for 15 ohms).
Inputs *4 electrically mixed inputs. *3 individual mixing controls. *Separate bass and treble controls common to all 4 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State circuitry. *Attractive styling.
INPUT SENSITIVITIES — Input — 1). Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity.) — Inputs — 2), 3), 4). Medium output equipment — ceramic cartridge, tuner, tape recorder, organs, etc. — all 250mV sensitivity. AC Mains, 240V operation. Size approx: 12½"×6"×3½". **£20.00** +£1.35 p & p.

8 TRACK HOME CARTRIDGE PLAYER

Elegant self selector push button player for use with your stereo system. Compatible with Viscount IV system, Unisound module and the Stereo 21. Technical specification Mains input, 240V, Output sensitivity 125mV.

Yours for only
£16.20 +£1.70 p & p.

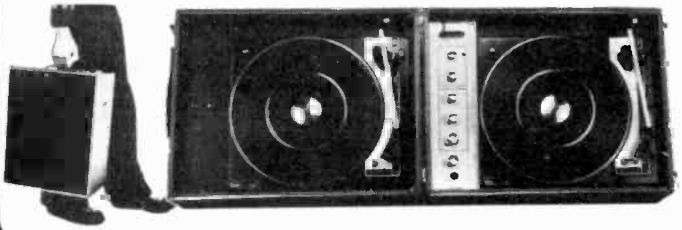
BUILD YOUR OWN STEREO AMPLIFIER*

For the man who wants to design his own stereo — here's your chance to start, with Unisound — pre-amp, power amplifier and control panel. No soldering — just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum. 240V. AC only.

Also available with 2 speakers (7"x4") £10 + £1.75 p & p. **£8.95** + £1.05 p & p.
Also available with the 'Compact' (see opposite page) easy build speaker kit £13.50 + £2 p & p

PORTABLE DISCO CONSOLE*

INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables. Two B.S.R. MP60 type single play professional series decks, fitted with crystal cartridges.



TECHNICAL SPECIFICATION:
Pre-amp — Output — 200mV. Auxiliary inputs — 200mV and 750mV into 1 meg. Mic input — 6mV into 100K. 240 volt operation.
Turntables capacity — 7", 10" or 12" records. **Rumble, wow and flutter** Rumble Better than —35dB. Wow Better than 0.2%. Flutter Better than 0.06% (Gaumont kalee meter).
Finish — Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.

Console size —
Unit Closed — 17¾"×13¾"×8¾" (app.)
Unit Open — 35¼"×13¾"×4¾" (app.)
This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.
The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

Yours for only
£49.00 +£6.50 p & p.

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Mail orders to Acton. Terms C.W.O. All enquiries stamped addressed envelope. Goods not despatched outside U.K.
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AC152	0·25	BF115	0·20	2N2221A	0·18
AC153	0·27	BF200	0·25	2N2222	0·17½
AC176	0·14	BF194	0·09	2N2646	0·30
AC187K	0·27	BF195	0·09	2N2904	0·18
AC188K	0·27	BF198	0·12	2N2905	0·18
AD161	0·35	BF199	0·12	2N2906	0·18
AD162	0·35	BF257	0·24	2N2907	0·18
BA102	0·10	BF258	0·24	2N2926G	0·09
BAX13	0·03	BF259	0·24	2N3053	0·20
BAX16	0·04	BFX29	0·22	2N3054	0·40
BC107	0·09	BFX30	0·22	2N3055	0·45
BC108	0·09	BFX84	0·20	2N3393	0·12
BC109	0·09	BFX85	0·27	2N3441	0·58
BC147	0·09	BFY50	0·19	2N3442	0·96
BC148	0·09	BFY51	0·19	2N3638	0·10
BC149	0·09	BFY52	0·19	2N3638A	0·10
BC167	0·10	BY126	0·11	2N3702	0·10
BC168	0·10	BY127	0·11	2N3704	0·10
BC169	0·10	OA47	0·08	2N3706	0·10
BC182	0·09	OA90	0·04	2N3708	0·10
BC183	0·09	OA91	0·04	2N3771	1·25
BC184	0·09	OA200	0·05	2N3772	1·35
BC212	0·09½	OA202	0·06	2N3773	2·00
BC213	0·09½	IN914	0·04	2N3904	0·11
BC214	0·9½	IN4004	0·05	2N3906	0·12
BC237	0·08	IN4007	0·06	2N5294	0·35
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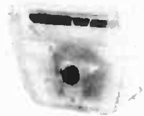
BC239	0·08	IS920	0·05	2N3794	0·20
BC307	0·09	2N697	0·15	2N3819	0·30
BC308	0·09	2N698	0·14	2N4036	0·55
BC309	0·09	2N706	0·10	2N4037	0·40
BC327	0·12	2N708	0·10	2N4921	0·80
BC328	0·12	2N916	0·23	2N5060	0·25
BCY70	0·13	2N1305	0·25	2N4289	0·25
BCY71	0·13	2N1307	0·25	2N5447	0·12
BCY72	0·12	2N1308	0·25	2N5449	0·12
BD135	0·25	2N1613	0·15	2N5457	0·30
BD136	0·26	2N1711	0·15	2N5458	0·27
BD137	0·27	2N2218	0·17½	2N6027	0·40

4¼in × 3¼in METER. 30μA, 50μA or 100μA, £3·85. 13p P. & P.



