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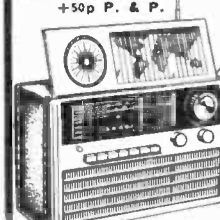

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Power watts	Tolerance	Range	Values available	Price 1–99	100+
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½	10%	3·3MΩ–10MΩ	E12	1·0p	0·8p
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4	10%	1Ω–10Ω	E12	6p	5·5p

Quantity price applies for any selection. Ignore fractions on total order.

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0·5 watt 5% Iskra resistors 5 off each value 4·7Ω to 1MΩ.
E12 pack 325 resistors £2·40. E24 pack 650 resistors £4·70.

POTENTIOMETERS

Carbon track 5kΩ to 2MΩ, log or linear (log ½W, lin ½W).
Single, **12p.** Dual gang (stereo), **40p.** Single D.P. switch **24p.**

SKELETON PRESET POTENTIOMETERS

Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0·1 matrix).
Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **6p** each.

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AC126	12p	BC108	10p	BFY50	22p	OC82D	12p	2N3704	13p
AC127	12p	BC109	10p	BFY51	22p	OCP71	40p	2N3705	12p
AC128	12p	BC147	10p	BFY52	22p	ORP12	50p	2N3706	11p
AC131	12p	BC148	13p	BSY56	32p	2N2369	16p	2N3707	12p
AC132	12p	BC149	13p	OC26	45p	2N2646	60p	2N3708	10p
AD140	50p	BC157	13p	OC28	45p	2N2926R	9p	2N3709	11p
AD161	33p	BC158	13p	OC35	45p	2N2926O	9p	2N3710	11p
AD162	36p	BC159	13p	OC42	12p	2N2926Y	9p	2N3711	11p
AF114	20p	BD131	75p	OC44	12p	2N2926G	10p	2N4062	12p
AF115	20p	BD132	75p	OC45	12p	2N3054	58p	ZTX302	15p
AF116	20p	BF179	32p	OC70	12p	2N3055	60p	ZTX500	16p
AF117	20p	BF181	25p	OC71	12p	2N3442	140p	ZTX503	16p
AF118	38p	BF194	15p	OC72	12p	2N3702	13p	40362	58p

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400mW 5% 3·3V to 30V, 15p.

LINEAR IC's (DIL)

709	50p	741	50p
710	50p	748	50p

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14 and 16 pin
16p

DIODES

RECTIFIER

BY127	1250V	1A	12p
BZY10	800V	6A	25p
BZY13	200V	6A	20p
IN4001	50V	1A	7p
IN4004	400V	1A	8p
IN4007	1000V	1A	12p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
IN4148	5p
BA114	8p

BRUSHED ALUMINIUM PANELS

12in x 6in = 25p; 12in x 2½in = 10p; 9in x 2in = 7p.

SLIDER POTENTIOMETERS

86mm x 9mm x 16mm, length of track 59mm.
SINGLE 10K, 25K, 100K log. or lin. **40p.**
DUAL GANG, 10K + 10K etc. log. or lin. **60p.**
KNOB FOR ABOVE 12p.
FRONT PANEL 65p
18 Gauge panel 12" x 4" with slots cut for use with slider pots. Grey or matt black finish complete with fixings for 4 pots.

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400V: 0·001μF, 0·0015μF, 0·0022μF, 0·0033μF, 0·0047μF, **2½p.** 0·0068μF, 0·01μF, 0·015μF, 0·022μF, 0·033μF, **3p.** 0·047μF, 0·068μF, 0·1μF, **4p.** 0·15μF, **6p.** 0·22μF, **7½p.** 0·33μF, **11p.** 0·47μF, **13p.**
160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF **3½p.** 0·15μF, **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **13p.**

MULLARD POLYESTER CAPACITORS C280 SERIES

250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF. **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p** 1·5μF, **20p.** 2·2μF, **24p.**

MYLAR FILM CAPACITORS 100V.

0·001μF, 0·002μF, 0·005μF, 0·01μF, 0·02μF **2½p.** 0·04μF, 0·05μF, 0·068μF, 0·1μF, **3½p.**

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100pF to 10,000pF, **2p** each.

ELECTROLYTIC CAPACITORS—MULLARD C426 SERIES 6p each

(μF/V) 10/2·5, 40/2·5, 80/2·5, 160/2·5, 320/2·5, 500/2·5, 8/4, 32/4, 64/4, 125/4, 250/4, 400/4, 6·4/6·4, 25/6·4, 50/6·4, 100/6·4, 200/6·4, 320/6·4, 4/10, 16/10, 32/10, 64/10 125/10, 200/10, 2·5/16, 10/16, 20/16, 40/16, 80/16, 125/16, 1·6/25, 6·4/25, 12·5/25, 25/25, 50/25, 80/25, 1/40, 4/40, 8/40, 16/40, 32/40, 50/40, 0·64/64, 2·5/64, 5/64, 10/64 20/64, 32/64.

MULLARD C437 SERIES

100/40, 160/25, 250/16, 400/10, 640/6·4, 800/4, 1000/2·5, **9p.** 100/64, 160/40, 250/25, 400/16, 640/10, 1250/4, 1000/6·4, 1600/2·5, **12p.** 160/64, 250/40, 400/2·5, 640/16, 2000/4, 1000/10, 1600/6·4, 2500/2·5, **15p.** 250/64, 400/40, 640/25, 3200/4, 1000/16, 1600/10, 2500/6·4, 4000/2·5, **18p.**

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(μF/V): 10/12, 50/12, 100/12, 200/12, 5/25, 10/25, 25/25, 100/25.

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3¾ x 3¾	24p	21p
3¾ x 5	28p	28p
17 x 2½	75p	57p
17 x 3¾	100p	78p
17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
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JACK PLUGS AND SOCKETS

Standard screened	18p	2·5mm insulated	8p
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Plug 12p. Socket 8p.
4 way screened cable 15p/metre
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2500μF	50V	58p	4500μF	25V	£1·68
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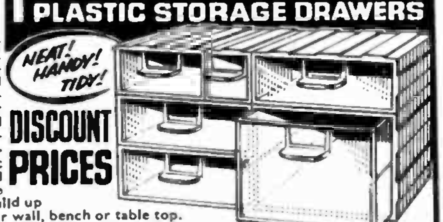

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Power output: 4 watts per channel into 8 ohms
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PUSH BUTTON
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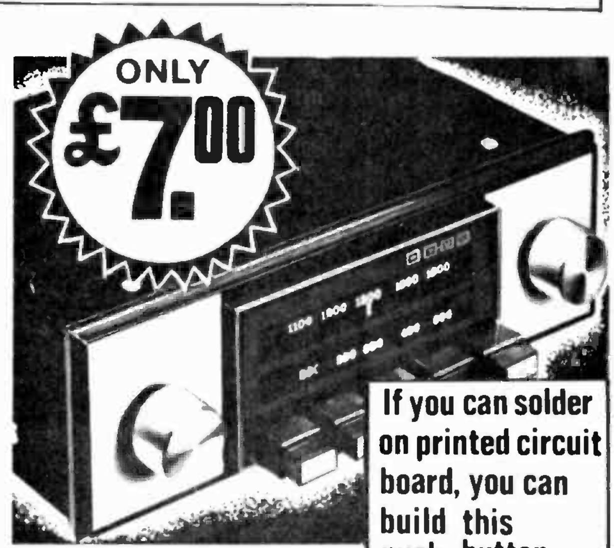

Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components, this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

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1 W (range 4·7 ohms to 10 Meg) 2p each
2 W (range 4·7 ohms to 10 Meg) 3p each

Iskra Miniature High Stability carbon Film Resistors with negligible noise factor.
All Resistors ± 5% (except values over 4·7 Meg). These Resistors are even lower in price than most 10% and older carbon composition types.

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100v	0·33 µF	9p
100v	0·47 µF	10p
100v	0·68 µF	15p
250v	0·01 µF	5p
250v	0·015 µF	5p
250v	0·022 µF	5p
250v	0·033 µF	6p
250v	0·047 µF	6p
250v	0·068 µF	6p
250v	0·1 µF	6p

ELECTROLYTIC

Voltage	Capitance	Price
10v	22 µF	7p
10v	470 µF	11p
16v	47 µF	7p
25v	10µF	7p
25v	100 µF	9p
25v	220 µF	11p
25v	470 µF	14p
25v	1000 µF	22p
25v	2200 µF	42p
35v	4·7 µF	7p
35v	220 µF	14p
100v	10 µF	8p
100v	22 µF	9p
100v	47 µF	14p

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AF139	28p	26p
BC107	9p	8p
BC108	8p	7p
BC109	9p	8p
BC147	8p	7p
BC148	8p	7p
BC149	8p	7p
BCY70	14p	13p
BCY71	20p	19p
BCY72	14p	12p
BDY20	91p	73p
BFX29	24p	23p
BFX30	24p	23p
BFY50	19p	18p
BFY51	18p	17p
BFY52	19p	18p

	1+	25+
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NKT210	24p	19p
NKT211	24p	19p
NKT212	24p	19p
NKT213	24p	19p
NKT214	19p	17p
NKT218	24p	19p
NKT219	24p	19p
NKT223	26p	20p
NKT224	21p	19p
NKT242	14p	12p
NKT243	51p	44p
NKT401	70p	56p
NKT402	75p	59p
NKT403	64p	50p
NKT453	41p	33p
OA47	6p	5p
OA79	6p	5p
OA90	5p	4p
OC70	12p	12p

	+1	25+
OC76	22p	21p
OC170	24p	21p
1N4001	6p	5p
1N4002	6p	5p
1N4003	7p	6p
1N4004	8p	7p
1N4005	10p	9p
1N4006	12p	11p
1N4007	18p	16p
1N4148	4p	3p
2N1302	16p	15p
2N1304	21p	20p
2N1613	14p	13p
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2N2904	29p	28p
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Switches Comprehensive range of N.S.F. Toggle switches and Rotary Wafer switch kits (to enable you to make *your own* switch to *your own* specification).
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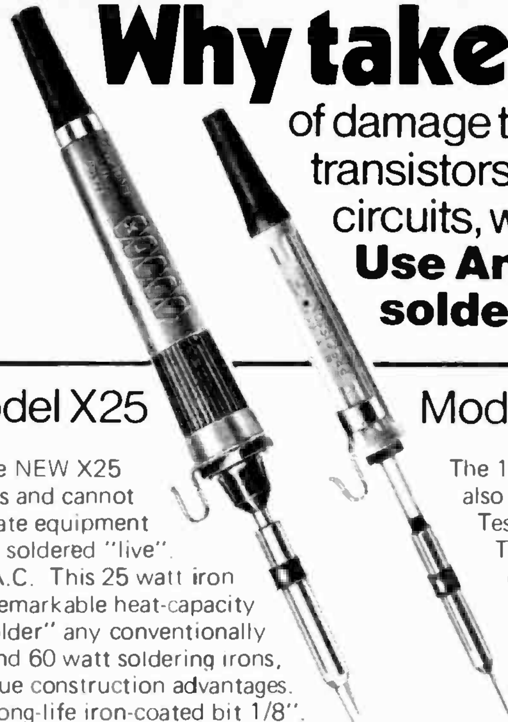

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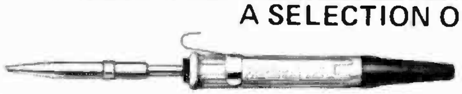

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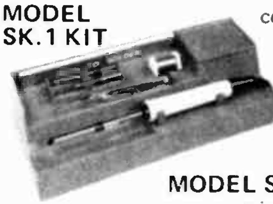

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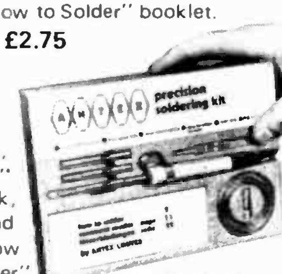

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2N1131	25p	2N3708	8p	40432	160p	AF127	22p	BC184L	11p	BFX88	26p	NKT677F	22p
2N1132	25p	2N3709	10p	40512	179p	AF129	33p	BC186	30p	BFY50	25p	NKT713	30p
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2N1303	19p	2N3711	10p	40669	120p	AL102	77p	BC213L	13p	BFY52	23p	OA47	8p
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2N1599	76p	2N4058	13p	AC142HK	29p	B1912	31p	BC300	49p	C762	19p	OC28	70p
2N1613	22p	2N4059	11p	AC153K	22p	B5041	72p	BC301	37p	C1412	60p	OC29	76p
2N1711	26p	2N4060	11p	AC176	16p	BA102	21p	BC303	50p	E2512	107p	OC35	60p
2N1893	54p	2N4061	11p	AC176K	17p	BA130	5p	BCY30	49p	EA403	10p	OC36	65p
2N2147	114p	2N4062	11p	AC187K	17p	BA145	21p	BCY31	60p	EB383	10p	OC41	42p
2N2218	33p	2N4124	15p	AC188K	23p	BA155	15p	BCY70	18p	EC401	18p	OC42	46p
2N2218A	44p	2N4126	22p	*AC187K/188K		BA156	13p	BCY71	33p	EC402	16p	OC44	42p
2N2219	38p	2N4284	24p		40p	BAX13	8p	BCY72	15p	ER900	33p	OC45	38p
2N2219A	51p	2N4286	15p	ACY17	31p	BB103/B	16p	BD121	105p	MC140	25p	OC70	21p
2N2270	62p	2N4289	15p	ACY18	19p	BB103/G	16p	BD123	105p	MJ481	120p	OC71	38p
2N2369A	19p	2N4291	15p	ACY19	23p	BC107	12p	BD124	100p	MJ491	135p	OC72	38p
2N2483	35p	2N4292	15p	ACY20	20p	BC108	11p	BD130	50p	MJE371	68p	OC75	40p
2N2484	42p	2N4410	24p	ACY21	21p	BC109	12p	BD131	77p	MJE521	62p	OC81	25p
2N2646	47p	2N4443	88p	ACY22	16p	BC122	21p	BD132	81p	MJE2955	106p	OC81D	25p
2N2904	38p	2N4906	274p	ACY39	62p	BC125	15p	BD135	38p	MJE3055	68p	OC83	25p
2N2904A	42p	2N4915	227p	ACY40	17p	BC126	15p	BD136	44p	MPF102	37p	OC84	25p
2N2905	44p	2N4991	44p	ACY41	18p	BC140	30p	BD141	227p	MP86531	28p	P346A	17p
2N2905A	47p	2N5062	42p	ACY44	31p	BC147	10p	BDY20	92p	MP86534	24p	82CN1	12p
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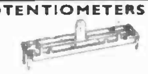

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C	1/2W	5%	4·7 Ω–10M Ω	E24	1·2	1	0·9
C	1W	10%	4·7 Ω–10M Ω	E12	2·5	2	1·8
MO	1/2W	2%	10 Ω–1M Ω	E24	4	3	2 nett
WW	1W	10% ± 1/20 Ω	0·22 Ω–3·9 Ω	E12	7	7	6
WW	3W	5%	1 Ω–10K Ω	E12	7	7	6
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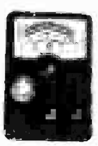

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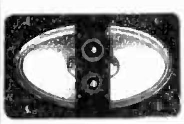

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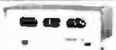

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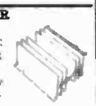

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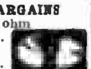

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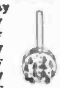

1 pole 12 way
2 pole 2 way
2 pole 3 way
2 pole 4 way
2 pole 6 way
3 pole 4 way
4 pole 3 way
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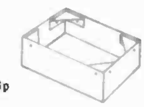

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50K	**12p** ea,	50K	Switch
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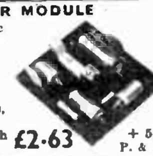

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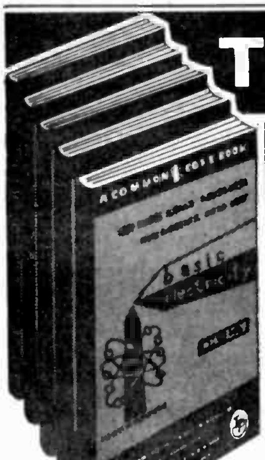

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everyday electronics

PROJECTS...
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CONVERSATION PIECE

We talk about it a lot. Usually to complain, more rarely to praise. Countless conversations have been sustained on this single topic alone. Weather.

All the paraphernalia of modern science and technology is harnessed in the cause of weather forecasting. Earth satellites report by radio what their electronic instruments detect high up in the atmosphere and computers devour this data and then produce their predictions.

From such sophisticated methods, let us now come back to earth and see what can be done in the ordinary garden or backyard, with some quite simple electronics. The *Weather Station* featured this month is not a scientific instrument of known and precise accuracy. Neither is it, on the other hand, simply a toy. With its convenient remote monitoring unit, the study of the weather can become a new absorbing interest.

THE MEANS

The means, no less than the end, are of interest, too. The *Weather Station* employs sensors and transducers that convert physical phenomena such as light, heat, moisture, and wind speed and direction into electric currents. These electric signals are used to produce a visual indication on a meter.

Employed here in this simple system are the same basic principles that are exploited on a far grander scale in all manner of advanced electronic equipments used for industrial and professional purposes.

The *Weather Station* might well provide valuable meteorological data to back-up that casual conversation in pub or train. It will certainly give the student of electronics a convincing demonstration of the inter-action between natural forces and certain electronic devices. Properties that provide the key to much modern technology.

RESIST!

At least one reader has noted that for the resistor, EVERYDAY ELECTRONICS uses a circuit symbol different to that recommended as first choice by the British Standards Institute.

We are not by nature rebels, but in this instant we do feel that the long established British zig-zag is, by far, a superior representation of the resistor (and its properties) than that nondescript oblong box, long favoured by the Continentals and more recently imported into the U.K.

If the pint is sacrosanct, and Parliament decrees that it shall remain despite impending national conversion to metric measurement, then surely the same privilege should be accorded to the traditional British resistor symbol!

Our September issue will be published on Friday, August 18

EDITOR F. E. BENNETT • M. KENWARD • B. W. TERRELL B.Sc.
ART EDITOR J. D. POUNTNEY • P. A. LOATES • S. W. R. LLOYD
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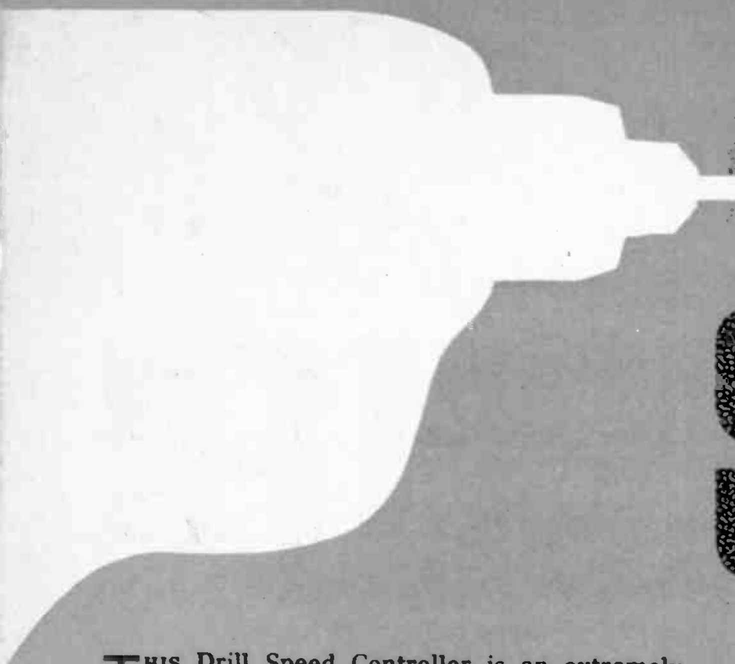
VOL. I NO. 10 AUGUST 1972

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

DRILL SPEED



This Drill Speed Controller is an extremely useful addition to the handyman's workshop. The unit will provide continuous control of speed of any a.c. mains operated series wound brush motor—most commonly used in hand electric drills and food mixers. Speed control is from approximately half full speed (which could be in excess of 1,000 r.p.m.) down to less than 15 r.p.m. The advantage of using electronic control is that one can obtain this dramatic variation without necessarily losing torque.

Even the newcomer to electronics will probably be surprised by the absolute simplicity of the circuit to be described (only five "electronic" components are used) and the unit can be made in one evening for a fraction of the cost of a commercially made equivalent. Making use of a standard electrical wall box simplifies mechanical construction and gives a very professional looking end product.

THE THYRISTOR

A thyristor or controlled silicon rectifier (CSR) is used to control the main current supplied to the motor; as this may be a new component to some readers we shall briefly describe the functions of this type of device.

