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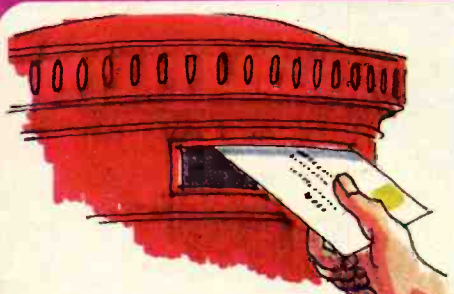

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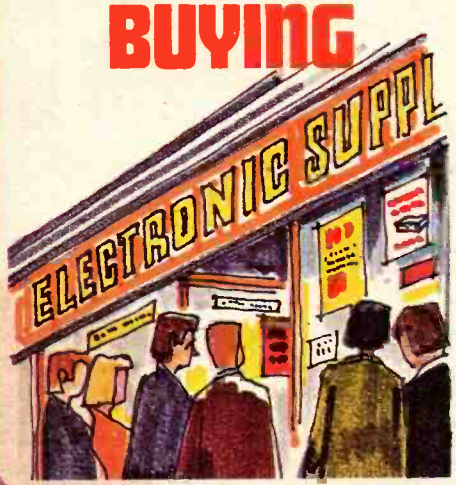

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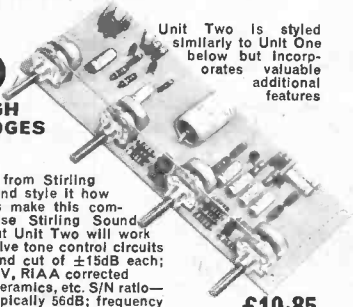

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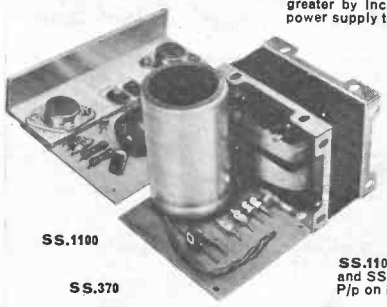

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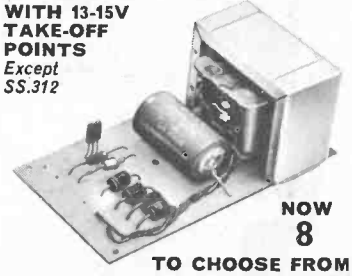

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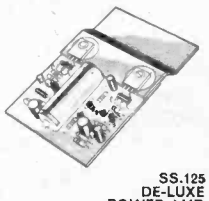

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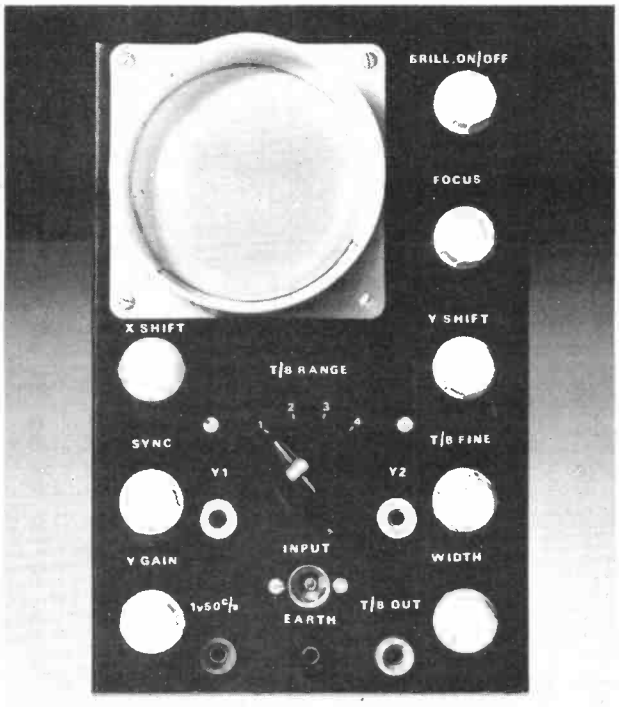

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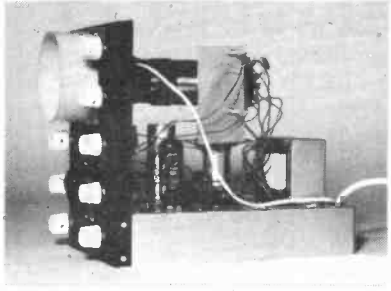

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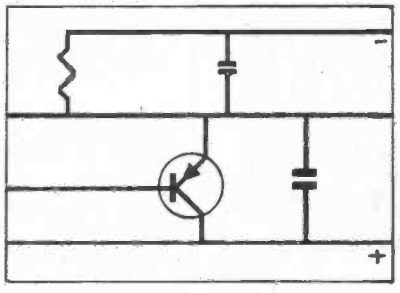

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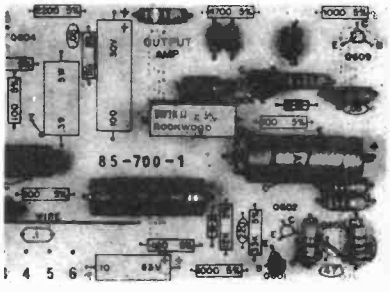

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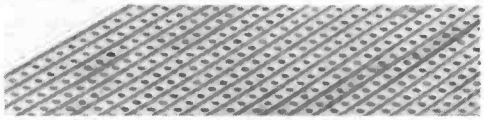

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2N2369A	0·25	2N4059	0·20	AF109	0·75	BC214L	0·17	ME4102	0·10	CA3080	0·68	NE567	1·80	TBA720Q	2·30		
2N2646	0·75	2N4060	0·20	AF124	0·65	BC237	0·14	ME4104	0·10	CA3080A	1·88	SAS560	2·50				
2N2647	1·40	2N4061	0·17	AF125	0·65	BC238	0·12	MJ480	1·35			SAS570	2·50	TBA750	1·98		
2N2904	0·36	2N4062	0·18	AF126	0·65	BC239	0·15	MJ481	1·55	CA3086	0·51	76003N	2·55				
2N2904A	0·37	2N4126	0·17	AF127	0·65	BC251	0·15	MJ490	1·35	CA3088	1·59	76013N	1·70	TBA750Q	2·07		
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2N2905A	0·38	2N4919	0·65	AF186	0·50	BC257A	0·17	MJ2955	1·25	CA3090	3·80	76023ND	1·57	TBA800	1·20		
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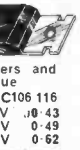

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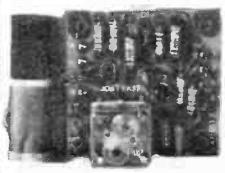

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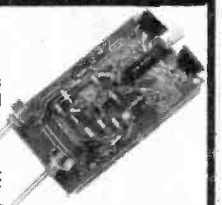

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Radiant Wall Heaters for bathrooms, workshops etc. advantage with this type of heater is that the benefit is felt immediately, there is virtually no warm up period. Due to a recent large purchase we can offer the Springfield 750w. This is a 750w heater 20½ inches long. Quite nice design with highly polished reflector and crome plated guard, wall mounting brackets and pull cord switch. Retail price originally intended to be £6·50p, we are able to see these at £3·95p + 32p. Post 70p + 6p.

4 Pole Motor. Carefully balanced spindle fitted with belt drive pulley for tape recorders etc. Normal mains working, speed 1250 rpm. Price £1·50p + 19p. Post 30p + 13p.

100watt Mains Transformer. 240v 50hz primary wound in separate halves, primary screen. This has three secondries 24–0–24v, 0–49v and 0–88v tapped to 80v. Any one of these secondries may be loaded up to the 100 watts or the load can of course be spread over to all the secondries. Upright mounting, impregnated and varnished. Size 4" × 3½" × 3". Price £3·50p + 28p Post 80p + 6p.

Stereo Flex twin screen flg. 8 type. PVC insulated overall. 10 metres for £1 + 8p.

Latching Relay by Guardian Electric, mains operated it is in fact two relays mounted on a metal base plate. The relays being mounted in such a way to ensure that when one closes the other opens and vice versa thus when closed, relay A would remain locked until manually released or electrically released by energising relay B. Each relay has 2 sets of 10 amp change-over contacts. Should be ideal for burglar alarms and similar applications. Price £1·95p + 16p.

Connecting Wire. 7 stranded PVC insulated on 500 metre drums, 6 different colours available, price £4 per 500 metres + 32p. Post £1 + 8p. Please give alternative colours when ordering.

8 Track Stereo Cassette Deck. Complete mechanism with push button operated track selection. Tape head and pre-amp, Japanese made with front flap for cassette entry. Price £5 50p + 62p. Post 40p + 5p.

Mains Power Supply to suit deck £2 + 25p.

8 Track Stereo Car Cassette Player. 12 volt with polarity reversing switch. Speakers not included, these were sold under the trade name "Elpico" at just under £20 each. The ones we have were faulty on arrival from Japan but have been serviced. Price £9·50p + £1·99p. Post 50p + 7p. We also have few of these still in need of a repair but complete and we believe quite repairable. Price £6·50p + 82p. Post 50p + 7p.

Shaver Light with isolated socket. As you know normal mains sockets must not be used in bathrooms on account of the danger of an accident through touching the live side when earthed through bath or sink etc. However, provided it is isolated from earth a shaver socket is allowable and the one we are offering complies with this requirement. It is also fitted with a pull cord switch and is ideal for use over the mirror in the bathroom. Price £3·50p + 68p. Post £1·50p + 12p.

Pressure Control Switch made by Allan Bradley of the U.S.A., their ref. no. 836. Completely adjustable from 30" of vacuum to zero then up to 75lbs per square inch of air pressure. This also has an adjustable differential which can be set to pressure tolerance of between 2–15 psi. The switch operates changeover contacts which look capable of breaking up to 15 amps AC. Few only of these, price £15 + £1·20p.

Air Flow Senser, American made by the Foxborough Company. We have two different types. One bears ref. NF8–503A and the other MF8–502B. These are beautifully made precision units obviously intended for fitting into very high pressure air or gas lines. There is an inbuilt turbine and transducer/convertor with electrical contacts but other than this we have no information on these sensers, price is negotiable.

Convertor Amplifier, again made by the Foxborough Company, their part no. N 137 CR. We believe these are for use with the above air flow sensers, price again negotiable.

Motor with Gear Box made by Klaxon, their type no. EK3Q J2–M21. This is a very popular type of motor, final drive shaft comes out at right angles to the motor. Final speed is 10 rpm. Approximate size of the motor casing 07" long × 1" diameter. These are ex-equipment but guaranteed o.k. supplied complete with transformer for use on standard 230v 50hz mains. Price £4 + 32p. Post 80p + 6p.

Mains Table Radio, Japanese made. This is a Medium wave valve receiver with built in aerial, plenty of volume and reasonable tone. Will receive all strong and medium powered stations on the wave bands—medium wave. This type of radio is coming back into popularity owing to the very high price of batteries. Price £4·95p + 50p. Post £1·50p + 19p.

Auto Transformer 20 watt 240 volt to 115 volt. This is the same as the transformer above as this has a centre tapped primary. Price £1·50p + 19p.

Mains Battery Eliminator, Japanese made. Bakelite encased with two prongs for shaver and adaptor. This has output of 4·5v at 100 mA and is, therefore, suitable to use in radios or similar equipment that use three 1·5 cells or by small internal alterations the voltage can be stepped up to 6 volts very easily or 9v and 12v. Price £2·00 + 25p. *ditto* but 9V, Price £2·50p + 30p.

Car Starter. Most drivers who use their car around town find that on a very cold morning they have difficulty in starting because the battery has not any charge left in it. This always seems to happen on the morning when you are in a particular hurry so a charger/starter is well worth having. Our kit for this comprises: a heavy duty 250w transformer and full wave rectifier which for short periods will deliver 20 amps. This is usually enough to get the car started, directly it has started of course it can be disconnected from the battery as the car's internal charger will take over. Special offer price of this is £6·50p including post and VAT.

MULLARD UNILEX

A mains operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost any one in easy-to-assemble modular form and complete with a pair of Celestion speakers. This should sell at about £30—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only £14 including VAT and postage.

PAPST MOTOR

West German make, these fine motors are noted for their performance and reliability. Special features are the rotating heavy outer which acts as a flywheel to eliminate wow and flutter and switchable reversing.

We have four types in stock, all 1350 revs., including starting capacitor.

(1) Reference No. KLZ 20.50-4, 230 volts 50HZ, price £5·50
(2) Reference No. KLZ 32.50-4, 230 volts 50HZ, price £6·50
(3) Reference same as above, 115 volts 50HZ, price £2·50
(4) Reference same as above, 110 volts 60Hz, price £2·50

Post and VAT 80p each extra.

AEROSOL RELEASE LUBRICANT

Dry Film Lubricant. In aerosal can for easy application and for putting lubricant into places where the normal oil can cannot reach. Home and everyday uses. We have purchased a large quantity of these from the Liquidator and are able to offer them to you for about half of the original list price. 88p per 8oz can or 12 cans for £5 Post & VAT Paid. The lubricant is I.C.I. fluon L169.

MAINS MOTOR

Precision made—as used in record decks and tape recorders—ideal also for extractor fans, blower, heaters, etc. New and perfect. Snip at 95p + VAT & Postage 35p. 1" stackmotor £1·56 + VAT & postage 35p. 1½" stack-motor. £2 + VAT and Postage 40p.

MULTI SPEED MOTORS

Six speeds are available 500, 850 and 1,100 r.p.m. and 7,000, 9,000 and 11,000 r.p.m. Shaft is ¼ in. diameter and approximately 1 in long. 230/240v. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor size approx. 2 in. dia × 5 in. long. Price £2·00 including Post & VAT. 8speed control switch 50p + 4p.

DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·75, VAT & postage 85p.

MOTORISED DISCO SWITCHES

With six 10 amp changeover switches. Multi adjustable switches are rated at 10 amp each so a total of 2000w's can be controlled and this would provide a magnificent display. For mains operating £4·25 post & VAT Paid. Ditto 9 switch £4·95 Post & VAT Paid. DITTO BUT 12 SWITCH £5·75 POST & VAT PAID.

BATTERY CONDITION TESTER

Made by Mallory but suitable for all batteries made by Ever Ready and others, most of which are zinc carbon types but also mercury manganese—nicad—silver oxide and alkaline batteries may be tested. The tester puts a dummy load on the battery and the meter scale indicates the condition depending upon which section the pointer rests. The section reads "replace" "weak" or "good". The tester is complete in its case, size 3¾" × 6¼" × 2" with leads and prod. £4·50 post & VAT paid.

CENTRIFUGAL BLOWER

Miniature mains driven blower centrifugal type blower unit by Woods. Powerful but specially built for quick running—driven by cushioned induction motor with specially built low noise bearings. Overall size 4½" × 4½" × 4". When mounted by flange, air is blown into the equipment, but to suck it out, mount from centre using clamp. Ideal for cooling electrical equipment or fitting into a cooker hood, film drying, cabinet or for removing flux smoke when soldering, etc. etc. A real bargain at £3·30. 60p post & VAT.

BREAK-DOWN UNIT

Contains hundreds of useful parts some of which are as follows—66 silicon diodes equivalent OA91, 68 resistors, mostly ¼ watt 5% covering a wide range of values 4 × ·1 mfd 400v mfd condensers, 15 × ·01 mfd 100v condensers. 2 RF chokes 8 × B9 valve holders, 1 × 4H choke, 1 × 115v transformer, 1 boxed unit containing 4 delay lines also tag panels, trimmer condensers, suppressors, etc., on a useful chassis sized approx. 9" × 5" × 7". Only 75p (the 66 diodes would cost at least 10 times this amount). This is a snip not to be missed. Post and VAT 75p.

HONEYWELL PROGAMMER

This is a drum timing device, the drum being calibrated to equal divisions for switch-setting purposes with trips which are infinitely adjustable for position. They are also arranged to allow 2 operations per switch per rotation. There are 15 changeover micro switches each of 10 amp type operated by the trips, thus 15 circuits may be changed per revolution. Drive motor is mains operated 5 revs per min. Some of the many uses of this timer are Machinery control. Boiler firing. Dispensing and Vending machines. Display lighting animated and signs. Signalling, etc. Price from makers probably over £20 each. Special snip price £9·96. £1·00 Post and VAT. Don't miss this terrific bargain.

TERMS: Where order is under £6 please add 50p surcharge to offset packing expenses

J. BULL (ELECTRICAL) LTD.

(Dept. E.E.), 103 TAMWORTH ROAD, CROYDON CR9 1SG.

IT'S FREE!

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—It's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from a recent list.

Light for Growing. With the ever increasing price of oil, more and more growers are using insulated buildings without any daylight and are using electric lamps for light and heat. Various different types of lamps are recommended, amongst these are 8' fluorescent tubes, warm white with internal reflector. We recently acquired a quantity of these, with suitable control gear and can, therefore, make a special offer as follows: if you buy 100 sets each set comprising 8ft tube, instant start ballast, current regulating capacitor, two bi pin tube connectors and two terry clips for holding the tube. Price £3 + 24p per set. Collected from our depot in Sussex or delivered to you—delivery charge at cost. We have only 1000 of these sets so this offer should be taken up quickly.

Mains Volt Drop Compensation Transformer. Another irritating thing which happens in cold weather is that the mains voltage drops and this can often drop to such a low point as to make soldering irons unusable or very slow in operation and also upsets the working of other instruments. Even in normal weather if you put a long line through to a distant workshop you may find that the voltage is low, due to voltage drop along the line so the compensation transformer may be the cheap way of restoring voltage to normal. The other alternative is to install a much heavier cable. **Our 500w Auto Transformer** will give voltage increases of 10, 20, 30 or 50 volts depending on which tapping you use. Price £4·50p + 38p. Post £1·00 + 8p.

Cable Bargains. We have now sold out of all the 7029 3 core and also all the 1·5mm 3 core. We are also rapidly going through our stocks of 7029 3 core and earth and 1·5, 3 core and earth. You will recall that we made a special offer of these cables at £9·50p + 76p and £5·50p + 44p. So if you have installation work planned then we advise you to buy early to avoid disappointment. We have most other sizes of cable in stock but of course these are not so popular.

Variable Inductance Choke. In an unsaturated core state a choke will oppose the flow of AC very much more than when its core is saturated, therefore, if the choke is built with a separate coil to deliberately saturate the core, a very small current of variable dimension will act as a voltage regulator. Use this for lamp dimming and a multitude of other purposes. We offer such a choke of 8 amps AC rating requiring 75mA DC control current at bargain price of £22·50p + £1·86p. Carriage £5·00 + 40p. Weighs app. 60lbs.

Panel Meter 0–1mA. Japanese made full vision perspex front, flush mounting. Price £2·00 + 16p.

Constant Voltage Auto Transformer for operating 110v equipment off our standard 230/240v mains. Input voltage can be plus or minus 20% output voltage will be a steady 115 volts, beautifully made by an American Company. Two models available 500w £35 + £2·80p. Post £2 + 16p. 750w model £50 + 4. Carriage £3 + 24p.

Tangential Blower, paddle type metal impeller driven by a powerful but quiet mains operated induction motor. These give a real blow (or suck) with the minimum of noise. The air outlet is 9½" × 1½" approx. so they are ideal for fitting into a cooker head, forced draft heater etc. Price £3·00 + 24p. Post 80p + 6p.

Tubular Heating Element. Spiral wire element, wound on a porcelain tube approx. 1¼" dia. and 3¾" long. 500w rating at 240 volts with flat tag connectors. Internal diameter of the porcelain tube is ¾" and it is completely free from obstructions and live parts so this can be slipped over a tube to heat the contents of the tube or the tube could simply be used to support the element, for instance if this was being mounted in front of the tangential blower mentioned above. Price 50p + 4p.

Rectangular Hot Plate. Polished aluminium panel with ridged top and angles underneath to strengthen it. This is approx. 10" × 4½" of flat plate. Beneath plate is 100w element and sensor switch which will maintain the surface of the plate just too hot to touch. With leads and tags. This is ideal if you are making up a fitted warmer or for an airing cupboard etc. Price 75p + 6p. Post 20p + 2p.

Miniature Mains Transformer, standard primary centre tape secondary giving 4·5v–0–4·5v 200 mA. Price £1·50p + 12p.

Mains Transformer 20volt ½ amp. Upright mounting standard, primary centre tapped and fixing feet. Price £1·50p + 19p.

Humidity Switch, American made by Ranco, their type No. J 11. The action of this device depends upon the dampness causing a membrain to stretch and dryness causing it to contract. The stretching of the membrain through the dampness will trigger a sensitive microswitch. The actual point of switching is adjustable by a screw within the device. It is quite sensitive breathing on it for instance will switch it on. The rating of the micro-switch we understand is 3 amp at 250v AV. Overall size of the device approx. 3¾" long 1" wide and 1¼" deep. Price 60p + 5p.

Charge/Discharge indication meter. This is a heavy panel mounting instrument made originally for the G.P.O., rather old design but still we feel will fill an urgent need. Basically the operation of this depends upon a Mercury motor which revolves clockwise or anti clockwise depending upon whether the batteries are charging or discharging. A pointer shows the state of charge of the batteries at any time. Also fitted within the instruments are auxilliary contacts which could be used to set off alarms like lamps etc. Price £4·50p + 36p. Post £1·00 + 8p.

everyday electronics

PROJECTS . THEORY....

IDEAS ABOUND

Readers' suggestions for projects continue to arrive at our office in a steady flow. This is a good sign for it indicates a lively interest and frequently a very fertile imagination on the part of those who write.

All ideas are looked at carefully, and those judged to be viable are actively pursued. Our investigations do not always come up trumps, however. Some suggestions will not stand our three-part test which involves these considerations: (1) technical feasibility, (2) practicability and (3) cost to the builder.

Sometimes it happens that alternative approaches can be made to a problem. An example is given by the recent projects for use with tumble dryers. Last month's Tumble Dryer Alarm was a spin-off from an earlier design and had the advantage of being battery operated, simpler in design and less expensive to build. The original Tumble Dryer Controller (published in January) offered automatic control of the mains supply to the machine—a valuable facility but one that had to be paid for of course, both in cash and in the more demanding nature of the construction work because of the more complex design.

Some readers may feel that their particular suggestions take a long time to materialise. But never give up hope! For instance the Model Railway Controller is an answer to a model railway enthusiast whose comments appeared in EVERYDAY ELECTRONICS exactly a year ago. At that time we promised that some designs for model railways would be forthcoming. In this case, the longer-than-normal delay in publishing was not due to design problems, but simply because of prior commitments in our available space.

We strive to give every specialist interest a fair crack of the whip. But because electronics is so universal in use, the range of possible applications is immense and it is inevitable that suggestions have to take their turn in the queue.

BUYING COMPONENTS

Isn't this remarkable? A vast number of electronics constructors will never have stepped across the threshold of an electronic component shop—and as likely as not they have never even *seen* such a shop. The answer of course is Mail Order. Without this service thousands of constructors would be deprived. Despite the odd stories one does hear from time to time, mail order works very well.

The *Guide To Component Buying* which comes as a special supplement in this issue, gives a listing of component retailers who advertise in EVERYDAY ELECTRONICS and indicates the kind of components they normally stock. A useful reference for all constructors, both those who order by post and those who can indulge in personal shopping. For the privileged latter—a reminder also of those shops that are in their own neighbourhood or within easy reach.

Fred Bennett.

Our May issue will be published on Friday, April 15
See page 177 for details.