TAPE RECORDER LEVEL METER

500μA, 70p. 10p P. & P.

CARDIOID DYNAMIC MICROPHONE

Model UD-130. Frequency response 50–15,000c/s. Impedance Dual 50K and 600 ohms, £7·40. 13p P. & P.

42 × 42mm meters 1mA, 10mA, 100mA, 500mA, £2·76. 11p P. & P.

60×45mm meters 50μA, 100μA, 500μA and 1mA VU meter, £2·92. 11p P. & P.

Edgewise meters 90mm × 34mm 1mA, £3·40. 13p P. & P.

MULTI-METER

Model ITI-2 20,000 ohm/volt, £6·90. 16½p P. & P.

3 WATT STEREO (1½ + 1½) PER CHANNEL AMPLIFIER

£4·30. 12½p P. & P.

All above prices include V.A.T. LARGE S.A.E. for List No. 11. Special prices for quantity quoted on request.

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7lb BARGAIN PARCELS
Hundreds of new components—pots, resistors, capacitors, switches, + PC boards with transistors and diodes, also loads of odds and ends. Amazing value at only £3·25.

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Large quantity always available. 3lb assorted £1·75; 7lb £3; 56lb £16. Pack with about 500 components inc. at least 50 transistors £1. Pack with 12 high quality panels, inc. power transistors, multiturn trimpots, IC's, zeners, and stacks of small signal transistors, resistors and capacitors. Only £2·75.

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Anhydrous technical quality in 1lb double sealed bags. 1lb 85p; 3lb £1·90; 10lb £4·80; 100lb £36.

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All have mains primaries. 6-0-6V 100mA 90p; 9-0-9V 100mA 95p; 12-0-12V 50mA 80p; 12-0-12V 100mA £1; 24-0-24V 500mA £2·05. Multitapped transformer to give 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 or 30V, or 12-0-12V, or 15-0-15V. 1A version £3·15; 2A version £4·45; 30-0-30V 1A £3·25; 6-0-6V 1½A £1·95; 12-0-12V 1A £2·15; 25V 1½A £2.

VEROBOARD
100 sq.in assorted sizes and pitches, about 8 pieces, £1·20.
All prices quoted include V.A.T. at 8% or 25% as appropriate, and U.K. postage. Price increases are due to new postal rates which came into effect 29th Sept. S.A.E. list, enquiries. Send 10p for Multimeter brochure. Surplus components and equipment wanted for cash.

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10+ 26p; 25+ 23p; 1,000+ 21p.

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115V or 240V Sec. only
Centre tapped and Screened

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149	60	4·37	45
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151	200	8·13	53
152	250	9·83	73
153	350	11·88	73
154	500	13·65	91
155	750	20·51	BRS
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Ref. No.	Amps. 12V	Amps. 24V	£	P & P p
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213	1·0	0·5	1·74	30
71	2	1	2·29	38
18	4	2	2·86	38
70	6	3	4·12	45
108	8	4	4·56	45
72	10	5	5·14	53
116	12	6	5·52	53
17	16	8	7·28	60
115	20	10	10·30	73
187	30	15	13·90	83
226	60	30	16·83	BRS

30 VOLT RANGE
Secondary Taps
0-12-15-20-24-30

Ref. No.	Amps.	£	P & P p
112	0·5	1·81	30
79	1·0	2·40	38
3	2·0	3·49	38
20	3·0	4·35	45
21	4·0	5·13	53
51	5·0	6·41	53
117	6·0	7·16	60
88	8·0	9·87	67
89	10·0	9·90	73

50 VOLT RANGE
Secondary Taps
0-19-25-33-40-50

Ref. No.	Amps.	£	P & P p
102	0·5	2·58	30
103	1·0	3·38	38
104	2·0	4·88	45
105	3·0	5·81	53
106	4·0	7·60	67
107	6·0	12·10	67
118	8·0	12·90	85
119	10·0	16·99	BRS

60 VOLT RANGE
Secondary Taps
0-24-30-40-48-60

Ref. No.	Amps.	£	P & P p
124	0·5	2·33	38
126	1·0	3·41	38
127	2·0	5·06	45
125	3·0	7·52	60
123	4·0	8·75	67
40	5·0	9·75	73
120	6·0	11·30	85
121	8·0	15·00	BRS
122	10·0	17·52	BRS
189	12·0	19·98	BRS