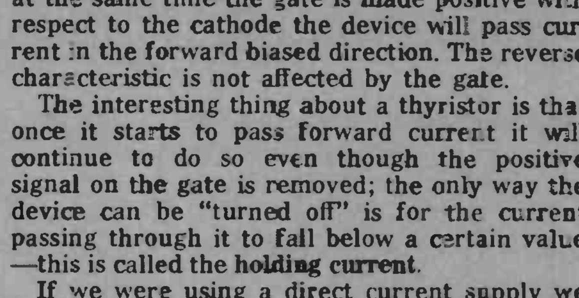
Its symbol and designation are shown, together with a typical type in Fig. 1. The similarity of its symbol to that of a diode is deliberate because, to some extent, it shows similar properties. The anode and cathode are the main electrodes through which current can be made to pass and the third electrode—the gate—is used to effect control of this current.

If connected into a circuit passing alternating current the thyristor presents a high resistance when the cathode is positive with respect to the anode (just like a conventional diode) but unlike a conventional diode it also presents high resistance the other way. If, however, the anode is made positive with respect to the cathode and at the same time the gate is made positive with respect to the cathode the device will pass current in the forward biased direction. The reverse characteristic is not affected by the gate.

The interesting thing about a thyristor is that once it starts to pass forward current it will continue to do so even though the positive signal on the gate is removed; the only way the device can be "turned off" is for the current passing through it to fall below a certain value—this is called the **holding current**.

If we were using a direct current supply we would somehow have to interrupt the flow of current; in the case of a.c., however, the direction of current flow is reversed during every cycle of the mains and this effectively breaks the flow and the device will turn off. The thyristor then stays off until such time that the gate is once more made positive with respect to the cathode.

Fig. 1. Circuit symbol and typical controlled silicon rectifier.



CONTROLLER

Electronic speed control for small electric drills and food mixers.

By Mike Hughes

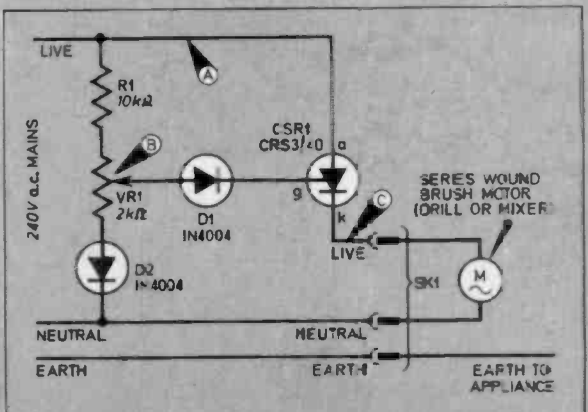
Approximate cost of components £2·10 inclusive

THYRISTOR TYPE

Unlike a transistor the thyristor has no linear slope to its characteristic and is either presenting very high or very low resistance to the flow of current. This means that there is never a great deal of power dissipated within the device and its temperature does not rise excessively even though it may be handling high currents at high voltages.

The thyristor we shall use (CRS3/40) has reverse and forward blocking voltages of 400 volts and when switched on can handle currents up to 3 amps. To switch on we must make the gate at least 2 volts more positive than the cathode and allow at least 20 milliamps gate current to flow for about 1·5 microseconds (this is approximately the time it takes the device to switch on and for holding current to be

Fig. 2. Circuit diagram of the Drill Speed Controller.



established). The holding current minimum value is approximately 10mA—if the anode/cathode current falls below this level the device turns off.

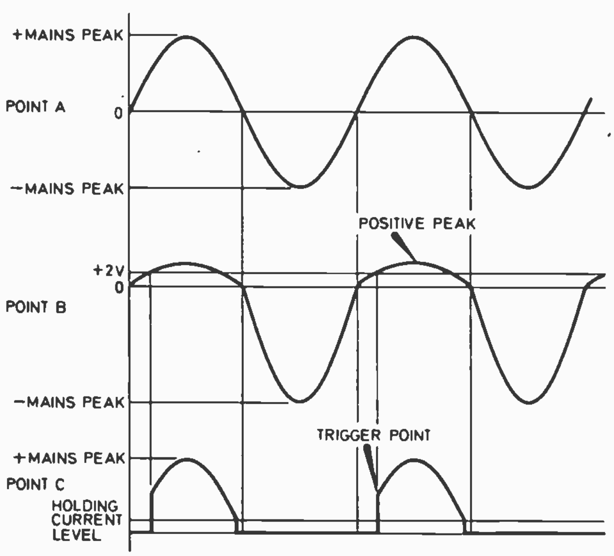
CIRCUIT DESCRIPTION

The circuit of the speed controller is shown in Fig. 2. The simplicity of the circuit is a little deceiving because the way it works is not quite as obvious as you might think at first sight. As we shall be operating from alternating current we shall assume that all voltages and waveforms are described relative to the "neutral" line, i.e., the line feeding the cathode of D2 and the motor. The "live" line will thus alternate from positive to negative.

During negative half cycles CSR1 will be reverse biased and can never be made to conduct therefore no power will be fed to the motor. For identical reasons D2 will not pass current therefore there is no dissipation within R1 and VR1.

During the first positive half cycle the potential difference across CSR1 will build up in the forward biased direction but as yet no conduction will take place. However, while this is happening D2 becomes forward biased and the potential at the wiper of VR1 (point B) will be rising in a positive direction—the peak voltage it can rise to is set by the potential divider effect of the wiper's position. As no current is, as yet, flowing through the motor the potential at the cathode of the thyristor will be the same as at the cathode of D2, thus we can say that the potential at point B is rising positive with respect to the cathode and D1 becomes forward biased.

Fig. 3. In the absence of feedback voltage, these graphs show the voltage variation at points A, B and C. The points in time over which the trigger point can be controlled are from zero to halfway through the positive half cycle.



As soon as the potential at point B rises to about 2 volts positive with respect to the cathode of CSRI (assuming the wiper has been set at a position where this can happen) the thyristor will start to conduct and the full mains voltage appears across the motor.

Diode D1 now becomes reverse biased and no more gate current flows but because the thyristor is passing much more than the holding current it does not turn off. All this happens before the mains positive half cycle has reached its peak.

As the positive half cycle returns towards zero the current through the motor will fall—eventually to below the holding current—and the thyristor switches off; it stays off during the negative half cycle and in the absence of any other effects would be triggered on again some time during the first half of the next positive half cycle.

FEEDBACK

By adjustment of VR1 one can alter the position in time of the instant point B reaches 2 volts relative to the time of the start of the positive half cycle; thus we can control the length of time before the thyristor is triggered and mains is applied to the motor during the early part—the first 90 degrees—of the cycle. If we trigger early in the cycle more total power will be fed to the motor than if we triggered later.

Because, at best, only the positive half cycles can be used to power the motor it will not run at its full speed because we are halving the total energy supplied. By adjusting the total energy fed to the motor by setting VR1 at different levels we can influence the speed but at the expense of torque.

This circuit however goes quite a bit further and compensates for the apparent loss of torque at low speeds. This is brought about by a signal that is fed back to our circuit from the drill itself.

There is always a certain amount of remnant magnetism left in the iron that makes up the field coil of a motor and if the armature is spun within this remnant field the motor will behave like a dynamo producing an output voltage—in a series wound brush motor this will be in the form of a d.c. level and will be directly proportional to the speed at which the armature is turning.

You can see this effect quite easily if you connect a 10V d.c. meter across the input leads to the motor (**it must not of course be plugged into the mains while doing this**) and spin the chuck—if it is a drill—by hand. Remember while doing this to press the starting switch otherwise no current can flow through the meter! Even at low speeds you can detect several volts.

Components.... SEE SHOP TALK

Resistor
R1 10kΩ 5W wirewound

Potentiometer
VR1 2kΩ 2W wirewound

Semiconductors
CSR1 CRS3/40 or any 400V 3A thyristor
D1 IN4004
D2 IN4004

Miscellaneous
3 inch length of 2 inch wide tag strip, small aluminium bracket—for mounting CSR1, insulated knob—preferably push-on type, MK double wall box type 2025, MK 13 amp unswitched socket, MK standard cover plate, three core mains cable—length as required, two 4BA countersunk screws—to mount circuit board, short length of connecting wire, grommet, mains plug—fused 13 or 15A type.

TORQUE

If we assume that this can happen to the motor in our circuit a rather interesting state of affairs is set up. During the negative half cycle following the first cycle when we set the motor going the armature will freewheel because of its inertia and now instead of the potential at the cathode of the thyristor being the same as that of the cathode of D2 (as was the case before switch on) the potential at point C will be a few volts positive—depending on the actual speed of rotation of the armature during its freewheeling action.

This voltage will be maintained well into the next positive half cycle. This means that the potential at B will have to rise to a higher level if the gate is to be made 2V more positive than the cathode; thus firing during this positive cycle will occur later (it might not even occur at all if the wiper of VR1 is set low down). This reduces the energy fed to the motor and it will slow down until the next cycle when the "back voltage" produced will be less and triggering will occur slightly earlier in the cycle.

If the motor is subjected to heavy torque there will be a tendency for the motor to slow up dramatically during the freewheeling (negative) half cycle and thus the feedback voltage will be less allowing extra energy to be fed in when the next trigger cycle comes along. This extra energy will compensate for the increase in torque.

The net effect of this is that the motor will keep running at its lower speed but the amount of energy being fed to it will be hunting up and down as torque is applied and removed. The speed is altered simply by setting the potential at which point B can fire the thyristor.

When running at very low speeds with very little torque applied the freewheeling action of the armature may continue over several full cycles before extra energy is applied. The motor will appear to "hunt." The effect is known as "skip cycling" and is inherent to this sort of circuit; as soon as torque is applied the skip cycling will stop and very steady low speed operation will take place.

The waveforms at points A, B and C are shown in Figs. 3 and 4, these may help in explaining the method of operation.

CONSTRUCTION

All components are mounted on a 3 inch length of 2 inch wide tag board which will ultimately be mounted in one half of an MK double wall box. The advantage of using this box is that not only does it make a very convenient and nice looking housing but is amply insulated because you must remember that **all the**

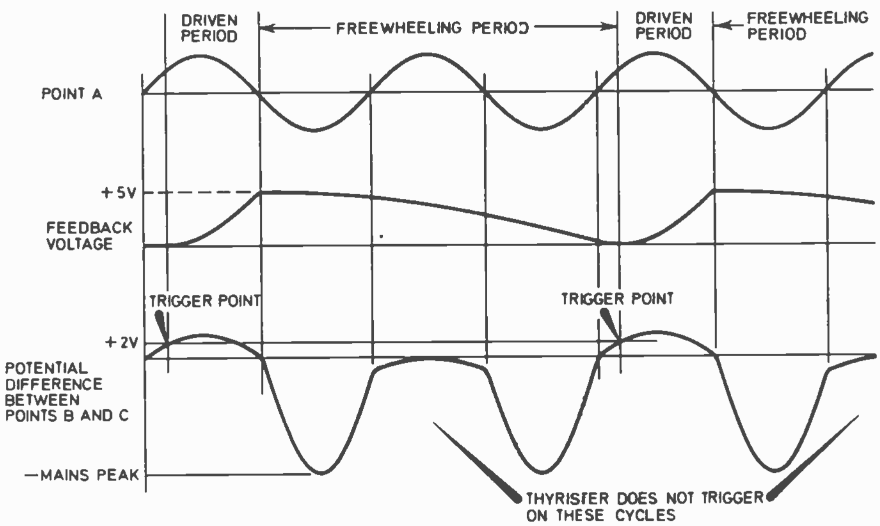


Fig. 4. A typical example of low torque allowing the feedback voltage to suppress triggering for the whole of one cycle (skip cycling).

DRILL SPEED CONTROLLER

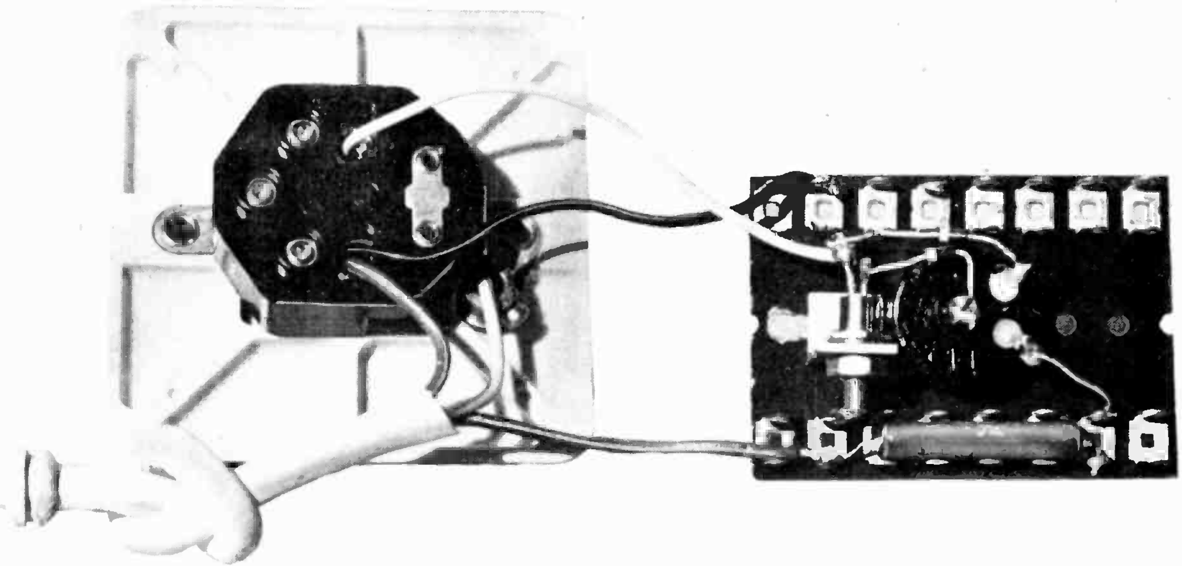
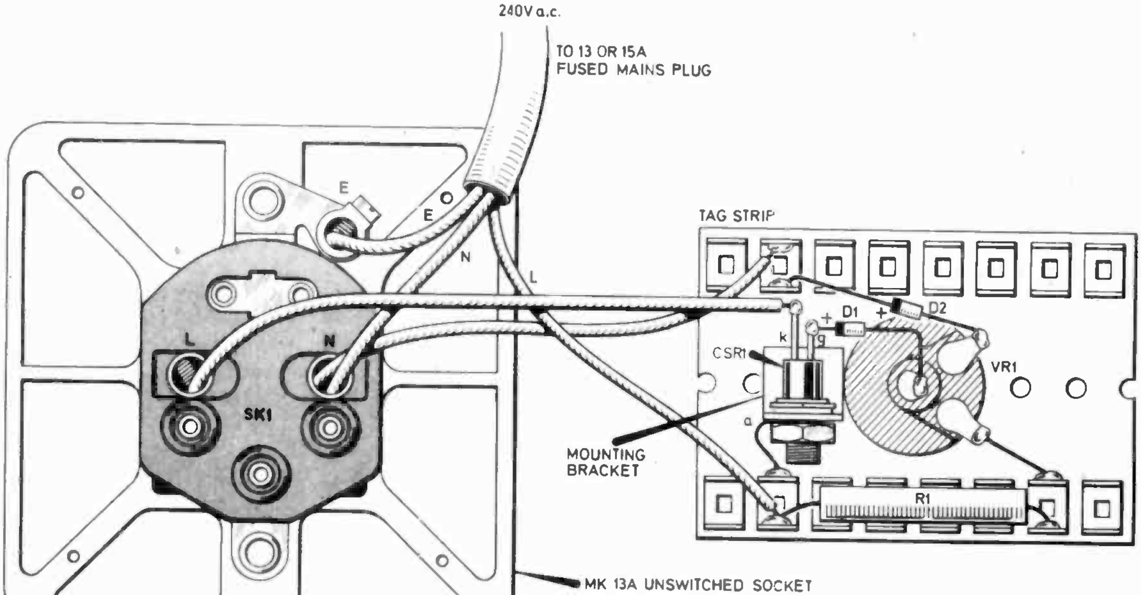


Fig. 5. Complete layout and wiring of the Drill Speed Controller.



circuitry is live to mains voltages.

The thyristor is mounted on a small aluminium bracket that is bolted to the tag board. The bracket acts as a small heat sink and easily disposes of any heat generated by the thyristor. Resistor R1 must be a 5 watt wirewound device and VR1 should have a rating of at least 2 watts and again should be wirewound. There is quite some latitude in the ohmic value of the latter.

If you cannot get a 2 kilohm potentiometer any value up to 5 kilohm will do but the range of control will tend to be cramped towards one end of the movement. The diodes D1 and D2 must be capable of withstanding full peak mains voltage and although the current passed is comparatively small the most convenient devices are 1N4004 one amp rectifiers, which are easily obtainable and relatively cheap.

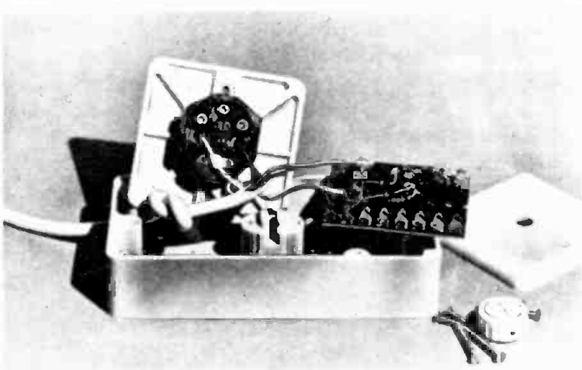
Mains input to the unit is from a 13 or 15 amp fused plug connected to a flying lead entering the case through a grommet. The output to the motor is via a standard MK 13A socket that conveniently bolts into the other half of the box.

Once the component board is completed and wired to the socket (Fig. 5) it should be fixed—using countersunk screws—to two of the recessed tapped holes of the box and a standard cover plate is drilled to allow the spindle of the potentiometer to protrude. Screw the cover plate into position using the other two tapped holes and fix an **insulated** knob on to the shaft. **Make sure that no metal parts of the potentiometer can be touched just in case there is an internal short.**

OPERATION

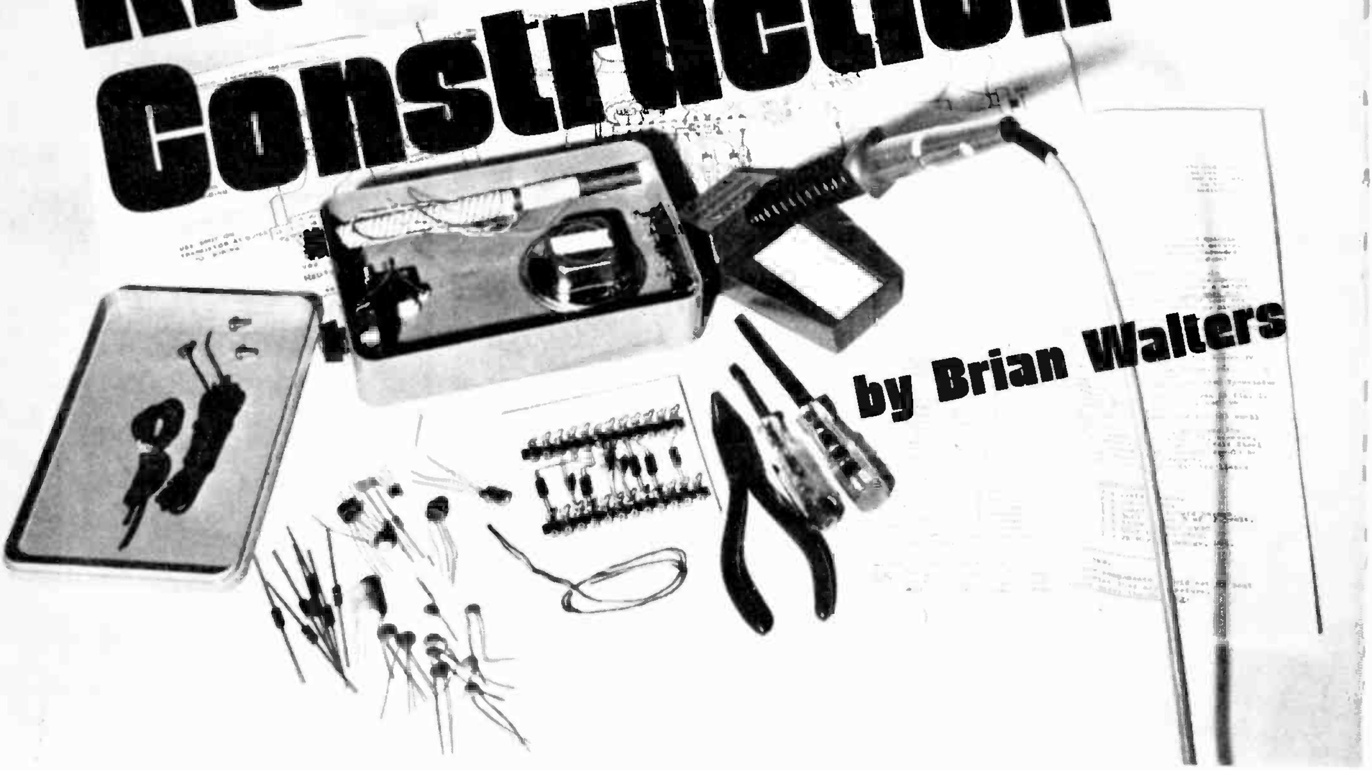
When using the controller with an electric drill it is just as well to remember that, although the drill may be turning at low speed, if the torque applied is high you might be applying more electrical energy than you think and as some drills have a cooling fan coupled with the armature there could be an increase in temperature of the drill itself.