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...EASY TO CONSTRUCT
...SIMPLY EXPLAINED

VOL. 6 NO. 4 APRIL 1977

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

SPECIAL SUPPLEMENT

BACK NUMBERS, LETTERS AND BINDERS

We are unable to supply back copies of Everyday Electronics or reprints of articles and cannot undertake to answer readers' letters requesting modifications, designs or information on commercial equipment or subjects not published by us. An s.a.e. should be enclosed for a personal reply. Letters concerning published articles should be addressed to: The Editor, those concerning advertisements to: The Advertisement Manager, at the address shown opposite.

Binders for volumes 1 to 6 (state which) are available for £2·10, including postage, from Post Sales Department, Lavington House, 25 Lavington St., London SE1 0PF

WHEN power for a model train is derived from a.c. mains, by means of a transformer and rectifier, speed control is easily provided by incorporating a silicon controlled rectifier or thyristor. The thyristor does not act as a series resistive element, as when using a variable power resistor and similar circuits, but provides full-voltage pulses whose length can be controlled. This results in better slow speed starting and running of the engine, than does variable voltage control.

CIRCUIT OPERATION

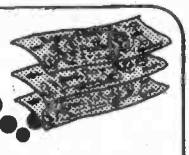
The controller circuit is shown in Fig. 1 where T1 is the mains transformer, which reduces the voltage and isolates the model circuit. The full-wave rectifier bridge D3 to D6 provides pulsating d.c. for the control circuit and model. During each half-cycle the rectifier output rises from zero to peak voltage, then falls away again to zero. This pulsating d.c. is present across the speed control VR1.

The rectifier output is also taken to the thyristor which supplies power for the model. When the thyristor gate g, receives a trigger pulse, an avalanche discharge causes the thyristor to conduct, and continues until the voltage across it falls to a low level, resulting from the zero output part of the rectifier half cycle. If the thyristor conducts for the whole of the half cycle, full output is obtained. But as VR1 slider is moved towards the negative line the required trigger pulse is delayed, so that the thyristor only conducts for part of the half cycle.

Switch S1 is the main on-off switch, and S2 a reversing switch with central off position. The lamp LP1 is to limit current in the event of a short circuit. The filament is of low resistance when cold so it has negligible effect on running.

Capacitors C1 and C2 of the values shown were found to give the best results, though these values are not critical; C3 helps quiet running of the motor, as does D1. With the usual popular model engines, VR1 provides

FOR GUIDANCE ONLY

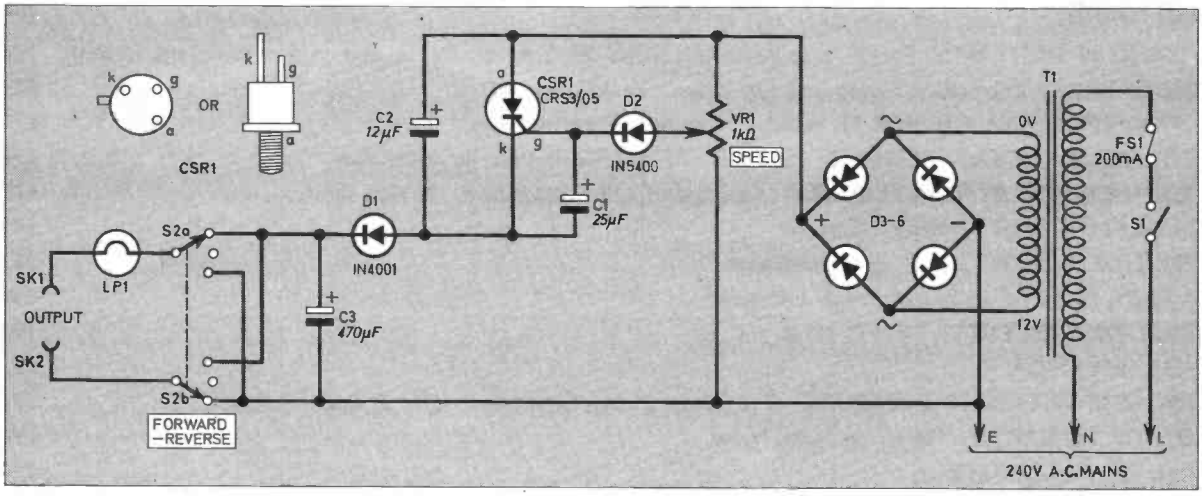


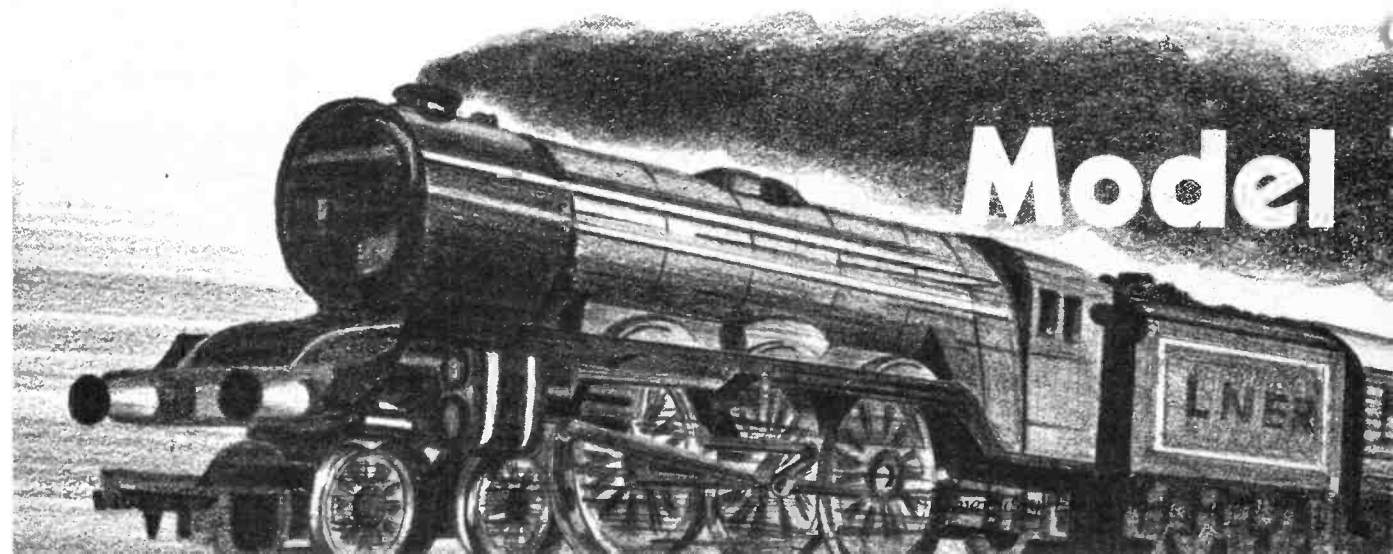
ESTIMATED COST OF COMPONENTS * excluding V.A.T.

£6.40

excluding case

Fig. 1. Circuit diagram of the Model Railway Controller.





control from a standstill to full speed.

CONSTRUCTION

The prototype case was made from 6mm plywood for the front, back and sides and 4mm plywood for the top and bottom such that the control panel was on top and sloping from the rear to the front. Any convenient metal or insulated box could be used.

It is a good idea to provide some ventilation holes in the case back and bottom, and stand the case on four small rubber feet.

The layout of the components within the case and complete wiring up details are shown in Fig. 2. The transformer is bolted to the back of the case. One side carries two output sockets, and a strap of metal formed so that it holds the lamp, which sits under a coloured lens in the control panel.

Anchor the mains lead at a tag strip as shown, taking the earth lead (yellow-green) to the d.c. negative line (which will include the metal box, if used).

Most items are supported by a tag-strip, which is bolted at X-X. Four 1N4001 diodes could be used instead of the full-wave bridge rectifier if these are more readily available. Diode D2 has a band at the positive end, and the larger diode D1 tapers to indicate positive.

The thyristor anode stud was fitted with a solder tag, and then soldered to the tagstrip as shown. No difficulty arises in fitting items here with the tagstrip already bolted to the side of the case. (Pinning for CSR1 is shown in Fig. 1.)

The transformer used was tapped for 2, 6 and 12 volts charging, at 1 ampere, and delivers approximately 17 volts peak. A 12 volt 12 watt lamp at LP1 will limit current to 1 ampere, if derailment or other circumstances result in a short circuit, which is indicated by the indicator lamp fitting above LP1 being illuminated.

Assuming that any such mishap will soon be cleared, a 21 watt lamp can be used here. Another alternative to the 12 watt lamp is a 10 watt festoon bulb, which does not of course cause any temporary overload. A lamp of unnecessarily low wattage should not be used.

There is some latitude in components, but it is wise to fit a thyristor and D1 rated at over 1A, even though this is the normal maximum load for the controller.

Speed controller, VR1, should have a large control knob and it must not be overlooked that S2 needs a central off position which avoids any short-circuit of power.

RUNNING

It should be found that VR1 allows the train to be started and run at a very low speed if wished, and that tractive effort is good at low speed. The engine is less likely to stall, when running very slowly and encountering additional friction or load, than when a series resistance controller is used.

Track and wheels should be clean, as at low speed there is no momentum to carry the engine over any dirty spots where contact is poor. ⌑

Components

Capacitors
C1 25μF elect. 25V
C2 12μF elect. 25V
C3 470μF elect. 25V

Semiconductors
D1 1N4001
D2 1N5400
D3-D6 2A 50V bridge rectifier
CSR1 CRS3/05 or similar 3A 50V thyristor

Miscellaneous
S1 mains on/off toggle
S2 d.p.d.t. with centre off position
T1 mains primary/12V 1A secondary transformer
VR1 1kΩ 1 watt lin. potentiometer
LP1 12V 12W lamp with coloured lens
FS1 200mA fuse
SK1, 2 insulated screw terminals 1 red, 1 black (2 off) Tagstrip: 10 way and 3 way; mains cable; BA fixings; connecting wire; fuseholder for FS1; case.

See Shop Talk

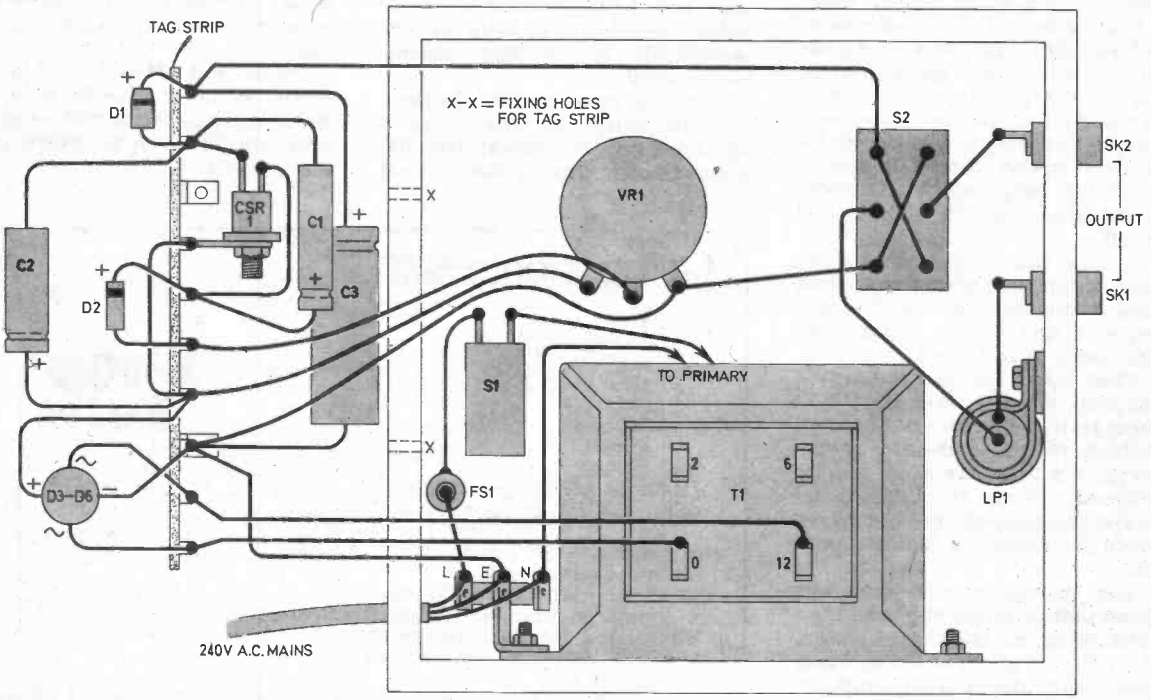
Railway Controller

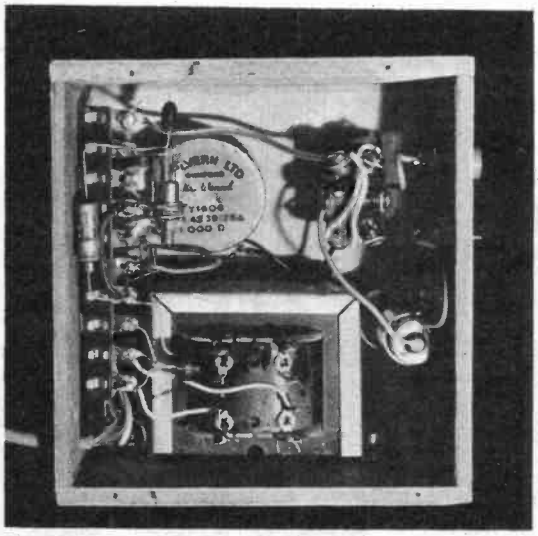
A simple unit providing realistic speed control.

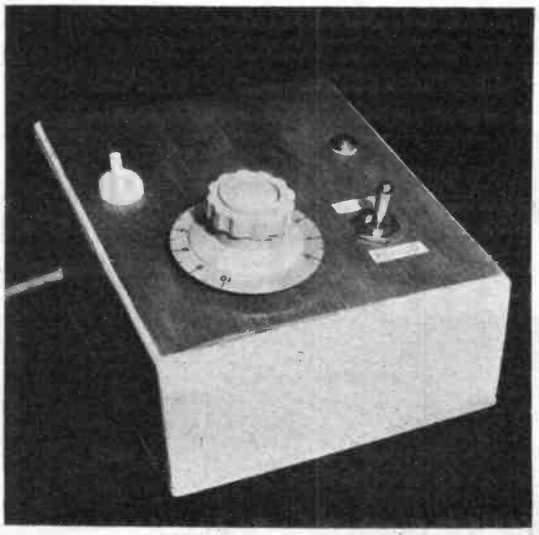
by F. G. Rayer

Model Railway Controller

Fig. 2. Construction and wiring of the Model Railway Controller.







car burglar alarm

By A. D. Huff

With crime on the increase, and the cost of cars and "in-car" stereo equipment, radios etc, also on the increase, a cheap effective car alarm is essential for the everyday motorist.

If a car is fitted with a trembler switch in the engine compartment and microswitches on the doors and boot, the following protection is afforded.

Anyone tampering with the wheels, spotlights and such will set off the alarm (car horn) due to the trembler switch. The alarm will sound off and reset itself.

If the thief opens the car door the horn will sound, two things may happen. If he runs away leaving the door open the horn will continue to sound until the battery is exhausted, the door is closed or the alarm switched off.

It was thought disadvantageous in the design to have the horn switch off automatically whilst the door is left open. If the would-be thief closes the door in an effort to stop the horn sounding, it will only switch off after the pre-set time has elapsed.

The time that the horn will sound has been designed to be between 5 and 25 seconds. In fact with one component change the range can be extended to be between 12 and 45 seconds. Longer times than these should not be required for a car alarm.

An automatic turn off saves having to switch the alarm off if it is accidentally triggered by children for example.

With this design the driver will not return to his car to find a flat battery if the alarm has been sounded in his absence.

CIRCUIT

The complete circuit diagram of the Car Burglar Alarm is shown in Fig. 1. It is simply a monostable feeding a relay driver. The monostable is composed of TR1 and TR2 and associated components. With the microswitches and trembler open circuit, and the unit turned on, TR1 is fully on and TR2 is fully off. There is no drive to TR3 hence the relay is not energised.

The circuit will remain in this state until a microswitch or the trembler is caused to short D1 cathode to ground. Transistor TR1 is then caused to switch off and TR2 on thereby supplying drive to TR3 and causing the relay to be energised; the relay contacts close and supply power to the horn. The horn will continue to sound even though the microswitch or trembler become open circuit and will remain in this state until capacitor C3 discharges through the resistance formed by (R3+VR1), so that the potential on the base of TR1 exceeds that on TR2 when the circuit will revert to its original state i.e. TR1 on TR2 off.

Thus the relay on time is controlled by the value of VR1 and C3. An approximate formula for the on time of the relay is $T = 0{\cdot}7 \times C3 \times (R3 + VR1)$ seconds where C3 value is in microfarads and resistance is in ohms. It can be seen that doubling the value of C3 doubles the on time.

SOME ASPECTS OF THE CIRCUIT

Capacitor C2 is incorporated to prevent the ripple on the +ve supply line (caused by the horn operating), from prematurely resetting the monostable. The back e.m.f. from the horn is prevented from re-triggering the unit by the inclusion of D4.

Diode D3 is used to suppress the back e.m.f. developed across the relay coil when de-energised. Diode D2 is included to limit the reverse bias on the base/emitter junction of TR1 due to the large negative voltage present on C3.

If more than one horn is connected to the circuit the value of the 5 amp fuse will have to be increased. Also a relay with a higher contact current rating will have to be used. It is a good idea to check the current consumption of your horn circuit before building this unit and selecting the relay to suit if greater capacity than 5A is required.

CONSTRUCTION AND FITTING TO CAR

The prototype unit was constructed on a piece of 0·1 inch matrix stripboard measuring 19 strips by 39 holes. The layout of the components is shown in Fig.2 as are the breaks to be made on the underside of the board. The holes to take the relay tags should be enlarged to suit the size of the tags. There are two copper strips that need to be reinforced to carry the current to the horn. This is easiest done by soldering

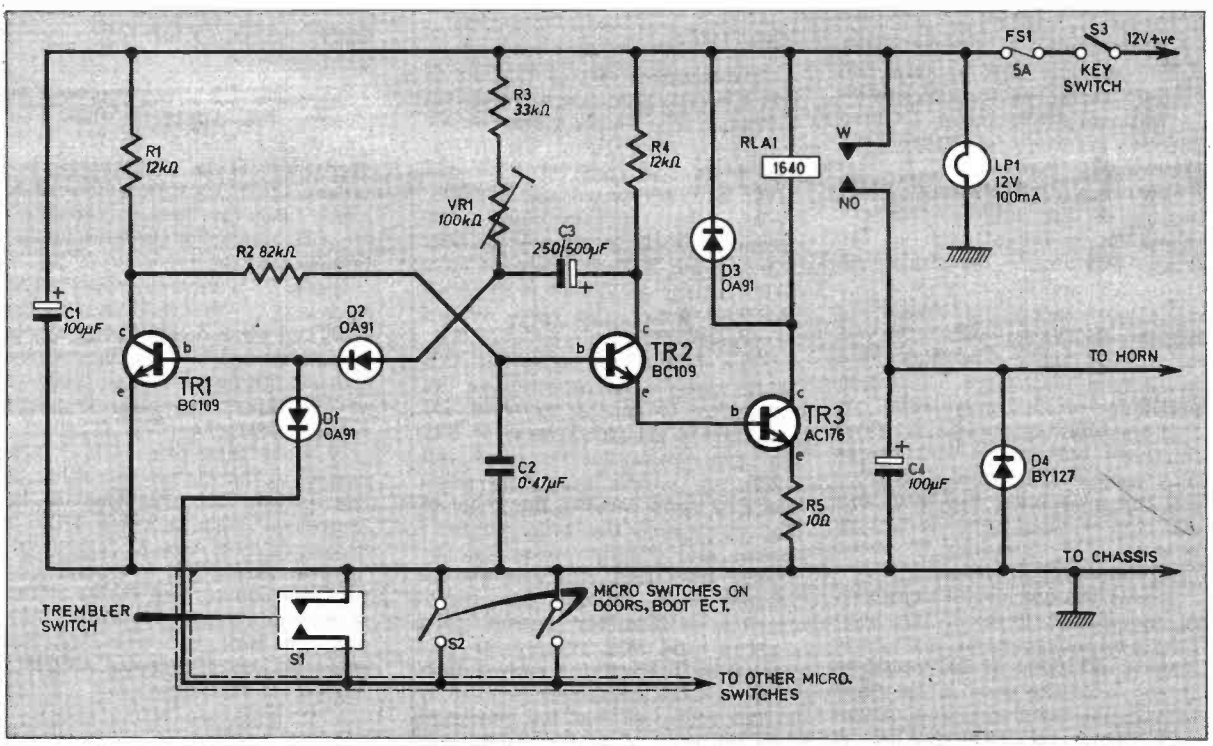


Fig. 1. The Complete circuit diagram of the Car Burglar Alarm.

Components

Resistors
R1 12kΩ
R2 82kΩ
R3 33kΩ
R4 12kΩ
R5 10Ω
All ¼W carbon ± 10%

Potentiometer
VR1 100kΩ horizontal preset

Capacitors
C1 100μF 25V elect.
C2 0.47μF plastic or ceramic
C3 250μF 25V elect.
C4 100μF 25V elect.

Semiconductors
TR1 BC109 silicon *npn*
TR2 BC109 silicon *npn*
TR3 AC176 germanium *npn*
D1 OA91
D2 OA91
D3 OA91
D4 BY127

Miscellaneous
FS1 5A with in-line fuseholder
RLA1 12V 1640 ohm coil with 5A normally open contacts (Doram 349-131)
S1 Trembler type switch
S2 Microswitches (number to suit)
S3 Key operated switch
LP1 12V 100mA m.e.s. with holder and lense to suit
Stripboard: 0.1in. matrix 19 strips x 39 holes; robust case; screened lead; 5A connecting wire.

FOR GUIDANCE ONLY

ESTIMATED COST OF COMPONENTS * excluding V.A.T.
£4.80
excluding switches and case

SEE SHOP TALK

short lengths of stout tinned copper wire to the tracks as indicated.

The usual practice should be observed in assembling the components, that is, resistors and capacitors, link wires, flying leads, followed by the semiconductors (use a heatshunt when soldering these in place).

Screened cable should be used for connecting the microswitches to the component board to reduce the possibility of the alarm being triggered by r.f. transmitted from the wiring of passing vehicles.

The placement of the completed unit within the car will be a personal choice, but the author recommends that for long time reliability the unit should be fitted inside the car and not in the engine compartment. It is also advisable to fit the completed component board inside a robust case such as an aluminium diecast box.