AUTO TRANSFORMERS

Ref. No.	VA (Watts)	Auto Taps	£	P & P p
113	20	0-115-210-240	1·67	30
64	75	0-115-210-240	2·90	38
4	150	0-115-200-220-240	4·12	45
66	300	0-115-200-220-240	5·82	53
67	500	0-115-200-220-240	8·82	67
84	1000	0-115-200-220-240	13·68	91
93	1500	0-115-200-220-240	18·11	BRS
95	2000	0-115-200-220-240	24·29	BRS
73	3000	0-115-200-220-240	35·00	BRS

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240V mains lead input and U.S.A. 2-PIN outlets:

20VA	£3·23	P. & P. 38p	113W
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SCREENED MINIATURES

Ref.	mA	Volts	£	P&P p
238	200	3-0-3	1·54	10
212	1A, 1A	0-6, 0-6	1·84	30
13	100	9-0-9	1·41	13
235	330, 330	0-9, 0-9	1·58	19
207	500, 500	0-8-9, 0-8-9	1·92	30
208	1A, 1A	0-8-9, 0-8-9	3·30	38
236	200, 200	0-15, 0-15	1·43	19
214	300, 300	0-20, 0-20	1·93	30
221	700 (d.c.)	20-12-0-12-20	2·17	38
206	1A, 1A	0-15-20-0-15-20	3·46	38
203	500, 500	0-15-27-0-15-27	3·00	38
204	1A, 1A	0-15-27-0-15-27	3·85	38
S112	500	12-15-20-24-30	1·88	37

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VA.	Ref.	£	P & P p
60	243	4·37	63
350	247	10·41	95
1000	250	27·08	BRS
2000	252	41·07	BRS

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50V	2A	35p
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600V	2A	50p
500V	10A(PM 7A6)	£2·35

P & P 15p

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CC12-05 Output Switched 3-4-5-6-7·5-9-12V at 500mA, £4·08. *P & P* 30p

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MAGNETIC TO CERAMIC CARTRIDGE CONVERTOR
Operating voltage 20–45V only £2·05 *P. & P.* 18p.

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8Ω angled £3·56 pr. *P. & P.* 37p.

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Above motor board 3¼in. Below motor board 2½in.
with STEREO and MONO XTAL **£9·25** Post 50p.

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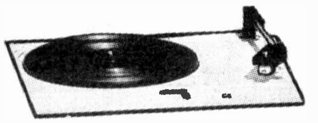
Modern design. Rexine covered. Large front grille. Lift-up Lid. Chrome fittings. Approx. size 17in × 15in × 7in. Few only in red and black rexine. Motor board cut for Garrard deck **£5·25** Post 50p

B.S.R. SINGLE PLAYER

MODEL P128. IDEAL AS DISCO PLAYER. 3 SPEEDS. BALANCED ARM. CUEING DEVICE STEREO CERAMIC CARTRIDGE. BARGAIN. SIMILAR TO MP60
£16·50 PLUS POST 75p



R.C.S. DISCO DECK
SINGLE RECORD PLAYER
Fitted with auto stop. Compatible cartridge. Baseplate. Size 11in × 8½in. Turntable. Size 7in diameter. A/C mains. 200/250V motor has a separate winding 14 volt to power a small amplifier. Three speeds. Plays all records.
£6·95 Post 45p

SOLID MAHOGANY PLINTH
Post 75p
With P.V.C. Cover. Cut out for most B.S.R. or Garrard decks. Size 12¼ × 14¼ × 7¼in. **£7·50**

COMPLETE STEREO HI-FI SYSTEM
Two full size loudspeakers 13¼ × 10 × 3¼in. Player unit clips to loudspeakers making it extremely compact, overall size only 13¼ × 10 × 8¼in., 3 watts per channel, plays all records 33 r.p.m., 45 r.p.m. Separate volume and tone controls. 240V AC Mains.