Provided common sense is used this does no more harm than the occasional overload but if you allow overheating to persist without sufficient cooling time you could burn out the armature! ■



Kit Construction

by Brian Walters



Do you envy those fortunate folk who own the last word in test or hi-fi equipment? Do you sometimes wish that you could enjoy the same standard of professionalism in your home? If only it was not so expensive. Well now you can; your equipment may not be to the very highest standards, but price for price it will be of a higher standard than ordinary equipment.

You can do this by taking advantage of the many types of construction kits for radio, hi-fi and electronic equipment that are advertised by many firms and, more particularly, for hi-fi, the v.h.f. radio tuner and record player kits available in many types, prices and sizes.

CONSTRUCTION

It is not necessary for you to have a degree in electronic engineering, or that you should be a specialist in electrical equipment. Many of the kits now on sale are easy to build, both in time and effort, and will provide a great deal of pleasure, both in the building, and in their use afterwards.

Why build a kit? Here are two reasons: firstly, there is a saving in cash, exactly how much will depend on the piece of equipment you intend to build.

If you were to build, say, a high quality record player, while it would not necessarily be cheaper than a commercial record player, it would certainly have a better performance than a comparably priced commercial unit.

Secondly, you could of course build to your own design, but in the first place this assumes that you have the knowledge to design such a unit and, secondly, although you might well end up with a sophisticated design, the finished unit would probably have a distinctly "home made" appearance. Kits do have the considerable advantage of professionally styled appearance, which would otherwise be difficult to achieve at home.

Quite apart from the knowledge that you will have created something that will be acceptable to your family and friends, when the time comes, who would be better qualified to service it than the man (or woman) who built it.

TYPES

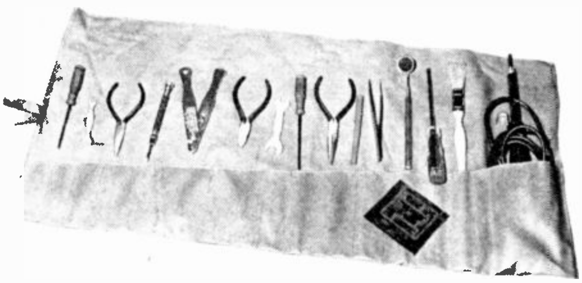
Basically kits come in two types: The "little bits" type, in which, when you open the box,

The heading photograph shows a Transona Five radio kit from Radio Exchange Co., under construction. This type of kit is suitable for a first project.

you find yourself with all the individual components, one at a time, and the obvious assumption that you have enough electrical knowledge to sort them all out for yourself.

Then there are the "big bits" type where, on opening the box, you find yourself the proud possessor of a number of ready wired panels, or modules, which need only be connected together, to make whatever it was you had in mind. This type is very much more simple and quicker to assemble.

These are the two fundamental types, and which one you decide to buy would depend on your present knowledge, and/or whether you wish to learn as you build. Some kits, especially some of the "little bits" types are very instructive, while the others enable you to put the equipment together in the shortest possible time, and with the least chance of errors in assembly.



The very comprehensive tool kit sold by Heath (Gloucester) Ltd. This firm market "Heathkit" kits.

TOOLS

It will be necessary for you to have some small hand tools, which should include, a small electric soldering iron, of about 25 watts with a 3/16 inch diameter bit, a pair of small wire cutters, a pair of small tapered nosed pliers, and one or two screwdrivers. Most of which with the possible exception of the soldering iron, you probably own already.

A multimeter is not absolutely essential, but it is highly desirable. This piece of equipment is moderately expensive (about £8 for a reasonable meter), but with care, should last for years. It would justify itself during its lifetime, merely on the strength of the many checking jobs it would simplify.

SOLDERING

Do not be afraid of that soldering iron. Soldering is not the exact science that it is sometimes made out to be, and with modern resin cored solder and the correct iron, for the type of work you would have to do, nothing could be simpler, providing you use a little care and common sense.

When making soldered joints, there are three golden rules. First, make sure that the two pieces of material you wish to solder together are clean. That is, free from grease and free from insulation material like wax, enamel or any form of plastic. The second rule is **never ever** use any solder or flux on any electronic equipment except the resin cored type specifically sold for the purpose.

Thirdly, put the solder on to the joint, and **not** on to the iron. Allow the solder to flow around the joint, but be very careful not to overheat the components you are soldering.

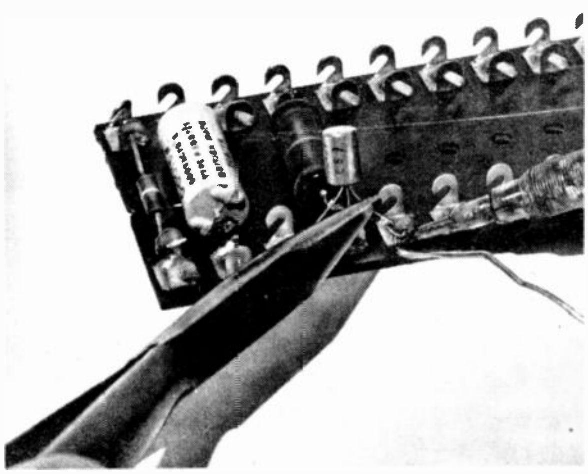
It is better to use a hot iron "quickly," than a cooler iron which must be held onto the joint for a longer time, thus allowing the heat to travel along the wire to the component, which may become almost as hot as the solder and be permanently damaged. This is **very** important with transistors.

It would be a good idea, if necessary, to practice making soldered joints with odd lengths of wire, before you start assembly of your kit.

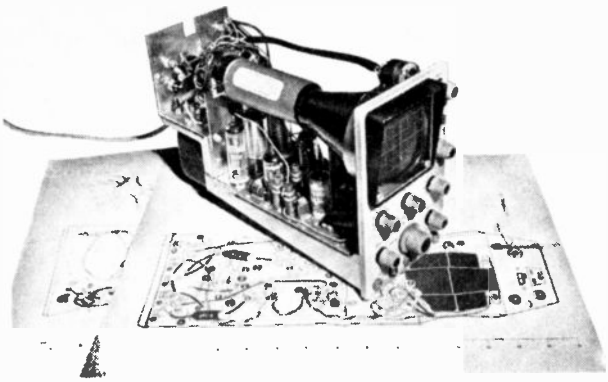
HEAT SHUNT

Using a "heat shunt," your long nosed pliers, held on the component lead between the component and the soldering iron, to keep the heat away from the comparatively fragile component, will save a lot of worry. A heat shunt should always be used when soldering transistors.

When completed, the soldered joint should be bright and shiny, and not crystalline as it would be if you moved the two parts before the solder has had time to cool and set. The photograph shows how to use a heat shunt and a good finished joint.



Photograph showing how to use a pair of pliers as a heat sink for soldering transistors.



A rather more ambitious kit, the Heathkit service oscilloscope. A large saving can be made by constructing your own test equipment of this type.

HIGH VOLTAGE

It is as well at this stage, to realise that there is **some element of danger** in most electrical or electronic equipment; if you are worried about building mains powered equipment, then all is not lost. There are still the transistor radio kits for you to build.

These transistor radios often provide added facilities not found on commercial types and are in every sense portable, as well as being free of high voltages. One of the many small radio kits available would make a good first project to get you used to the techniques.

COST

There would seem at first sight to be a very large difference in the cost of kits from the various manufacturers. The reason for this apparent difference can often be seen in the manuals provided with the kits.

Some manufacturers supply a very comprehensive book, which will provide all the information you could possibly need, both in the theory and the practice of building their kit. This applies particularly to the "little bits" kits, although there are some kits which are obviously intended for those who have already a working knowledge of electronics, and thus have only a limited amount of information.

The module type kit will generally provide a book or data sheet that will tell you what is required to connect up the separate panels, and a few do give a basic description of how the equipment works, but not a full description of the theory.

So, before you buy, ask to see the manual, and see if you can understand what is expected of you. You do not have to understand how the equipment functions, but you must understand how to put the parts together. Generally, the more expensive kits have the more informative manuals.

AFTER SALES SERVICE

Some suppliers provide a repair service for their customers, but if you can understand what is needed you should not need their help, with a consequent saving in time, effort and money. You will also get greater enjoyment from having built the equipment unaided. Nevertheless, check that your kit could be repaired by the supplier, should you have trouble.

It would be advisable, if you have never built any electronic equipment before, to start with a small kit, as previously indicated. The confidence you will obtain, plus the experience, will stand you in good stead if and when you want to build something more ambitious. But whatever you do, do not rush the job.

UNENDING

There is one snag; the process seems to be never ending, when you have improved your record player, you will feel that you ought to bring your radio up to the same standard, and then your loudspeaker system up to a quality that will do justice to the equipment you have already built. Or you might wish to construct some test equipment for your workshop, the possibilities are endless.

You can spread the cost, and for that matter the time, over as long a period as you wish.

Finally, comes the compensation for all your effort, when you have built it, whatever it may be, and your friends show their interest, you will have the satisfaction of telling them not where you bought it, but who built it. ■

The Radio and TV Components Unisound stereo record player. This kit is of the module type which can be assembled in a relatively short time.

SHOP TALK

By Mike Kenward

SINCE we seem to have more than enough news of suppliers and new products this month we will quickly get down to buying problems for the constructional projects and then look at the news. There is just one point that has come to light from last months articles; the 0·5 μF tantalum capacitor specified for the *Shaver Inverter* is not readily available. A 0·47 μF type can be used and it does not in fact have to be tantalum.

Through The Lens Light Meter

Although the *Through The Lens Light Meter* is very simple to build, when properly calibrated and used it could prove invaluable. One important factor in the construction of this unit is the camera design and how it affects the layout of components in the case.

The case used for the prototype was originally a clear plastic box with hinged lid but any small box will do and some of the slide boxes supplied by film developing firms may be suitable.

Buying problems should be limited to the microswitch and the meter. Although there are many microswitches available a small one must be found if the case size is to be kept small. Different shops sell different types and if you want a small one unfortunately you will just have to look around until you find one —the current and voltage rating are not important in this design.

The meter is of course the most expensive part of this unit and will probably cost about £2. One of the SEW MR38P, 100μA types will be suitable. However, if you can find a small 100μA meter (moving coil type) cheaper, then this would be suitable. The scale will have to be recalibrated so do not worry about how it is designated when you buy it.

Drill Speed Controller

No problems with buying for the *Drill Speed Controller*, the case can be obtained from most electrical suppliers as can the socket and blank panel used, if the supplier does not have these items he should be able to order them for you. It is worth noting that all the MK parts can either be obtained in white or cream and a better appearance will result if you get all one colour. Fixing screws should be supplied with the socket and cover plate.

The CSR (thyristor) used can be any 400V, 3A type if the CRS3/40 is not available. Just in case anyone is wondering, this unit is **not** suitable for use as a light dimmer but we may publish such a design in the future.

Weather Station

Not really any actual problems with buying for the *Weather Station* but a few points that must be noted. Firstly the two pots used for the wind direction vanes, these must be easy to turn, be of such a design that the stops can be removed and be of carbon construction—not wire wound. We have found that the plastic spindle types often fill all these requirements and two of these should be modified as indication in the article.

The motor used for the windspeed section can be any small model makers motor; the method of securing this to the case will vary according to the motor used. The three cup rotor can be fabricated from any suitably shaped items but a kit of all the rotor parts and the two windvanes is available from Kaspex, 16, Seymour Road, Tilbury, Essex RM18 7AP at a cost of 50p, including postage—mail order only.

When buying the moving coil meter look for the cheapest 1mA design with a large scale; this scale will have to be redesignated for each range of the instrument. The case used for housing the monitor unit in the prototype was purchased from G. W. Smiths but we believe a number of other firms can also supply this case.

New Products

For all newcomers to stereo hi-fi reproduction. Linear have announced a low cost amplifier providing 5 watts output (they do not state if this is an r.m.s. or peak figure—or the speaker impedance used), with a frequency **range** of 20Hz, to 20kHz (this is not the same thing as frequency **response**). Price is £17·50 which seems reasonable but we would like to see proper figures quoted, not nondescript ones. Linear give a 12 month inclusive guarantee—more literature from your local dealer or Linear Products Ltd., Electron Works, Armley, Leeds, LS12 3SA.

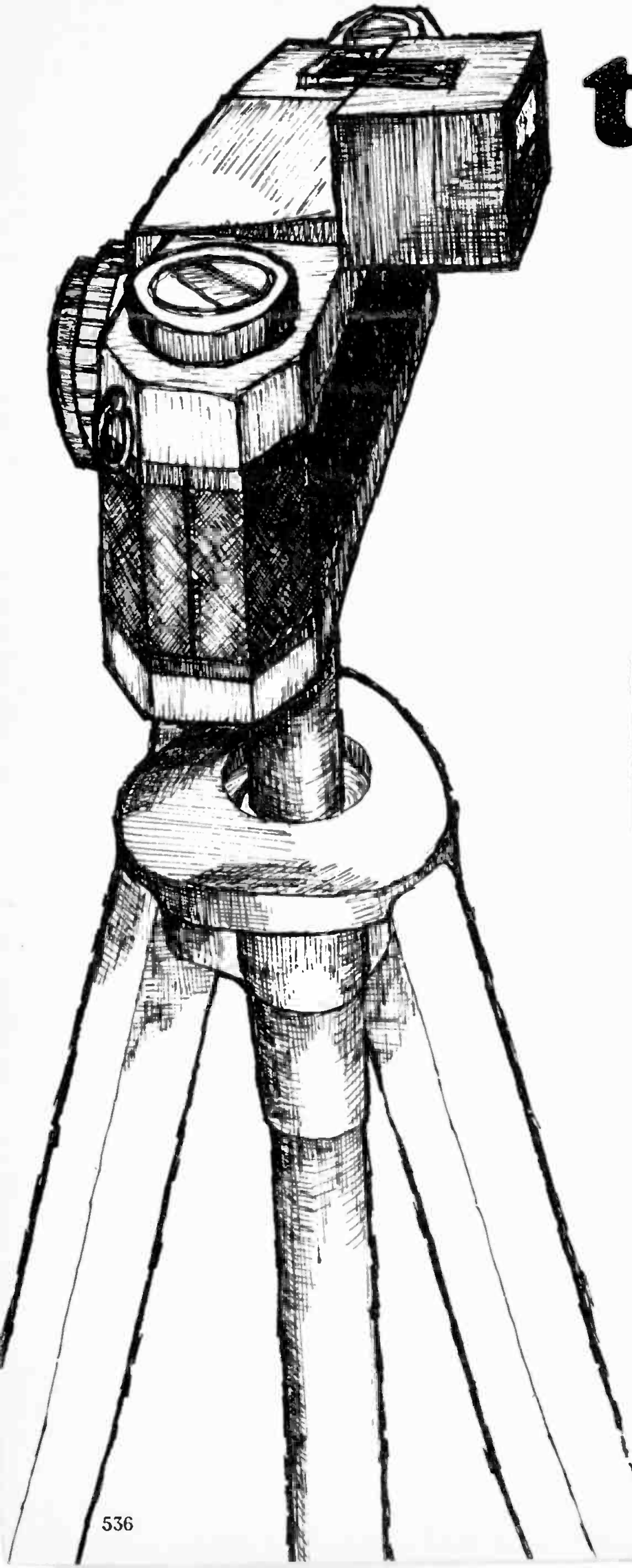
A 12V Invader soldering iron has recently been introduced by Adcola products, who advertise in our pages. Designed to operate from a 12V car or boat battery, the iron is available in two sizes, 3/16 and 1/4 inch bit diameter, rated at 23 and 27 watts respectively. The iron is provided with crocodile clip connections, 12ft of lead and a fire resistant transit cover which fits over the element and bit, allowing the iron to be stored away without having to wait for it to cool down. The 3/16 inch bit model costs £2·37 and the 1/4 inch model £2·47.

Suppliers

Two news items concerning suppliers, the first, which is of general interest, is that G. W. Smiths and the Laskys group have merged. These are probably the two largest companies retailing hi-fi equipment and electronic components. It has been stressed by the officials of Audiotronic Holdings Ltd., a new company formed to amalgamate the two companies, that there will be no change in trading policy or shop names etc. A possibility arising from the merger is the opening of a new shop somewhere outside the London area, but this may be well into the future.

Of more direct interest to readers is the opening of a new shop by Henry's Radio Ltd. at 404-406, Edgware Road, London, W.2. This new branch should have been open a few weeks when you read this; it will carry mainly components plus audio equipment and test gear.

through



A simple light meter for use with single lens reflex cameras.

By E. B. Eves

Approximate cost of components £2·75 plus case

WITH the dramatic fall in price which has taken place over the last few years many more people own single lens reflex cameras than would have seemed likely even five years ago. As most of these cameras are fitted with interchangeable lens systems there is a much greater scope for using a camera for "unusual" photography, employing the use of extension tubes or telephoto lenses.

Many people use their cameras as an extension to another hobby. In this connection bird watching and other naturalist pastimes come to mind in conjunction with a camera and telephoto lens, while many collectors of small items such as stamps and coins, make use of extension tubes to take close-up pictures of their specimen pieces.

The main problem which arises in both these cases is that of finding the correct exposure. The technique of taking several exposures is suitable if cheap film is being used but becomes rather expensive if colour or special films are employed. The meter described below overcomes this problem, although it is only really suitable if the camera is being used on a tripod, as the viewfinder has to be obscured while the meter is in use.

the lens light meter

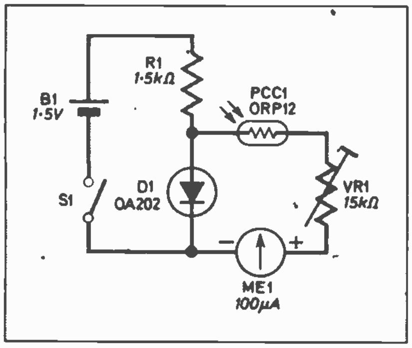


Fig. 1. Complete circuit diagram of the Through The Lens Light Meter.

THE CIRCUIT

The circuit is a simple one using a photo conductive cell, a meter, a silicon diode, a battery and two resistors, one fixed and one variable. The circuit is shown in Fig. 1.

To describe the action of this simple circuit let us assume that it is in two parts, the first consisting of B1, S1, R1 and D1. It will be seen that with S1 closed, current will flow around the circuit since D1 is forward biased. In this condition the diode, which is a silicon type, will always have a voltage of approximately 0·6 volts across it.

It is this small voltage that is measured by the second part of the circuit which is a low range voltmeter formed by PCC1, VR1 and ME1. Once VR1 is set the voltmeter will read a value dependent on the resistance of PCC1; the voltage being measured is always steady at 0·6 volts. Since the resistance of PCC1 varies in proportion to the level of light falling on its surface ME1 will, in fact, indicate the light level.

THE CASE

The construction of the case depends on the type of camera to which the device is to be fitted. The case shown in Fig. 2 was designed to fit a camera where the accessory shoe is mounted directly above the eyepiece.

The only requirement is that when clipped into the shoe the grommet surrounding PCC1 must be centred against the view-finder. The micro-switch S1 is depressed by the pressure against the camera and "automatically" switches the circuit on. The case used can be any plastic or metal case of minimum dimensions 2 inches by $1\frac{3}{4}$ inches by $1\frac{3}{4}$ inches but this size will depend on the meter available.

CONSTRUCTION

The components can be mounted as shown in Fig. 2. The photo-conductive cell must be provided with sufficient lead length to allow it to be positioned as described above.

Start construction by mounting S1, PCC1, ME1 and B1 inside the case. B1 can be mounted by a small Terry clip with a flat brass connector at each end, held in place with foam rubber glued to the side of the case.

Next attatch R1 and VR1 as shown, connect up S1 and PCC1 and finally solder in diode D1 using a pair of long nose pliers held on the wires to prevent heat from the soldering iron damaging the diode.

COMPONENTS

The photo-conductive cell PCC1 is an ORP 12 or similar type. The meter can be any small inexpensive 100μA moving coil type. The front of the meter is removed to allow a paper scale to be fitted over the existing one.