Obviously the key operated switch will have to be mounted on the car bodywork if you don't want the alarm to sound as you are getting back into the car so that it can be "de-activated" before getting into the car. For obvious reasons the wiring to the horn and battery from the unit should be well concealed. ⌑

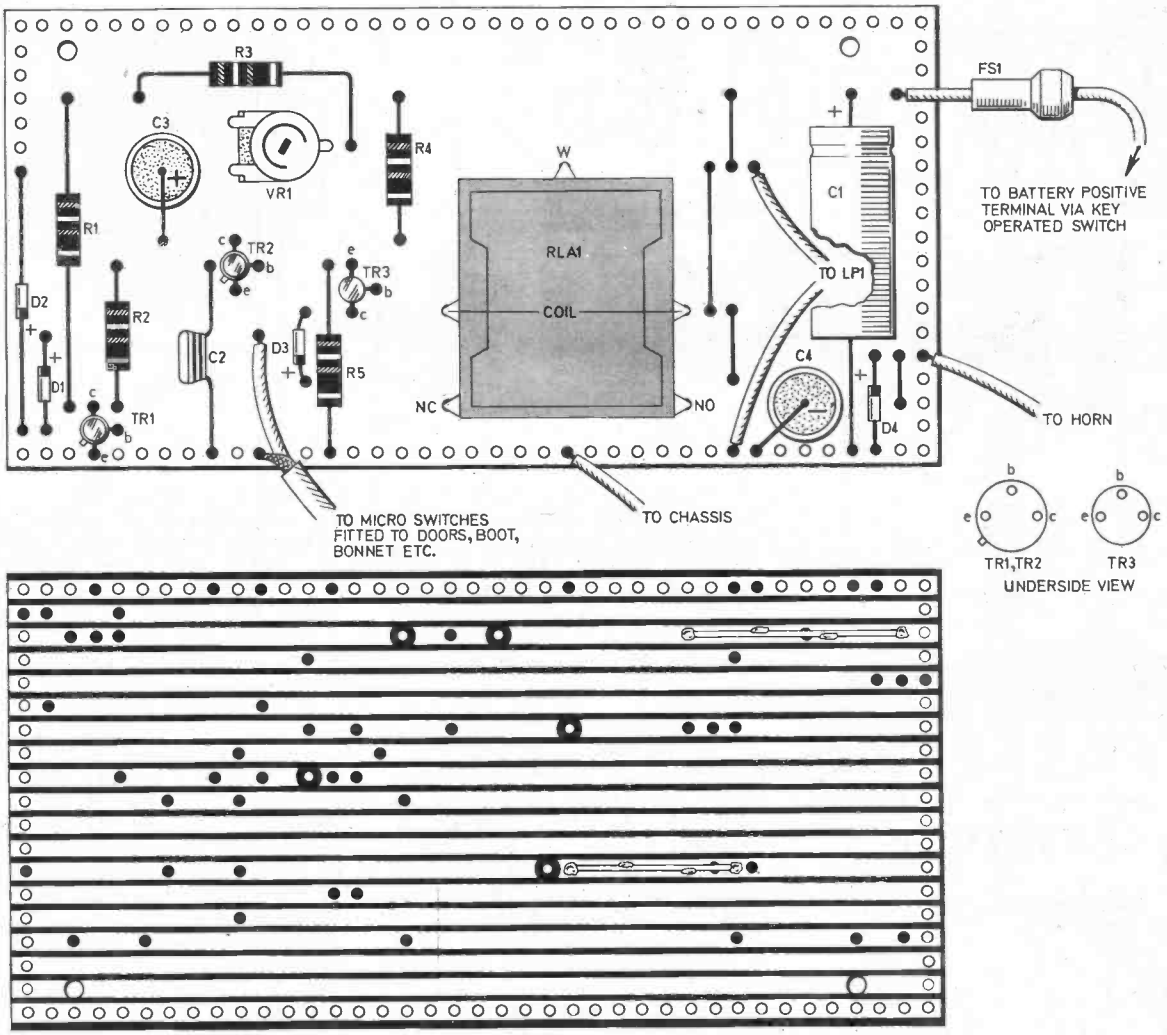
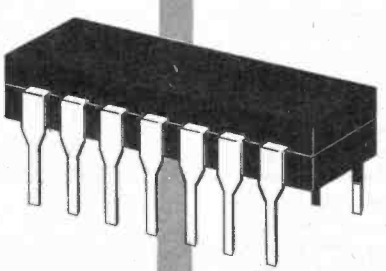


Fig. 2. The layout of the components on the topside of the stripboard and the cut-outs to be made on the underside and wiring details to the car. Note the stout copper wire soldered along the strips to enable high current flow.

Doing it Digitally...

Part 7

By O. N. Bishop



THREE new circuits are discussed in this month's section: a single pulse generator; the WIRED-OR connection and the Schmitt trigger. We will also look at two useful input devices which can be made quite easily from a piece of stripboard some drawing pins and paper clips.

A SINGLE PULSE GENERATOR

The single-pulse generator is a useful circuit which produces a short high pulse every time its input changes from low to high. A typical use for this circuit might be after a light operated switch whose output goes from low to high at dusk. The single pulse may then be used to clock a flip-flop or some other counting device.

The basic circuit is shown in Fig. 7.1a and it can be seen that the heart of the circuit consists of two NOR gates. One of the gates is connected to form an INVERTER. Normally the input is low which causes the output of the INVERTER to be high and hence the output of the second gate to be low. In this state the voltage across the capacitor C1 will be zero.

If the input is now taken high (Fig. 7.1b) the output of the INVERTER will immediately go low. The voltage across C1 will gradually rise towards the high input but for a certain time (determined by the values of C1 and R1 and the switching threshold of the gate) gate IC1b will see a low on both its inputs and so its output will be high.

Eventually C1 will charge to such a voltage that it presents a high input to gate IC1b (Fig. 7.1c) and the output will there-

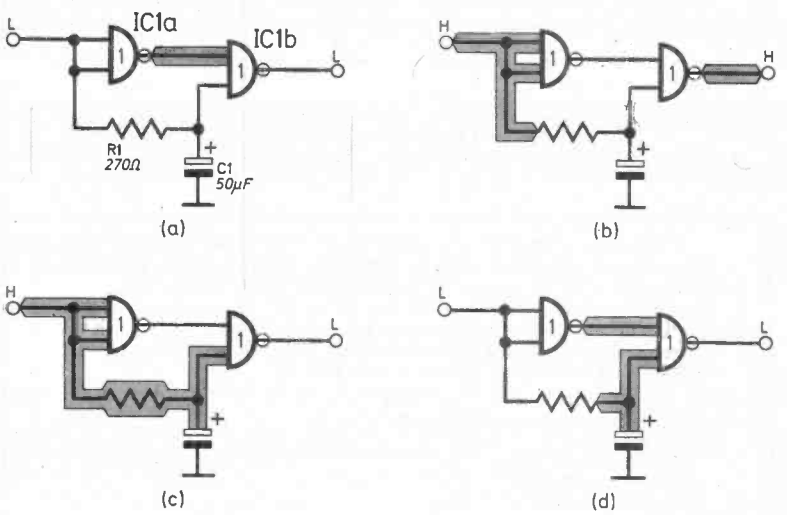


Fig. 7.1. Single pulse generator (a) shows the circuit before it is activated. The shaded areas indicate a high level. (b) shows the state of the circuit just after the input has gone high (c) shows the state after the capacitor has had time to charge and (d) shows the circuit when the input returns to low.

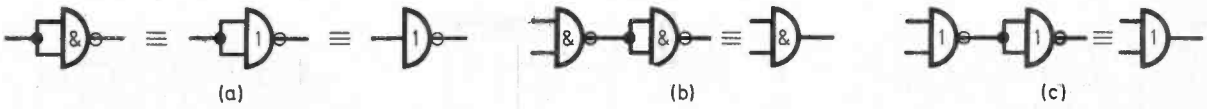


Fig. 7.2.(a) Using a NAND or NOR gate as an INVERTER (b) Combining two NAND gates to form an AND (c) Two NORs forming an OR

fore go low again.

If the input now goes low the output will be unaffected since the INVERTER will immediately present a high input to gate IC1b keeping its output low. Capacitor C1 will now discharge through R1 until its voltage falls to that equivalent to a low input and sufficient time must be allowed for this to happen before the generator is once again ready for action.

The length of the pulse can be varied by changing the value of C1. With the value shown the pulse length will be about five milliseconds.

WIRED-AND CONNECTION

On looking through the list of 7400 integrated circuits it will be found that there are many containing NAND gates and quite a few containing NOR gates. Most logic combinations can be formed with just these two types but sometimes other functions such as INVERT, AND and OR are required.

If only one of these gates is required it is easy to make them from NANDS and NORS and this saves the trouble of buying a package containing four gates.

In Fig. 7.2 various functions which can be obtained from combinations of NAND and NOR gates are illustrated. If several AND gates are required then it is wise to buy the 7408 i.c. which contains four such gates and if several INVERTERS are needed then one would use the 7404 i.c. which contains six.

Rather than waste two NAND gates just to make a single AND gate, there is a way of using just a few discrete components to achieve the required result.

Remember that TTL (*transistor transistor logic*) gates work by drawing current from the following gate when the input is taken low. In other words we can say that if no current is being drawn from the input of a gate then that input must be high.

Referring to Fig. 7.3, input to gate *D* will be high if no current is drawn from the gate through any of the diodes D1 to D3. No current can be drawn from the gate through the resistor since it is connected to the positive supply—it is called a pull-up resistor as it "pulls up" the voltage on the input when no current flows through the diodes.

Now if the outputs of any of the gates *A* to *C* goes low (Fig. 7.3b) the respective diode will conduct and the voltage at the input to gate *D* will fall to a value equal to the forward voltage drop across a diode (about 0·6V) which is seen by the gate as a low input and hence current flows from the input. (This assumes that the voltage at the output of a gate when it is low is zero which is not exactly true, there always being about 0·2V present.)

From this description it can be seen that the input to gate *D* will only be high if the outputs from gates *A* to *C* are all high (Fig. 7.3c)—hence D1 to D3 and R1 form an AND gate.

It is an unfortunate fact that diodes are as expensive as gates so it is not an economic proposition to use this method of making AND gates if many are needed. The use of 7408 i.c.s means that one is restricted to two-input gates. Happily there is a way of forming AND gates with as many inputs as required without using any gates!

Suppose one has a circuit with a number of outputs from NAND gates and one wishes to AND their outputs to give a single output which only goes high when all the outputs from the gates are high. The outputs could be combined with a diode gate as described above but if, instead of ordinary type 7400 NAND gates, one uses a special type of NAND gate then no diodes are required—the outputs are simply joined together with wire, the common connection being taken to the positive supply through a resistor.

This method of connecting the outputs of special gates with wire to form AND gates gives rise to the name "WIRED-AND". The special i.c.s containing these gates

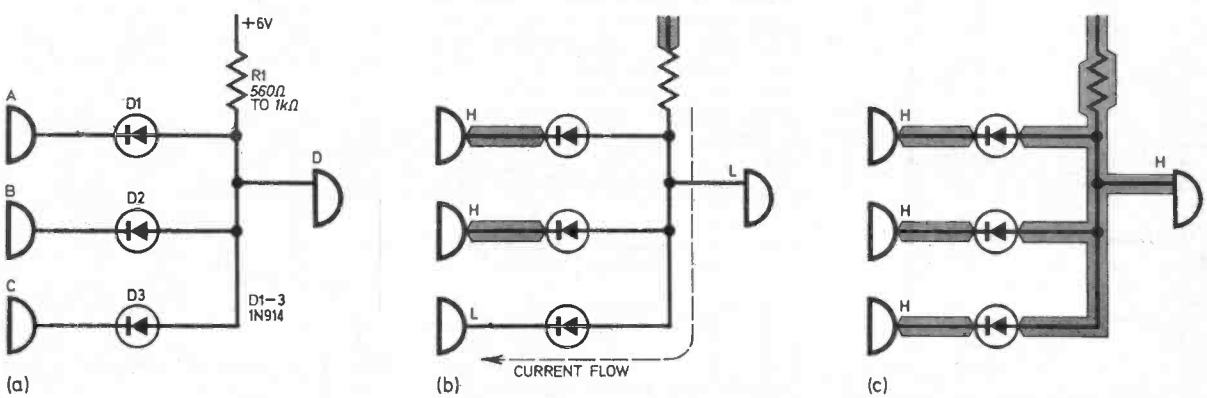


Fig. 7.3.(a) An AND gate using three diodes and a resistor connected to the output of three gates. Gates A, B, C and D can be any type of gate. (b) Current flow when the output of one of the gates is low (c) State of the circuit when the output from all gates are high.

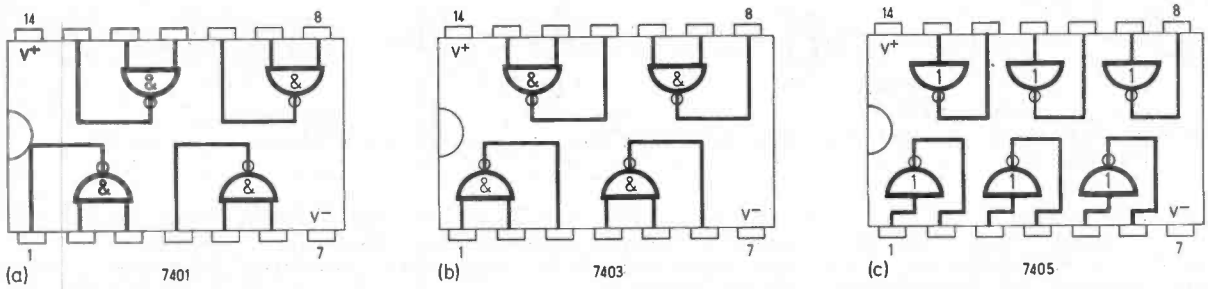


Fig. 7.4. Pin connections for three types of open collector i.c.s. (a) the 7401 quad two-input NAND gate (b) the 7403 quad two-input NAND gate and (c) the 7405 hex INVERTER.

are usually referred to by the manufacturers as "open collector" gates.

The internal connections of three i.c.s containing open collector gates are shown in Fig. 7.4. The 7401 is a quad two-input open collector NAND gate i.c. as is the 7403. The pin connections of the 7403 are identical to those of the 7400 but the 7401 is different. Also available is the 7405 which contains six INVERTERS with open collector outputs which can be WIRED-AND connected.

When wired together the outputs of the 7405 are ANDed but if the inputs of these gates are considered it will be seen that if any one or more of them is high its output is low and the ANDed output is therefore low. This takes us once more to NOR. Thus a NOR gate with many inputs can be formed using the 7405 i.c. (see Fig. 7.5b).

This type of gate is sometimes seen referred to as a WIRED-NOR gate for obvious reasons. By placing an INVERTER after the WIRED-NOR gate, a WIRED-OR gate is obtained.

It can be seen that a gate is not always what it appears to be—a NAND gate may in fact be part of an INVERTER and an INVERTER may be part of an OR gate! When in doubt either build the circuit on the experimental board and test it or write the truth table for the gate.

It is permissible to WIRE-AND as many as eight outputs together using 7401 or 7403 or 7405 i.c.s and the ANDed output can be used to feed up to seven inputs.

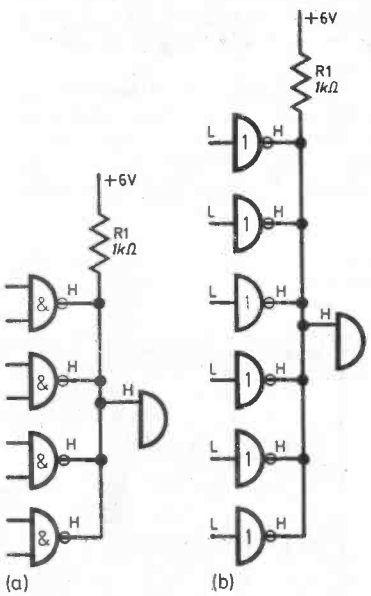


Fig. 7.5.(a) Type 7403 or 7401 i.c.s. wired together to form a WIRED-AND gate (b) Gates in a 7405 wired together form a WIRED-NOR gate.

THE SCHMITT TRIGGER

One of the problems of operating counters and flip-flops is that they require clock pulses with very short rise and fall times. This is because with a slowly changing clock pulse the input to a gate may be biased into a region of uncertainty where the gate changes from being an on/off switch into an amplifier with very high gain. This can in turn lead to oscillation which can cause serious malfunctioning of a system.

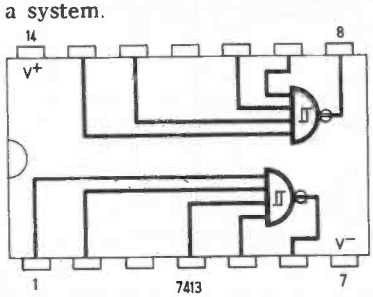


Fig. 7.6. Pin connections of the 7413 four-input Schmitt NAND.

One method of overcoming the problem is to use a circuit called a Schmitt trigger. An integrated circuit type 7413 is available which contains two four-input NAND gates with a rather special property. Its pin connections are shown in Fig.7.6.

The Schmitt trigger NAND gates differ from the ordinary NAND gate in that the switching voltage differs depending on whether the input is going from high to low or low to high.

As the voltage rises from zero the gate will switch at about 1·7V, the output then going low. If the input voltage is now reduced nothing will happen when it passes through 1·7V. In fact the voltage has to fall below about 1V before the output of the gate will go high. The gate switches at 1·7V "on the way up" and 1V "on the way down."

A slowly changing input is shown in Fig. 7.7a with the output states of the gate. Even with slowly changing inputs the Schmitt trigger produces an out-

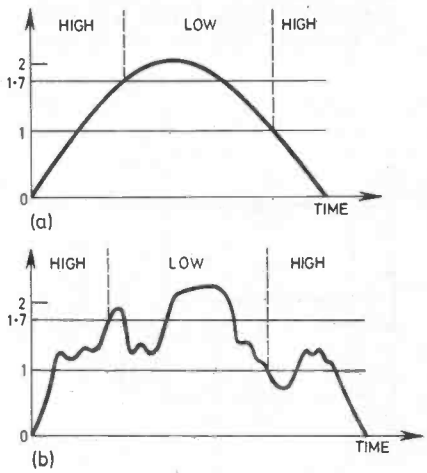


Fig. 7.7(a) The output of the 7413 with a slowly changing input (b) the elimination of noise using the Schmitt.

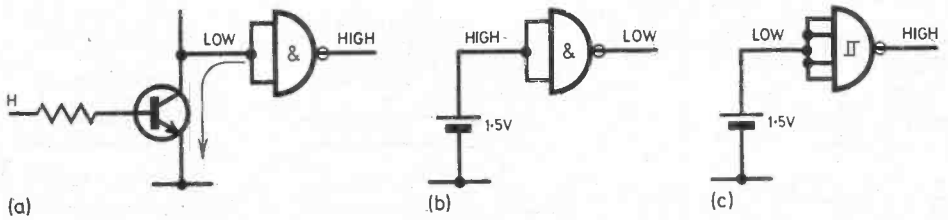


Fig. 7.8(a). A transistor connected to an ordinary gate provides a path for current to ground (b) A battery connected to an ordinary gate does not provide a current path to ground. (c) A 1·5V battery connected to a Schmitt gate acts as a low input

put with fast transitions.

The Schmitt trigger is also useful for removing "noise" from waveforms as illustrated in Fig. 7.7b. The input is a waveform which wanders up and down rather than switching from on to off directly. This "wandering" would cause many pulses to be generated by an ordinary gate but the Schmitt trigger only produces one transition.

There is another use for the 7413 because it depends only on its input voltage to make it change state. Other i.c.s need to have a certain type of input—one that will let current flow from the gate to ground. Even a slight voltage at the input will be equivalent to a high input, as shown in Fig. 7.8.

The Schmitt will treat any input voltage below 1V as low and "on the way up" and will treat any voltage below 1·7V as low. There is no need to provide a path to ground.

This means that the gate can be operated by devices other than transistors or other gates or direct connection to positive or ground.

For instance the input can be from a potentiometer connected across a 6V battery as shown in Fig. 7.9a. It is possible to connect the spindle of the pot to a working model using a pulley or gearwheel so that as some part of the model moves it produces a logic output.

Since the light operated switch shown in Fig. 7.10 using the ORP12 is really a potential divider the ORP12 can be connected directly to the 7413 Schmitt gate to give a clean changeover as the light increases or falls. Because the switching levels of the Schmitt vary according to whether the input is on the way up or down, the light level for "on" will be different to that for "off". This can be an advantage for example, if the device is being used to turn a radio on at sunrise a passing cloud will not turn it off again.

The Schmitt can also be used to detect when the voltage of a battery falls below a certain

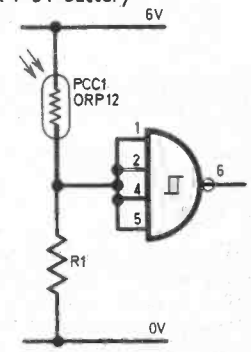


Fig. 7.10. The light operated switch described in an earlier part may be used to drive the Schmitt

level. Suppose the battery must not fall below 5·1V. The circuit is shown in Fig. 7.11a.

The Zener diode stops the voltage to the potential divider from

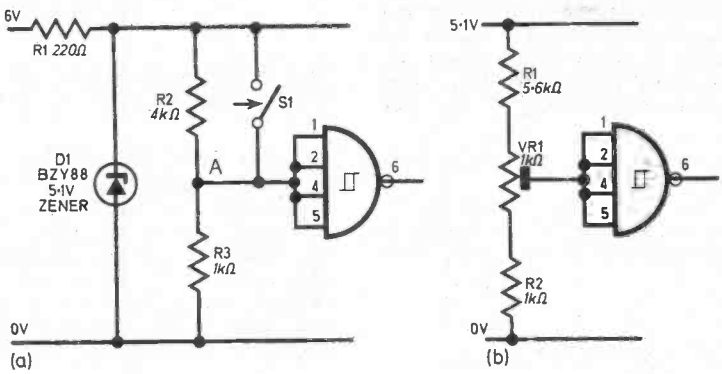


Fig. 7.11.(a) Circuit for a low battery indicator. The potential divider can be made from a preset and two resistors for setting the switching point, as at (b).

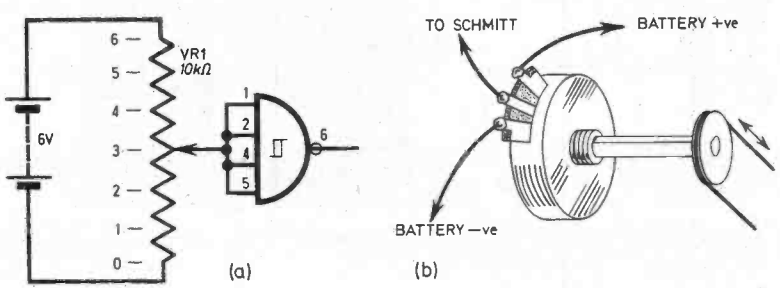


Fig. 7.9.(a) The input to the Schmitt can be from a potentiometer connected across a 6V battery. The potentiometer can be part of a working model as shown in (b).

rising above 5·1V but if the battery goes flat this voltage will fall below 5·1V. When the voltage is 5·1V the voltage at point *A* will be one fifth of this i.e. nearly 1V.

To activate the low battery indicator the switch S1 is closed which applies a high voltage to the Schmitt causing its output to go low. The switch is then released. Now if the voltage ever falls below 1V the output of the gate will go high indicating a low battery.

Components

Single Pulse Generator
R1 270Ω ¼W
C1 50μF elect. 6V
IC1 7402

Wired—AND
R1 560Ω to 1kΩ ¼W
D1-D3 IN914 (3 off)
IC1 7403
IC2 7401
IC3 7405

Schmitt Trigger
R1 5.6kΩ
R2 1kΩ
VR1 10kΩ lin.
VR2 1kΩ preset
D1 5.1V 400mW Zener diode
IC1 7413

Keyboard/Card Reader
Stripboard: 0.15in. matrix 25 holes x 16 strips; drawing pins (10 off); large paper clips (10 off); terminal pins (20 off).

The circuit of Fig. 7.11a shows two fixed resistors making up the potential divider. In practice it might be hard to find two resistors with a ratio of exactly four to one and this, together with the fact that the Schmitt may not trigger at exactly 1V makes the use of a preset potentiometer as shown in Fig. 7.11b more apt. The preset can then be adjusted so that the Schmitt triggers when the voltage of the battery falls below 5·1V.

This is just one example of the use of the Schmitt trigger. It has applications in many other circuits as a voltage level detector.

SIMPLE KEYBOARD

It is very useful to have a set of keys ready made especially when working with flip-flops. The set of keys to be described here is easy to construct and gives five switches very cheaply.

The keyboard is assembled on one half of a piece of 0·15in matrix stripboard as shown in Fig. 7.12. The card reader to be described next uses the other half of the board. If required the board could be sawn in half and the two units used separately.