Attractive Teak finish Weight 13 lb.
Bargain Price **£25** 85p Carriage

SPECIAL OFFER!
SMITH'S CLOCKWORK 15 AMP TIME SWITCH UP TO 60 MINUTES

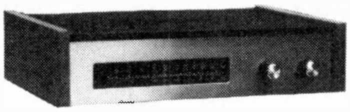
OUR PRICE **£2·50** Post 45p

ALUMINIUM BOXES. 3 × 3 × 3in 75p; 4 × 4 × 4in 90p; 6 × 4 × 4in £1·10; 9 × 4 × 4in £1·30; 12 × 4 × 4in £1·50.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 × 4in 55p; 8 × 6in 68p; 10 × 7in 80p; 12 × 8in £1; 14 × 9in £1·20; 16 × 6in £1·20; 12 × 3in 60p; 16 × 10in £1·40.
ALUMINIUM PANELS 18 s.w.g. 6 × 4in 15p; 8 × 6 in 25p; 14 × 3in 25p; 10 × 7in 30p; 12 × 5in 30p; 12 × 8in 40p; 16 × 6in 45p; 14 × 9in 50p; 12 × 12in 55p; 16 × 10in 75p.
1¼ inch DIAMETER WAVECHANGE SWITCHES. 45p ea.
2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way.
1 p.1. 2-way, or 4 p. 2-way, or 4 p. 3-way.
TOGGLE SWITCHES, sp. 20p; dp. 25p; dp. dt. 30p.

BRITISH FM/VHF TUNING HEART
88 to 108 Mc/s British made. 2 Transistors ready aligned requires 10·7 Mc/s I.F. Complete with tuning gang. Connections supplied but some technical experience essential. **Our price £3·95** Post 20p
SUITABLE I.F. STRIP £4·95. DECODER £4·95

R.C.S. STEREO FM TUNER BRITISH MADE



This completely cased mains powered Hi-Fi Tuner with brushed aluminium facia is British made using the latest circuitry. Few Only. **£30** Post 75p.

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE
Ideal for Mike, Tape, P.U., Guitar, etc. Can be used with Battery 9-12V or H.T. line 200-300V d.c. operation. Size: 1¾ × 1¼ × ¾ in. Response 25 c/s to 25 kc/s, 26 dB gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **£1·45** Post 30p

R.C.S. POWER PACK KIT
12 VOLT, 750mA. Complete with printed circuit board and assembly instructions. **£3·25** Post 45p
12 VOLT 300mA KIT, £3 9 VOLT 1 AMP KIT, £3·25.

4MFD 800V DC PAPER CAPACITOR
Block Capacitor. Ideal as Filter Unit in 100 watt Loudspeaker Systems. 95p each, post 30p.

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2/350V	20p	250/25V	14p	50+50/300V	50p
4/350V	20p	500/25V	20p	32+32/350V	35p
8/350V	22p	100+100/275V	65p	32+32/450V	60p
16/350V	30p	150+200/275V	70p	350+50/325V	55p
32/500V	50p	8+8/350V	22p	16+16+16/275V	45p
25/25V	10p	8+16/350V	25p	32+32+32/350V	65p
50/50V	10p	16+16/350V	40p	900/350V	95p
100/25V	10p	32+32/350V	40p	4700/63V	95p

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 20p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.
CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 7p; 0·5 18p; 1mF 15p; 2mF 150V 15p.
500V-0·001 to 0·05 4p; 0·1 10p; 0·25 8p; 0·47 25p.
TWIN GANG. "0-0" 208pF + 176pF, £1.20p.
Slow motion drive 365pF + 365pF with 25pF + 25pF, 50p;
Twin 500pF 75p. Twin 410pF 50p. Twin 120pF 50p.
SHORT WAVE SINGLE. GANGABLE 50pF, 65p.
NEON PANEL INDICATORS 250V AC/DC. Amber 30p.
RESISTORS. ¼W. ½W. 1W. 20% 2p; 2W. 10p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 12p each.
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FERRITE ROD 8 × ⅜in 20p; 6 × ⅜in 20p; 3 × ⅜in 10p

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ALL POST Small 45p each Large 75p each

250-0-250 80mA. 6·3V 2 amp .... £2·90
250-0-250 80 mA. 6·3V 3·5A 6·3V 1A or 5V 2A ... £4·60
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300-0-300V 120mA, 6·3V 4A C.T.; 6·3V 2A ...... £7·00
SMALL 220V 45mA, 6·3V 2A 2¾ × 2¼ × 2in ...... £1·25
HEATER TRANS. 6·3V ½ amp 85p, 3 amp £1.40p
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30V £4·60
1 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £4·60
2 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £7·00
5 amp, 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £11·25
10, 30, 40V 2 amp. £3; 20V 3 amp. £2·30. 5, 8, 13V, 5 amp. £1·50; 6-0-6V 500mA 90p; 9V 1 amp. 95p; 12V 300mA 75p; 12V 500mA 85p; 12V 750mA 95p; 40V 2 amp. £2·75; 22-0-22V 4 amp. D.C. £3·45; 16V ½ amp. 95p; 16V 2 A. £2; 5V, 8V, 10V, 16V ½ A. £1·90. 20V 1A. £2.
AUTO TRANSFORMERS. 115V to 230V or 230V to 115V 150W £4·60; 500W £8·70; 750W £17·50; 1000W £21.
CHARGER TRANSFORMERS. 1½A £2·75 4 amp £4·60.
BATTERY CHARGERS. Ready built with leads and clips, 4 amp £4; 5 amp. £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12V outputs. 1½ amp 40p; 2 amp 55p; 4 amp 85p.