Alternatively if some care is taken a slot can be cut in the upper edge of the front cover, when it is removed, using a hot sharp knife blade and finishing with fine sand paper, in such a way that a very thin piece of aluminium, sprayed with white paint and calibrated (on both sides if required), can be slid in over the top of the existing scale and beneath the pointer of the meter, Fig. 3. By this means scales calibrated for different film speeds may be prepared and fitted easily. The method of calibration will be described later in the text.

The variable resistor should be a 15 kilohm carbon skeleton preset type mounted in such a way that it can be set by means of a screwdriver.

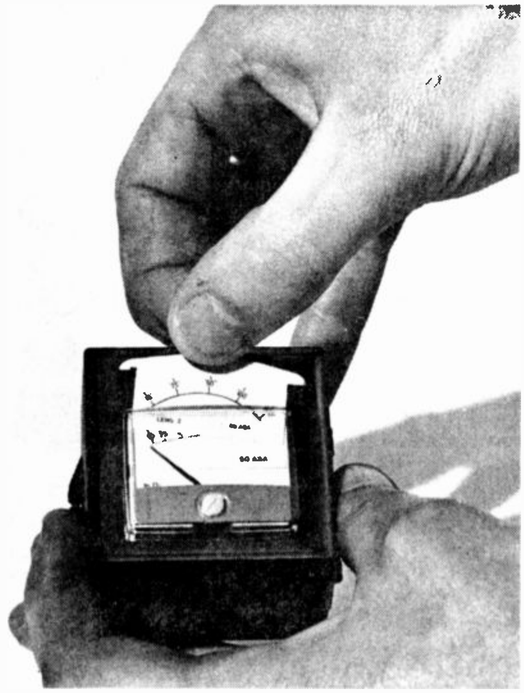


Fig. 3. Method of inserting various scales in the meter movement.

SETTING UP AND CALIBRATING

When the circuit has been wired up and checked the photocell should be pointed into a fairly dark corner and the micro-switch pressed. The meter should give a reading and moving the unit about should change this reading as the light level changes. If this is not the case the circuit should be re-checked. The light meter may now be mounted on the camera which should be set on a tripod with the normal lens fitted, pointing at a plain white surface.

The camera need not be focused, indeed, if the surface is not uniform the camera being out of focus as far as possible would be an advantage. The white surface should be illuminated, preferably by normal daylight. The meter will give a reading dependent on the light level.

An ordinary light meter is used to determine the light level from the surface at the camera. The camera is then set up using this reading. at $^1/_{100}$ of a second, for the film normally used.

The needle on the light meter is set to centre scale by means of the resistor VR1. The point at which the needle rests must be marked $^1/_{100}$. If the aperture is now opened by exactly one stop the needle will move, its new position should be marked $^1/_{200}$, if closed to one stop below the original the scale must be marked $^1/_{50}$. This is repeated at one stop intervals until a scale as shown in the photograph is obtained.

The scale is now calibrated for the chosen film speed, other scales may be made by setting the camera to a chosen aperture and marking the scale with the corresponding shutter speed, the variable resistor must not be altered after the initial calibration, and can be sealed with a spot of candle wax dropped, hot, onto the centre of the preset.

If two film speeds are normally used the scales for them may be marked on one scale.

USING THE METER

When the meter has been completed an easy check can be carried out to see if the calibration is correct. The camera is mounted on a tripod with the normal lens fitted and a meter reading of the exposure required is taken by means of a normal light meter. The meter described above is then fixed to the camera and the aperture adjusted until each speed in turn is reached. The corresponding aperture should coincide with the required exposure as found by the other meter.

In general, to use the through the lens meter a shutter speed is selected, the camera focused on the subject and the aperture adjusted until the needle rests on the selected shutter speed ■

Components.... SEE SHOP TALK

Resistor

R1	1·5kΩ	¼W ± 10% carbon

Variable Resistor

VR1	15kΩ	skeleton preset

Diode

D1	OA 202 or any small silicon diode

Miscellaneous

PCC1	ORP 12 photo-conductive cell
ME1	100μA moving coil meter, small type
B1	1·5V HP7 battery
S1	S.p.s.t. miniature micro-switch or small push button

Case (see text), grommet to hold PCC1, wire, metal for battery connectors and mounting bracket, fixings for mounting bracket, small Terry clip

through the lens light meter

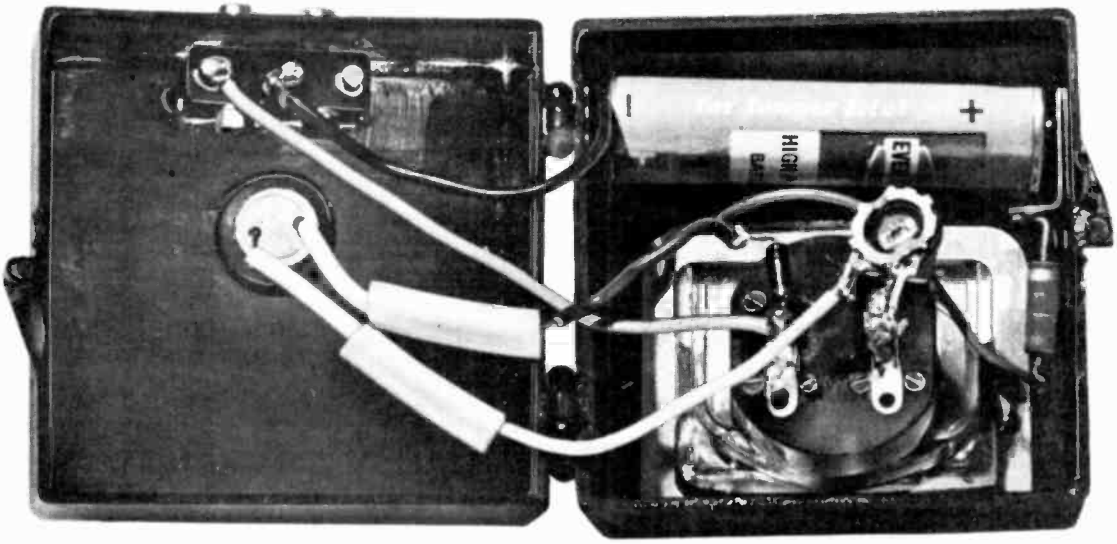
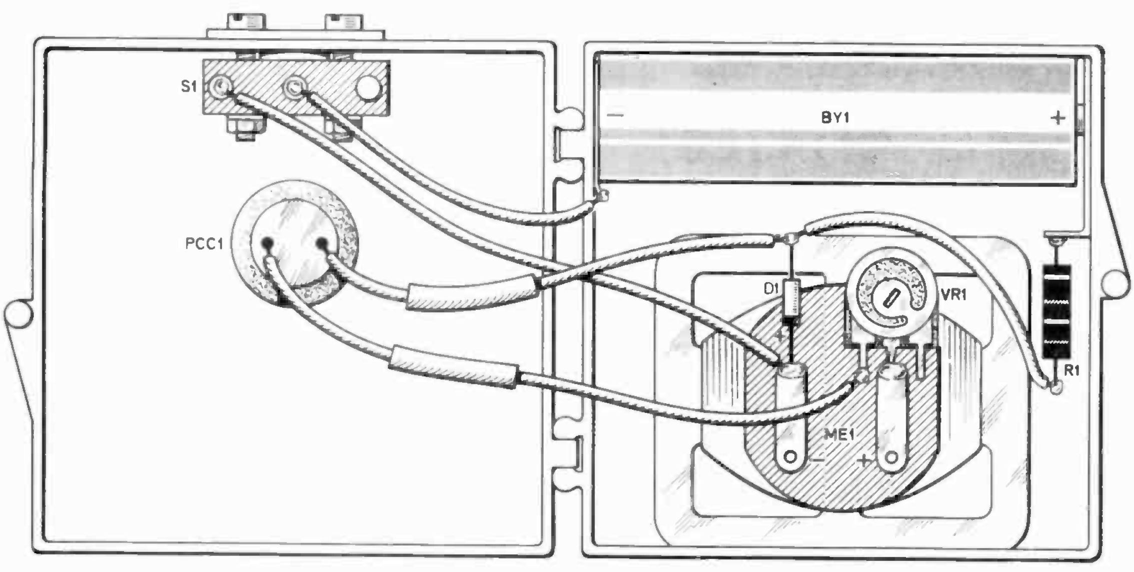
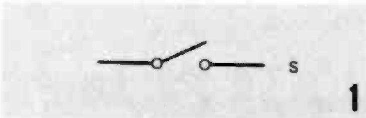


Fig. 2. Complete construction and wiring details of the Through The Lens Light Meter.

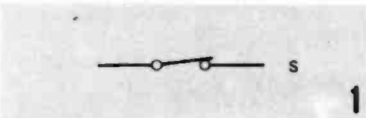


guide to circuit

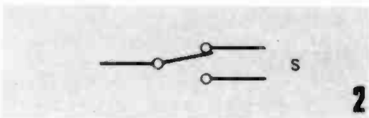
Switches



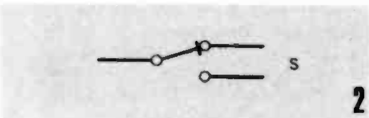
Single pole single throw make contact



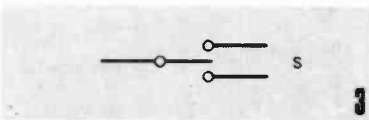
Single pole single throw break contact



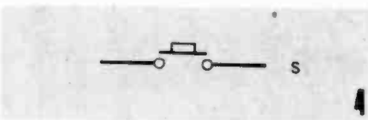
Single pole double throw change-over break before make



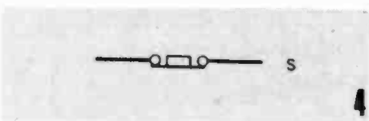
Single pole double throw change-over make before break



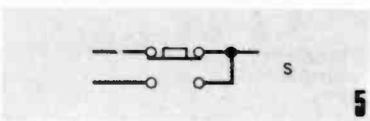
Single pole double throw centre off



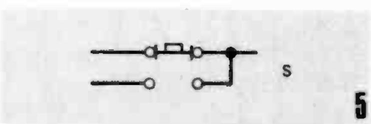
Single pole push to make contact



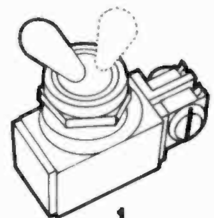
Single pole push to break contact



Single pole push button change-over break before make



Single pole push button change-over make before break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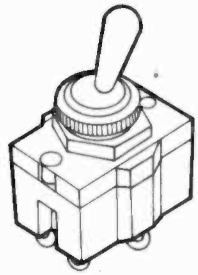
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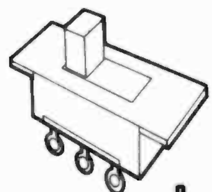
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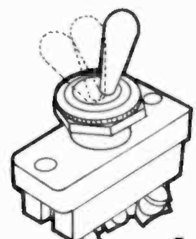
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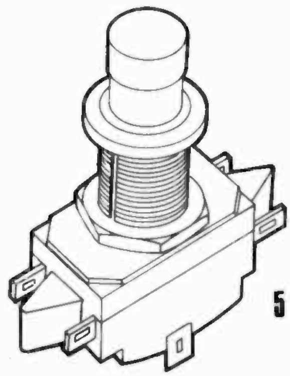
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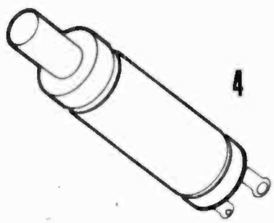
symbols . . . part 3



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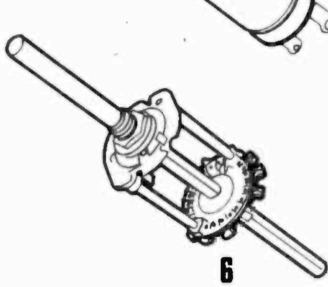

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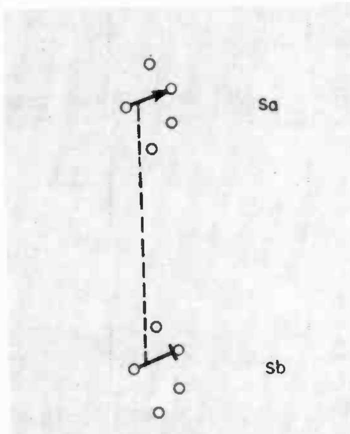

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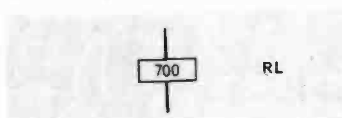
Double pole multi-way switch (usually rotary). Having one break before make pole and one make before break pole. Each pole has a suffix letter after the switch number. The dotted line indicates that two or more poles are operated simultaneously

Relays



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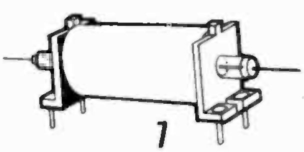
Relay coil with resistance indicated in ohms. Relay coils are annotated RLA, RLB, etc. The number of contact sets operated by the coil is shown under the coil annotation e.g. $\frac{\text{RLB}}{5}$



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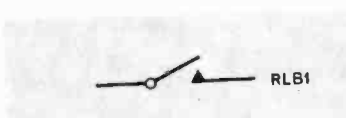

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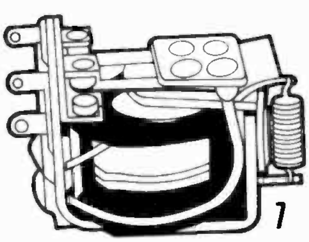
Make contact



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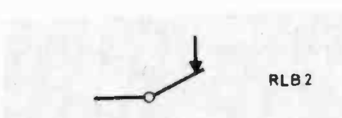

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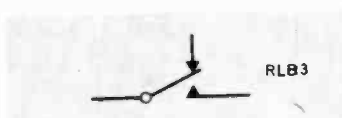
Break contact



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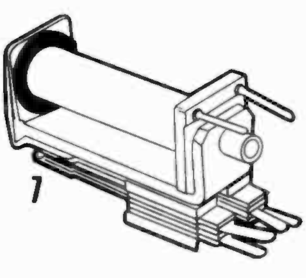
Changeover break before make contact



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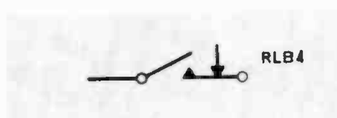

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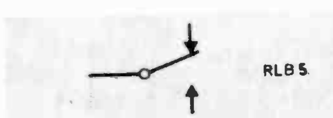
Changeover make before break contact



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Changeover, both sides stable—no normal rest position.

ELECTRONIC CIRCUITS–
.....IN THEORY and PRACTICE

TEACH-IN

...FOR BEGINNERS

By Mike Hughes M.A.

10 REACTANCE & INDUCTANCE

THIS month we'll begin with an experiment to illustrate **a.c. resistance.** You will need a reasonably high resistance a.c. voltmeter. This is to show that although a capacitor will block the flow of direct current, alternating current appears to flow.

Make the circuit of Fig. 1 and measure the r.m.s. a.c. voltages at points A and B. You should find that (making allowances for experimental error and component tolerances) that the a.c. potential at point B is approximately half that at point A. This means that current must be flowing "through" C1 otherwise the potential at B would be the same as at A.

As the potential we measure is approximately half the supply voltage, this means that the resistance of C1 to the flow of current must be approximately half the total resistance of R1 and C1 in series.

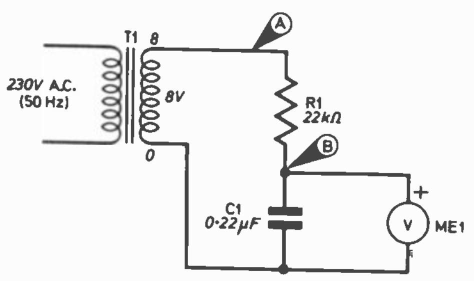


Fig. 1. Circuit diagram for experiment to illustrate capacitor reactance and impedance. Capacitor C1 must not be an electrolytic. Try different values of C1.

AC RESISTANCE

Resistance to a.c. by a capacitor is not a simple thing like that of a normal fixed resistor, because it will vary with frequency. Its effect is very similar and hence we measure it in ohms, but, we also have to state at what frequency we are quoting the value.

To distinguish it from conventional resistance we call this effect of the capacitor, "reactance" and it can be fairly easily calculated for a given value of capacitance at a certain frequency from the following expression:

$$\text{Reactance of capacitor } X_c, = \frac{1}{2\pi \times f \times C}$$

Where X_c is in ohms, π is the constant 3·142, f is the frequency in Hz and C is the value of the capacitor in farads.

Thus we can calculate the reactance of our 0·22μF capacitor at 50Hz:

$$X_c = \frac{1}{2\pi \times 50 \times 0{\cdot}00000022}$$
$$= \text{approx } 14{,}000 \text{ ohms or } 14 \text{ kilohm}$$

We therefore say that the reactance of a 0·22μF capacitor at 50Hz is approximately 14 kilohms.

Do you notice, though, that this is much less than half the total resistance of R1 and X_c added together. When dealing with capacitors and resistors in series we cannot simply add resistance to reactance to obtain what you might call the total resistance. We have to do it in a much more roundabout fashion and the end result (although still measured in ohms) is called the "impedance" and is usually given the symbol Z.

For a single resistor and single capacitor in series the impedance Z is calculated as

$$\text{Impedance, } Z = \sqrt{(R^2 + X_c^2)}$$

where Z, R and X_c are measured in ohms.

This means that the impedance Z of our circuit is:

$$= \sqrt{(22{,}000 \times 22{,}000 + 14{,}000 \times 14{,}000)}$$
$$= \sqrt{(484{,}000{,}000 + 196{,}000{,}000)}$$
$$= \sqrt{680{,}000{,}000}$$
$$= \text{approximately } 26{,}000 \text{ ohms or } 26 \text{ kilohm}$$

You can now see that the reactance of our capacitor is just over half the total impedance of the circuit and this is why the r.m.s. voltage we measured at point B was approximately half the supply voltage.

FERRITE TRANSFORMER

Last month we saw that when we connected a d.c. source of current across the primary side of a transformer, we got a momentary voltage generated across the secondary. We must now look at this a little closer and see which way the current in the secondary flows when the primary is connected a given way round.

It is a little difficult to do this with the Friedland transformer because it is not obvious which way the turns go round the core. To simplify matters it is best if we make a very crude transformer for ourselves.

For this you will need about 6 inches of 3/8 inch diameter ferrite aerial rod and some 28 or 30 swg enamelled copper wire (a 2oz reel of this will be ample).

CONSTRUCTION

Anchor the free end of the copper wire to the ferrite rod with Sellotape—leaving about 6 inches flying for later connections—and wind 200 turns of wire over a length of about 1 inch. The turns can be wound on top of each other. When you have done this anchor the last turn in place and cut the wire—again leaving about 6 inches free.

Leave a gap of about 1/2 inch and wind an identical coil on the same rod adjacent to the first but make sure that the turns go round the rod **exactly** the same way as before, see Fig 2(a). We now have a simple transformer with a turns ratio of 1:1. **We must hasten to add that this assembly is only applicable to our experiment and you should not use this technique for making a power or mains transformer!**

Fig. 2(b) is the schematic of this transformer; notice the black spots at one end of each of the windings. These denote the wires leading into the "start" of each coil (i.e. the wires you anchored to the ferrite rod as you started to wind each coil). It is most important in this

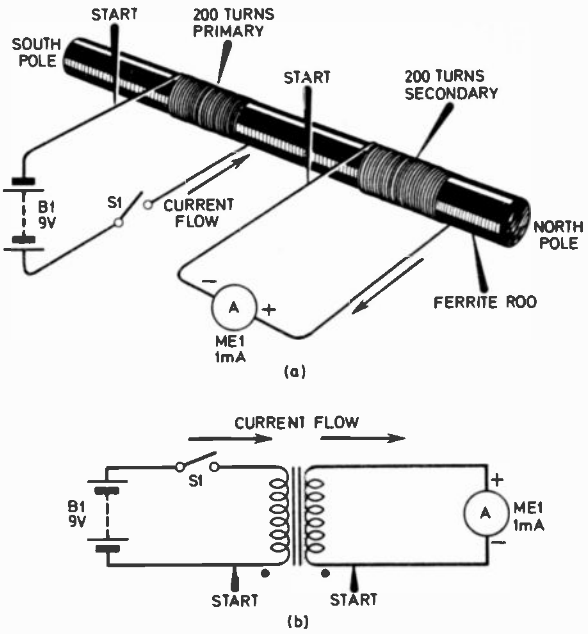


Fig. 2(a). The experimental transformer wound on six inches of ferrite aerial rod. (b) Shows the schematic diagram with designations for the start of each winding. Arrows show direction of current flow when the circuit is "made". The current through the secondary reverses when the primary circuit is broken.

experiment that you can recognise these leads.