The method of construction is similar to that used with the paper tape reader described last month. The drawing pins are soldered into the board as shown and their ends cut off. They are all joined together and the wire is taken to a terminal pin at the side of the board. The paper clips are then bent as shown and placed in position on the board. A piece of Blu-Tack or Plasticene is then used to hold the clip in position while it is soldered. The clip must lie so that it is slightly above the drawing pin, only making contact when it is pressed.

Keys or switches made in this way are called "push to make" switches: when they are pressed they make contact; when pressure is released they open.

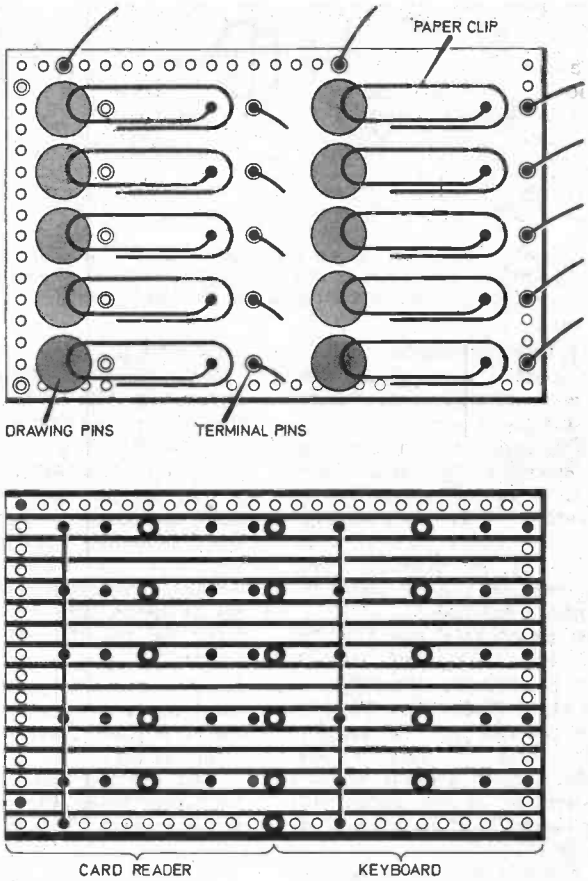
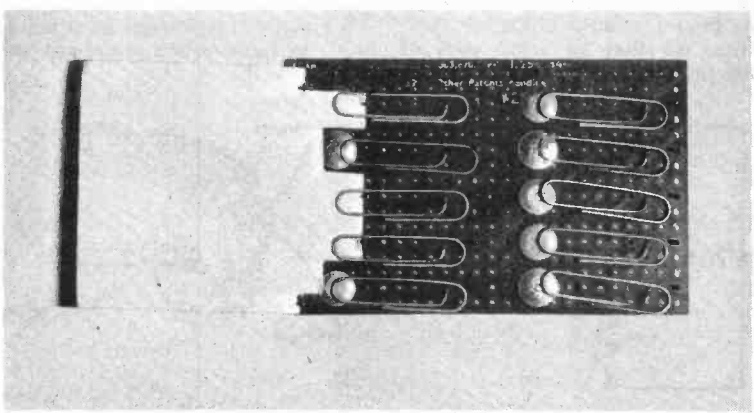


Fig. 7.12. Layout of the card reader (left) and keyboard (right) on the 0·15in matrix stripboard. Note the cuts in the strips under the board. The board can be sawn in half if the two units are to be used separately.



Photograph of the keyboard and card reader.

CARD READER

The card reader is similar to the keyboard except that the keys are normally touching the drawing pins. When a card is pushed between the keys and the drawing pins, some contacts (depending on how the card is cut) are broken (see Fig. 7.13). The method of construction is the same but when soldering in the paper clips hold them firmly in contact with the drawing pins.

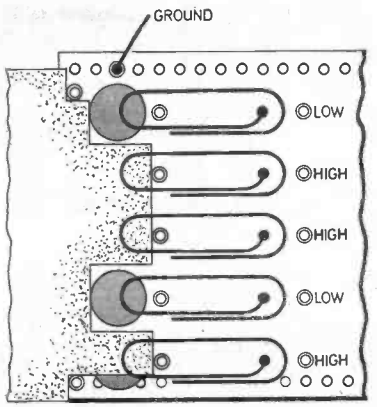


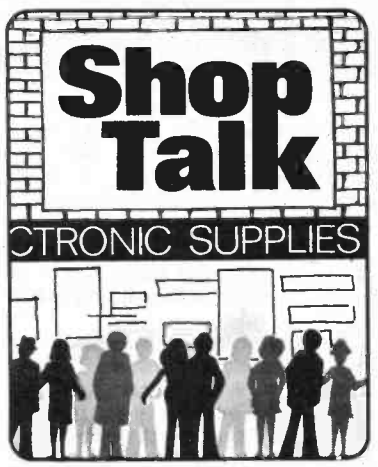
Fig. 7.13. A card inserted into the card reader. It has been cut so as to produce a high on pins two, three and five.

As with the keyboard, join the drawing pins together and to a terminal pin at the side. If the keyboard is on the same piece of board as the card reader, make sure the cuts in the copper strips are made as shown.

Some of the pins in the card reader are not for electrical connections but serve merely to guide the card in straight.

The card reader can serve as a keyboard if required since contact will be broken if the paper clips are pressed at the end farthest from the drawing pin.

To be continued



By Mike Kenward

New products and component buying for constructional projects.

FOR the first time in the history of Marshall's they have produced a second catalogue (now available) within 12 months. This has been necessary mainly due to the "unprecedented increase in component prices, stemming partly from the falling pound, but also from an all round rationalisation of prices and product ranges from our main suppliers," more about this aspect later. The new catalogue also includes an additional 500 lines which come mainly from National Semiconductors, these lines include various microprocessor items.

It was unfortunate that the very day we received the new catalogue we also received the sad news that Mr. Marshall had died a few days earlier. His firm have always been helpful and provided an excellent service which we are sure will be continued by his able staff.

Rationalising

Many of the larger semiconductor suppliers have recently been looking closely at their range of products and have taken steps to rationalise the range. This has resulted in the axeing of some lines and also in large price increases in lines which are deemed to be "specialist". It can also mean lengthy delays in the supply of some of these specialist items because they are no longer manufactured continually and because the supplier might well be trying to discourage their use in order to delete them from the new streamlined range.

Fortunately this has not affected many of our projects since we tend to use the most common devices. However two transitors specified for our *Transistor Assisted Ignition*, published three years ago, now cost about £5 each and are not expected to be available again for a good few months. This obviously makes that particular circuit redundant since it would now be cheaper to buy a commercial unit, even if supplies of the transistors were readily available.

Continuity Tester

As is mentioned in the article none of the parts for the *Continuity Tester* are particularly critical and those constructors who have been around for some time will probably find they have something suitable for most of the parts at hand.

The case for this project can be any of suitable size and no doubt many constructors will build their own.

Car Burglar Alarm

Some items used in the *Car Burglar Alarm* require a special mention, they are the relay which is a Doram type available direct from them—see the buyers guide for details of how to order etc.—and the trembler switch. Although this switch is not essential it is a useful addition to the circuit, however we have not been able to locate a source of supply of new switches but we are informed that one can usually be purchased from a breakers yard. This should provide a suitable source for most readers although we feel that it must be possible to buy such a switch on its own as a replacement unit.

A similar thing applies to the key switch—although some of the larger suppliers can provide suitable switches these are usually expensive and an old ignition switch would be a cheap alternative.

Train Controller

None of the components for the *Train Controller* should cause any buying problems but readers should make sure that they obtain the correct type of switch—a centre off type—for S2.

Paper/Scissors/Stone

A number of switches are employed in the *Paper/Scissors/Stone Game* and these are rather special in that they are double pole push buttons. Since there are six to buy it is important that they are reasonably priced—we suggest you contact Electrovalue who can supply Castelco switches cheaply; see the buyers guide for their details.

Catalogue

Just as we were about to submit the copy for this page a Maplin catalogue "landed" in the office. Having only had a brief chance to scan the pages we must say that it appears to have been well worth waiting for and is probably the most comprehensive catalogue we have ever come across. How they have managed to provide it and send it out for 50p is beyond us.

The range of available items is vast—covering components, kits, tools, instruments and books with many items of allied interest such as hi fi, disco and organ parts and equipment. We are sure they should be able to provide most constructors with all their requirements.

CONTINUITY TESTER

By A. Irwin

THE unit described is of triple purpose; it can be used as a morse code practice oscillator, as a continuity tester, or test oscillator.

A morse code practice oscillator is often required for the training of scouts, cadets and radio amateurs. This unit can be built up mostly from spare components as none of the values of capacitors or resistors are critical. It is desirable, however, to use a high-gain type of transistor and high-resistance phones.

CIRCUIT

The oscillator (Fig. 1) is a basic three section dippy type which relies on the phase shift created by the network consisting of C1 to C3 and R1 to R3 to provide positive feedback and thus cause TR1 to oscillate. The transistor itself provides 180 degrees phase shift, which would give negative feedback if applied to the base but this signal is taken via the phase shift network, which provides a further 180 degrees shift, to the base of TR1.

Potentiometer VR1 alters the base bias on TR1 and thus provides some control of the tone, whilst the output is taken from VR2 which acts as a volume control.

CONSTRUCTION

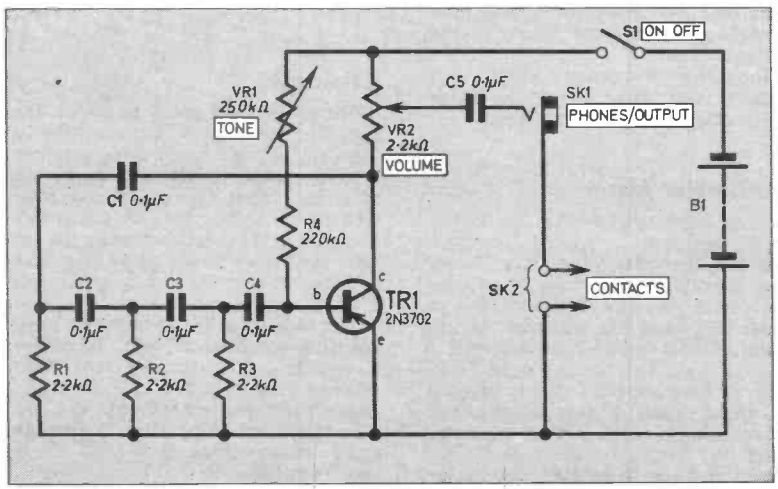
Commence construction by drilling a suitable panel to take the main components and tag board as shown in Fig. 2. Next mount the various components on the tag panel together with link and connecting wires. Fix the tag panel and other parts to the front panel and complete the wiring up of the unit.

The metal box is large enough to take any type of 4·5 volt battery. It is essential that red and black leads are used to connect the battery so that the transistor will not be harmed by incorrect connection.

USE

Used as a continuity tester when trying to trace faults, the unit has several advantages over an ordinary buzzer. It delivers a clear, audible note which can be adjusted to ones liking. It will stand a lot of knocking about and the note does not depend on a critical mechanical adjustment,

Fig. 1. The circuit diagram of the tester.



like a buzzer, and will remain constant throughout tests. One other advantage, it is not necessary to look up from the work to read a meter as when a visual type of indicator is used.

To use the unit as a test oscillator to feed an amplifier or other audio equipment, simply short the two terminals of SK2 and take an output from SK1 to the unit being tested. ☐

Components

Resistors

R1	2·2kΩ
R2	2·2kΩ
R3	2·2kΩ
R4	220kΩ

All ¼W ±10% carbon

Potentiometers

VR1	250kΩ
VR2	2·2kΩ

Capacitors

C1	0·1 μF
C2	0·1 μF
C3	0·1 μF
C4	0·1 μF
C5	0·1 μF

Any small types

Transistor

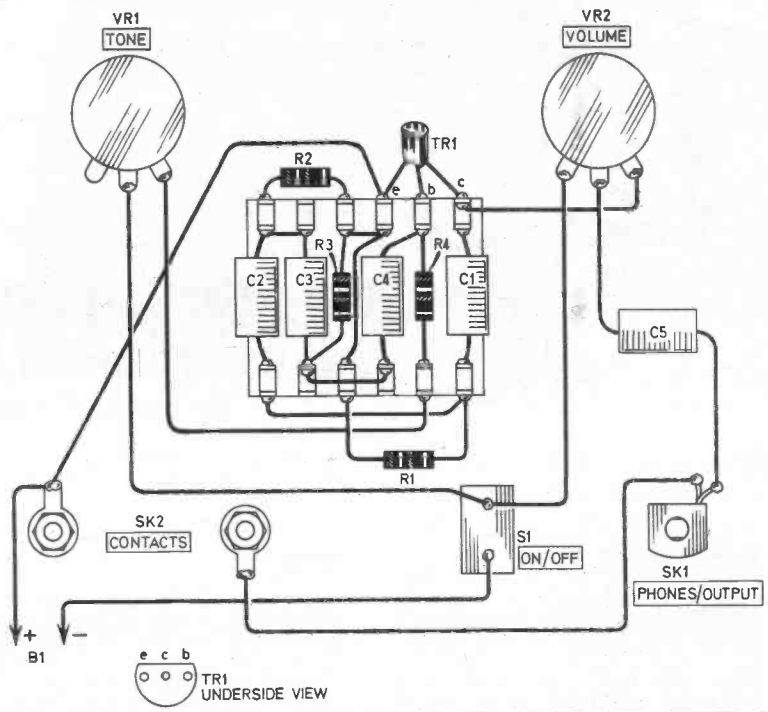
TR1 2N3702 silicon *pnp*

Miscellaneous

S1 s.p.s.t. toggle switch
SK1 mono jack socket
SK2 single screw contacts (2 off)
B1 4·5V battery
Six way double tag board; knobs for VR1 and VR2; case, approx 150 × 100 × 75mm; connecting wire; 4BA fixings etc.

See Shop Talk

Fig. 2. Mechanical construction and wiring of the unit.



ONE big advantage you have dear reader, which I would like to stress, is that you are dealing almost exclusively with people who are enthusiasts. The staff of EVERYDAY ELECTRONICS are dedicated to giving you the best, and right the way down the chain to the humble retailer like myself, because we are extremely interested in our subject we want you to be also.

Obviously the most useful way we can do this is to give you good service. In case a cynically minded reader suggests we do it for money, I would assure him there are many easier ways available. In addition none of the firms you buy your supplies from are very big, which means that any grumble is dealt with at the top, as it should be.

In my own case I always insist on dealing with any dissatisfaction. I am pleased to report that not much of my time is taken up in this way. I even go further, I demand that all orders that are incomplete be brought to me. I then go through them to see if I can offer a reasonable substitute. There is usually plenty of scope here.

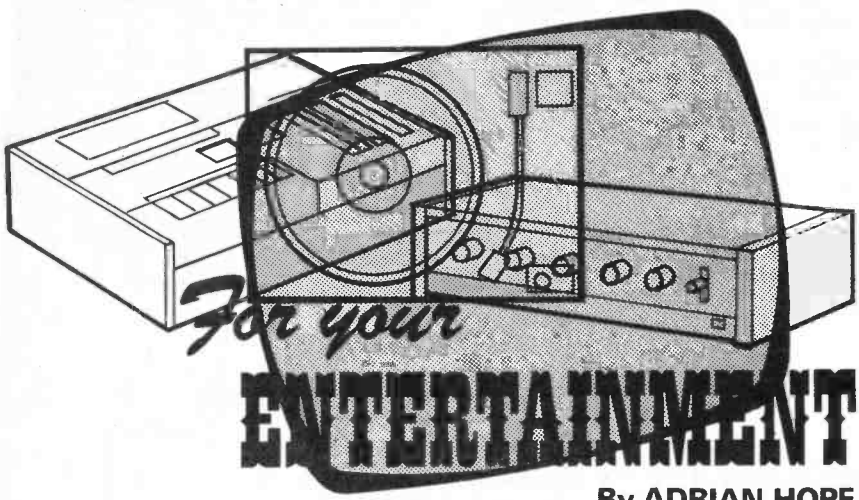
For example if we are out of a particular value of resistor in $\frac{1}{8}$ watt, one can send a $\frac{1}{4}$ watt, or if the customer wants a capacitor we may not have it in 10 volts but we have it in 16 volts. What is less obvious, is that a single pole double throw toggle switch could be replaced by a double pole, double throw. In fact you will probably have worked out for yourself that the latter could be used to replace all of them except the centre off variety and the biased types.

If there are items on the order which are out of stock, we photostat the order and send them on later. If there is likely to be long delay, we return the money in the form of a credit note.

We may not please all the people all the time, but we do try, and believe me in this day and age this is really something. I am also very optimistic that in time we shall improve our performance and this will be done by narrowing down our selection. With a smaller range we can stock in greater depth and the chance of running out of stock will be much less.

It would be nice if all the component retailers got together and stated the items they were going to concentrate on. It would mean that you would have to purchase from more than one source but I have said previously that you may have to deal with about four suppliers to be completely covered.

I know in the past, we have erred in giving customers too large a choice. To quote, we were offering electrolytic capacitors in the following voltages: 2·5V 6·4V 10V 16V when obviously the 16V one would have covered the lot. I often wonder, is it correct to offer a choice of 10 different colours, when probably the customer would be just as happy if we repeated Henry Fords' dictum, "you can have any colour you like as long as it's black."



By ADRIAN HOPE

HAVE you ever wondered how it is that schools can receive television programmes without a roof aerial?

In the London area, 500 miles of coaxial cable were laid underground by the Post Office ten years ago. One object was to provide good TV reception for all ILEA schools without the need to erect aerials. Another was to enable those schools to receive closed circuit broadcasts originating from an educational TV studio at Battersea. This coaxial cable can carry nine seperate TV channels (BBC1, BBC2, ITV and several special ILEA programmes) to every educational establishment in the London area, and the school sets each have a tuner with switching between nine channels.

Standard

The sets are unusual in that, although they operate on 625-line standard, they can accept only v.h.f. (rather than u.h.f.) signals. This is because it is easier to distribute television signals on v.h.f. frequencies rather than u.h.f., there being more loss of signal in a cable the higher the frequency it carries. Even so, the Post Office have to provide underground repeater amplifiers every mile along the main route and every half mile along the spur routes which use thinner cable. As the channel spacing on the educational distribution network differs from that adopted for normal broadcasting, the TV sets you find in schools are usable only in schools.

Although it comes as a surprise to some schools this is why an ordinary, off-the-shelf video recorder (videocassette or reel-to-reel) intended for domestic use will almost certainly not work if plugged straight into a school TV set.

Colour

Although all the ILEA distribution network to schools is colour-capable and the BBC and the ITV stations are piped down the line in colour, very few schools have colour sets. There was a plan a few years ago to start replacing old monochrome sets in London schools with colour sets, and the Post Office have been updating the distribution network with improved colour quality in mind. But with money for education so short, all hope of introducing colour sets to schools is now gone, at least for the foreseeable future.

There is even talk of axing the distribution network for London schools. This would surely be madness, because, apart from anything else, it would involve every school in the London area in the need to expensively erect an aerial to receive off-air signals in u.h.f. They would then have to convert the signals to v.h.f. for feeding to the school TV which, of course, can only work with v.h.f.

Let's hope that no decisions are taken over this by politicians who don't understand the technology involved and end up spending more money than axing the system saves!

Anyone using a London school TV set may wonder why and how educational TV programmes are sometimes interrupted by the sound of airline pilots talking to ground control. It's one of the disadvantages of using a v.h.f. distribution network. Some of the channels operate on exactly the same frequencies as the very powerful transmitters installed in modern airliners. If one is approaching London Airport only a thousand feet above a TV set tuned to the same frequency, breakthrough is virtually inevitable.

VAT Calculation

As we are still cursed with multi-rate VAT and some shops are still advertising exclusive prices, there is often a need to convert exclusive to inclusive, at one rate or another. How odd that no-one made any effort to tell the public that the original Budget reduction (25 per cent to 12½ per cent) was actually an overall ten per cent cut on retail prices, and was thus a very easy calcutation if you knew how.

In fact most exclusive-to-inclusive and *vice versa* calculations can be made with an equally simple single step, if you know how. To convert a VAT-exclusive price to a VAT-inclusive price, all you do is multiply the exclusive price by the VAT rate with the digit 1 ahead of the decimal point. It may sound complicated, but actually it's dead easy.

To get a price including 8 per cent VAT, you simply multiply the exclusive price by 1.08, and to get a price including 12½ per cent you multiply by 1.125, and so on. Even more convenient, the formula works in reverse. So, to get an exclusive price you divide the inclusive price by 1.08, or 1.125 and so on. I find it somewhat odd that officialdom has never let the public into this simple secret—or wasn't I listening when they told us?

Space Junk

Here's a final unrelated thought for the month. It is topical and fashionable to bemoan the amount of valuable waste that we throw away, usually because it is too expensive to repair or reclaim. But the ultimate in waste must be the 1½ million dollars' worth of electronic, mechanical and photographic hardware that I understand the USA left on the moon because it was cheaper to junk it than bring it back home again with the astronauts.

" Of course I can't cook like your mother used to—I haven't got the electronic devices her husband made for her!"

Free! - in next month's issue

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MULTI-BAND TUNER

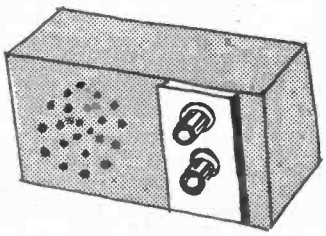
This a.m. tuner is capable of receiving many stations on the short, medium and long wavebands.

REMOTE READING THERMOMETER

Designed for measuring temperatures outside the house, in the garage or greenhouse from inside the home.

METRONOME

An aid for the musician with a range from about 45 beats per minute to over 300 beats per minute.



everyday electronics

MAY ISSUE ON SALE FRIDAY APRIL 15

Your Career in Electronics

by Peter Verwig

TV CAPITAL EQUIPMENT

TELEVISION today is so commonplace that we hardly give a thought to the fact that it is a comparatively recent invention, much newer, for example, than the automobile which equally had a profound effect on our life-style.

Of course imaginative people had dreamed about it long before it became a practical system. Transmitting still-pictures by electric telegraph was not too difficult. An elementary system was being worked on in France as early as the 1860s although the first practical system was not to be demonstrated before 1904.

The invention of the selenium cell in 1873 provided the means of defining light and shadow in terms of electrical current and the famous scanning disc invented by Paul Nipkow in 1884 provided the basic elements of a crude low-definition television system. But it was not until 1925 that the British pioneer John L. Baird made his first public demonstration in Britain and in the same year Charles Jenkins demonstrated a similar system in the USA.

EARLY SYSTEMS

Although the early systems using mechanical scanning with either the Nipkow disc or mirror-drums showed considerable ingenuity it soon became obvious that an all-electric system would be the ultimate solution. The theoreticians had already worked out that for reasonable picture quality some 100,000 picture elements would need to be transmitted and, to obviate flicker, at a rate of more than 20 times a second. A mechanical system relying on spinning discs or drums would be expensive to build and extremely difficult to synchronize at such operating speeds.

The famous British experimenter A. A. Campbell-Swinton had foreseen all this and had suggested that electronic scanning tubes would be the answer as early as 1908 but it was not until Dr Vladimir Zworykin invented the iconoscope in 1928 that electronic scanning and the all-electric TV system became a practical possibility. From then on TV developed at remarkable speed.

The first public regular high-definition TV service in the world was transmitted by the BBC in 1936 from Alexandra Palace in North London. In the same year RCA in the United States started experimental transmissions from the Empire State Building in New York and television was here to stay. Except, that is, for the war-time years when all stations closed down because the TV transmitters might be used as "homing" beacons by enemy bombers.