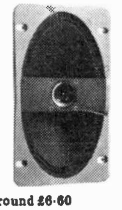
MAINS ISOLATING TRANSFORMER
Primary 0-110-240V. Secondary 0-240V 3 amps 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make (Value £19) OUR PRICE **£13·50** Carr. 95p
Can be used as 800 watt auto transformers 240-110V.

VOLUME CONTROLS
Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 25p. D.P. 40p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p.

80 ohm Coax 5p yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd £2·00; 60 yd £3·00.
FRINGE LOW LOSS Ideal 625 and colour. **10p** per yd

Wire Wound controls 1¼in diam. 3 Watts. 10 ohms to 100K British Made with long spindles ¼in dia. 85p each.
DUAL CONCENTRIC POT 500K LOG AND 500K LIN D.P. switch. Inner spindle 3¼in; outer spindle 2½in 75p.

E.M.I. 13½ × 8in. SPEAKER SALE!



With tweeter and crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£5·25** Post 45p
With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 c/s. Flux 10,000 gauss. State 3 or 8 or 15 ohm. Post 45p **£3·45**
13 × 8in Bass unit 20 watt rubber cone surround £6·60

LOUDSPEAKER FRONT GRILLES
Teakwood strips mounted on cloth backing, easily glued on to baffle to modernise cabinets.
Size 18¼ in × 10¼in. **75p** Or size 10¼in × 7¼in. **45p**

GOODMANS 6½in. HI-FI SPEAKER

8 ohm. 10W. Large ceramic magnet. Special Rubber cone surround. Frequency response. Twin cone. 30-12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4·60**

ELAC CONE TWEETER

The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3½ × 3½ × 2in deep. Rating 10W, 3 ohm.
Crossover £1·85 **£2·20** Post 30p.

GOODMANS 8 in. WOOFER

8 ohm 15 watt. Rubber surround. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. Ideal bass unit for Hi-Fi system. **£5·75**
Post 50p

SPECIAL OFFER LOUDSPEAKERS
3 ohm, 2½in; 2¾in; 3½in; 5in; 7 × 4in; 8 × 5in.
8 ohm, 2½in; 2¾in; 5in × 3in; 3in; 4in; 5in; 6 × 4in.
15 ohm, 3½in; 5in; 6 × 4in; 5 × 3in; 7 × 4in; 8 × 5in.
25 ohm, 2½in; 5 × 3in; 5in; 6 × 4in; 7 × 4in.
35 ohm, 3in; 5in. 64 ohm 2½in.
80 ohm, 2½in; 2¾in. 120 ohm 3in. **£1·25** EACH

RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in diameter 4W £2·50, 10 in diameter 5W £2·95; Post 25p 12in diameter, 6W, £3·50; 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E
Horn Tweeters 2-16Kc/s. 8W 8 ohm or 15 ohm £2·50
De Luxe Horn Tweeters 2-18Kc/s, 15W, 15 ohm £4·50
TWO-WAY 3,000 c.p.s. CROSSOVERS 3, 8 or 15 ohm £1·85

CASSETTE MACHINE MOTOR. 6 Volt. Will replace many types £1·25.

R.C.S. 2/3 WAY CROSSOVER
Complete with 12 ft. twin lead fitted with din speaker plug. Ready assembled with leads for speakers, bass, mid and tweeter. Crossover frequencies—950 cps and 3,000 cps. For systems up to 25 watts. **£2·25**

VALVE OUTPUT TRANSFORMER 50p.
MIKE TRANSFORMER MU metal 100-1 £1·25.
PUSH-PULL VALVE OUTPUT TRANSFORMERS.
50 watt .... £14·00 100 watt .... £20·00

ELECTRO MAGNETIC PENDULUM MECHANISM
1·5V d.c. operation over 200 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. **95p** Post 30p

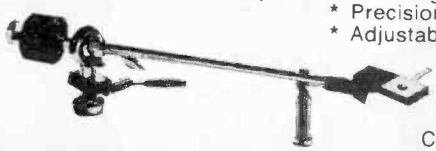
R.C.S. "MINOR" 10 watt AMPLIFIER KIT
This kit is suitable for record players, guitars, tape playback, electronic instruments or small P.A. systems. Two versions available: Mono, £12·50; Stereo, £20. Post 45p. Specification 10W per channel; input 100mV; size 9¼ × 3 × 2in. approx. S.A.E. details. Full instructions supplied.