Before proceeding further you must remove the insulating enamel from the four ends. This can be done by scraping gently with a razor blade or rubbing with fine emery cloth.

Now decide which of the two coils you will call the primary and which the secondary, and then connect the secondary across the 1mA meter on the Demo Deck with the **start** end going to the **negative** terminal. The negative terminal of a 9V battery should be connected to the start of the primary.

When you complete the primary circuit, by connecting up the positive terminal of the battery, watch the meter very carefully. You will see a very small kick in a positive direction which very rapidly falls back to zero. Now disconnect the battery and you get a slight "kick" in the negative direction—just as we had last month only the "kicks" are not so strong.

INDUCTION—MUTUAL INDUCTANCE

Now we know the sense of the windings we can see that a change in current flowing one way round the core in the primary gives rise to a build up of magnetisation of the core (for the direction of current flow we are considering the north pole of the magnet is as shown in

Fig. 2) which in turn causes a momentary current to flow in the secondary—but in the opposite direction around the core. This effect is called "induction".

We say that the "signal" in the secondary is "induced" by the change of current in the primary. If the secondary coil was connected to a very fast reading voltmeter and we were able to control the rate of build up of the primary current, you would see that the output voltage was proportional to the rate of change of primary current.

Secondary voltage, $V = M \times$ Rate at which primary current changes

V is measured in volts, the primary rate of change in amperes per second, and M is a constant of proportionality set by the numbers of turns on each coil, the distance between the coils, the dimensions of the coils and the magnetic properties of the core.

We call the constant, M, the "mutual inductance" (between the two coils in question). This is measured in units called henries (abbreviation "H") and frequently we come across mH (millihenries) and μH (microhenries).

One henry is the mutual inductance which will cause an output voltage of **one volt** when the primary current changes at the rate of **one ampere per second.**

SELF INDUCTANCE

Now imagine a single turn on the primary and a single turn (having the same winding sense) on the secondary—Fig. 3.

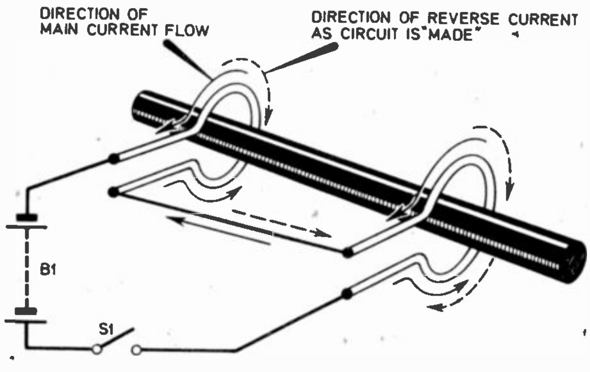


Fig. 3. The main current from the battery through the first turn induces a reverse current in the second turn as the circuit is "made". This resists the build-up of the main current, this effect is called reactance. The influence of the turns on each other is called self inductance.

Let us connect the first turn to the second turn (exactly as if we had wound on two adjacent turns) and pass a current through both. The change in current through the first will still induce a reverse current in the second and this induced current will oppose the flow of the original current—because the two turns are connected in series.

This means that as we try to generate a fast change of current the inductance between the two turns will try to oppose it; this slows up the rate at which our "primary" current can build up. In effect the two turns work together to resist the flow of current—especially if we try to make the current change fast. The faster the change in current we apply the stronger will be the opposing current and hence this resistance.

This obviously is not a simple sort of resistance because it is generated by the "self induction" between the two turns and has nothing directly to do with the material from which the wire is made.

As with capacitors rates of change affect the degree of this resistance and hence we call the effect reactance. It is still measured in ohms with a symbol X_L. To differentiate between mutual and self inductance we designate the term L to the latter. It is still measured in units, or fractions, of henries and is dependent on the number of turns, their spacing, diameter, and the properties of the core. The higher the self inductance the greater the reactance of the coil for a given rate of change of current.

An inductance may have a very low resistance to direct current, but if we try to pass alternating current its resistance increases—we call this form of resistance "reactance" and this increases with frequency.

We can calculate the reactance of a coil if we know its inductance from the following expression

$$X_L = 2\pi f L$$

where X_L is the reactance measured in ohms, π is our old friend 3·142, f is the frequency at which we want to know the reactance, and L is the inductance in henries.

If we have an inductor in series with a resistor in a circuit we **cannot** simply **add** the value of the resistor to the reactance of the inductor to obtain the total resistance to a.c. current flow. As with the capacitor, we have to calculate the impedance. The formula is very similar:

$$Z \text{ (impedance)} = \sqrt{(R^2 + X_L^2)}$$

SERIES AND PARALLEL

If you have several inductors in series (provided they are physically far enough apart to prevent mutual inductance) you can simply add the values of inductance together to find the total effect:

$$L_{total} = L_1 + L_2 + L_3 + \ldots +$$

For inductors in parallel

$$\frac{1}{L_{total}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots +$$

HIGH VOLTAGE

If we have a large inductor in transistor circuits that switch currents on and off very fast we can sometimes have a problem.

If you pass a reasonably heavy current through an inductor and then break the circuit very quickly, the energy that is stored within the magnetised core will fall and while doing so will try and generate a reverse current; but as the circuit is broken the current cannot flow anywhere and we can momentarily generate a very high voltage across the ends of the inductor.

We can do a simple experiment to demonstrate this. You will need the Friedland bell transformer a 9V battery and a 60 to 70V neon bulb (it should be a "bare" neon and not the type with a built in resistor as used for panel indicators).

Connect the neon across the primary (mains) side of the bell transformer and then connect the battery up across the same terminals—do not connect anything to the secondary, see Fig. 4.

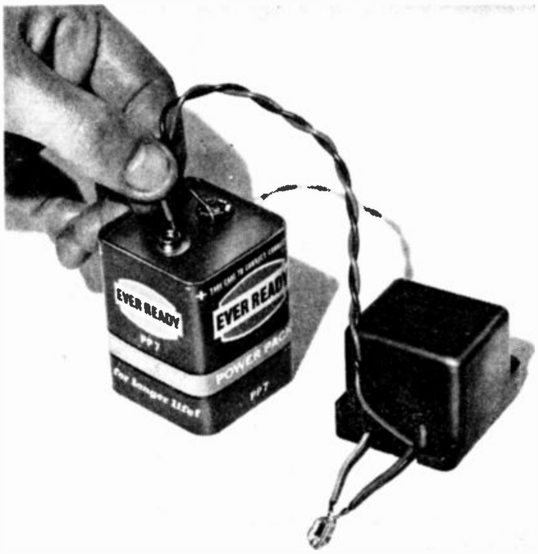


Fig. 4. Experiment to show that a momentary high voltage can be developed across the terminals of a high value inductor when the current suddenly stops flowing.

The neon does not light up because we are only supplying 9V to the circuit and the bulb needs at least 60/70V across it before it will glow. Now quickly disconnect one terminal of the battery and watch the bulb, but **do not hold the bare wires**, otherwise you will get a small electric shock; you should see a brief "flash" indicating that for a fraction of a second the voltage across the ends of the transformer primary (our indicator), must have risen to a value greater than 70V.

If you could make and break the circuit very quickly you would see a steady glow from the neon. You can do this by using a buzzer that runs from batteries. Connect the neon directly across the coil and connect the battery.

You should see a steady glow from the bulb indicating the continuing recurrance of the high voltage caused by the inductance of the buzzer's coil and the constant making and breaking of the circuit by the contacts. Incidentally it is this high voltage that causes the sparking across the gap of the contacts.

Sometimes you will see the specification for a switch that says it may only be used to switch d.c. with non-inductive loads. This means that the contacts are not made to withstand the sparking that can be caused.

DIODE SHUNT ACROSS RELAY

Quite often a transistor is used to control the current flowing through the coil of a relay—a typical circuit is shown in Fig. 5.

If the transistor is made to switch off very fast by removing the base current, the potential across the coil will momentarily shoot up to a value much greater than the supply voltage in such a way that the potential at the end connected to the collector of the transistor will go more positive than the positive rail. In severe cases this might momentarily exceed the collector base reverse breakdown voltage and the transistor might be destroyed.

To prevent the collector going any more positive than the positive rail, designers sometimes incorporate a diode across the relay coil. This diode has no effect on the normal working of the circuit but will act as a short circuit to reverse voltages generated across the coil.

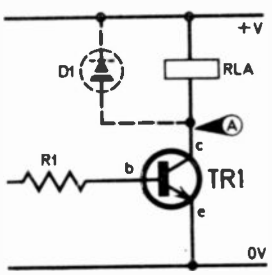


Fig. 5. When a transistor switches off very quickly, the voltage at point A can rise to a positive value much higher than the supply voltage. Sometimes a diode, D1, is connected across the relay coil to "short circuit" this high voltage pulse and thus protect the transistor.

PHASE SHIFT

There is another very important effect which we have not yet covered. This is to do with the fact that we cannot simply add reactance to resistance to find the total effective resistance of a circuit.

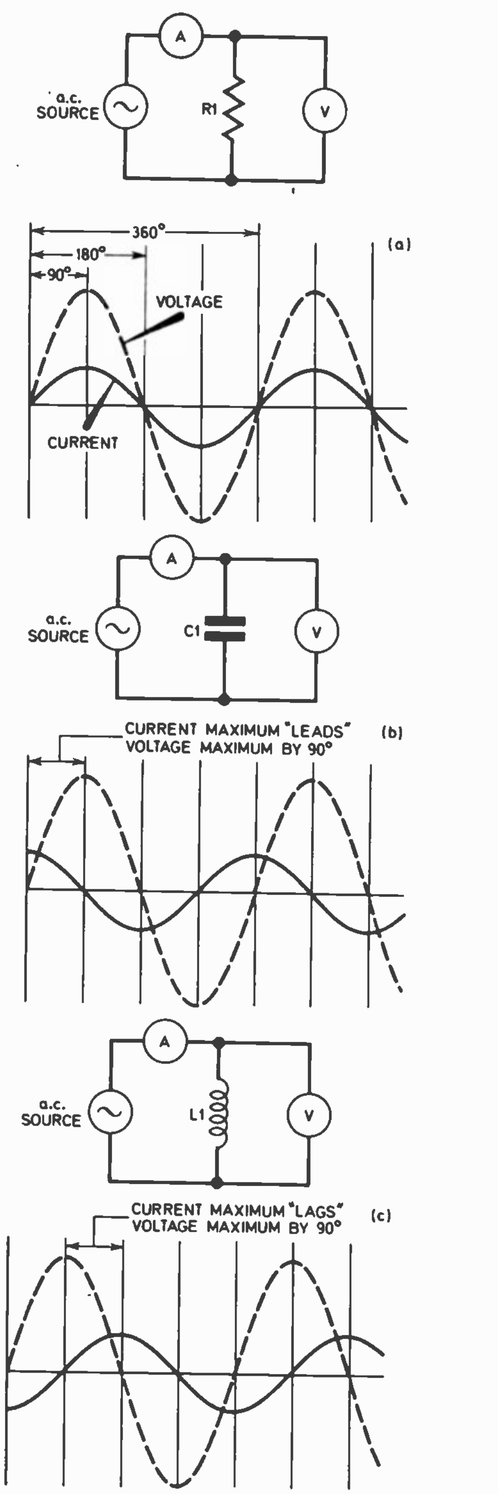


Fig. 6. Voltage and current phase relationships. (a) For a resistor, current and voltage are in phase. (b) For a capacitor, the current flowing "through" it leads the voltage across it by 90 degrees of angle ($\pi/2$). (c) For an inductor, the current flowing through it lags the voltage across it by 90 degrees ($\pi/2$).

In Fig. 6(a), (b), (c) we show a resistor, a capacitor and an inductor respectively connected across a source of a.c. voltage. In the case of the resistor we can say that at any instant in time the current flowing through the resistor is directly proportional to the voltage; i.e. when the voltage is maximum positive the current is maximum positive, when the voltage is zero the current is zero.

This is shown graphically by the superimposed voltage and current waveforms. We say the voltage and current are "in phase".

When the voltage across the capacitor is zero, but rising from negative to positive, most current will be flowing into it, but as the voltage across it reaches maximum (i.e. the capacitor is fully charged in one direction) the charging current falls to zero.

As the voltage falls from maximum positive towards zero, the capacitor in effect discharges and current starts to flow in the opposite direction (i.e. becomes negative).

We can say that as the voltage passes through zero but is rising in a positive direction we get maximum positive current; when the voltage reaches maximum we get zero current and when the voltage passes through zero in a negative direction we get maximum negative current. This means there is a shift in phase between the maximum current and voltage.

The shift is a quarter of a wavelength which is 90 degrees or $\frac{\pi}{2}$ radians. We say by definition that the current "leads" the voltage by 90 degrees.

The male and female approach works here because the opposite happens with an inductor. We get maximum rate of change of current when the current waveform passes through zero. If the current is rising in the positive direction this gives us maximum postive voltage across the inductor. As the current passes through maximum, the rate of change momentarily becomes zero (it stops at the maximum before coming down again) and this gives rise to zero voltage. As soon as the current passes through zero in a negative direction we get maximum negative voltage, and so on. Again there is phase shift between the voltage and current but this time the current "lags" behind the voltage by 90 degrees.

RESISTOR—CAPACITOR—INDUCTOR COMBINATION

The reason why we could not simply add resistance to reactance for a resistor/capacitor or a resistor/inductor circuit was because of the relative phase shifts between voltage and current waveforms. Likewise there is a phase shift between an inductive and a capacitive circuit only more so—180 degrees—so therefore we cannot simply add together the reactance of a capacitor to that of an inductor in series.

Table 1: Comparison of some capacitor and inductor properties

Capacitors	Inductors
A capacitor will not pass d.c.	An inductor passes d.c. easily
A capacitor passes high frequency a.c. easily	An inductor is a very poor conductor of a.c.
The reactance of a capacitor decreases as the frequency increases	The reactance of an inductor increases as frequency increases
Formula for reactance	
$X_c = \frac{1}{2\pi fC}$	$X_L = 2\pi fL$
Series connection	
$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$	$L_{total} = L_1 + L_2 + \ldots$
Parallel connection	
$C_{total} = C_1 + C_2 + \ldots$	$\frac{1}{L_{total}} = \frac{1}{L_1} + \frac{1}{L_2} + \ldots$
High capacitance gives low reactance	High inductance gives high reactance

Strangely enough (and this is difficult to prove without fairly complicated mathematics) we have to subtract the reactance of one from the other.

The formula for calculating total circuit impedance becomes:

$$Z \doteq \sqrt{[R^2 + (X_L - X_c)^2]}$$

Next month: Amplification. Additional components required for next month: microphone insert type ACOS MIC 43-3 or Duvidal CM20; resistors: 3·3 megohm (1 off), 1 megohm (1 off), 330 ohm (1 off).

Ruminations
By Sensor

Summer Is Icumen In

I have just finished a spell of home decorating—three weeks of painting and papering—which has stopped me from completing any of the four electronic construction projects that I have on hand at present. For me, home decorating is a continuous process with long troughs of low level activity and occasional high peaks of short duration. It is one of the latter that has just been completed.

My gardening follows a similar pattern, so that the "seed-time and harvest" of the good husbandman could be more accurately described in my garden as "weed-time and putrefaction". Since I bought an electric lawn mower my schoolboy son mows the lawn regularly and I recommend other fathers to follow my action.

Weeding is a problem to which I have not found an answer, apart from getting down onto one's knees and digging them out or preferably, getting one's wife to do it (and there's nothing novel about that!). I use various weed-killers and find them effective but they have their limitations and bring their own problems.

Back To Work

So; having, as it were, subcontracted most of the gardening, I folded up the pasting table and turned again to the bench. What a mess! Why does my bench gather all the family's rubbish?

The surface was covered with items ranging from eggs (a pullet's first and a goose's), an old blackbird's nest, two strings of beads, seashells, an old teapot, through a variety of household utensils needing attention to a couple of electric motors awaiting assembly. The whole was overlaid with a fine layer of sawdust, acquired during my last session with the circular saw. My own neglected projects were not in evidence—a second layer had built up over them.

Have you noticed that if you leave a job undone long enough the need for it often disappears? Indeed, it can become impossible to carry on with it due to the parts becoming obsolete and unobtainable—and that doesn't take long these days.

Well, then, what is to be done about those unfinished jobs? I think that one must be ruthless; remove from the bench all things not immediately required (put them into the children's bedrooms), select one job that is possible to finish and concentrate on that, do not allow yourself to be persuaded into anything else, be single-minded to the point of selfishness. Set yourself a reasonable time for completion and stick to it.

If you find the method works, let me know, perhaps I'll try it myself!

WEATHER STATION

by D. T. Goodwin B.Sc.

A simple device using basic electronic principles for measuring some basic weather parameters.

How convenient it would be to know the weather details at the push of a button (or the throw of a switch), whilst sitting comfortably at home.

The complete Weather Station is in two parts, that is to say, it is built in two separate cases, one (the transducer case) to be installed outside in an unsheltered unobstructed position, and joined by several wires or multicore cable to the monitoring case located inside the house or laboratory.

CIRCUITS

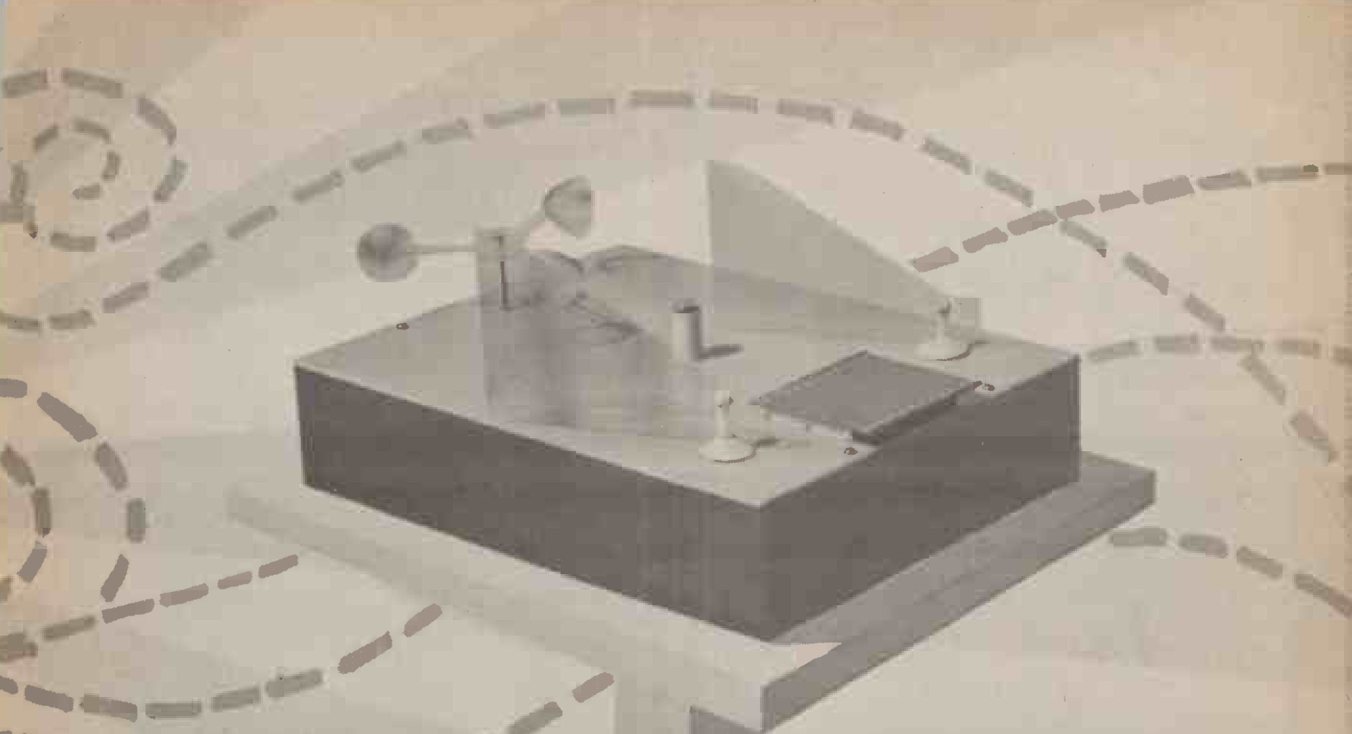
The complete circuit diagram for the Weather Station is given in Fig. 1. It is seen to consist of five separate and independent units wired together around a three-pole-four-way wafer switch S2. These units are: rain indicator, temperature monitor, wind speed and direction indicator, and a light intensity indicator.

In the prototype, with the exception of the rain indicator, the units share the meter ME1 via switch S2 which is used to select the parameter to be measured.