FREQUENCY

It was not only the problem of the camera tube and the picture tube in receivers that delayed high-definition TV for so long. Because of the wide bandwidths required to carry all the picture

CCTV in action. Six camera channels monitor the road traffic through the Dartford Tunnel.

Mini-Mobile OB van introduced by Marconi last year. Note the cameraman with his hand-held portable camera protruding through the vehicle roof.

Marconi Telecine equipment nearing readiness for export

information plus the synchronizing signals, it was necessary to transmit and receive on v.h.f. and this part of the frequency spectrum had been virtually unexplored. So not only did electro-optics need developing but transmitting and receiving valves which would work at v.h.f. with acceptable efficiency. In fact the early TV work on developing v.h.f. and u.h.f. valves, circuits and antennas, enormously helped radar development, then in its experimental period, and a lot of the technological advances made in the crash research programmes on radar during the war were to enhance new TV developments when services resumed after the war.

An interesting point to note is whereas with radio the early development was for professional communications with broadcast entertainment only coming after some 30 years with the BBC, for example, not being formed until 1926, TV started life as a system for entertainment and only later found application in other areas.

The BBC re-started the TV service on June 7, 1946, using the pre-war equipment and a second station serving the Midlands started transmission on December 17, 1949. The North was next to be served by Holme Moss which came into service on October 12, 1951. Thereafter, the programme went smartly ahead to give complete coverage of the United Kingdom.

On June 6, 1954, international viewing became possible through the Eurovision network and a month later the Independent Television Authority was formed to provide the viewer with alternative programmes and ITA's first transmissions were put out to London area in September 1955.

DEVELOPMENT

In the past 20 years TV development has been spectacular with nation-wide coverage now in colour, Eurovision supplemented by intercontinental broadcasts via earth satellites, and the imminence of new types of service via TV such as information on demand through CEEFAX and ORACLE. And TV is no longer confined to the technologically developed nations. You find it today in all the great sub-continents and even in the poorer areas of the world.

When I started preparing this report I thought of heading it Television Broadcasting. By this I meant not the receivers in your home which belong to that broad category of products we call consumer electronics, but the professional end meaning TV cameras, studio equipment, transmitters and antennas. But this sector is only half of the professional TV sector.

APPLICATIONS

TV may have started as an entertainment but its value has now been recognised in dozens of other ways. Most of us have seen closed-circuit television at main railway stations, at airports, on motorways and as security devices in shops.

Less well known are the remarkable developments in low-light TV as used in military applications which enable bright pictures to be resolved with natural ambient lighting no brighter than starlight. Military aircraft are flying today armed with TV-equipped stand-off missiles and bombs. These are released in safety well away from the target area and are guided to their target by a built-in TV camera and transmitter in the nose, the aircraft crew observing the progress of the bomb on their airborne TV receiver.

The effect is just as if you, yourself, were in the bomb guiding it to its destination, the target approaching at what seems higher and higher speed and growing larger and larger until the moment of impact when the picture suddenly goes blank.

One such system is Martel, an Anglo-French development with the TV guidance and command system engineered by Marconi Elliott Avionic Systems. Performance figures are secret but informed guesses estimate the range of the Martel missile at about 40 miles although this would depend on the height of release from the parent aircraft. If this figure is anywhere near accurate it means that the missile can be released, say, 20 miles away from the target and be directed from the TV screen by the missile operator while the aircraft is already on its way home.

An American TV-guided missile, the Condor, made a direct hit on a ship target at a range of nearly 40 miles from the parent aircraft during trials in 1971. Both Martel and Condor are now deployed with the armed

services of their respective countries.

We might also mention in passing that TV is used in medicine, in all sorts of hostile environments such as atomic power stations and the bottom of the ocean, and in hundreds of industrial applications. This is why I broadened the title of the article to Television Capital Equipment.

COMPANIES

It can thus be seen that TV is today a lot more than Angela Rippon, or Poldark, Panorama or Kojak. It is true that today's professional TV engineer may have some connection with these programmes by working in the BBC engineering department or with the Independent channel equivalents by working for the IBA, but these jobs are only a fraction of the total. At the user end the TV engineer might equally work in a hospital or with an underwater salvage firm or with a security company.

At the manufacturing end the engineer is likely to be in the TV division of one of the major companies such as Pye TVT, Marconi, or EMI, all with considerable business in TV equipment supply, or with a smaller specialist equipment company such as Crow of Reading or Prowest, or with Ampex who specialise in professional video recorders. Or as a TV specialist in a Ministry R & D establishment or in the Services.

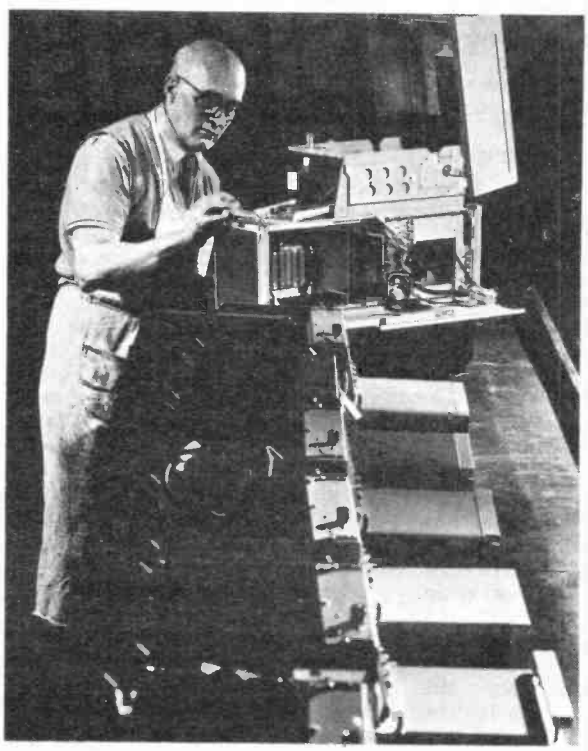
SPECIALISING

TV engineering is a good career because it embraces so many different engineering disciplines. Once you have found employment and have some fundamental training behind you it is possible to specialise. I have met people who have spent upwards of 20 years solely on successive designs of TV cameras. Others might wish to specialise in other areas which interest them, perhaps TV transmitters or mixing consoles or telecine equipment.

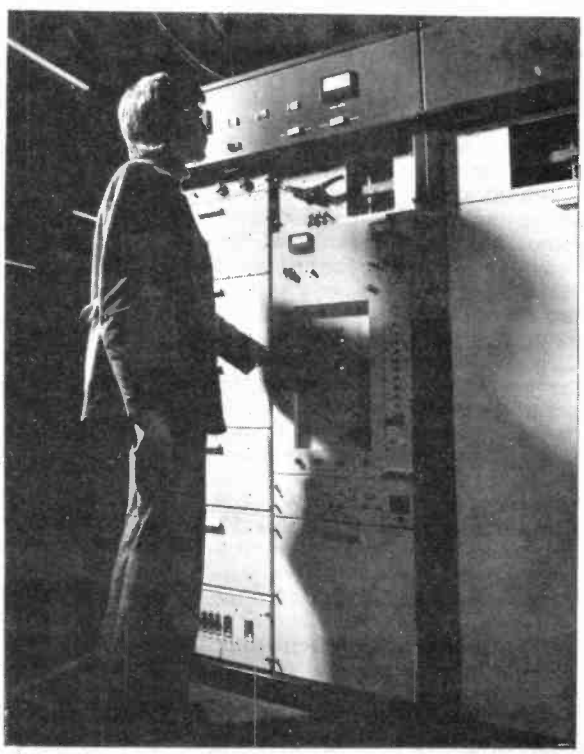
Some super-specialists have even narrower interests, perhaps concentrating only on the all-important electro-optics or in such delicate subjects as video recording heads. The fact is that there is room for everybody who has his wits about him (or her) and who is willing to learn and to make a contribution. In the factory environment there is nearly always a demand for test engineers and for those who like knocking around the world and seeing how the other half lives there are opportunities to travel as installation and commissioning engineers.

In fact a willingness to travel is almost a necessity nowadays. If you join a TV manufacturing company as an apprentice or trainee it is quite likely that at a late stage in your training programme you will do a stint on commissioning equipment on site. Even if you are eventually destined for the R and D laboratories such outside experience in the field is invaluable in revealing the real-life problems that need to be faced. What worked quite well in the temperate conditions in the UK may not do so well in the high temperatures and humidity of the tropics or survive the salt-spray of the marine environment. Of course all export equipment is built to withstand such hazards and are tested in environmental chambers at home, but it is hard to appreciate the working conditions, for example, an outside broadcast van and its equipment has to cope with until you've actually experienced it.

Marconi Mark VIII colour cameras in final assembly at Chelmsford.



Final check-out of a Marconi v.h.f. TV transmitter.



MARKET

First the bad news. The home market for TV broadcast equipment is stagnant. Very little business is being done because (a), the nation is virtually saturated with transmitters and studios. The great build-up is virtually over, including the transition to colour, which leaves only a replacement market and it's a fair bet that the manufacturers are wishing now that they hadn't built such long-lasting equipment. And (b), even if most of the equipment was falling to pieces (which happily it isn't) the BBC and IBA are not by any means flush with cash in these hard times.

Now for the good news. TV broadcast equipment exports are doing very nicely. Among the reasons for this is that no other country in the world has such long experience in the game as the British. The technical quality of British TV equipment is in the world leadership class. Those reared only on British TV should give themselves a treat and see what passes for TV in New York and here I'm talking of picture quality, not programme content although that's pretty awful there, too. In short, the British have a deservedly fine reputation for TV engineering and a present currency exchange rate which makes our exports attractive.

OVERSEAS

Another reason why we are doing well overseas is because although we have reached saturation in the UK with 94 per cent of all households equipped with TV (each on average used 21 hours a week!) there are dozens of other countries who have hardly yet started on monchrome systems, let alone got around to colour. So there is still plenty of business about provided the British product remains competitive in the world market.

What's more, the larger British companies supply complete turnkey projects. This is virtually the complete package from surveying a country or territory to decide on location of transmitters and aerials, laying the first brick, equipping the studios and right through to getting the first programmes on the air. Such contracts go down to the last detail such as provisioning of spares and supplying emergency generator sets in case of power supply failure.

This is the sort of service that won Pye TVT an £8 million contract in the great complex of over 3,000 islands forming the Indonesian archipelago. Marconi was also in on the same deal with orders worth over £5 million for both sound radio and vision equipment.

Many countries are in the process of changing to colour equipment. Egypt's changeover to colour, for example, brought another £4 million worth of orders to Marconi as a follow on to other substantial orders from Jordan and the Lebanon when they, too, made the change. More recently further TV contracts came from Nigeria and the equipment is to be air-freighted there later this year.

SUBSYSTEMS

As well as complete systems, British companies supply subsystems and individual pieces of equipment. Crow, for example, is doing very well with the Berkshire colour receiver/monitor now selling by the thousand at £850 each. You can see from the price that professional quality equipment is of a different standard to that found in the home.

Marconi enjoys a big export trade with telecine equipment and TV cameras, both monochrome and colour. The Marconi telecine won the Queen's Award for technology last year and orders are now well in excess of £5 million and the Mk VIII colour camera is used by broadcast authorities all round the world including China, the Soviet Union and the U.S.A. The new portable version for TV news action shots and interviews is another winner.

Thus, we see television engineering as still an expanding field of enterprise with a secure future. Those entering this exciting activity as young people today will see further startling developments. TV transmission through fibre-optics, domestic coverage by satellites, seven stereoscopic 3-D pictures, perhaps. ⌑

JACK PLUG & FAMILY...

Physics is FUN!

By DERRICK DAINES

A PUPIL was walking with his tutor in a garden. "What is happening, Grasshopper?" the old man asked.

"The temple bell is ringing, master," replied the young man.

The old man did his proverbial nut. "You are ignoring a long string of miracles" he shouted. Indeed he was, from the effect of gravity on the bell, kinetic energy, the impact of the clapper causing the bell to vibrate, and so on, all the way to the transmutation of tiny electrical signals to the brain into knowledge that it was the temple bell ringing and not some other bell. A great string of miracles; an exciting string of miracles, that it behoves us not to ignore.

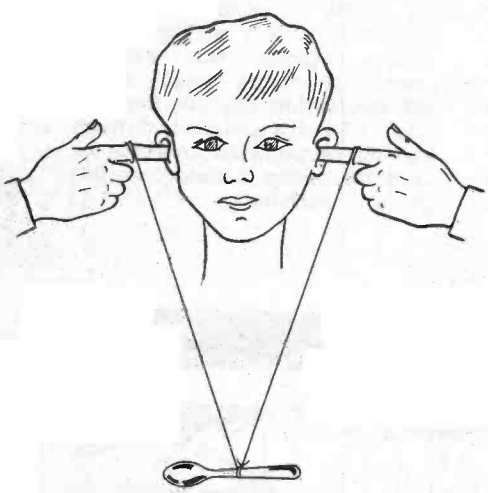


Fig. 1. Simple experiment with sound.

Sound is produced by vibrations, easily observable when a cymbal is struck. Even a pin firmly held in a piece of wood will give off a very high-pitched sound, while strips of tin or phosphor-bronze wire will sound louder. The vibrations of the metal cause the air around to vibrate thus being transmitted to the ear. Solids and liquids however will transmit sound far better than does air and we've all seen films in which the cowboy puts his ear to the ground, thus hearing hooves sooner.

EXPERIMENTS

A fascinating series of simple experiments may be conducted as shown in Fig. 1. Take a piece of hard thin string about 2 or 3 feet long and tie the middle of it round a spoon. Wrap the ends once or twice round the forefingers and put the forefingers into the ears. Bend forwards so that the spoon swings freely and allow it to strike the table edge. The spoon will sound like a gong. Any number of other objects may be substituted for the spoon and you will soon get an instinct for the type of thing that will vibrate.

Similar but softer sensations can be heard with the string held in the teeth, while the sound can be heard very loudly if the vibrating object is held directly between the teeth. Some kinds of deafness can be by-passed in this way, giving rise to the science of dentophonics.

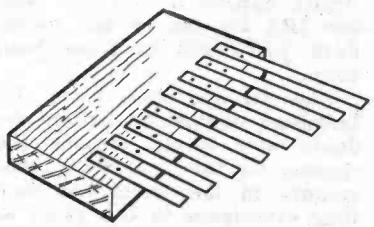


Fig. 2. The construction of a Kaffir Piano.

KAFFIR

A versatile and genuine musical instrument that used to be known as the Kaffir Piano is commonly seen in use in Africa, combining dentophonics and vibrating metal reeds. It is very easily made and has the overwhelming advantage that only the player can hear it! See Fig. 2.

The base is a piece of hard wood smoothed and polished and is of a size to fit easily and comfortably in the mouth. Strips of springy metal of various lengths are tacked to it and then trimmed with scissors to achieve the chromatic scale—or any other arrangement desired. In use the wooden part is held between the teeth, leaving the fingers of both hands free to pluck the reeds. The writer has observed Africans playing such an instrument on numerous occasions and has no doubt that much pleasure is to be obtained from one.

The string telephone is another well-known instance of the transmission of sound along a solid object but I pose the question, is it capable of transmitting intelligible speech? (Fig. 3). I ask because although sounds

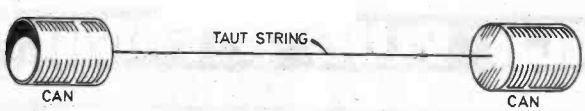


Fig. 3. Arrangement of a string telephone.

can certainly be transmitted and received, personally I have never been successful in understanding speech. I begin to suspect that there might be an element of the Indian rope trick about it, or that the speech heard has been transmitted through the air. Anyway, I would be interested to hear of successful experiments under test conditions.

The velocity of sound in air is easy to remember—333 metres per second, although barometric pressure has an effect.

SCISSORS·STONE·PAPER GAME

By A.W. GIBBS

THIS is based on an old game for two players which can be played with no preparation or equipment, but it allows the maximum of gamesmanship, "guessability" or E.S.P.

The basic idea is that PAPER wraps STONE, STONE blunts SCISSORS, and SCISSORS cuts PAPER; these are represented by both players simultaneously offering a hand as a clenched fist—STONE, or an open palm—PAPER, or with fingers in a V-sign—SCISSORS. One will win over the other, or it will be a draw.

Although there is some satisfaction in playing the game physically, it can be inconvenient or impossible to do so, and in any case it is essentially a contest of minds.

The device described here is the application of this old principle to circuitry so that, instead of making hand signs, each player presses one of three switches on his hand-held control. The result of the players "conflict" will be shown by a lit lamp on one or both sides of a central box. This enables the game to be played at any time without the players having to stand and face each other, and to play it at a faster rate than is possible with the hands only.

CIRCUIT DESCRIPTION

The circuit diagram of the Scissors, Stone, Paper Game is shown in Fig. 1 and is seen to be a simple switching arrangement with diodes used to steer to produce the required results.

The wiring has been designed so that the indicator lamps will light on the winning players side according to the above statements. In the event of the same name button being pressed by each player, a lamp will light on each side of the display box (this is accomplished by the steering diodes).

CONSTRUCTION

The lid of the display box (of any convenient size and material) is first drilled or cut to take the six lampholders—three at each end. These can be of three colours, but it is not essential because the bulbs positions indicate what they represent. They should preferably be low voltage types.

Six-way miniature tag strip is fixed to the lid between them, and the connections are made as detailed in Fig. 2.

A neat job is possible when the wires are cut and bent at right angles before soldering to fit snugly down the sides of the lamps and along the surface of the lid to go into the tag strips from the inside as indicated in Fig. 2. All the tag strips can then be soldered from the middle of the strips away from the wires.

The prototype used 6-core screened cable (about one metre or so) to connect the players boxes to the display box. The screening braid is used as the seventh conductor between the boxes. Begin by cutting the leads to their respective differing

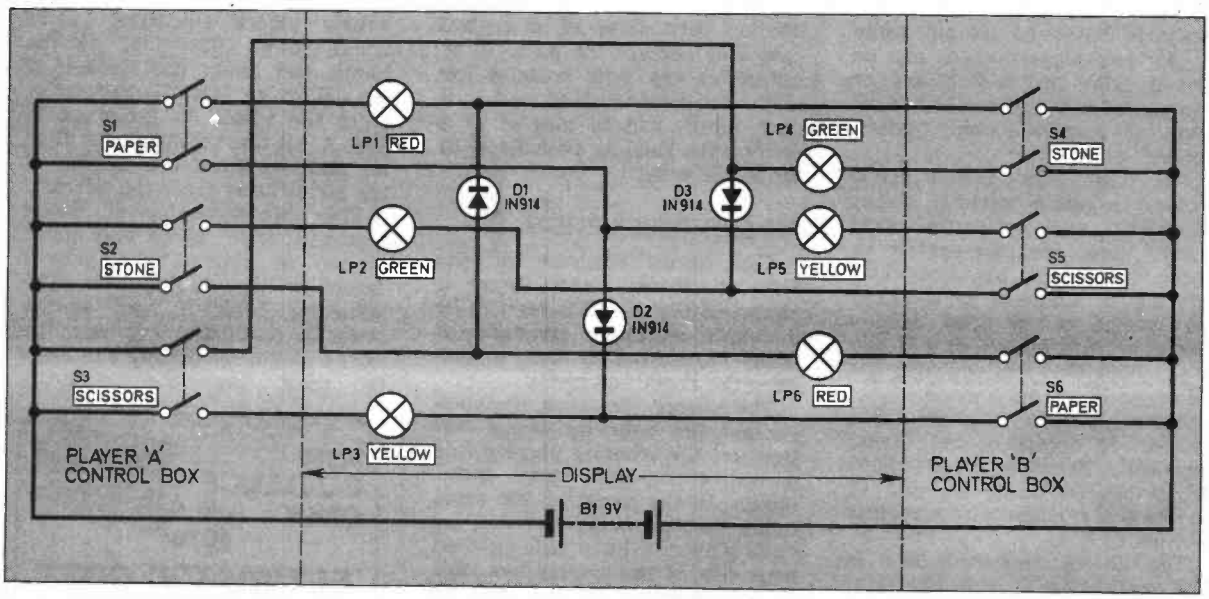


Fig. 1. The circuit diagram of the Scissors-Stone-Paper Game.

lengths so that they fit along the edge of the box. Attach the battery clip to the screening from each lead and cover the joint with insulating tape.

Next the diodes should be soldered as shown in Fig. 2—again these are best bent at right angles where necessary to fit before being soldered to the tags. In the prototype the diode leads were insulated.

The sides of the display box can then be cut at the top to allow the leads to pass under the lid when it is screwed down. There should be enough space in the box to comfortably accommodate the PP3 type battery.

The hand controls need be only as wide and deep sufficient to take three double pole switches. In this case the switches can be positioned in the box itself.

Where the material is thick it may be necessary to shave the edges of the holes to allow the cap to be screwed down far enough for the buttons to be depressed fully. This was found necessary on the prototype.

The double pole switches will have four lugs. (Where they are of a different type to that shown, the respective terminals can be found by using a loose battery and bulb).

A notch is cut at the edge of the box to allow the lead to be passed through the front of the box but held in place by the screwed down lid. (Alternatively, a hole can be drilled in the box and the wire pulled through before work is started—a grommet will keep the lead in place).

The switch buttons tops can be chosen to correspond with the lamp colours if required or the names of the switches can be printed/typed on. Wiring up details within the player boxes are given in Fig. 2.

Components

See Shop Talk

Diodes

D1 to D3 — IN914 or similar (3 off)

Lamps

LP1 to LP6 — 12 volt 0·1 amp Lilliput screw types (6 off)

Switches

S1 to S6 — double pole push-to-make release-to-break (6 off)

Miscellaneous

B1 — 9 volt type PP3

Tagboard miniature 6-way; 6-core screened cable (about 2 metres); battery clip to suit; square head, indicator lamp-holders with coloured lenses (6 off); plastic cases size 110 × 60 × 30mm (3 off).

PLAYING THE GAME

No lamp lights until two buttons are pressed, but if more than one button is pressed on one or both sides, then two lights will show on one side indicating a "cheat". The controls are held cupped in the hands so that both thumbs can be used and without the other seeing which button is pressed.

The game will suit all ages and moods. Children can simply press the buttons as quickly as they like without regard to their significance, and they can play the "best of five" or the first one to get, say, ten wins. Adults can play more slowly trying to anticipate the other's reaction. Usually, one player somehow obtains dominance over the other at different times. As well as the previous games, adults can see which player gains three consecutive wins. A game is drawn say after three consecutive draws.

Further rules can increase the sophistication, such as barring the use of the same button for more than twice consecutively, or awarding an extra point for a sequence such as the second PAPER (say red) light, on the opposite side.