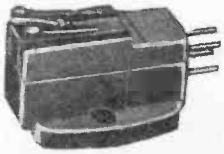
COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18 OUTLET BOXES, SURFACE MOUNTING 50p.
BALANCED TWIN RIBBON FEEDER 300 ohms, 7p yd.
JACK SOCKET Std. open-circuit 20p, closed circuit 30p; Chrome Lead Socket 45p. Phono Plugs 7p. Phono Socket 7p
JACK PLUGS Std, Chrome 30p; 3·5mm Chrome 20p DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p DIN SOCKETS Lead 3-pin 25p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p.
VALVE HOLDERS 5p; CERAMIC 10p; CANS 5p.

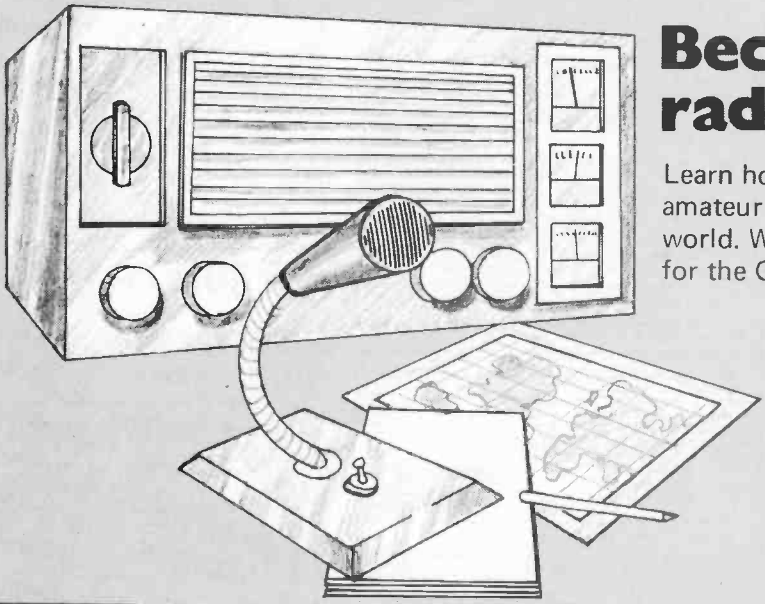
CASH PRICES INCLUDE VAT ● 30p MINIMUM POST AND PACKING ● CALLERS WELCOME ●

RADIO COMPONENT

Illustrated Brochure, Radio Books & Component Lists 10p   Written guarantee.







TELEVISIONS AND SPARES TO THE TRADE

MONOCHROME TELEVISIONS

BBC 2 Dual Standard TVs (19in. 23in) in batches of 10—£3 each (makes include Bush, Thorn, Philips, Pye/Ekco, Baird). Many with transistorised tuners.
GEC 2000, Thorn 950 series, Bush 141, Philips Style 70, Baird 600 and 700 series all at £6 each.
Thorn 1400, Bush 160/170 series, Philips 210, Pye-Ekco Olympic, etc., Baird 673, Push Button—all at £12·50 each.
20in and 24in square screen Dual Standard sets—Thorn, GEC, etc., 20in—£15, 24in—£16·50.
20in and 24in Single Standard Thorn 1500, GEC, Bush Acoustic, 20in—£19·50, 24in—£22.

(1) Discounts for quantities. (2) All monochrome spares supplied free of charge. (3) All tubes guaranteed. (4) All cabinets very good. (5) All sets "walk and talk". (6) All sets guaranteed complete inside and out. (7) Delivery and VAT extra.

COLOUR TELEVISIONS

Colour TVs 19in and 25in. Makes include Thorn 2000, Bush CTV25, Decca CTV 19/25in, Pye-Ekco, Baird 700 and 710 series, Philips G6, GEC 2028. All sets guaranteed complete inside and out—cabinets first class and tubes guaranteed. From £65 each.
20in and 22in Colour Televisions are always available in varying quantities—please telephone for availability and cost.

Please Note: (1) We deliver anywhere by our own transport. (2) All goods are blanket wrapped in our vans. (3) All orders with half deposit, balance on delivery after inspection. (4) Cheques most welcome. (5) Any quantity supplied. (6) We do not sell rubbish, and we stand by our guarantees. (7) We aim to please. (8) All spares supplied free of charge (mono only).

N.B. Special arrangements for delivery to North and South Ireland and world-wide exports orders welcomed.

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WORLD WIDE DELIVERIES OF TVs, SPARES

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Large quantities of stereograms, fridges, deep freezers, Hoovermatics, radios, etc., always at hand—prices on request.