RAIN INDICATOR

The rain indicator circuit has been designed so that when rain or moisture falls on the Veroboard sensor, the lamp LP1 on the control box front panel lights up. The components of the rain indicator consist of TR1 and TR2 directly coupled, R1, R2, LP1 and the Veroboard sensor.

With S1 switched on, and under dry conditions (no moisture on the sensor) the base of TR1 is virtually open circuit i.e. no base current flows.



Under this condition no emitter current flows in TR1, and hence no base current in TR2. Transistor TR2 is thus off—no current flows through the lamp.

When moisture (rain) bridges the sensor, the very high resistance between the adjacent strips of the sensor is greatly reduced and base current flows in TR1, allowing emitter and collector current flow.

This condition allows base current to flow in TR2 thus turning the latter on and illuminating the lamp.

If it is found that the sensitivity of the sensor is too high, it can be reduced by inserting a 5 kilohm preset potentiometer (wired up as a variable resistor) in series with R1; adjust to the required sensitivity.

With no moisture on the sensor, the unit is very economical, current drain from the battery being minimal and due only to the leakage of the transistors.

However, when it is raining, current drain is considerable and for this reason it is advisable to switch S1 off.

If desired, the lamp may be replaced by a suitable relay that can be used to switch on an audible alarm.

TEMPERATURE INDICATOR

Ambient temperature is indicated on ME1 with S2 in position 1.

The unit utilises the variation of resistance with temperature in a device called a thermistor. The type used in the prototype is one whose resistance decreases with increasing temperature. It is used, with R4 to form a potential divider chain.

The Zener diode, D1, together with its series resistor R3, produces 3·3 volts across the transistor and the potential divider chain. This lower voltage helps to reduce the effect of self-heating of the thermistor.

As the temperature increases, the resistance of RTH1 drops and more base current flows in TR3, and therefore, more emitter and collector current flows. The collector current flows through ME1 and can be varied by VR1.

To calibrate the temperature scale, a conventional thermometer is needed (unless it is only coarsely calibrated as in the prototype as "cold" "warm" "hot" and "very hot," by trial and error on days of these descriptions).

If we are only concerned in measuring outdoor temperatures, then 40 degrees Centigrade is a suitable figure to make as our full-scale deflection on ME1 (in the U.K. that is).

Place the conventional thermometer alongside RTH1 on the "transducer box" with S2 in position 2, and bring up a heat source in the vicinity of the thermometer and RTH1 (the bulb of a table lamp is a good source of heat) and adjust VR1 so that the meter reads full scale when the thermometer indicates 40 degrees Centigrade. Mark this position on the meter scale with 40. Repeat this procedure working down in five degree steps.

WIND SPEED

The wind speed is indicated on ME1 with S2 in position 2.

This is quite a straightforward device that uses a small d.c. motor rated at between 3-6 volts as a generator—this was found to be satisfactory in the prototype.

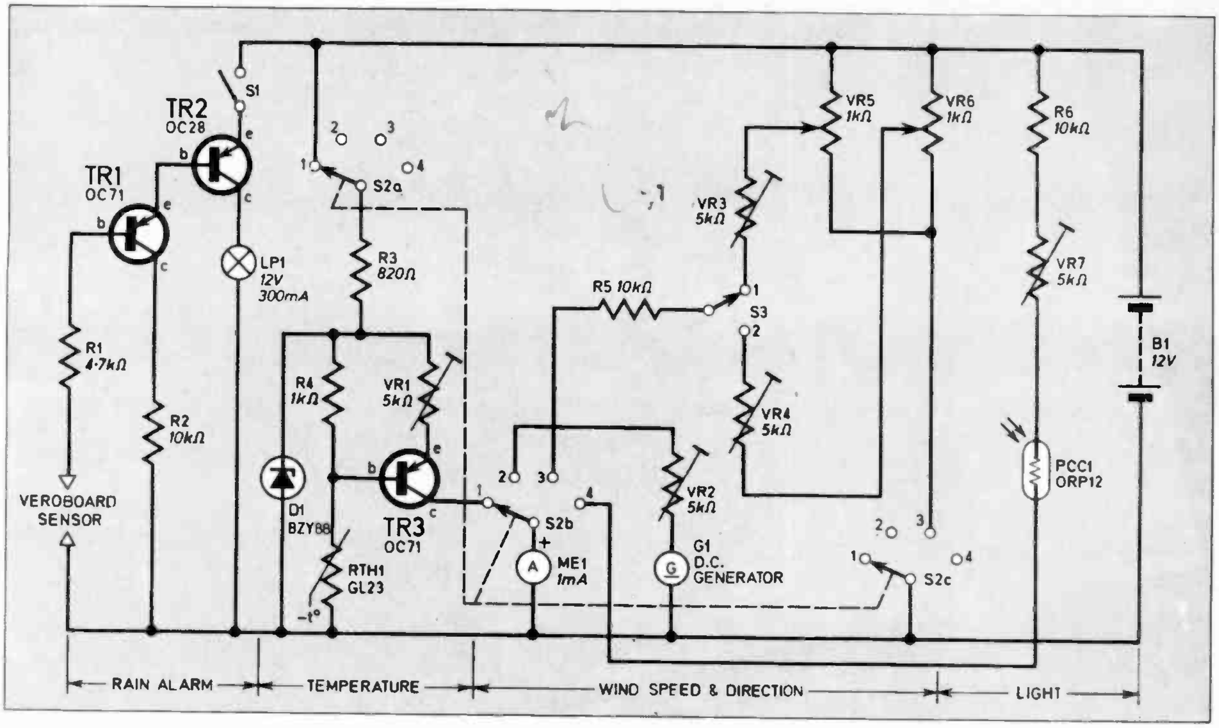


Fig. 1. The complete circuit diagram of the simple Weather Station.

The rotor containing the wind cups is connected to the shaft of the generator, and as the wind carries the cups round, a current is generated which passes through the meter via VR2.

The variable resistor VR2 controls the current flowing into the meter and should be adjusted such that when the rotor is spinning at maximum wind velocity the current flowing is 1mA.

The meter scale can be calibrated in several ways: in the prototype it was carried out by experiment on days of different wind strength, i.e. "light," "blowy," "strong," "gale," and the face marked accordingly.

Alternatively, if an accurate method of producing or calculating a wind speed in m.p.h. is known (such as a wind tunnel or mounting on a car and driving at an observed speed on a still day) the scale may be calibrated in m.p.h.

WIND DIRECTION

Wind direction is indicated on ME1 with S2 in position 3.

The combination of R5 with each of VR3 and VR4 in series with the meter converts ME1 to a voltmeter than can be adjusted (by means of VR3 and VR4) to read 10-15V full scale.

The full battery supply of 12V is across VR5 and VR6. Depending on the position of S3, the meter records the voltage at the wiper of VR5 or VR6 relative to the negative line.

The wind direction vanes are connected to the spindles of VR5 and VR6.

Two vanes (with potentiometers) have been used to eliminate the small portion on the potentiometers which will not give a reading when the stops have been removed, see later.

The two potentiometers are mounted in approximate opposite directions to each other. Only one is used at a time, S3 being employed to change from one to the other when one goes into the null region. In fact, it is advisable, for accurate measurements, to switch S3 when the needle is near to either end of the direction indicator scales.

There are two scales, one for each switch position and these should be calibrated as follows; for the upper scale (1), set S3 in position 1, and VR3 to maximum resistance. Position VR5 vane so that ME1 reads a maximum. Adjust VR3 so that this maximum is full scale.

Repeat this for the other vane using VR4 with S3 in position 2. Return S3 to position 1.

Rotate the vane on VR5 so that a small fraction above zero is shown on ME1. Mark this point on the meter face with one of the four compass points, i.e. N, E, S or W—say N for example.

Now turn the vane through 90 degrees clockwise and mark the new needle position E. Rotate a further 90 degrees and mark S. Another 90 degrees rotation gives the W position.

Turn the vane back to the S position.

Switch S3 to position 2, and position VR6 so that the needle lines up with the N position on the upper scale with the vanes in the same

Components....

Resistors
R1 4·7kΩ
R2 10kΩ
R3 820Ω
R4 1kΩ
R5 10kΩ
R6 10kΩ
All ¼ watt ±10%

SEE **SHOP TALK**

Potentiometers
VR1 5kΩ skeleton preset
VR2 5kΩ skeleton preset
VR3 5kΩ skeleton preset
VR4 5kΩ skeleton preset
VR5 1kΩ linear carbon
VR6 1kΩ linear carbon
VR7 5kΩ skeleton preset

Light Dependant Resistor
PCC1 ORP12

Semiconductors
TR1 OC71 germanium *pnp*
TR2 OC28 or AD142 or similar
TR3 OC71 germanium *pnp*
D1 BZY88 C3V3 400mV Zener diode

Thermistor
RTH1 GL23 glass bead type

Switches
S1 S.P.S.T. toggle or slide
S2 Three-pole-four-way wafer
S3 S.P.D.T. toggle or slide

Miscellaneous
ME1 1mA meter
LP1 Lamp 12V 300mA plus panel type holder
G1 Generator 3–6V d.c.—see text
B1 Battery 12V—use PP1 6V (2 off in series)
Veroboard 0·15 inch matrix: control box 30 x 10 holes, rain sensor 24 x 20 holes (approx.); Rotor cups and vanes; $\frac{1}{16}$ inch clear Perspex or similar material; pointed knob; materials for transducer box; control box case, 5 x 5 x 8½ inches with sloping front panel.

direction. Mark S on the lower scale (2), and then carry out similar rotations to those above for marking the lower scale W, N, and E respectively.

Secure VR5 and VR6 in these positions.

LIGHT LEVEL INDICATOR

The light level is indicated on ME1 with S2 in position 4.

The circuit utilises a photoconductive cell, PCC1, whose resistance varies with light intensity from approximately 10 megohm in dark conditions to about 75 ohm in bright light.

As the light intensity varies so the total resistance of the circuit R6, VR7 and PCC1 in series varies, affecting the magnitude of the current flowing through ME1.

Once again, the maximum current flow should be 1mA. To realise this condition VR7 should be set so that 1mA flows when very bright sunlight is incident on PCC1.

To do this set VR7 at a maximum (i.e. 5 kilohm) and point PCC1 at the sun on a clear summer day. Now adjust VR7 so that the reading is full scale.

The full scale position should be marked "very sunny" and the zero position "dark".

For intermediate intensities it is suggested that these be marked "dull," "bright," "sunny," the positions being determined by days when these light intensities are evident.

METER DISPLAY

A suggested meter-scale is shown in Fig. 2. It consists of five bands to represent each of temperature, light, wind speed and wind direction (upper and lower which are used in conjunction with S3, see above).

It is suggested that these concentric bands are all firstly drawn together on a piece of plain paper and then pasted in position over the original scale.

Pencil markings will be sufficient to locate positions which can then be inked over neatly or printed with Letraset.

The start and end positions of the new scale must coincide with the original "zero and full scale" positions of the meter.

CONSTRUCTION-CONTROL BOX

The layout of the components on the Veroboard is shown in Fig. 3.

The circuitry in the control box is built on a piece of 0·15 inch matrix Veroboard size 30 by

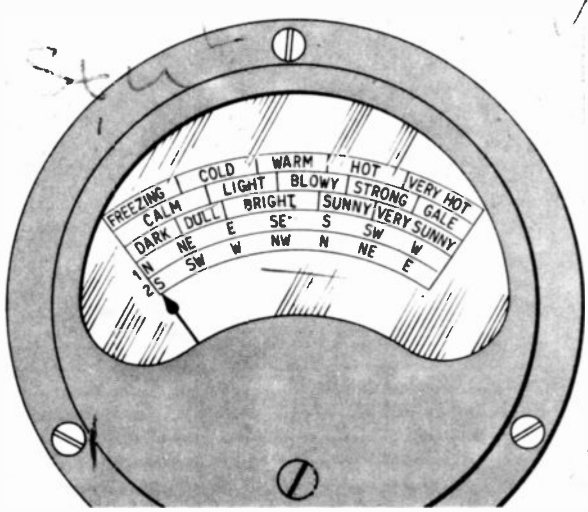


Fig. 2. A suggested meter scale display as used in the prototype. The individual scales will have to be calibrated as described.

10 holes with the copper strips cut as detailed.

Begin assembly by fixing TR2 in position and carefully soldering. The collector of TR2 is its casing and this connection is made via a small nut and bolt through a solder tag. This connection is also made through the Veroboard at position *G1/F1* by drilling a hole to take the bolt used. Continue by soldering the resistors and potentiometers in places as shown in Fig. 3.

Remember that the potentiometers are being used as variable resistors therefore only one outside leg is used with the middle leg. The redundant leg should be bent upwards away from the board, making sure neighbouring components are not touched.

Now attach the switches, S1, S2 and S3, the lamp holder and bulb, and the meter to the front panel as shown in Fig. 4, and wire them to the Veroboard as indicated. Next wire the 10 wires from the Veroboard and panel components to the 10 way terminal block, mounted on the back of the case. All wires will need to be about 6 to 9 inches long. Connect the battery leads to the Veroboard.

The transistors TR1 and TR3 and the Zener diode, D1, should now be soldered in position—remember to use a heat shunt on each lead otherwise damage to these devices may result.

TRANSDUCER BOX

In the prototype, the components were all mounted on the top panel (approximate size 13 x 10 inches) of a Perspex case. Perspex was chosen for the transducer box because of its excellent weather resistant properties. Any other case material may be used but it will probably need a good coat of paint to protect it.

If a metal case is used some method of insulating the nut, bolt and solder tag connections to RTH1 and the Veroboard sensor must be employed.

The positioning of the components in the prototype is indicated in Fig. 5. This is not critical but there are some important points to watch.

The rotor should not be too close to the vanes such that its rotation will cause the direction vanes to be affected.

The photocell PCC1 should be in an unobstructed position of daylight. Shadows from the rotor or vanes should not be allowed to fall on it at any time.

DIRECTION POTENTIOMETERS

Before assembly of the transducer components, VR5 and VR6 must be modified.

They must be dismantled and their stops removed.

With all potentiometers there is a gap between the two ends (start and finish) of the carbon tracks; this must be bridged with an insulating material otherwise the slider will get stuck in this gap and erroneous measurements will be taken, A suitable material for this is Araldite. Fill the gap, smooth over and leave to set. Ensure, when dry, that the slider can move across this region with minimum pressure.

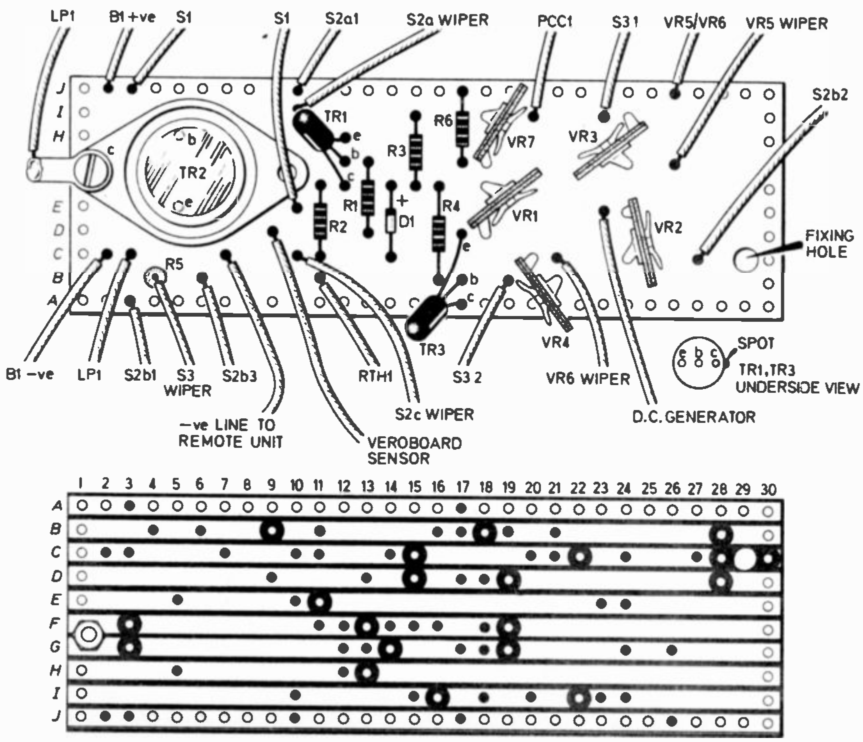


Fig. 3. The layout of the components on the Veroboard for the control box, and the regions of copper strip to be removed from the underside.

weather station

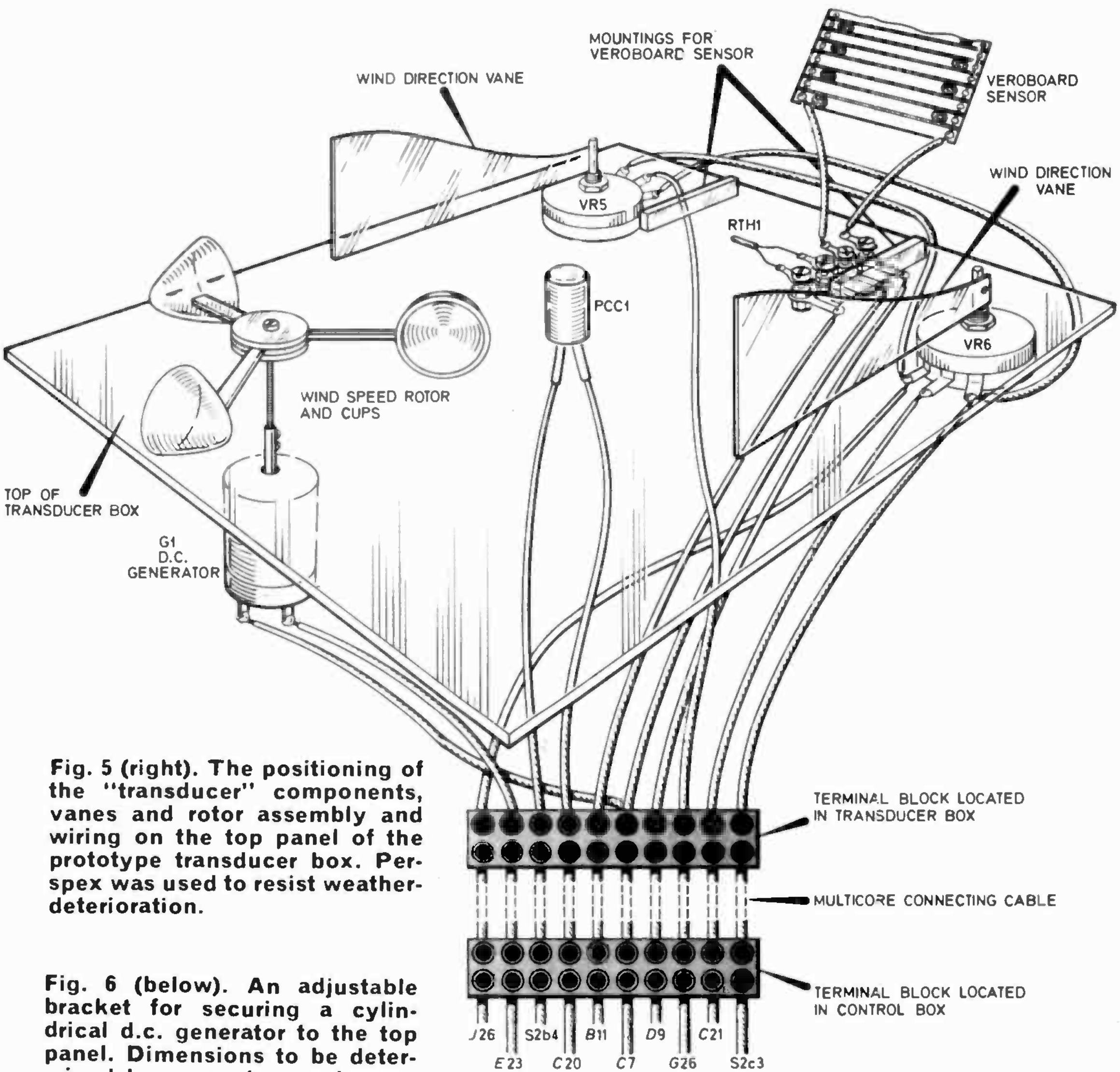
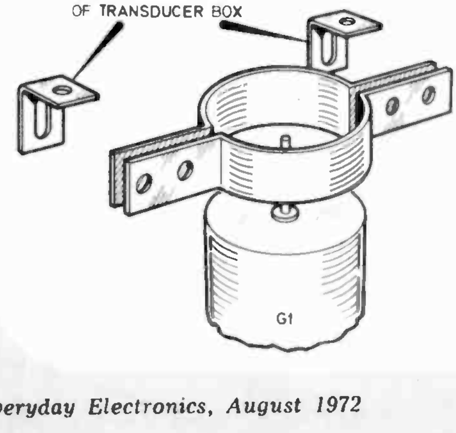
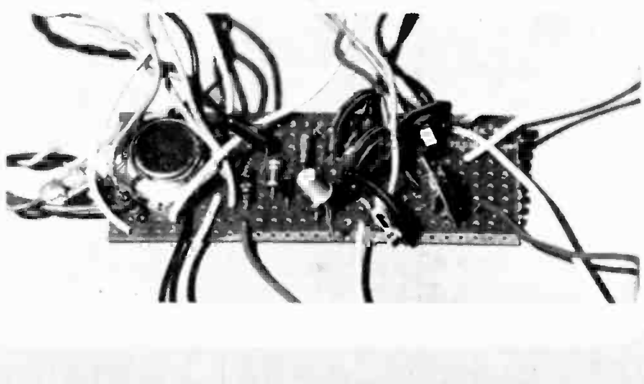


Fig. 5 (right). The positioning of the "transducer" components, vanes and rotor assembly and wiring on the top panel of the prototype transducer box. Perspex was used to resist weather-deterioration.