SCISSORS•STONE•PAPER GAME

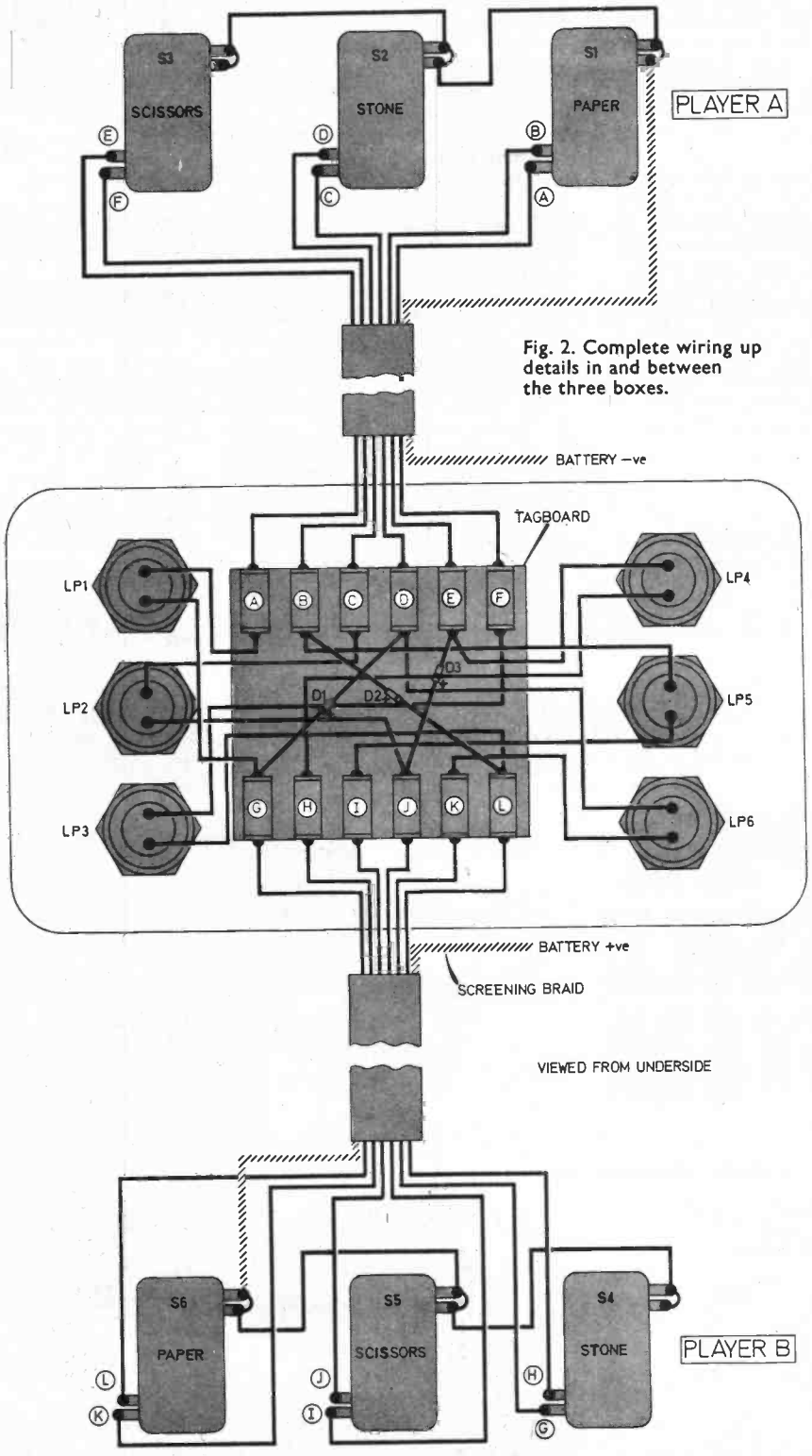


Fig. 2. Complete wiring up details in and between the three boxes.

RAPIER MISSILE SYSTEM

From target search through to its destruction.

By G.A.G. Brooke

THE BAC "Rapier" low-level anti-aircraft missile system was in the news recently as having been re-ordered by Iran. In service with the British Army, the RAF and the forces of other countries it is the most successful weapon of its type. Unlike the Franco-German "Roland" which uses a proximity fuse, a Rapier missile is designed to score a direct hit.

When you think of the fleeting chance offered by a modern, small fighter-type aircraft crossing at the speed of sound about a mile away, the fact that Rapier constantly scores a very high percentage of hits, borders on the miraculous. Add that the operator is usually a young soldier of unflappable demeanour but no special qualifications and one is even more impressed. How does it work?

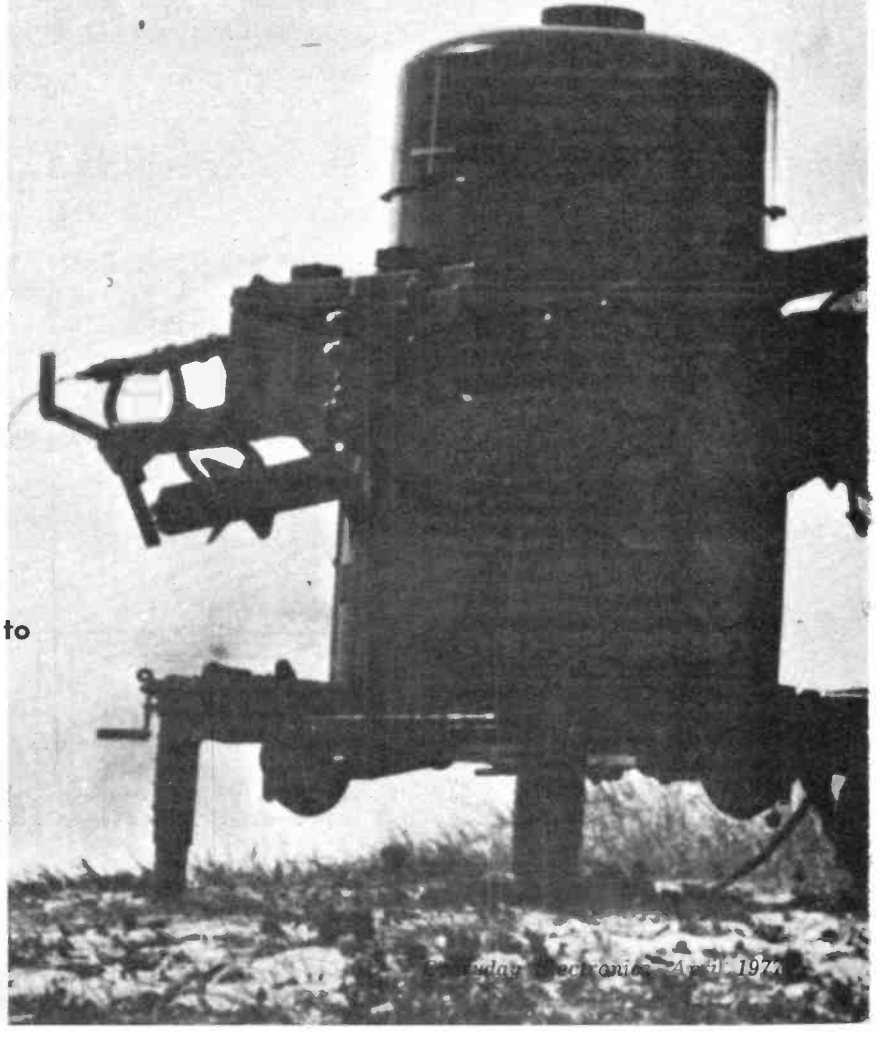
BASICS

Though the new order calls for a self-contained tracked vehicle with which the two parts of the system are integrated, the standard Rapier consists of a Launcher (incorporating a generator) towed by a Land Rover, in which is carried the Tracker. To deploy the system the Launcher is detached from the Land Rover, which, after depositing the Tracker about 30 metres away, moves off to hide. Launcher, Tracker and generator are then connected by cabling. Four missiles are mounted on the Launcher in the top of which is a search radar aerial. There is also a computer and a missile control (command) radio transmitter with a dish aerial mounted in front. The Tracker consists of an optical sight, a TV camera and control facilities.

On being brought into action the radar carries out a normal 360 degree search. When a target is detected it is automatically interrogated by IFF (Identification Friend or Foe) and the radar ceases to respond to information from any other sector. If a friendly reply is received full surveillance is resumed, but if not, an alarm is initiated. This alerts the operator and also slews the optical Tracker head onto the bearing indicated. The Tracker's bearing is transmitted to the Launcher turntable, on which the missiles and their command radio aerial are mounted, and the turntable follows this bearing.

The operator, whose optical sight will be already on the target for bearing searches for and locates it in elevation. He then switches to the "track" mode which stops the radar control of the Tracker bearing, leaving the optical tracking of the target under his full control. It also causes the missile launcher arms (hitherto immobile in elevation) to elevate as necessary,

While the operator keeps dead on target, the computer, which is being fed with information from both the radar and the Tracker's sight, assesses whether or not the target is engageable and informs



the operator. If the computer's answer is yes it lights an IN COVER indication lamp in the operator's field of view and he can then press the FIRE button when he wishes.

On being launched the missile receives an initial correcton which directs it into the field of view of the Tracker's vidicon camera. Flares in the tail of the missile are picked up by the camera which is mounted as one with the optical sight. The camera then measures the amount by which the missile is off the line of sight (the error) and transmits this to the computer. The necessary corrections are formulated by the computer and transmitted by the command radio transmitter to a guidance receiver in the missile. Thus the missile is made to fly as near as possible along the operator's line of sight.

In this article we are particularly concerned with the surveillance radar and command transmitter elements (designed and manufactured by Decca Radar Limited) and let us now go back over the sequence of events, with particular emphasis on these two aspects.

RADAR

The computer in the Launcher, in order to work out whether a detected target is (or will soon be) engageable by the missile system, needs more radar information than can be supplied by a standard pulse radar of the type described in the January 1975 issue (*How Radar Works*). In particular it needs the ability to detect moving low-level targets in heavy ground clutter. This require's a radar with the facility of extracting target velocity.

The Doppler principle is best explained by the train whistle analogy. When the train is approaching a stationary listener the note rises due to the fact that the distance between the sound source and the listener is decreasing and hence each successive sound wave has less distance to travel than the preceding one. This causes each individual sound wave to arrive at the listener a little earlier than would have been the case if it has been emitted from a stationary source.

The shortened interval between the sound waves arriving at the listener results in the reception of a higher tone than that emitted. Conversely, when the train has passed, the increasing distance results in a lengthened interval between sound waves and the listener hears a lower tone than that emitted. Hence a prolonged whistle sounds like a wail that rises and then falls.

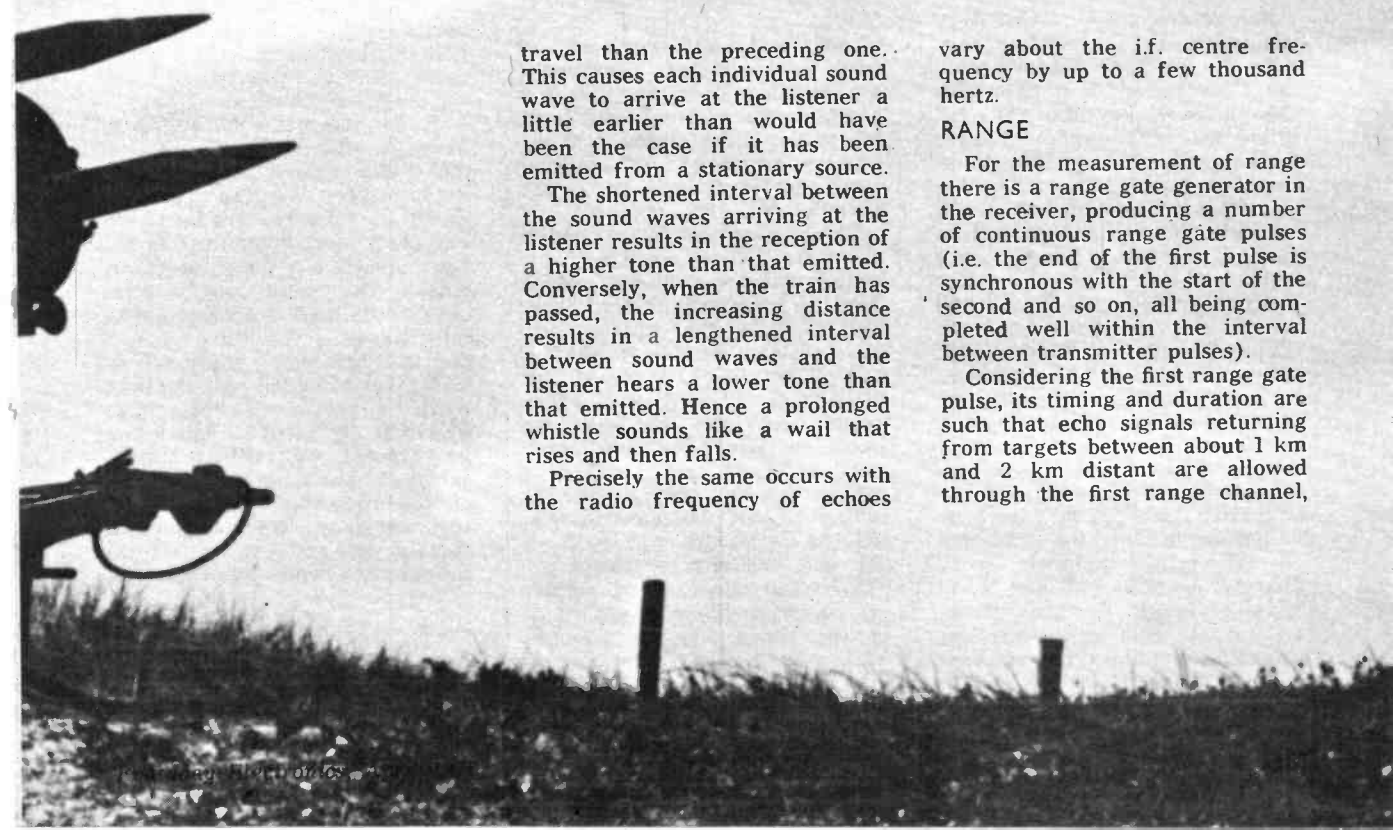
Precisely the same occurs with the radio frequency of echoes returning from moving objects. When an aircraft is circling at constant range there will be no change of frequency (i.e. no Doppler shift) but as soon as it closes or retires a change occurs and can be translated into radial velocity by comparison with the outgoing frequency (crystal controlled to ensure consistency). Radial velocity of the target can be obtained from the amount of Doppler frequency shift, and the direction of travel (i.e. approaching or receding)from the polarity of the Doppler frequency shift.

In the Rapier radar a solid state drive unit is used to provide the transmitter drive, the first and second local oscillator signals and the clock pulse for r.f. generating range gates. As the transmitter drive and the first local oscillator signals are derived from the same crystal oscillator they are coherent (i.e. spaced apart by a constant frequency) any variation occurring equally to both. Any Doppler shift of frequency due to a moving target) can vary about the i.f. centre frequency by up to a few thousand hertz.

RANGE

For the measurement of range there is a range gate generator in the receiver, producing a number of continuous range gate pulses (i.e. the end of the first pulse is synchronous with the start of the second and so on, all being completed well within the interval between transmitter pulses).

Considering the first range gate pulse, its timing and duration are such that echo signals returning from targets between about 1 km and 2 km distant are allowed through the first range channel,



Shows the Rapier System in operation: the Tracker is shown in the foreground and the Launcher in the background containing four missiles.

The end result of a successful missile launch—a direct hit.

that is, reach the rest of the receiver. Similarly, the next range gate pulse passes echoes from 2 to 3 km through the second range channel and so on.

The result is that an echo from a certain range channel generates a signal representing that range, the information being passed to the computer as target range. The measurement is imprecise but very accurate range is not required in the Rapier system.

RADIAL VELOCITY

Radial velocity is obtained by comparing the echo frequency with the emission frequency on the Doppler principle described. The Rapier operator is not interested in stationary targets (those without any change of frequency) and these are rejected by a clutter filter tuned to second i.f. centre frequency. Signals from moving targets, which pass through the filter in any range channel, are amplified and applied to a bank of ten frequency-conscious filters. Each one covers a band of frequencies corresponding to a 50 metre per second range of radial velocities.

The first velocity channel covers from about 37 microseconds to 87 microseconds, the next from 87 to 137 microseconds and so on, in much the same way as the range channels cover discrete sections of the total range coverage. The presence of an output from any particular velocity channel, in the relevant range channel, indicates target velocity and this information is fed to the computer.

In the context of velocity information, it should be mentioned that the presence of sidebands in the Doppler receiver results in an ambiguity which can cause a slow approaching target to appear as a fast receding one, and vice versa. This ambiguity is resolved in the computer.

BEARING MEASUREMENT

Bearing (or azimuth) measurement is a combined operation on the part of an azimuth pulse generator (situated in the radar head), the Doppler radar receiver and a digital counter and store in the Tracker. The aerial beamwidth is 8 degrees and it is necessary to ascertain the bearing of the aerial (relative to the fore and aft line of the Launcher) when the target is in the centre of the beam.

There is an optical system in the pulse generator comprising a lamp, lens, and a disc which revolves between these and photo electric cells. The disc has two concentric tracks, one of which is half clear and half blank, and the other divided into 2048 porforations. The disc is driven by the gearbox of the aerial which revolves at 60 r.p.m., and so it follows that the intermittent light falling on the photoelectric cells will be in square waveform of 1Hz and 2048Hz respectively.

Electrical signals of this nature are passed to the second element of the combination, a counter. This uses the 1Hz signal as an azimuth zero reference. As soon as the radar detects a moving target, a target width pulse is generated in the Doppler receiver which causes the counter to stop counting and transfer its contents to the store. But the bearing at this moment is that of the leading edge of the beam, not its centre, and to obtain the latter it is necessary to add half the beamwidth.

This is done by feeding pulses at half azimuth pulse frequency (i.e. half-speed pulse) from the Doppler receiver into the Tracker store for the whole of the duration of the target width pulse. The resultant final count then equals aerial bearing at target start plus half the beamwidth, which is the same as when the target is at the centre of the beam.

So we now have the ability to assess a target's range, bearing and radial velocity. The bearing data is used (in the SEARCH mode) to turn the Tracker head and the Launcher onto the target bearing when a radar alarm is raised. The range and velocity data are used together with information from the Tracker, during coverage computation. This takes place between the time when the operator switches from SEARCH to TRACK and when he presses the FIRE button. When the missile is fired the role of the computer changes from coverage computation to guidance computation and the TV vidicon camera then comes into the story.

VIDICON CAMERA

As soon as the missile flare appears in the camera's field of vision, the latter informs the computer of the error between the

flare position and the centre of the camera's field of view. Though there is no c.r.t. involved as with normal TV the principle is similar but in reverse. Instead of a picture being built up by a scanning process, the bright light from the flare is recorded by what can be termed a reverse scanning process which transmits its findings to the computer.

To convert the vidicon output into flare-spot position information, it is first necessary to find the flare spot on the image plate. During the initial period of an engagement, the television is operating in the widefield flare acquisition mode and a systematic search is performed over an area of the image plate which is slightly larger than the area of the optical field of vision presented to it.

The search is made by a fine electron beam which scans the underside of the vidicon image plate, and an output from the vidicon occurs when the electron beam passes across the flare image. After flare acquisition the TV optics change to high magnification and narrow field.

In order to scan the designated area of the image plate, the beam makes 625 horizontal sweeps across the plate. These sweeps are said to cover a frame, and take 10mS to do so. At the end of each sweep the beam returns very quickly to a new starting point on the same side of the plate from which it started but slightly displaced perpendicularly from the last starting point. The displacement is brought about by the vertical sweep which takes place at the same time as the horizontal sweep.

In effect, when the beam ends its return journey it finds that it has been slightly deflected from its original starting point. As only one vertical sweep is required for the whole series (frame) of horizontal sweeps needed to scan the designated area of the image plate, the vertical sweep speed is much slower than the horizontal, and lasts for 10mS.

AZIMUTH AND ELEVATION

Now, the beam is caused to sweep across the image plate by supplying a current, increasing with time, to the vidicon control circuits required. For a particular current magnitude then, the beam is moved to a defined spot on the image plate. Conversely, by measuring the current supplied, the position of the beam at any instant can be determined. This feature is made use of in the television system, for the length of the horizontal sweep is made to represent the full ambit of the TV system in azimuth, and the vertical sweep the ambit in elevation. It has been explained that when the electron beam passes the flare image, the vidicon tube produces an output.

Considering the azimuth alone, the vidicon output is used to switch a sample of the horizontal sweep current to the azimuth error channel. As explained, the magnitude of this current is indicative of the point reached by the beam during the horizontal sweep and is thus directly related to the azimuth of the flare image. For elevation, the vidicon output causes the vertical sweep current to be sampled and switched to the elevation error channel. The magnitude of this current is indicative of the distance of the path of the vertical sweep in progress, from the path of the first horizontal sweep in the frame, and is thus directly related to the elevation of the flare image.

The outputs to the error channels are processed within the TV system so that when the flare image is at a point on the image plate which is coincident with the TV optical axis, a zero output is given in each channel. If the image is offset from this position in a channel, an output is given with polarity dependant on the direction of offset.

The computer receives 'error' signals from the vidicon camera which are derived from the flare's position relative to the line of sight. Resolving these the computer produces pitch and yaw demands for the command transmitter to send to the missile.

TRANSMITTER AND MISSILE

The command radio transmitter changes the characteristics of the pulses so received in accordance with the code used by the particular Rapier in question. If this did not happen an adjacent Rapier might be affected by mistake. The specially coded pulses are applied to the modulator which fires the magnetron, which in turn changes them into r.f. pulses for beaming to the missile.

Two aerials are employed for this. The first is a flared horn type with wide beam for "gathering" the missile in its early stages. After allowing a short time for the latter to settle, an automatic waveguide change-over switch switches to the second aerial, a dish with narrow beam.

The command signals are received as pulses in the missile, detected, amplified and converted into voltage analogues of the original yaw and pitch demands, and passed eventually to the guidance assembly. This demands control solenoid valves regulating the flow of a hot gas to cylinder and piston actuators operating the four control surfaces near the tail of the missile. Manipulation of these is the last link in the chain of operations, the missile being brought onto the line of sight of the vidicon camera, and therefore of the operator.

The missile carries an impact fuse, and all the operator has to do, having pressed the FIRE button, is to keep his sight exactly on the target. This is done with a sensitive joy-stick control, simply a lever that can be pressed in any direction to transmit information in the two modes with an urgency varied by pressure on the stick. The effect of a hit is devastating, far more destructive than a proximity fuse. ⌑

Comments about a Retailer

Having just read *Counter Intelligence* in my copy of February EVERYDAY ELECTRONICS, I would suggest that you inform Mr. Paul Young of the existence of Orchard Electronics in particular, and most component retailers in general (except, it seems, for the establishment he orders from) who have a remarkable service.

They remit your order within a few hours of receiving it, and the only reason for an order taking more than three days to return is either that a 6½p stamp was used or the terrible postal service has just put its third foot in the grave.

Orchard are so fast that inflation does not have a chance to act. Please ask Mr. Young to try their services or print a retraction.

S. Phillips,
Chislehurst, Kent

. . . and more

What on earth was the writer of *Counter Intelligence* (Feb. 1977) thinking of? Having read the article I half expected customers to crawl in on their hands and knees apologising for intruding and begging forgiveness for having the gaul to come in at all.

Is he trying to kill off the component business? He writes—"I am always baffled by the customer who phones to say their order was a fortnight in coming and they consider it disgraceful". The customer is the baffled one. The order comes in, is checked for accuracy, is packed and sent out. What is difficult about that?

Two weeks delay!! a month!! this guy says two months. Come off it. We advertise a by return post service and we mean it. If your goods fail to arrive in 7 days let us know. The inference that component suppliers are a lazy bunch of inefficient layabouts is just not on.

The magazines spends weeks preparing projects. The customer pays good money for the magazine. He is tempted to build a project and by the time he gets the bits two more issues of the publication are on his bookshelf. The writer of *Counter Intelligence* is baffled.

Dear reader, disassociate Orchard Electronics from such clap-trap. "By return post" means what it says.

Inflation is another matter, we are all suffering with that one. The clearly written and accurately calculated order is a joy to deal with. The only part of our service we cannot control is the postal system. According to our records about a dozen packages have failed to arrive. Not bad when one considers that at least half of these went up in smoke when some goon set fire to the local Post Office.