Colour	Mono
SCAN COILS	
All dual standard £5 plus £1 P. & P.	All makes £2 inclusive.
VALVES	
All colour valves **40p** each plus 5p P. & P. per valve.	All mono valves **10p** each plus 2p each P. & P.
TUBES	
19in—£15, 22in—£22, 25in—£20 (post, insurance, packing £5).	19in—£4, 20in—£5·50, 23in—£5, 24in—£7 (post, insurance, packing £3·50).
CABINETS	
19in—£12, 22in—£16, 25in—£14 (post, insurance, packing £5).	All cabinets—£5 including post, insurance, packing.
LOPTs	
All dual standard colour £5·50 plus £1 P. & P. All makes available.	All dual standard mono £2·50 plus £1 P. & P. All makes available.

Colour	Mono
PANELS	
IF, Decoder and Convergence—frame output for all dual standard models from £7·50 plus £1·50 P. & P. All models available.	IF, Line timebase £3 plus £1 P. & P. All dual standard models in stock.

SLOT METERS

10p meters—£1·50 each including postage and packing.

SPEAKERS

6in × 4in, 5in Round, 8in × 2in **30p** each plus 10p P. & P.

MAIL ORDER SERVICES

BLACK/WHITE TELEVISIONS
Working: 19in—£12·50, 23in—£15, 20in—£25, 24in—£29·50.
Untested (but guaranteed complete with good tubes): 19in—£4, 23in—£5, 20in—£15, 24in—£19.
(Postage, packing and insurance £4·50 each, prices include VAT.)
N.B. All tubes guaranteed

COLOUR TELEVISIONS
Working: 19in—£85, 22in—£125, 25in—£130.
Untested (but guaranteed complete with good tubes): 19in—£70, 22in—£90, 25in—£95.
(Postage, packing and insurance £9 each; prices include VAT.)
Thorn 2000, Bush CTV25, Philips G6, GEC2028, Baird 700, Decca CTV25

MAIL ORDER SPARES. Special Offer—Brand new spares:
BRC 2000 panels, video, convergence, and regulator—only £12·50 plus £1·50 P. & P.
Bush CTV 25 Line timebase-tower unit including LOPT and valves Mk. I and II only—£18 plus £3 P. & P.
BRC single standard colour 4 button tuners colour and mono—£7·50 plus £1 P. & P.
UHF Vari-cap tuner units—£6·50 plus £1 P. & P.
VHF Vari-cap tuner units—£7·50 plus £1 P. & P.
Pye-Ekco CTV Tripler units—£6·25 plus 75p P. & P.
Philips G8 Tripler units—£7·50 plus 75p P. & P.
KB VC Series LOPT £2·50 including P. & P.
Bush 125 and 135 IF PANELS—£3·50 plus 75p P. & P.
Thorn 850 IF Panels—£2·50 plus £1 P. & P.
GEC 2000 IF Panels—£3·50 plus £1 P. & P.

EX-EQUIPMENT TUNERS:
Colour:
All dual standard colour push button—rotary and integrated models in stock from £4·50 plus £1 P. & P.
Mono:
All VHF tuners available from £2 plus £1 P. & P.
All UHF tuners for dual standard models in stock. Push button—£4·50 plus £1·50 P. & P.
Rotary—£2·50 plus £1 P. & P.
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Comprehensive list of capacitors, resistors, etc., too numerous to mention. Prices on request.

PLEASE ALLOW 2 WEEKS DELIVERY. S.A.E. PLEASE FOR ENQUIRIES. ALL STOCK EX-EQUIPMENT

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WASHERS, NUTS, ETC.

BARGAIN PACK FOR HOME CONSTRUCTOR

100 assorted steel screws, nuts and washers—various BA sizes and lengths—all plated for rust prevention £1·50 or 10 bargain packs for £13·50.

Packs of 10 individual parts

Length	2BA	4BA	6BA
¼in.	10p	7p	7p
½in.	10p	8p	8p
1in.	12p	10p	10p
Nuts	8p	7p	6p
S/p washers	2p	2p	2p
Plain washers	5p	5p	4p

Also available 10A terminal blocks 3-way moulded pvc 250V a.c. wkg., 10p each.
Panel mounting variable transformers 0·9A output complete with knob and dial, £7·50 each.
Terms: C.W.O. only, P. & P. 20p up to £5; 50p up to £10; 75p above £10. Please add 8% VAT to total
Phone: 023-063 542.