Fig. 6 (below). An adjustable bracket for securing a cylindrical d.c. generator to the top panel. Dimensions to be determined by generator used.



Photograph showing the Veroboard details.



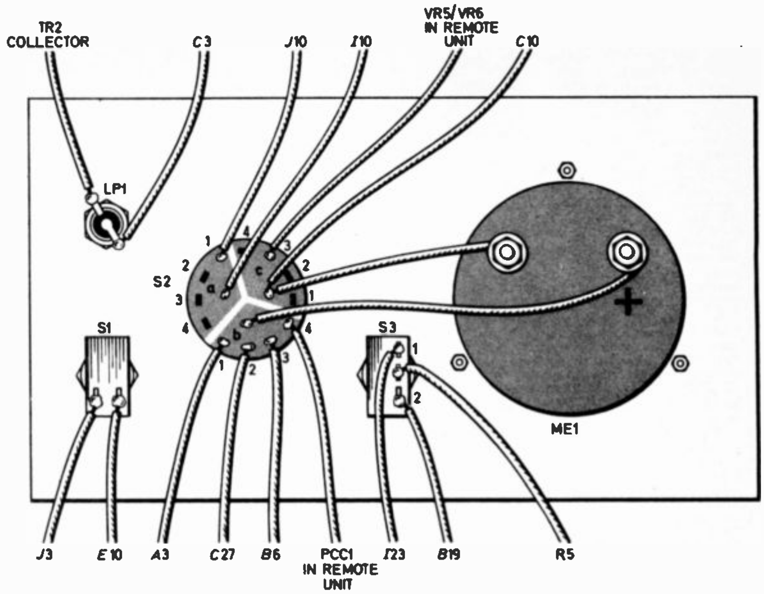


Fig. 4. The positions of the components and the wiring on the back of the control box front panel. Note the meter polarity. The layout is not critical and may be changed to suit individual requirements.

ROTOR CUPS AND VANES

The cups and vanes used in the prototype are made of Perspex (see *Shop Talk* for details).

If desired the cups can be made from suitable plastic egg cups by cutting away the base of the egg cup and filing smooth.

The dimensions of the direction vanes are not critical, except that they should, for efficient and speedy alignment, be triangular in shape, as shown in Fig. 5. These can be bolted to the flat sides of the spindles of VR5 and VR6, suitable holes being drilled in the spindles to accommodate the fixings.

LIGHT CELL AND RAIN SENSOR

The light cell can be mounted in any unshadowed position. In the prototype its position was central on the top panel and raised by means of a short length of plastic tubing.

A suitable sensor can be made from Veroboard cut and soldered as shown in Fig. 5, approximate size 3½ by 3 inches. In the prototype, tapped Perspex ¼ x ¼ x 2 inches was glued to the base of the sensor and this was screwed in position on the top panel. The thermistor, RTH1, is located under this sensor for convenience and protection.

GENERATOR FIXING

Motors suitable for use as the generator G1 are available in all shapes and sizes. The one used in the prototype is cylindrical, and is attached to the top panel by means of the adjustable bracket shown in Fig. 6. This can be modified to suit different generator shapes.

The rotor may be attached to the generator shaft by fixing a long thin brass bolt through the centre of the rotor system and uniting this to the generator shaft with a spindle coupling.

WIRING

When all the components have been fixed in their final positions on the transducer box, wiring may be carried out in accordance with the wiring diagram of Fig. 5. All wires go to the terminal block located inside the transducer box.

The two boxes are best and easiest united using a long length of multicore cable passed out through a grommet in the transducer box—the length depending on the final position of the two boxes.

The cable must contain at least 10 insulated wires. This type of cable is available from some of our advertisers.

TESTING AND SETTING UP

When the two parts have been connected, the wiring should be thoroughly checked out before switching on.

When you are satisfied that wiring is correct switch on and test each discrete unit individually and calibrate as detailed earlier.

It only remains now for the transducer box to be placed in position in the right direction. This is done with the aid of a magnetic compass.

With S3 in position 1, and S2 turned to the "wind direction" position, point the narrow end of VR5 vane in a due east direction and hold in this position while turning the transducer box until the needle on the meter indicates east (E). Secure the transducer box in this position.

Small plastic cups (such as those used in bottle tops) can be fitted over the wind speed and direction spindles so that no rain or moisture will run down the spindles into the "electronic" parts. A small amount of grease or Vaseline placed around the spindle bases will also provide protection.

The Weather Station is now complete. ■

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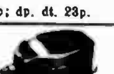

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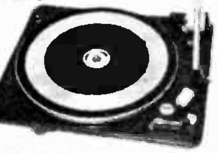

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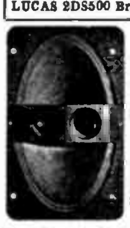

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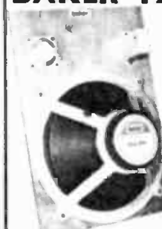

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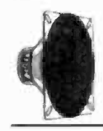

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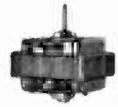
VALVE HOLDERS, 5p; CERAMIC 8p; CANS 5p.



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THEY MADE THEIR MARK

No 4 Ohm

By J. E. Gregory

TABLE I THE OHM (Ω)

The oldest and one of the most important electrical "laws" was formulated by Georg Ohm, and the unit of resistance—the ohm—is named after him. This is used to measure the value of the resistor, the most commonly used of all electronic components.

Ohm's law illustrates that the resistance of a conductor is equal to the voltage across it divided by the current flowing through it. When the resistance is in ohms the voltage is in volts, and the current in amps.

The Omega sign (Ω) used for the ohm was suggested by Sir William Henry Preece the British electrical engineer and wireless telegraphy pioneer, whilst lecturing to Indian telegraph service cadets at the Hartley College, Southampton in 1867.

This month we move to Germany, to hear about the man who gave his name to the unit of resistance, Georg Simon Ohm, and his now famous law (see Table 1).

The Ohm family lived in Erlangen, South Germany with their two sons Georg and Martin. Ohm senior was in business in a modest way as a locksmith, his wife complimented the family income by taking lodgers and it was one of these who was to influence the eldest son Georg, born March 16, 1787, in his early years.

It was expected that Georg being the eldest would take over the family business, but having been inspired by the student lodger to study he entered the local university. He was a competent pupil, and a natural born teacher, and on completing his course, accepted in 1817, at the age of 30, the post of professor of mathematics at the Jesuits college in Cologne.

OHM'S LAW

During this time he set his mind to many problems contained in mathematics, physics, and the new power electricity. It was at Cologne he learnt how the "Flux of Heat" in a metal bar is directly proportional to the difference of temperature between its ends, and then, influenced by the journals of Schweigger and Poggendorf the German physicists which had appeared in 1825. Ohm sought to discover what laws regulated the flow of electricity in a conductor.

His results were published in Berlin in 1827 in a pamphlet with the title "Die Galvanishe Kette Mathematisch Bearbeitet" which roughly translated means "The Mathematical Works of the Galvanic Chain". The theory Ohm proposed set out that the electric current is a conductor is directly proportional to the difference of potentials between its ends.

The publication of the pamphlet caused a major upset in German scientific circles, people said Ohm was mad, and his law absurd, he was even forced to resign his post at Cologne.

For six years he was an outcast doing very little scientific work then in 1833 he obtained a post at Nuremberg polytechnic.

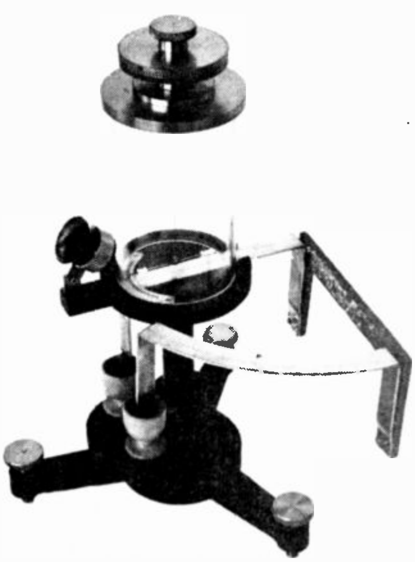
RECOGNITION

Gradually, however, the pamphlet began to get a wider circulation and his law was being quoted. Then, quite suddenly in 1841, came the first official recognition, Ohm was awarded the Copley medal of the Royal Society and made a foreign member of the society.

This recognition from Britain, and one of Europe's oldest scientific societies inspired Ohm to return to his work. He published a number of papers on mathematics and a memoir on interference in uniaxial crystals.

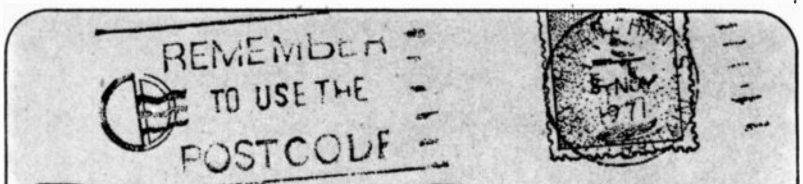
In 1849 he was appointed to the important post of conservator at the physical collection at Munich, and in 1852 professor of experimental physics in the high school at Munich, he started work on a text book of physics which was published in 1854 just before he died of apoplexy brought on by overwork, on July 7.

Thus at 67 died the man who in the face of great opposition took the first steps towards the formulation of the laws of the electric current.



Ohm's apparatus used in his work with his law on the Galvanic circuit.

Photograph: Crown copyright Science Museum, London.



Readers Letters

Resistor Symbols

I have read every issue of EVERYDAY ELECTRONICS and I have only just noticed, in reading your *Guide To Circuit Symbols*, that you have been using the old symbol for resistors (a zig-zag line). I use many drawings of electronic circuits in my work and all up to date drawings now use the B.S. symbol (an oblong box) for a resistor. Whether this is done on purpose, to make it plain for the beginner I do not know, but I just thought I would point it out to you.

K. C. Vicars,
Portsmouth.

The symbol we use is given by B.S. as an alternative; see this month's editorial for comment.

That 15p Effort

As one who was brought up on thermionic valves and was introduced to electronics largely through your parent magazine, P.E., I should like to add to the congratulations you have received on the success of E.E.

Although I have experimented with radio for over 25 years, it is thanks to your magazine that I am beginning to feel at home with solid state devices.

Unfortunately, some of your ungrateful critics have yet to learn to walk before they can run, and it is hardly the function of E.E. to provide detailed modifications and servicing for commercial devices. Lack of effort, indeed, Mr. Alexander! Some people do not realise how much effort must go into making E.E. the best value on the bookstall—and all for 15p a month!

Mr. D. B. Lyall,
Cheltenham.

Modification

It may be of interest to you that the circuit given in the May issue of your magazine for a *Bee Counter* was used as the basis of a paper counting machine for our school magazine. I had been planning to make such a device using a photocell, one transistor amplifier and a relay, thus operating a magnetic counter. Your circuit was a welcome alternative, being less bulky and requiring only one power source.

I built the circuit as described and arranged that the light beam should be broken by the sheet of paper falling vertically onto a chute which guided it into an output tray. In practice this arrangement failed to operate because of the small change in light level brought about by the sheet of paper.

This was due to two factors: firstly the paper is rather thin, and secondly, the interference from the room lighting which was not interrupted by the paper. Thus the circuit had to be made more sensitive to smaller changes in light level. To do this I introduced a further stage of amplification using a second OC72 and its two associated resistors. With this slight modification a very successful paper counting device was constructed.

I continue to be impressed with the variety of useful projects that you publish and wish you all success in future publications.

R. Anderson,
Leeds.

"B" Class

We followed with great interest your article on the electronic *Bee Counter*. However, we thought your entrance and exit labels a little strange because we don't know a lot of bees capable of reading and writing.

Of course, we have heard that the educational system has been greatly modified in the United Kingdom of late, presumably the "A" class is now reserved for people and the, dare we say it, "B" class, for insects.

Five unreadable signatures,
No address.

We must admit that we do not know of any educated bees, but if you know some—as you infer—we are sure many bee keepers would be interested. Perhaps you could tell us how the bees can read the signs when they are inside the hive?

To be more serious, if you look at page 380 you will find that the caption to the photograph refers to the labels, thus constructors (not bees) are made fully aware of which aperture is which.

Transistor Holders

I have a query to put to you. When I was at school, 15 years ago, transistors had just come into general use, and I had many knowledgeable friends who tried to introduce me to the hobby of electronics; unfortunately I never quite got to grips with the practical side and so never got going. This is why your magazine is so helpful to me, for example I now understand for the first time in my life how to solder a good joint.

My query is this; these friends of mine at school were unanimous in recommending the use of transistor-holders, to avoid the dangers of soldering direct to the leads; as you do not seem to mention these, I am wondering whether there is some good reason that their use has been discontinued.

N. E. Goller,
London, N.W.3.

Transistor holders are still available and can be used on almost any project if desired. However if some care is taken when soldering, the transistors should not be damaged in any way. Silicon transistors can of course stand much more heat than the original germanium types.

Rain Wanted

How lucky you are in the UK., you get your June issue in June. Here, the April issue has just hit the bookstalls. It's worth waiting for though. For years now, I've been wading through electronics magazines but the penny didn't drop until your *Teach-In* penetrated my grey matter.

I agree with your reader who asked for more mathematical tolerance. It became necessary for me to take a refresher course in Algebra so that I could follow your development of equations in the resistors in parallel bit.

Perhaps you are not so lucky there in the old country, we don't have that awful problem of where to go and what to buy when stocking up for one of your projects. It's a case of "shop a" or "shop b" or write off to the Eastern States, some 3000 miles away, and wait several weeks.

Your *Rain Warning Alarm* appealed to me and after wrecking it with reverse battery connections as per your erroneous instructions, I eventually got it working. Just one problem though. Its been installed on the roof for about 2 months now—but it hasn't rained!

How about a pull out data page suitable for clipping into a workshop manual. Such information as colour codes, transistor base connections, fundamental circuits like the diode pump, hints, tips and short cuts gathered together in one handy cover would be a boon for the likes of me who hit a problem and have to go searching through piles of magazines to find a clue to what could be wrong.

Ray Foster,
Western Australia.

To be correct our June issue is on sale during May in this country. By the time you read this you should have the Constructors Companion, *presented free with the May issue—we hope this will meet your needs.*

Prices

As many other readers have said, your magazine is a good one and has cleared up a few mystifying points. But now I would like to clear up a point myself, just in case someone got the wrong idea about New Zealand from Mr. J. Koppard's letter in E.E. April 1972. New Zealand is not a pin prick on the map down under where people walk round in grass skirts, but a modern thriving country.

The price of the OC71 is something of a mystery to me. Here in Auckland an average OC71 cost 70c or 35 English pence, not as cheap as in England but still a far cry from £3. I do not know the price of an OC71 in Wellington but since Wellington is the capital of N.Z., I doubt if the price would be higher.

My guess is that the price or type of article was confused somewhere along the line, but if this is not the case then Mr. J. Koppard paid an extra £2·65p to a very low dealer.

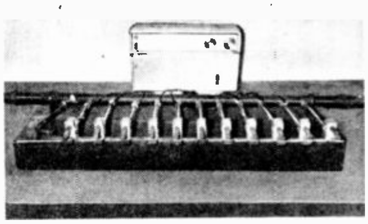
E. Van Dyke,
New Zealand.

Gas Station!

Sensor should eat his words. I have enclosed a photograph of a gas operated radio which the East Midlands Gas Board uses for demonstration. What is more, the device even works on natural gas.

G. A. Bolton
Shepshed,
Leicestershire.

Sensor *did not say that it could not be done, merely that "there are limits to what can be done by gas". However we thank you for the inclusion of the photograph, which we show below.*



Electronic Course

During the last two years, I have been running a course in basic electronics for the student with a non-vocational background. This course has a great deal in common with the "Teach-In" articles that you have been publishing since November 1971, and it has been suggested to me that your readers may be interested.

The course is based on attendance at the college for one evening per week (7.00-9.00 p.m.) for 24 weeks and runs from September to Easter. There is a strong practical background to the instruction, and demonstrations and experiments are conducted almost every night of the course.

I hope you find this suggestion of interest.

H. May,
Head of Electrical Trades Department,
Gateshead Technical College,
Durham Road,
Gateshead.

Thanks

Further to my letter in the June issue, I now know the secrets of *Snap Sequence, Indicator* and *Home Sentinel*, thanks to an unknown reader who rang me and sent me the first issue.

I would like to refund the postage to him, and also return his magazine (if he would like it back) if he will let me know his address. I am afraid I put the phone down before I realised I didn't know who it was.

R. Brown,
Burton-on-the-Wold.

Component Export

We would be obliged if you could put us in touch with some firms in the UK who would be interested in the export of electronic components and gadgets to an electronic agency here.

H. NG Wong
c/o School of Industrial Technology
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5mA	£2 20	300V. A.C.	£2·30
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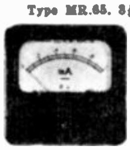
100-0-100µA	£1·75	20V. D.C...	£1·60
200µA	£1·75	100V. D.C.	£1·60
500µA	£1·65	150V. D.C.	£1·60
500-0-500µA	£1·60	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1-0-1mA ..	£1 60	750V. D.C.	£1·60
2mA	£1·60	15V. A.C...	£1·70
5mA	£1·60	50V. A.C...	£1·70
10mA	£1·60	150V. A.C.	£1·70
20mA	£1·60	300V. A.C.	£1·70
50mA	£1·60	500V. A.C.	£1·70
100mA	£1 60	8 Meter 1mA	£1·70
150mA	£1·60	VU Meter..	£2.10

Type MR.45P. 2in. square fronts.

50µA	£2 25	5 amp.	£1·70
50-0-50µA	£2·10	10V. D.C ..	£1 50
100µA ...	£2 10	20V. D.C. ..	£1·50
100-0-100µA	£1.87	50V. D.C ..	£1 50
200µA	£1 87	300V. D.C.	£1 50
500µA	£1 75	15V. A.C ..	£1·80
500-0-500µA	£1·70	300V. A.C.	£1·80
1mA	£1 70	8 Meter 1mA	£1·85
5mA	£1 70	VU Meter ..	£2·25
10mA	£1·70	1 amp. A C.*	£1·70
50mA	£1·70	5 amp. A C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp	£1·70	30 amp. A.C.*	£1·70

"SEW" BAKELITE PANEL METERS

Type MR.65. 3½in. square fronts.



		1 amp.	£1·95
		2 amp.	£1·95
		5 amp.	£1·95
		15 amp.....	£1·95
		30 amp.....	£1·95
		50 amp.....	£1·95
		5V. D.C. ..	£1·95
		10V. D.C. ..	£1·95
		20V. D.C. ..	£1·95
		50V. D.C. ..	£1·95
		150V. D.C.	£1·95
25µA	£3·50	300V. D.C.	£1 95
50µA	£2·75	30V. A.C.*	£1·95
50-0-50µA	£2·35	50V. A.C.*	£1·95
100µA	£2·35	150V. A.C.*	£1·95
100-0-100µA	£2·25	300V. A.C.*	£1·95
500µA	£2·20	500mA A.C.*	£1·95
1mA	£1·95	1 amp. A.C.*	£1·95
1-0-1mA ..	£1·85	5 amp. A.C.*	£1·95
5mA	£1·95	10 amp. A.C.*	£1·95
10mA	£1·95	20 amp. A.C.*	£1·95
50mA	£1·95	30 amp. A.C.*	£1·95
100mA	£1 95	50 amp. A.C.*	£1·95
500mA	£1·95	VU Meter ..	£3·10

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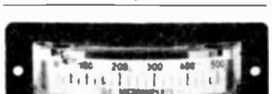
100µA	£4·65	50V d.c.	£4·40
1mA	£4·40	300V d.c. ...	£4·40
50-0-50µA ...	£4·65		
1-0-1mA.....	£4·40	Dual range	
1A d.c.	£4·40	500mA/5A d.c.	£4·65
5A d.c.	£4·40	5V/50V d.c...	£4·65
10V d.c. ...	£4·40		



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Type PE.70. 3 17/32in. × 1 15/32in. × 2¼ in. deep.