Finally we are proud to be part of the fastest developing industry in the world today. Proud to be British, the most advanced nation in electronics today.

So we suppliers may have problems, so what, that's what business is all about. If it were humanly possible we would deliver in two hours (in fact on more than one occasion we have even done that) but 2 months or 2 weeks—NO! Electronics should be a pleasure not a pain in the neck.

D. M. Trueman
(Orchard Electronics)

Thank you for your letter and constructive criticism. As you know I am as keen about the electronics industry as you. I think that I should perhaps have made it clearer in my article that two weeks is not the norm for the delivery of goods. We do manage an immediate turn round, or the same day where a customer has an account. No, this only occurs on out of stock items.

Where you have two unknown variables, (length of time for supply, and weekly demand) and where you are dealing with about 500 to 600 orders a week it is difficult not to be occasionally caught out.

The point that I was trying to make and failed, that compared to other hobbies our component retailers do superbly well. Anyway we can do with lots more enthusiasts like yourself in the business, so keep up the good work, even if it means criticising yours truly from time to time.

Paul Young,
Surrey

Appeal from abroad

I am writing on behalf of the International Voluntary Service in the Seychelles. We are part of the British Volunteer Programme which is a voluntary organisation with a view to training technicians etc in the developing countries.

At present the college in which I am teaching has a City and Guilds of London 235A and 235B Electricians Course. We are trying to start a Basic Electronics course, which is (in the "Electrical Industry") a vital part of training.

The Islands I should explain have just received independance, and of course have a limited budget, therefore we have problems in supplying texts for our students, and components for building circuits. I would add that a lot of British Technology is exported to the Islands but only limited training is available.

Part of the plan is to expand on this training, so I would like to appeal to you and your readers, to help in as many ways as possible. One very practical way would be to receive unwanted back issues of your magazine which I feel would be a tremendous help in the work. Also old or used texts, would certainly be gratefully received, and, of course, what we in the trade call "junk" such as old p.c.b.s, resistors, diodes, transistors, capacitors etc.

The students are hard working and would be grateful for any help in developing the skills of our industry.

My colleagues and I, some of whom are directly employed by the Seychelles government all feel that the possibilities that exist are excellent. British people have given *political* independance to the Seychelles, we can give them *economic* independance by giving as generously as possible the technical training that they need.

If anyone would like further information on our school please write and I would be only too willing to forward it.

Gordon Catto,
Seychelles Technical School, Education Department, P.O. Box 48, Victoria Mahe, Seychelles.

Can anybody help?

Your readers will be interested to know that large sheets of fibreglass can be obtained extremely cheaply—sometimes even for nothing—from any car breaker who deals with lorries and vans, particularly ex-GPO vehicles. Many of these have fibreglass roofs, etc, which the average breaker has no use for and is glad to get rid of.

I have used this material very successfully for circuit boards, and with the aid of a glass-fibre and resin car repair kit very neat and professional looking boxes, housings and cabinets can be constructed with it.

In common with many other electronic enthusiasts, I have a large collection of integrated circuits etc. mainly removed from computer and surplus panels which I cannot identify as I do not know the makers and they bear totally unfamiliar type letters and numbers which I cannot find in any reference book. Consequently they are completely useless to me.

Does anyone know how or where I can obtain identification and data on these devices? After all, somebody somewhere must know what they are and what they do!

Possibly someone might be interested in starting a "Postal Identification and Data Service".

How about it, some of you boffins? Possibly some scheme where for a reasonable fee (say £1?) you undertake to attempt to identify and supply brief essential data on up to 10 different devices—preferably, of course, on a "no identification—no fee" basis!

Some such service would be a godsend to people like myself, and should show a good profit to anyone who cares to operate it.

J.M. Pascoe, B.H.S.P.I.,
Kent.

We shall be pleased to forward any correspondence to Mr. Pascoe concerning the points raised in his letter. Please ensure that the letter to be forwarded is accompanied by a stamped envelope.

What's watt

I have just started with electronics as a hobby and decided that the best way to enjoy my new hobby was to take a magazine regularly. Having purchased your magazine I was delighted to find that it contained projects to suit people at different levels in electronics.

I was impressed with the *Brake Light Warning Device* (Jan. '77) and decided to build this as my first project. I have however experienced a little difficulty in buying some of the components, namely D1 (TIL 209) and R1 (0·47 ohm ½W, 4 off).

I did manage to find a 0·56 ohm resistor but rated at 1 watt. Four of these resistors wired in parallel gives the exact value quoted in the text (0·14 ohm) but gives a wattage of 4 watts instead of 2 watts. Is this wattage acceptable in this project?

The difficulty with the diode (l.e.d.) was finding one of the correct voltage. Shops locally do not seem able to translate the reference you gave (TIL 209). Please could you tell me where this component can be purchased or possibly state an alternative.

B. F. Scott
Sittingbourne, Kent.

When a resistor wattage is specified, it is in most cases the minimum preferred rating for the job. In your case the four 0·56 ohm 1 watt resistors are o.k.—provided the physical size of the components is acceptable. We are surprised you have had difficulty in obtaining the general purpose light emitting diode TIL209. Voltage ratings are never quoted. Any small l.e.d. will be suitable.

Improvement

On the *Transistor Checker* in the February edition of EVERYDAY ELECTRONICS, because of the wiring of the switch S1, to put it in *npn* you have to take it through *pnp* before you can test *npn* transistors. If you rewire the switch so all the connections which go to tag 1, go to tag 2, and all the connections which go to tag 2, go to tag 1. Thus you do not have to put the switch to *pnp* before *npn* because *off* is in the middle. All the connections which go to tag 3 stay the same.

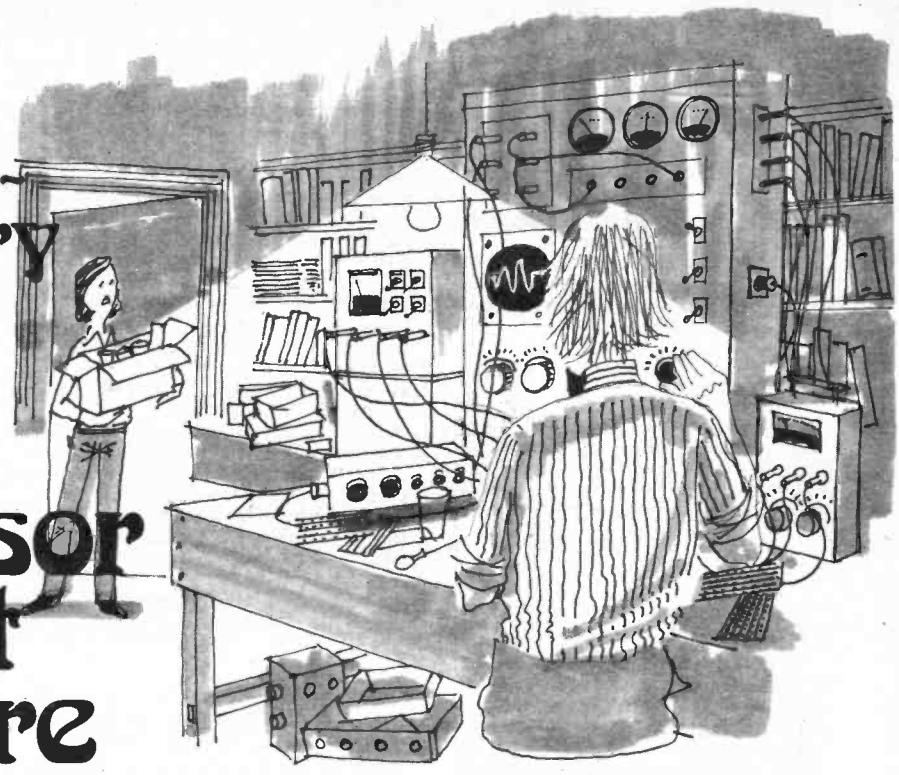
I read Everyday Electronics every month and enjoy it very much.

David Stratt (Age 10)
High Wycombe, Bucks.

...For Your Reference

a.c.	alternating current
a.f.	audio frequency
a.f.c.	automatic frequency control
a.g.c.	automatic gain control
a.m.	amplitude modulation
BA	British Association (nut and bolt sizes)
cm	centimetre
d.c.	direct current
d.p.d.t.	double-pole double-throw
elect.	electrolytic
e.h.t.	extra high tension
e.m.f.	electromotive force
f.e.t.	field effect transistor
f.s.d.	full scale deflection
f.m.	frequency modulation
g.	gram
h.t.	high tension
i.c.	integrated circuit
l.e.d.	light emitting diode
l.d.r.	light dependent resistor
lin.	linear
log.	logarithmic
m	metre (measurement of length)
mm	millimetre
m.w.	medium wave
npn, *pnp*	transistor structure (two types)
oz	ounces (avoirdupois)
p.i.v.	peak inverse voltage
p.v.c.	polyvinyl chloride
r.f.	radio frequency
r.m.s.	root mean square
s.p.s.t.	single-pole single-throw (switch)
s.r.b.p.	synthetic resin bonded paper
s.w.g.	standard wire gauge
t.r.f.	tuned radio frequency
u.h.f.	ultra high frequency
u.j.t.	unijunction transistor
v.h.f.	very high frequency
%	per cent
X	reactance
Z	impedance
A	ampere (amp)
dB	decibel
F	farad
H	henry
Hz	hertz (cycles per second)
Ω	ohm
V	volt
W	watt
p	pico (÷ 1,000,000,000,000)
μ	micro (÷ 1,000,000)
m	milli (÷ 1,000)
k	kilo (× 1,000)
M	Mega (× 1,000,000)

The Extra-ordinary Experi-ments of Professor Ernest Eversure



by Anthony John Bassett

WE will not occupy the reader unnecessarily with any detailed description of the joyful departure of Tom and Maurice from the Professor's laboratory, carrying with them impedance converters which allow connection of extra loudspeakers to an amplifier without mismatch, and an Electronic Steady Hand Tester.

Tom and Maurice have been "roped in" to assist with voluntary charity work, and the interesting technical problems which crop up ensure that they will be regular visitors to the Professor's laboratory. One of the ideas they have left with the Prof. is for a simple coin-collecting mechanism which can be connected to a number of simple but fascinating electronic amusements.

Meanwhile the ever-enquiring mind of the Prof.'s young friend Bob had prompted him along another channel of thought.

PICK-UPS

"I have been wondering, Prof., why there are so many different kinds of pick-ups for hi-fi, and for musical instruments. I have come across crystal, ceramic and magnetic pickups and microphones, and it is quite a puzzle to me why there should be so many different kinds. For instance, what are these mysterious crystals which are used in so many microphones and pick-ups?"

"These are crystals which, when a changing force is applied to them in certain directions, produce a changing output of electrical charges on the faces of the crystal. This electrical change can be picked up by an electrically conducting substance such as thin sheet metal, and taken by wires to the input of an amplifier.

A large number of chemical substances produce crystals which behave in this way, and are known as piezo-electric crystals. Each type of crystalline substance differs in its properties from the others, so that there is a large range of substances available for the purpose of experiments.

One which is very commonly used is known as Rochelle salt, and consists of sodium potasium tartrate. The particular properties which make it a favourite material for use in record-player pick-ups and crystal microphones are high sensitivity and large electrical output, low cost and ease of production. Also it is non-poisonous and is a safe chemical substance to experiment with. I have some in the laboratory stores".

The Prof. summoned his experimental robot and, using a strange code, quickly instructed it to bring some Rochelle salt from the stores. A few minutes later, guided by its electronic brain, a masterpiece of experimental electronic wizardry which the professor has connected using microprocessors and other miniature and integrated-circuit type devices, the robot returned and carefully presented to the Prof. a jar labelled 'Sodium Potassium Tartrate (Rochelle Salt)' and containing a white powder. It also gave the Professor a small package, which he unwrapped, and inside, Bob could see two clear colourless crystals of Rochelle salt.

SLICING

"You could experiment with one of these crystals Bob, by slicing it up carefully into thin slices in various directions parallel to the crystal faces, and across them. But you must take considerable care, because three of the physical properties of Rochelle salt may cause difficulty; one is that the crystals are brittle and must not be subjected to heavy stress or shock. So the material must be handled gently to avoid breakage.

Another property of Rochelle salt is that it is soluble in water, and the crystals may easily be destroyed by water or damaged

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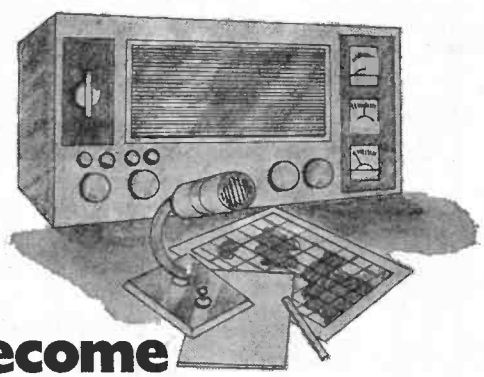

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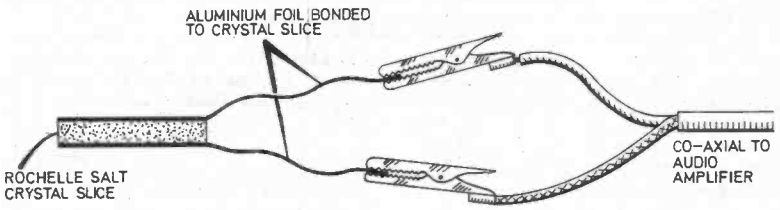

Fig. 1. The crystal pick-up constructed by Bob.

by perspiration during handling. So to avoid this, use a pair of plastic tweezers instead of picking the crystals up in your hands.

The third property is sensitivity to high temperatures. You must be careful not to overheat the material by rapid sawing, drilling or polishing as the crystal is likely to melt".

Now Bob, who had a few moments previously been full of enthusiasm, began to feel dubious.

"What if I damage one of those crystals, Prof., and make it unusable? Then there would only be another one left, and I would not be happy to break that as well".

"Don't worry about that, Bob. "The Professor advised. "You can experiment all you like with these two, as we can easily grow some more from the Rochelle salt in the bottle. By referring to a suitable book on the subject of physical chemistry you can easily find out how to grow the crystals from a saturated solution of water, using the same type of procedure as for say, copper sulphate crystals".

Bob was reassured, and began to very carefully cut one of the crystals into slices of about 1mm thick, rubbing the cut smooth with fine emery paper. Although he broke one or two of these delicate slices, he soon had a number of them ready.

CONTACTS

"Usually the metals used for the purpose of contacting the crystal surfaces are silver, or aluminium foil, Bob. Would you like to attach a piece of aluminium foil to each face of some of these slices of crystal, using quick set epoxy resin, whilst I try out some silver conductive paint on the others?"

Bob cut some aluminium foil into narrow strips, and, using quick set epoxy resin, bonded some of the foil to each crystal slice as shown in Fig 1, leaving plenty of spare foil loose, for the purpose of making connections.

A few minutes later, when the epoxy resin was set, Bob, knowing that it would be difficult to attempt to solder the aluminium foil, and that this would almost certainly melt the crystal, prepared a length of thin screened wire with a pair of crocodile clips at one end. He connected the crocodile clips to the aluminium foil as in Fig. 1, plugged the other end of the screened wire into the input of an audio amplifier and carefully turned up the volume control. Now, by gently tapping the crystal, the tapping sound could be clearly heard through the loudspeaker and it was obvious to Bob that he had made a simple crystal pickup capable of converting sounds and vibrations into electrical signals suitable for amplification.

Meanwhile the Prof. had been doing some experiments with the other crystal slices, and was busily making another type of pick-up, which could be used as a contact microphone.

Continued next month.

GEORGE HYLTON brings it down to earth

THE idea that a resistance, any resistance, just sitting by itself, minding its own business, should automatically generate a voltage seems at first sight to be very strange. Why should it? An electric cell, sitting alone, can generate an e.m.f., a voltage, because the chemicals inside it work that way. But a simple resistor, with no electro-chemical contents . . . surely not?

Yet the plain fact is that it happens. Resistors do generate voltages, and these voltages manifest themselves as electrical *noise*. How do they do it? Well, any source of electrical energy must have some sort of driving power. In the case of a cell, it's the chemicals. In a power station, it's the steam or water which turns the turbogenerators. In a cycle dynamo it's the muscle power of the cyclist, turning the wheel. In a resistor, it is *heat*.

Energy

Any piece of matter, solid liquid or gas, contains energy in the form of heat. If you cool it, you extract heat, which proves that the heat was there in the first place. If you could go on cooling it until *all* the heat was extracted it would have a temperature of about minus 273 degrees C, known as absolute zero (0 degrees K). But real-life resistors, even if they are at the South Pole, have temperatures far above absolute zero. So they all contain thermal energy.

This means that the atoms which they are made of are in a state of thermal agitation. The electrons which orbit the atomic nucleus can gain or lose energy from their neighbours. If they gain enough energy they may escape from their parent atom and skip to another. Since an electron is a charged particle, this movement is a tiny local *current* inside the resistor. (A current is just a movement of electrical charges.)

So, all the time, in the atoms and molecules which make up the resistor, there are tiny currents. They can flow in any direction and frequently they must happen to flow in opposite directions and cancel out. However, there's a definite chance that at any one instant enough charges will be moving in the same direction to set up an appreciable voltage across the resistor. This voltage changes constantly, both in size and polarity and is quite unpredictable.

Random a.c. voltages like this are called *noise* voltages. This thermal noise is an equal mixture of all frequencies. By analogy with white light, which is an equal mixture of all colours, this sort of noise is called white noise.

Power

If the resistor is large, there are more moving charges but also a greater chance that at any instant there will be opposite movements whose effects cancel one another. For this reason the the amount of noise is the same for all shapes and sizes of resistor. Similarly it turns out that the noise *power* is the same for *all* values of resistance. In a low resistance the noise voltage is low but the current high. In a high resistance it's the other way round. But the power, which is current times voltage, is the same.

The noise power, in fact, depends on only two factors. One is the temperature: the hotter the noisier. The other is the range of frequency over which you measure the noise.

Since white noise is an equal mixture of all frequencies, the more frequencies you take into account the greater the noise. So the essential factor which controls noise *power* is temperature times bandwidth, or TB for short. To get the noise power in watts you have to multiply this by a fixed number, a constant. It's called Boltzmann's constant, after the physicist who first computed it, and it's written K for short. So noise power in any resistance is KTB watts.

This may sound like a lot of noise power. In fact, K is a very small number indeed so the power (at ordinary temperatures) doesn't really come out in watts, or even microwatts. At room temperature (which is about 300 degrees on the absolute or Kelvin scale, which is the one to use here) the available noise power over the whole audio band up to 20kHz is only 80 $\mu\mu$W. The noise *voltage* depends on the resistance. For a resistance of 10 kilohms it is, over the entire audio band, 2 μV.

In most ordinary audio circuits this noise voltage is appreciably increased by noise generated by transistors in the amplifiers used. Also, carbon resistors themselves generate extra noise when d.c. flows in them. However, the thermal noise imposes an absolute limit on signal-to-noise ratio.

The Sky

In radar and radio astronomy there is another source of noise—the sky. For example, the sun, being a hot body, generates noise. Radar engineers often describe this noise in terms of a *temperature*. If the temperature of the aerial and receiver were raised, just as much noise would be generated as arrives from space. So you can say that a radar receiver pointed at the sun has a *noise temperature* of so many degrees.

It is impossible to escape entirely from noise from space. The whole of space generates a tiny amount of background noise, equivalent to a temperature of about 3 degrees above absolute zero. Astronomers who think that the universe began as a huge fireball which exploded and spread out regard this 3 degrees as the temperature to which the universe has now cooled since the original "Big Bang."

PLEASE TAKE NOTE

We apologise for a mistake in the *Quasi-Quad Adaptor*, March 1977. In Fig. 5 the signal wires of the screened leads to VR1 should be transposed.

There is a link wire missing from the drawing shown in Fig. 2 in the *Multi-Tester*, January 1977. On switch S1c the link between positions 2 and 4 (Ω and mA) has been ommitted.

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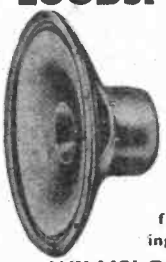

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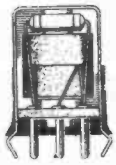

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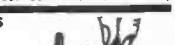

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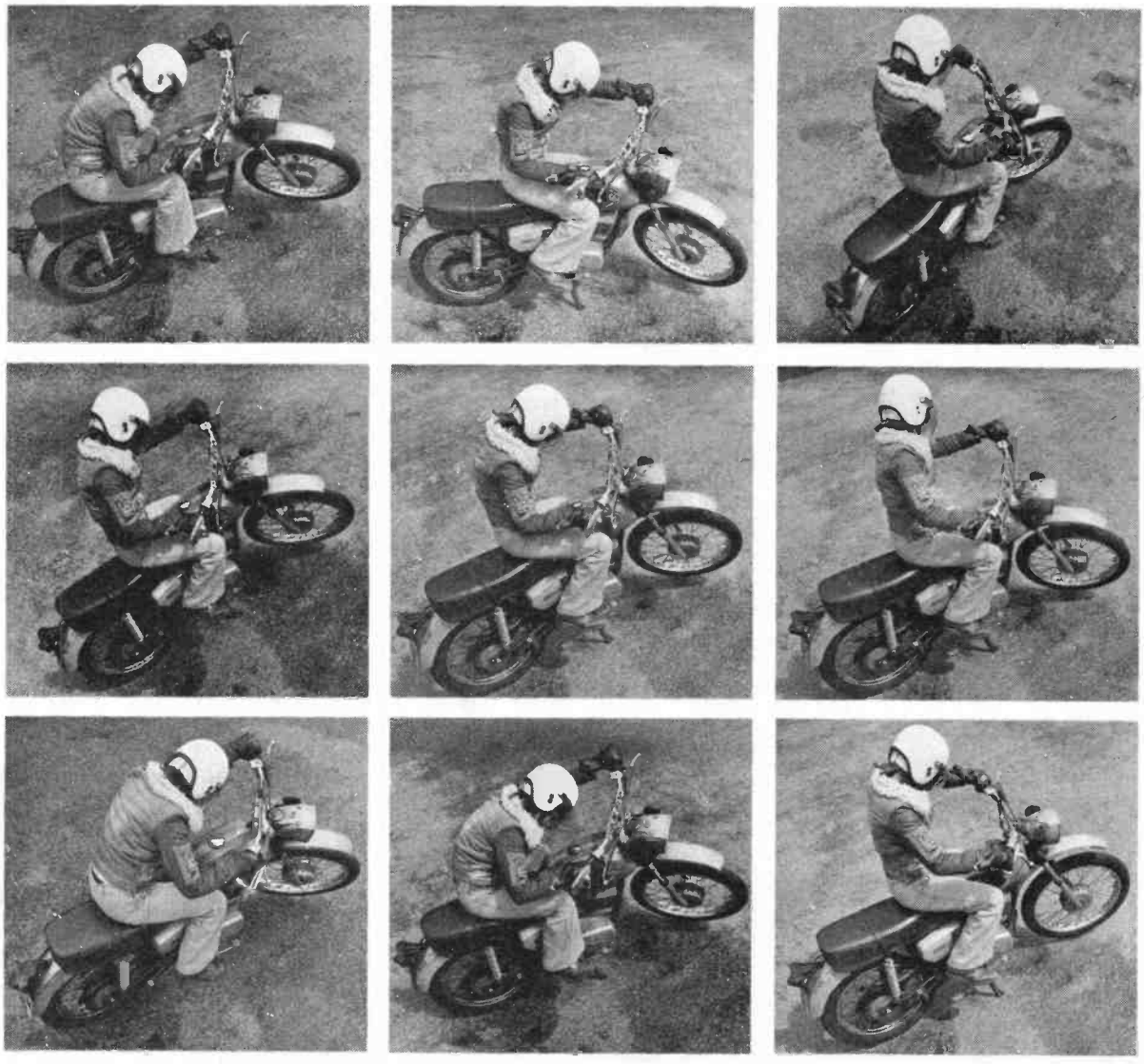