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- SEQUENCE
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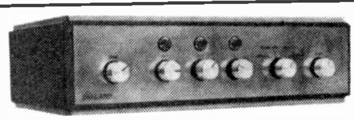

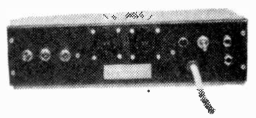

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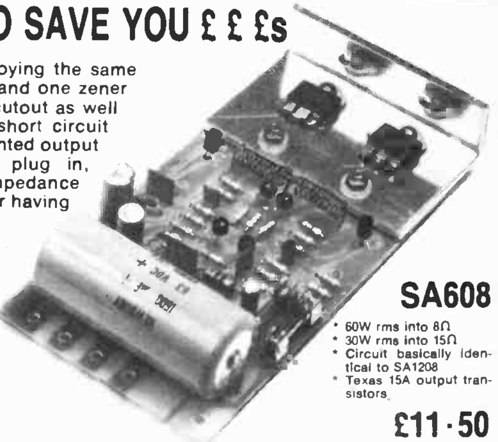
THE NEW POWER AMPLIFIERS

Three brilliant new power modules employing the same circuitry use 10 transistors, three diodes and one zener diode, with electronic over temperature cutout as well as normal thermal protection, load line short circuit and wrong load protection, integrally mounted output capacitor, etc. Fused supply terminal plug in, solder or screw connections. The input impedance is high enough to accept all types of mixer having an output of 250mV or higher.



SA608

* 60W rms into 8Ω
* 30W rms into 15Ω
* Circuit basically identical to SA1208
* Texas 15A output transistors.

£11·50

* NEW 90°C overtemperature electronic cut-out, not mechanical.
* NEW integral output capacitor means no external components normally required.
* Short circuit load line type protection with twin summing amplifiers.
* Inherently open circuit proof.
* Input sensitivity −10dBm (240mV into 100k) permits use with most mixers.
* Frequency response 20Hz–40kHz ±1dB.
* Distortion typically 0·4%. Noise −80dB.
* Compact: only 15cm × 8cm × 3cm.
* Suitable for all public address, discotheque, and group applications.
* Fused supply terminal.
* Single supply line (split supply not required).

CONSTRUCTIONALLY AND ELECTRONICALLY IMPROVED: MULTIPLE TESTED: GUARANTEED

SA1208 £16·00 120W rms into 8Ω, or 60W rms into 15Ω. Glass fibre pcb for strength and hard wear. 15A output transistors.

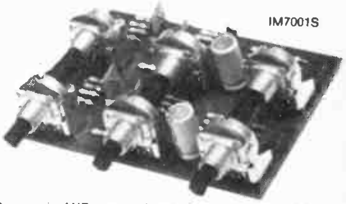
SA308 £9·00 30W rms into 8Ω, or 15W rms into 15Ω. Circuit is basically identical to that of SA1208. 10A "Plastic Power" output transistors, etc.

THE NEW POWER SUPPLIES

One piece units, ready to wire assembly with integral glass fibre pcb, size 10 × 8 × 10cm (PM1201 10 × 8 × 13cm). Grain oriented laminated transformers are used for compactness. Also facilities for preamp supply. Fully fused.

PM1201	95V for one SA1208	£11·00
PM1202	95V for two SA1208	£14·00
PM601	65V for one or two SA608	£9·00
PM301	45V for one or two SA308	£7·50

MODULAR PRE-AMPS



IM7001S

Mono and Stereo
Up to 20 × IM17001 input modules may be used with mixer module IM17002. Each input module has various types of equalisation and monitor path outlets.

* With equalisation to suit ceramic AND *magnetic* cartridges, low and high imp. mic. and all musical instruments. * Mono and stereo. * Mono module may be matrixed into a stereo system. * Carbon film resistors in low noise circuitry. * 20Hz–50kHz ±1dB response. * Wide range bass and treble controls—zero noise with volume at min. * For 18V operation. * Outputs for monitoring and echo send. * May be used with the discotheque mixers and Minotaur amplifiers.

IM7001M (mono) £5·50 **IM7001S** (stereo) £9·00

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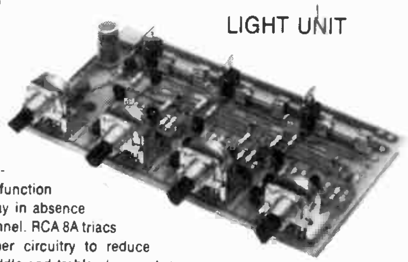

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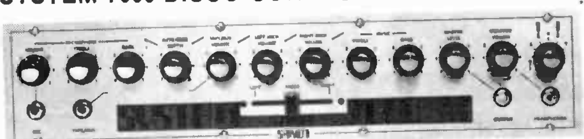

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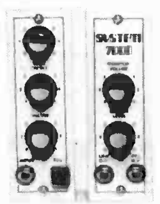

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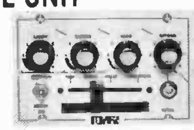

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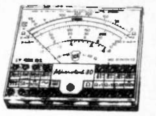

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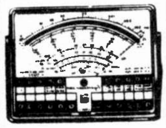

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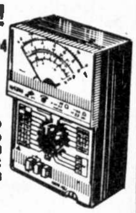

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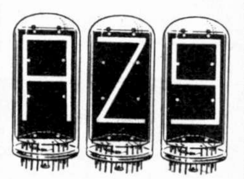

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