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50-0-50µA	£3·00	1mA	£2·45
100µA	£3·00	300V. A.C.	£2·45
100-0-100µA	£2 90	VU Meter..	£3·40
200µA	£2 90		

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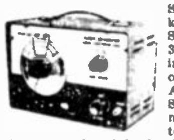
TE22 SINE SQUARE WAVE AUDIO GENERATORS



Sine: 20cps to 200 kc/s on 4 bands. Square: 20cps to 30 kc/s. Output impedance 5,000 ohms, 200/250V. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £17·50. Carr. 37½p

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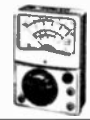

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Overload protection. 5/25/100/500/1000 VDC. 10/50/250/1000 VAC. 50 uA/250 mA. 20K/2 meg ohm. −5 to + 62db. £4 97. P. & P. 15p.

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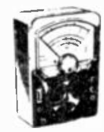
0/6/30/120/600 V. AC.
0/12/600µA/12/300 MA /12 Amp. DC.
0/10K/1 MEG/100 MEG.
−20 to +50 dB
0·01 … 2 mfd
Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13 50. P.P. 25p.



MODEL 500 30,000 O.P.V with overload protection mirror scale 0/·5/2·5/10/25/100/250/500/1,000 V. D.C. 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50uA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω. £8 87½. Post paid.

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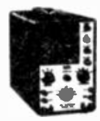

3in. tube. Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1 5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1.5 cps -800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps–300 KHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½ lb. 220 240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p

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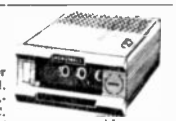

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ± 0·2, ± 1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5¾in. x 2 13/16in. x 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE. £49·97½. Carr. 50p.

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2G309	30p	2N3566	22p	2S303	60p	BC125	20p	BFX44	37p	NKT240	27p
2G371	15p	2N3568	25p	2S304	75p	BC126	20p	BFX68	67p	NKT241	27p
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2N696	15p	2N3606	27p	3N128	70p	BC138	20p	BFX88	20p	NKT261	20p
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2N698	25p	2N3638	18p	3N141	72p	BC141	35p	BFX93A	70p	NKT264	20p
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2N706	10p	2N3641	18p	3N143	67p	BC148	10p	BFY18	25p	NKT272	20p
2N706A	12p	2N3642	18p	3N152	87p	BC149	12p	BFY19	25p	NKT274	20p
2N708	15p	2N3643	20p	40050	55p	BC152	17p	BFY21	42p	NKT275	20p
2N709	62p	2N3644	25p	40250	60p	BC153	20p	BFY24	45p	NKT278	25p
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2N914	17p	2N3694	18p	40312	47p	BC160	35p	BFY50	20p	NKT404	55p
2N916	17p	2N3702	10p	40314	37p	BC167	11p	BFY51	20p	NKT405	75p
2N918	30p	2N3703	10p	40315	37p	BC168B	10p	BFY52	20p	NKT406	62p
2N929	22p	2N3704	11p	40316	47p	BC168C	11p	BFY53	15p	NKT451	62p
2N930	20p	2N3705	10p	40317	37p	BC169B	11p	BFY56A	57p	NKT452	62p
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2N1091	22p	2N3708	7p	40323	32p	BC171	15p	BFY90	65p	NKT717	42p
2N1131	25p	2N3709	9p	40324	47p	BC172	15p	BSX19	17p	NKT734	27p
2N1132	25p	2N3710	9p	40326	37p	BC175	22p	BSX20	15p	NKT736	35p
2N1302	17p	2N3711	12p	40329	30p	BC177	20p	BSX21	20p	NKT773	25p
2N1303	17p	2N3713	187p	40344	27p	BC178	20p	BSX26	45p	NKT781	30p
2N1304	22p	2N3714	200p	40347	57p	BC179	20p	BSX27	47p	OC16	50p
2N1305	22p	2N3715	123p	40348	52p	BC182	10p	BSX28	32p	OC19	37p
2N1306	25p	2N3716	130p	40360	40p	BC182L	10p	BSX60	82p	OC20	75p
2N1307	25p	2N3773	240p	40361	40p	BC183	9p	BSX61	62p	OC22	50p
2N1308	25p	2N3791	206p	40362	50p	BC183L	9p	BSX76	15p	OC23	60p
2N1309	25p	2N3819	34p	40370	32p	BC184	11p	BSX77	20p	OC24	60p
2N1507	17p	2N3820	55p	40406	57p	BC184L	11p	BSX78	25p	OC25	40p
2N1613	20p	2N3823	50p	40407	40p	BC186	25p	BSY24	15p	OC26	25p
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2N1637	30p	2N3855	27p	40410	62p	BC213L	12p	BSY27	15p	OC35	50p
2N1638	27p	2N3855A	30p	40412	50p	BC214L	15p	BSY28	17p	OC36	60p
2N1639	27p	2N3856	30p	40467A	57p	BCY10	27p	BSY29	17p	OC41	22p
2N1701	160p	2N3856A	35p	40468A	35p	BCY30	27p	BSY32	25p	OC42	25p
2N1711	24p	2N3858	25p	40528	72p	BCY31	30p	BSY36	25p	OC44	15p
2N1889	32p	2N3858A	30p	40600	57p	BCY32	50p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	25p	BSY38	20p	OC46	15p
2N2147	72p	2N3859A	32p	AC107	30p	BCY34	30p	BSY39	22p	OC70	15p
2N2160	57p	2N3860	30p	AC126	20p	BCY38	40p	BSY43	50p	OC71	12p
2N2193	40p	2N3866	150p	AC127	24p	BCY39	60p	BSY51	32p	OC72	12p
2N2193A	42p	2N3877	40p	AC128	20p	BCY40	50p	BSY52	32p	OC73	30p
2N2194	27p	2N3877A	40p	AC151	18p	BCY41	15p	BSY53	37p	OC74	30p
2N2194A	30p	2N3900	37p	AC152	22p	BCY42	15p	BSY54	40p	OC75	22p
2N2217	25p	2N3900A	40p	AC154	22p	BCY43	15p	BSY56	90p	OC76	22p
2N2218	20p	2N3901	97p	AC176	20p	BCY54	32p	BSY79	45p	OC77	30p
2N2219	20p	2N3903	20p	AC187	25p	BCY58	22p	BSY90	57p	OC78	20p
2N2220	25p	2N3904	25p	AC188	25p	BCY59	22p	BSY95A	12p	OC81	20p
2N2221	25p	2N3905	30p	ACY17	27p	BCY60	97p	C424	15p	OC81D	20p
2N2222	20p	2N3906	25p	ACY18	24p	BCY70	15p	C450	15p	OC82	25p
2N2222A	25p	2N4058	12p	ACY19	24p	BCY71	20p	GET102	30p	OC82D	15p
2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	20p	OC83	25p
2N2368	15p	2N4060	12p	ACY21	20p	BCY78	30p	GET114	20p	OC84	25p
2N2369	15p	2N4061	12p	ACY22	10p	BCY79	30p	GET118	20p	OC139	25p
2N2369A	15p	2N4062	12p	ACY28	17p	BCZ10	27p	GET120	25p	OC140	32p
2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
2N2483	27p	2N4248	15p	ACY40	20p	BD112	50p	GET880	30p	OC171	30p
2N2484	32p	2N4249	15p	ACY41	15p	BD116	112p	GET887	20p	OC200	40p
2N2539	22p	2N4250	18p	ACY44	25p	BD121	65p	GET889	22p	OC201	60p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	75p
2N2613	35p	2N4255	42p	AD149	47p	BD124	60p	GET896	22p	OC203	40p
2N2614	30p	2N4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	40p	2N4285	17p	AD161	35p	BD132	80p	GET898	28p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	25p	OC206	95p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	25p	OC207	75p
2N2713	27p	2N4288	15p	AF114	25p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	17p	AF115	25p	BDY62	100p	MAT121	25p	ORP12	50p
2N2904	20p	2N4290	18p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
2N2904A	25p	2N4291	15p	AF117	20p	BF117	47p	MJ420	80p	ORP61	42p
2N2905	25p	2N4292	15p	AF118	60p	BF152	28p	MJ421	80p	P346A	22p
2N2905A	20p	2N4294	17p	AF121	30p	BF154	20p	MJ430	102p	ST140	15p
2N2906	20p	2N4303	47p	AF124	22p	BF158	15p	MJ440	95p	ST141	20p
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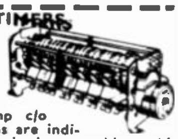

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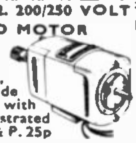

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ACY19	25p
ACY20	20p
ACY21	20p
ACY22	10p
ACY39	55p
ACY40	20p
ACY41	15p
ACY44	25p
AD140	50p
AD149	50p
AD161	35p
AD162	35p
AF114	25p
AF115	25p
AF116	25p
AF117	20p
AF118	60p
AF124	25p
AF125	20p
AF126	20p
AF127	20p
AF139	30p
AF180	50p
AF181	45p
AF185	50p
AF186	40p
AF239	40p
ASY26	25p
ASY27	30p
ASY28	25p
ASY29	30p
ASZ21	55p
BA100	15p
BA102	30p
BA110	25p
BA115	7p
BAX13	5p
BAX16	7p
BAY31	7p
BAY38	15p
BC107	10p
BC108	10p
BC109	10p
BC109C	12p
BC113	10p
BC114	20p
BC115	20p
BC116	20p
BC116A	25p
BC117	20p
BC118	20p
BC119	30p
BC134	20p
BC135	15p
BC136	20p
BC137	20p
BC138	20p
BC147	12p
BC148	10p
BC149	12p
BC153	20p
BC154	20p
BC167	15p
BC169	12p
BC169C	15p
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BFX84	25p
BFX85	30p
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BFX87	25p
BFX88	20p
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BFY50	20p
BFY51	20p
BFY52	20p
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MPSU56	55p
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NKT216	35p
NKT403	75p
NKT404	55p
OA5	25p
OA10	25p
OA47	10p
OA70	10p
OA79	10p
OA81	8p
OA90	8p
OA91	7p
OA95	7p
OA200	7p
OA202	10p
OC16	50p
OC20	85p
OC22	50p
OC23	60p
OC24	60p
OC25	40p
OC26	25p
OC28	60p
OC29	60p
OC35	50p
OC36	60p
OC42	40p
OC43	50p
OC44	15p
OC45	12p
OC70	12p
OC71	12p
OC72	20p
OC75	25p
OC76	25p
OC77	40p
OC81	20p
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ZTX304	25p
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ZTX501	15p
ZTX502	20p
ZTX503	17p
ZTX504	40p
ZTX531	28p
IN914	7p
IN916	10p
IN4148	7p
IS44	7p
IS921	7p
IS922	8p
2G301	25p
2G302	30p
2G303	35p
2N404	20p
2N696	15p
2N697	15p
2N698	30p
2N706	10p
2N706A	12p
2N708	15p
2N930	20p
2N987	40p
2N1131	25p
2N1132	25p
2N1302	18p
2N1303	18p
2N1304	22p
2N1305	22p
2N1306	25p
2N1307	25p
2N1308	25p
2N1309	25p
2N1613	20p
2N2147	75p
2N2160	60p
2N2217	25p
2N2218	20p
2N2218A	25p
2N2219	20p
2N2219A	25p
2N2220	25p
2N2221	20p
2N2221A	25p
2N2222	20p
2N2222A	25p
2N2369	15p
2N2369A	15p
2N2646	40p
2N2904	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906	20p
2N2906A	25p
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7403	Quad 2-input open collector NAND gates	20p	18p	16p	14p	12p
7404	Hextuple inverters	20p	18p	16p	14p	12p
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7410	Triple 3-input NAND gates	20p	18p	16p	14p	12p
7413	Dual 4-input Schmitt triggers	30p	27p	25p	22p	20p
7420	Dual 4-input NAND gates	20p	18p	16p	14p	12p
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7441	BCD-Decimal decoder/Nixie driver	75p	72p	70p	60p	55p
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7450	Expand dual 2-input AND-OR-INVERT gates	20p	18p	16p	14p	12p
7451	Dual 2-wide 2-input AND-OR-INVERT gates	20p	18p	16p	14p	12p
7453	Quad 2-input expand AND-OR-INVERT gates	20p	18p	16p	14p	12p
7454	4-wide 2-input AND-OR-INVERT gates	20p	18p	16p	14p	12p
7460	Dual 4-input expanders	20p	18p	16p	14p	12p
7470	Single J-K flip-flop (gated inputs)	30p	27p	25p	22p	20p
7472	Single J-K flip flop (gated inputs)	30p	27p	25p	22p	20p
7473	Dual J-K flip flop	40p	37p	35p	33p	30p
7474	Dual D flip flop	40p	37p	35p	33p	30p
7475	Quadruple bistable latch	45p	42p	40p	38p	35p
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7490	BCD decade counter	75p	70p	65p	60p	55p
7491	8-bit shift register	£1·00	95p	90p	80p	70p
7492	Divide twelve counter	75p	70p	65p	60p	55p
7493	4-bit binary counter	75p	70p	65p	60p	55p
7494	Dual entry 4-bit shift register	80p	75p	70p	65p	60p
7495	4-bit up-down shift register	80p	75p	70p	65p	60p
7496	5-bit parallel/serial in/out shift register	£1·00	97p	95p	90p	88p
74100	8-bit bistable latch	£2·50	£2·30	£2·00	£1·75	£1·50
74118	Hextuple Set-Reset latches	£1·00	95p	90p	80p	70p
74121	Monostable multivibrators	60p	55p	50p	46p	41p
74141	BCD-Decimal decoder/Nixie driver	£1·00	95p	90p	80p	70p
74145	BCD-Decimal decoder (1- 4-line) TTL O/P	£1·50	£1·40	£1·30	£1·10	£1·00
74150	16-bit data selector/multiplexer	£3·35	£3·20	£2·95	£2·15	£2·05
75151	8-bit data selector/multiplexer	£1·10	95p	90p	80p	70p
74153	Dual 4-line to 1-line data selector multiplexer	£1·35	£1·27	£1·20	£1·15	£1·10
74154	16-bit decoder/demultiplexer	£2·00	£1·75	£1·55	£1·30	£1·05
74155	Dual 2-line to 4-line decoder/demultiplexer	£1·55	£1·47	£1·35	£1·10	£1·05
74156	Dual 2-line to 4-line decoder/demultiplexer	£1·55	£1·47	£1·35	£1·10	£1·05
74190	Sync decade up-down counter, 1-line mode	£1·95	£1·85	£1·75	£1·60	£1·50
74191	Sync 4-bit up-down counter, 1-line mode	£1·95	£1·85	£1·75	£1·60	£1·50
74192	Sync decade up-down counter, 2-line mode	£2·00	£1·90	£1·80	£1·65	£1·55
74193	Sync 4-bit up-down counter, 2-line mode	£2·00	£1·90	£1·80	£1·60	£1·40
74196	Asynchronous presettable decade counter	£1·50	£1·40	£1·30	£1·10	£1·00
74197	Asynchronous presettable 4-bit binary counter	£1·50	£1·40	£1·30	£1·10	£1·00

Complete data on the above in booklet 20 pages. Ref. 29, issue 2 at 15p post paid.
Texas I.C. Handbook. Complete information on 100 types. 40p. Post 10p.
Integrated circuit sockets 14 pin D.I.L. 25p; 16 pin D.I.L. 30p.

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MFC4000P	55p
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PA246	£1·50
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TAD110	£1·50
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702C (TO5)	75p
709C (TO5)	45p
709C (D.I.L.)	45p
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741C(TO5)	80p
MC1303P	£2·00
MC1304P	£2·25
SL403D	£1·50
741C(DIL)	75p
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	1–24	25+	100+	500+	1000+
400m/w BZY 88 series*	12p	10p	8p	7p	6p
1½ watt ZL series	25p	23p	20p	17p	15p
3 watt 3TZ series	30p	27p	25p	22p	20p
10 watt ZS series +	40p	37p	35p	30p	25p

All types are 5%. Wire Ended + these Stud. in voltages 3·3-100 volt in all standard values. *3·3-33 volt.

TRIACS

Stud with accessories

Type	P.I. volts	Current	1·11
SC35A	100	3 amps	80p
SC35B	200	3 amps	85p
SC35D	400	3 amps	90p
SC40A	100	6 amps	90p
SC40B	200	6 amps	£1·05
SC40D	400	6 amps	£1·00
SC45A	100	10 amps	£1·05
SC45B	200	10 amps	£1·15
SC45D	400	10 amps	£1·25
SC50A	100	15 amps	£1·35
SC50B	200	15 amps	£1·45
SC50D	400	15 amps	£1·75
SC40E	500	6 amps	£1·25
SC46E	500	10 amps	£1·45
SC50E	500	15 amps	£1·95
DIAC SD2			25p

SILICON RECTIFIERS

1 AMP MINIATURE PLASTIC WIRE ENDED

Type	P.I.V.	1–49	50+	100+	500+	1000+
IN4001	50	6p	5p	4½p	4p	3½p
IN4002	100	7p	6p	5p	4½p	4p
IN4003	200	8p	7p	6p	5p	4½p
IN4004	400	8p	7p	6p	5p	4½p
IN4005	600	10p	9p	8p	7p	6p
IN4006	800	12p	10p	9p	8p	7p
IN4007	1000	15p	12p	10p	9p	8p

BRIDGE RECTIFIERS

Miniature Potted Silicon ½" × ½" × ½"

Type	P.I.V.	Current	1–12	Type	P.I.V.	Current	1–11
1002	100	2a	55p	4004	400	4a	75p
2002	200	2a	65p	6004	600	4a	80p
4002	400	2a	75p	1006	100	6a	70p
6002	600	2a	80p	2006	200	6a	75p
1004	100	4a	65p	4006	400	6a	£1·00
2004	200	4a	70p	6006	600	6a	£1·10

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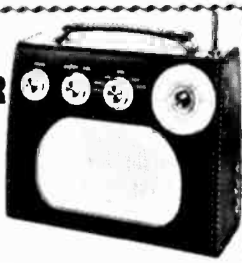
Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated Telescopic Aerial, for peak short wave and VHF listening. Push Pull output using 600mw Transistors. Car Aerial and Tape Record Sockets. Switched Earpiece Socket complete with Earpiece. 10 Transistors plus 3 Diodes. 8" × 2½" Speaker. Air Spaced ganged Tuning Condenser with VHF section. Volume on/off, Wave Change and Tone Control. Attractive Case in black with silver blocking. Size 9" × 7" × 4". Easy to follow instructions and diagrams. Parts price list and easy build plans 30p (FREE with parts).

Total building cost **£8·50**

P. P. & Ins. 50p

(Overseas P. & P. £1)

ROAMER EIGHT Mk I



NOW WITH VARIABLE TONE CONTROL

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. Switched earpiece socket complete with earpiece. 8 transistors plus 3 diodes. 8" × 2½" Speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts Price List and Easy Build Plans 25p (FREE with parts).

Total building cost £6·98 P. P. & Ins. 41p.
(Overseas P. & P. £1)

ROAMER SEVEN MK IV

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for MW and LW. Retractable 4 section 24in. chrome plated telescopic aerial for SW. Socket for Car Aerial. Powerful push-pull output. 7 transistors and 2 diodes. 8" × 2½" speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts). Earpiece with plug and switched socket for private listening, 30p extra.

Total building costs £5·98 P. P. & Ins. 41p.
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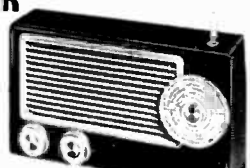
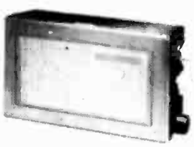
ROAMER SIX



6 Tunable Wavebands: MW, LW, SW1, SW2, Trawler band plus an extra M.W. band for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £3·98 P. P. & Ins. 26p
(Overseas P. & P. £1)

POCKET FIVE



3 Tunable Wavebands: MW, LW, Trawler Band with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½ × 1½ × 3½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £2·29 P. P. & Ins. 21p
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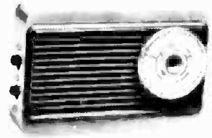
TRANSONA FIVE

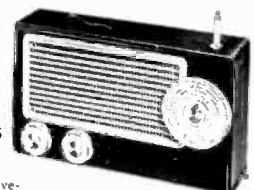


5 TRANSISTORS AND 2 DIODES

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6½ × 4½ × 1½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £2·50 P. P. & Ins. 22p
(Overseas P. & P. 63p)

TRANS EIGHT



8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2½in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £4·48 P. P. & Ins. 31p
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