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AC127	0·14	BC109C	0·08	BC556	*0·14	BFY50	0·14	TIP42C	0·95	2N3708	*0·07
AC128	0·12	BC147	*0·09	BC557	*0·13	BFY51	0·14	TIP2955	0·95	2N3708A	*0·07
AC128K	0·26	BC148	*0·09	BC558	*0·12	BFY52	0·14	TIP3055	0·75	2N3709	*0·07
AC132	0·15	BC149	*0·09	BC559	*0·14	BIP19	0·38	TIS43	0·22	2N3710	*0·07
AC134	0·15	BC157	*0·12	BD115	0·50	BIP20	0·38	TIS90	*0·18	2N3711	*0·07
AC137	0·15	BC158	*0·12	BD116	0·80	BIP19/		UT46	0·20	2N3819	0·20
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AC141K	0·30	BC167	*0·12	BD123	0·65	BRY39	0·45	ZTX108	*0·10	2N3821	0·60
AC142	0·18	BC168	*0·12	BD124	0·70	BUI105	1·90	ZTX109	*0·10	2N3823	0·40
AC176	0·12	BC169	*0·12	BD131	0·35	BU105/02	1·95	ZTX300	*0·12	2N4058	*0·12
AC176K	0·26	BC169C	*0·12	BD132	0·38	BU204	1·70	ZTX500	*0·14	2N4059	*0·14
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AC179	0·25	BC171	*0·10	132 MP	0·80	BU208	2·40	2N1711	0·20	2N4061	*0·12
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AC181K	0·30	BC178	0·16	BD137	0·38	MJE3055	0·60	2N2147	0·75	2N4286	*0·18
AC187	0·16	BC179	0·16	BD138	0·45	MJE3440	0·45	2N2148	0·70	2N4287	*0·18
AC187K	0·26	BC180	0·25	BD139	0·54	MP8113	0·45	2N2160	0·80	2N4288	*0·18
AC188	0·16	BC181	*0·25	BD140	0·60	MPF102	0·35	2N2192	0·38	2N4289	*0·18
AC188K	0·26	BC182L	*0·10	BD139/		MPF104	0·39	2N2193	0·38	2N4290	*0·18
AD140	0·60	BC183	*0·10	140 MP	1·20	MPF105	0·39	2N2194	0·38	2N4291	*0·18
AD142	0·85	BC183L	*0·10	BD155	0·80	MPSA05	*0·20	2N2217	0·22	2N4292	*0·18
AD143	0·75	BC184	*0·10	BD175	0·60	MPSA06	*0·20	2N2218	0·22	2N4293	*0·18
AD149	0·60	BC184L	*0·10	BD176	0·60	MPSA55	*0·20	2N2218A	0·20	2N4921	*0·55
AD161	0·36	BC207	*0·11	BD177	0·68	MPSA56	*0·20	2N2219	0·20	2N4923	*0·65
AD162	0·36	BC208	*0·11	BD178	0·68	OC22	1·50	2N2219A	0·24	2N5135	*0·10
162 MP	0·75	BC209	*0·12	BD179	0·75	OC23	1·50	2N2904	0·18	2N5136	*0·10
AF114	0·20	BC212	*0·11	BD201/		OC24	1·40	2N2904A	0·21	2N5138	*0·10
AF115	0·20	BC212L	*0·11	202 MP	1·70	OC25	0·60	2N2905	0·18	2N5194	0·56
AF116	0·20	BC213	*0·11	BD203	0·80	OC26	0·60	2N2905A	0·21	2N5245	*0·28
AF117	0·20	BC213L	*0·11	BD204	0·80	OC28	0·90	2N2906	0·16	2N5294	0·34
AF118	0·40	BC214	*0·12	BD203/		OC29	1·00	2N2906A	0·19	2N5296	0·35
AF124	0·30	BC214L	*0·12	204 MP	1·70	OC35	0·90	2N2907	0·20	2N5457	0·32
AF125	0·30	BC237	*0·16	BDY20	0·80	OC36	0·90	2N2907A	0·22	2N5458	0·32
AF126	0·30	BC238	*0·16	BDX77	0·90	OC70	0·15	3N2926G	0·09	2N5459	0·38
AF127	0·32	BC251	*0·15	BF457	0·37	OC71	0·15	2N2926Y	*0·08	2N5551	*0·30
AF139	0·58	BC251A	*0·16	BF458	0·37	TIC44	*0·29	2N2926O	*0·08	2N6027	0·32
AF180	0·58	BC301	0·30	BF459	0·38	TIC45	*0·29	2N2926R	*0·08	2N6121	0·70
AF181	0·58	BC302	0·28	BF594	*0·15	TIP29A	0·44	2N2926B	*0·08	2N6122	0·70
AF186	0·58	BC303	0·32	BF596	*0·17	TIP29B	0·52	2N3053	0·16	40311	0·36
AF239	0·38	BC304	0·38	BFR39	0·25	TIP29C	0·62	2N3054	0·40	40313	0·95
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AU110	1·00	BC338	*0·15	BFX29	0·25	TIP31A	0·54	2N3416	*0·29	40327	0·45
AU113	1·00	BC440	0·30	BFX30	0·30	TIP31B	0·66	2N3417	*0·29	40346	0·42
BC107A	0·08	BC441	0·30	BFX84	0·23	TIP31C	0·68	2N3614	0·85	40347	0·55
BC107B	0·08	BC460	0·38	BFX85	0·24	TIP32A	0·64	2N3615	0·90	40348	0·70
BC107C	0·08	BC461	0·38	BFX86	0·25	TIP32B	0·76	2N3616	0·90	40360	0·38
BC108A	0·08	BC477	0·20	BFX87	0·22	TIP32C	0·80	2N3646	*0·09	40361	0·38
BC108B	0·08	BC478	0·19	BFX88	0·22	TIP41A	0·66	2N3702	*0·08	40362	0·38
BC108C	0·08	BC479	0·20			TIP41B	0·70	2N3703	0·08	40406	0·40
		BC547	*0·12			TIP41C	0·80	2N3704	*0·07	40407	0·28
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7403	0·15	7412	0·23	7446	0·90	7485	1·20	7496	0·80	74154	1·30
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CD4002	0·18	CD4015	0·90	CD4024	0·72	CD4037	0·95	CD4049	0·55	CD4081	0·18
CD4006	0·98	CD4016	0·50	CD4025	0·18	CD4040	0·95	CD4050	0·55	CD4082	0·28
CD4007	0·18	CD4017	0·90	CD4026	0·98	CD4041	0·82	CD4054	1·20	CD4510	1·30
CD4008	0·95	CD4018	1·00	CD4027	0·60	CD4042	0·82	CD4055	1·20	CD4511	1·60
CD4009	0·55	CD4019	0·52	CD4028	0·85	CD4043	0·98	CD4056	1·40	CD4516	1·40
CD4010	0·55	CD4020	1·10	CD4029	1·15	CD4044	0·94	CD4069	0·40	CD4518	1·08
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CA3028A	*1·10	LM320-24V	2·00	NE540	*2·40	UA741C	*0·20	SN76110	*1·50	TBA641B	*2·25
CA3035	*1·30	LM380N	*1·00	NE555	0·40	72741	*0·20	SN76115	*1·90	TBA800	*0·80
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The book section contains over 150 titles of books about electronics, radio, TV, Hi-fi etc. Browse through the pages and choose from some of the best titles around including a superb set of books that will teach you electronics by experimentation! (foot of catalogue page 142)

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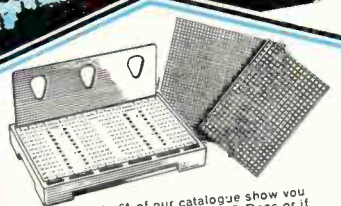
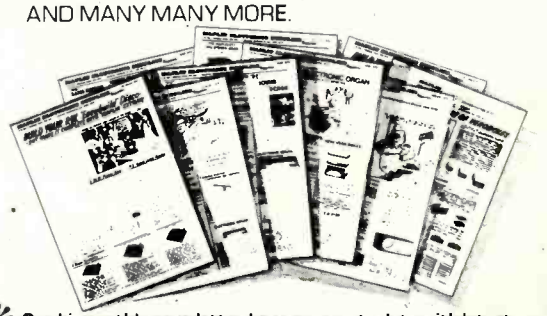


Pages 59 to 61 of our catalogue show you our range of Veroboards and S-Decs or if you prefer to make your own pcb's a range of etching systems including the novel Dalo etch-in-a-bag system, plus printed circuit transfers for that professional finish to your boards.

Catalogue includes a very wide range of components: hundreds of different capacitors; resistors; transistors; I.C.'s; diodes; wires and cables; discotheque equipment; organ components; musical effects units; microphones; turntables; cartridges; styli; test equipment; boxes and instrument cases; knobs, plugs and sockets; audio leads; switches; loudspeakers; books; tools – AND MANY MANY MORE.



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SPECIAL 8 PAGE SUPPLEMENT

GUIDE TO COMPONENT BUYING

A directory of firms advertising in EVERYDAY ELECTRONICS and the products they sell, including basic information for mail order customers.

THE information contained in this guide has been supplied by the various companies at our request. The initial list shows each company's name, address and—where submitted—telephone number and brief data about the firm and its trading policy.

The following five pages carry charts showing which of a selected list of components each firm can supply. These charts can be used in two ways, either to check on what a known firm can supply—do this by looking up the firm's name in the left hand column and following the line across the pages, each marked square represents one type of component (listed at the top) that the firm normally holds in stock. Or to find a supplier of a particular type of component—do this by finding the component required, along the top (listed in alphabetical order) and looking down the row, each marked square represents a company (listed on the left) that can supply the required item.

Arrow Electronics Ltd., Mail Order Department, Leader House, Coptfold Road, Brentwood, Essex. Telephone: 0277 219435 (Retail) 0277 226470 (Trade), Telex: 995393.

Catalogue 40p including p & p. Prices inclusive of V.A.T.

We have introduced an "availability reference" which should assist customers. Terms: Cash with order, Order under £5.00 in value 25p p & p. Orders over £5.00 postage free. The shop in Brentwood is open 9—5.30 p.m. 6 days per week (open during the lunch hour during winter months). The shop has many lines in addition to current catalogue and advertised items, and a popular feature is the wide range of semiconductor special offers.

B. Bamber Electronics, (Electronic Components and Equipment Suppliers), 5 Station Road, Littleport, Cambs, CB6 1QE. Telephone 0352 860185.

Terms of Business: Cash with order (except Government Departments). Minimum Order £2.00 post paid (U.K. only, except where stated). Goods in stock normally despatched same day, or within 36 hours. List published from time to time (s.a.e. required). Faulty goods replaced or money refunded without quibble.

B. H. Components Factors Ltd., 59 North Street, Leighton Buzzard, Beds, LU7 7EG. Telephone 05253 2316.

Bi-Pre-Pak Ltd., 222 West Road, Westcliffe-on-Sea, Essex

J. Bull (Electrical) Ltd., 102-3 Tamworth Road, Croydon, Surrey, CR9 1SG. Telephone 01 688 1833.

The company holds very large stocks and a new catalogue is in preparation, also monthly newsletters are issued which give details of new bargains as they arrive, these will be sent free upon receipt of a stamped addressed envelope and will be mailed automatically to all who subscribe £1.25p per annum, which just about covers the cost of stamps and envelopes.

Trading terms are cash with order except to schools and public institutions whose orders are accepted on a monthly credit basis. There are generous discounts for quantity orders.

Extra carriage on heavy items must be sent regardless of size of order. Letter weight items will be sent post free providing the order for these items exceeds £6.00—below this an amount of 40p should be added to cover cost of postage and the servicing of the order.

Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN.

The Components Centre, 7 Langley Road, Watford, Herts, WD1 3PS. Telephone 45335.

Crescent Radio Ltd., 164-166 High Road, London, N22 6EJ (also) 13 South Hall, Edmonton, N9. Mail order Department, 1 St. Michael's Terrace, Wood Green, London N22 4SJ. Telephone 01 888 4474.

Our minimum postage and packing charge for mail order customers is 50p per order unless otherwise stated. The postage and packing charge is subject to 8 per cent V.A.T.

Quantity trade prices will be quoted on application.

Denco (Clacton) Ltd., 355-7-9 Old Road, Clacton-on-Sea, Essex, CO15 3RH. Telephone Clacton 22807.

We offer a complete range of coils for valve and transistor useage plus a range of formers and cores, base cans etc.

Our products are available from most home constructor outlets or direct mail order. In order to cover high postal rates we require 15p postage and packing for goods up to the value of £2 and 5p per £1 thereafter, any overpayment will be refunded.

We manufacture a multitude of coils of customers own requirements and are always pleased to offer quotations to home constructors clubs, education authorities etc., for purpose wound coils, providing they can order minimum 100 quantities.

Doram Electronics Ltd., P.O. Box TR8, Wellington Road Industrial Estate, Leeds, LS12 2UF. Telephone 0532 34222 or 252548.

The Doram edition 3 catalogue carries full information on the 3,500 different items currently held in stock. The price of 60p includes free postage and update information for the duration of the catalogue.

The range of Doram construction kits is detailed in the full colour Kit Brochure, price 25p. If ordered together with the catalogue the price is 70p, which can be offset by using the two 25p vouchers on two separate orders of £5.00 or more.

Postage and packing is free for all goods with the exception of a minimum order charge of 40p for orders with a total value (excluding VAT) of less than £1.00. We offer a return of post service for all items in stock and guarantee components for one year.

Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. Telephone 0748 3 3603. Telex 264475.

Catalogue 40p retail. Small order surcharge 15p if order under £2.00. Company accounts opened with suitable references. No minimum order value but minimum invoice value is £1.00.

Greenweld Electronics, 443 Millbrook Road, Southampton, SO1 0HX. Telephone 0703 772501.

Greenweld Electronics was founded in Feb. 1973 and started life as a mail-order only business in West Wickham, Kent. As trade increased, so did the need for larger premises and a shop in Deptford was purchased, which is still operating today.

As the South Coast seemed to be lacking in component shops, a move to Southampton was made where, after a year in a smaller shop, the business was transferred to its present address on the main Southampton–Bournemouth (A36) road.

From here, all mail-orders are despatched, mostly on the day of receipt. The policy of the company is to offer a broad range of components used in designs within this and other magazines at a very favourable price.

Apart from advertised goods, our catalogue (new issue out April, price 30p with discount vouchers) lists thousands of components for the home constructor.

Callers are welcome at the shop between 9 and 6 Mon.–Sat. where many odd lines at bargain prices may be found.

Home Radio (Components) Ltd., 240 London Road, Mitcham, Surrey, CR4 3HD. Telephone: 01 648 8422.

Home Radio started as a radio and television business in 1946. The company was incorporated in 1967. We branched into components in 1951.

First catalogue produced in 1959 and has been continued until present date. Present cost £1.00 plus 40p postage. Over 200 pages with separate twenty page supplement, listing about 5000 items with over 1500 illustrations. Fixed rate of postage and packing 75p, irrespective of size of parcel.

Although 90 per cent of our business is mail order we have a shop and enjoy meeting our customers personally. Shop hours are: 9a.m.—5p.m.; 9a.m.—1p.m. Wednesday; 9a.m.—5.30p.m. Saturday.

Josty Kit (UK) Ltd., 16 Borough Road, Middlesbrough, Cleveland, TS1 5DQ. Telephone 0642 44542.

Josty Kit, (U.K.) Ltd., Mail Order Division, are the Sole U.K. distributors of the range of Josty kits. Our kits use only the very best components available from the world market.

The range of kits offered are for the beginner right through to the professional, and many industrial and military establishments find them invaluable.

All kits are sold direct through mail order and are priced including VAT. Please add 25p, postage and packing with your order.

LRS Electronic Supplies, 3 Clivesway, Hinckley, Leicestershire.

We are now offering a 24 hour turn round quote service. The client sends us a list of components he requires along with a s.a.e. we will then price it or give availability and return it within 24 hours.

As regards our terms, no minimum order charge, all our prices include postage and all orders are cash only with order.

We intend to make LRS a manufacturer only and have set up a separate company to deal with mail order, this company is called **M.D. Marketing**, P.O. Box 4, Hinckley, Leicestershire

All our mail orders should now be addressed to this company.

Magenta Electronics, Ltd., 61 Newton Leys, Burton-on-Trent, Staffordshire, England, DE15 0DW. Telephone: 0283 65435.

Magenta Electronics Ltd., was set up to provide a fast efficient no-nonsense source of components and hardware for constructors.

Our catalogue lists a wide range of carefully selected items all held in stock for same day despatch. It is available for 25p, and includes 25p in vouchers. To simplify ordering all our prices are fully inclusive. There is no minimum order value, but 20p must be added to orders under £2.00

Our product range is constantly increasing to include components used in the latest projects, and those items frequently requested by our customers.

Items not listed in the catalogue can usually be obtained—a stamped addressed envelope with your requirements will bring a quote.

A range of kits is currently being introduced—including a transistor tester, an experimenters power supply, and a multimeter range extender. Send a large s.a.e. for details of kits.

Magenta's aim is to give a friendly personal service with full technical back up.

Maplin Electronic Supplies, P.O. Box 3, Rayleigh, Essex, SS6 8LR.

Maplin's 216 page catalogue is priced 50p. Over 4,000 items listed with over 1,000 photographs and drawings, and several complete projects to build: Professional 4 to 16 channel audio mixer; sine/square oscillator; organists/guitarists 13-note bass foot pedal unit; electronic Ignition system; light show with a.v.c.; stabilised power supply for cassette-players, radio etc., (mains or car battery operation). Also includes 30 pages on i.c.s with complete circuits to build.

Maplin's trading terms: Same-day-service (on in-stock items). Prices guaranteed for two monthly periods, Bi-monthly newsletter/price list details—customers can check the actual prices before buying. Anyone can join the newsletter mailing list for 30p and receive one year's issues of the newsletter. Subscribers can take advantage of special offers that can save pounds. Discount vouchers given with orders valued over £2. Reply-paid envelope returned with every order and catalogue. Handling charge 20p on orders valued under £2. Prices include VAT and postage and packing.

A. Marshall (London) Ltd., 42 Cricklewood Broadway, London, NW2 3ET. Telephone 01 452 0161/2/3. Telex 21492. Also at 85 West Regent St., Glasgow, Scotland. Telephone 041 332 4133; 1 Straits Parade, Fishponds, Bristol, Telephone 654201, and 27 Rue Danton, Issy Les Moulineaux, Paris, France. Telephone 644 2356.

No minimum charge where cash with order. Postal charges extra as per catalogue. Orders normally despatched same day as received. Orders in excess of £10.00 sent recorded delivery or registered post. Credit accounts available.

G. F. Milward, Electronics Components, 369 Alum Rock Road, Birmingham, B8 3DR. Telephone 021 327 2339.

Orchard Electronics, Flint House, High Street, Wallingford, Oxon, OX10 0DE. Telephone 0491 364588, 35529.

We re-print our stock list once a month and every item listed is in stock. All orders are dispatched 1st class post on day of receipt, we are very serious about this, we cannot afford to allow any orders to be carried over-night. Trade, authorities and account holders (amateurs) may phone by 4 p.m. goods will be dispatched by 5 p.m.

P.B. Electronics (Scotland) Ltd., 57 High Street, Saffron Walden, Essex. Telephone: 0799 228 76. Also at 62 Largo Road, St. Andrews, Fife, Scotland. Telephone St. Andrews 2641.

P.B. supply the professional and the home constructor with everything to produce printed circuit boards and also manufacture p.c.b.s

We manufacture S-DeC, T-DeC, U-DeC breadboards and accessories, Blob-Boards and Sketch-N Etch.

No minimum order charge, free information, callers welcome.

Radio Component Specialists, 337 Whitehouse Road, West Croydon, Surrey.

Radio Component Specialists was established in the early 1950's by John Ladd to provide a service in South London previously only to be found in Central London. Return of post despatch is their mail order slogan,

Counter service in the shop is given on all aspects of the products on sale. In addition to stocks there is a range of hi-fi and disco equipment, amplifiers, lights and loudspeakers.

Baker Loudspeakers Ltd., is an associated company and with their factory next door to the components showroom in Whitehouse Road, audio service and expertise is second to none!

Everything in our advertisements is in stock before advertising and we ensure that sufficient stocks are held for mail orders and callers alike.

Rownsgem Ltd., Rosebank Parade, Plough Road, Yateley, Camberley, Surrey. Telephone 0252 871388.

Radio Exchange (Bedford) Ltd., 61A High Street, Bedford, MK40 1SA. Telephone 52367.

We are manufacturers and suppliers of transistor kits. We do not supply components to clients other than those who have purchased kits and require spares.

Tandy Corporation (Branch U.K.), Bilston Road, Wednesbury, West Midlands, WS10 7JN.

We supply a large range of electronic components and equipment. The catalogue, which is free from the above address, lists over 2,000 items.

There are over 150 Tandy shops in the country, eliminating the need for mail order. There is no postal delay and most shops stock the complete range.

Trampus Electronics Ltd., 58/60 Grove Road, Windsor, Berkshire SL4 1NS. Telephone Windsor 53779.

The company was formed in 1972 to market new technology. Now specialising in fast service semiconductor sales, carrying over one million devices in stock and a wide range of passive components.

Supplement to
EVERYDAY ELECTRONICS
April 1977

	Aerials			Amplifiers			Attenuators			Battery			Boards						Cabinets					Cable					
	Ferrite Rod	Telescopic	Complete	Modules	Aluminium Sheet	Audio	R.F.	Audible Warning Devices	Connectors	Holders	Copper Clad	Tag Panels	Insulating	Printed Wiring (Veroboard)	Plain Perforated	Plug-in Wiring	Bulb Holders	Bulbs	Steel	Plastic	Aluminium	Diecast	Co-axial	Mains	Multicore	Ribbon	Screened	Ceramic	Electrolytic
Arrow Electronics	✓	✓	✓		✓						✓	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓	✓	✓
B. Bamber Electronics												✓							✓			✓			✓		✓		✓
B. H. Components Factors	✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Bi-Pre-Pak			✓	✓				✓											✓	✓	✓								✓
J. Bull (Electrical)	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓	✓	✓	✓	✓	✓	✓
Chromasonic Electronics	✓			✓					✓	✓	✓	✓		✓	✓		✓	✓			✓			✓				✓	✓
The Components Centre	✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Crescent Radio	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Denco (Clacton)	✓											✓	✓																
Doram Electronics	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Electrovalue									✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Greenweld Electronics	✓	✓		✓				✓	✓	✓	✓			✓	✓					✓	✓	✓	✓	✓	✓		✓	✓	✓
Home Radio (Components)	✓	✓		✓				✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Josty Kit (UK)																					✓								
LRS Electronic Supplies	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Magenta Electronics	✓				✓				✓		✓	✓	✓	✓	✓					✓	✓	✓		✓	✓		✓	✓	✓
Maplin Electronic Supplies	✓	✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
A. Marshall (London)	✓			✓				✓			✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
G. F. Milward	✓	✓	✓	✓					✓	✓	✓	✓		✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Orchard Electronics	✓	✓	✓	✓						✓				✓			✓	✓		✓			✓	✓	✓	✓	✓	✓	✓
P.B. Electronics (Scotland)											✓			✓	✓	✓				✓									
Radio Component Specials	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Rownsgem																													
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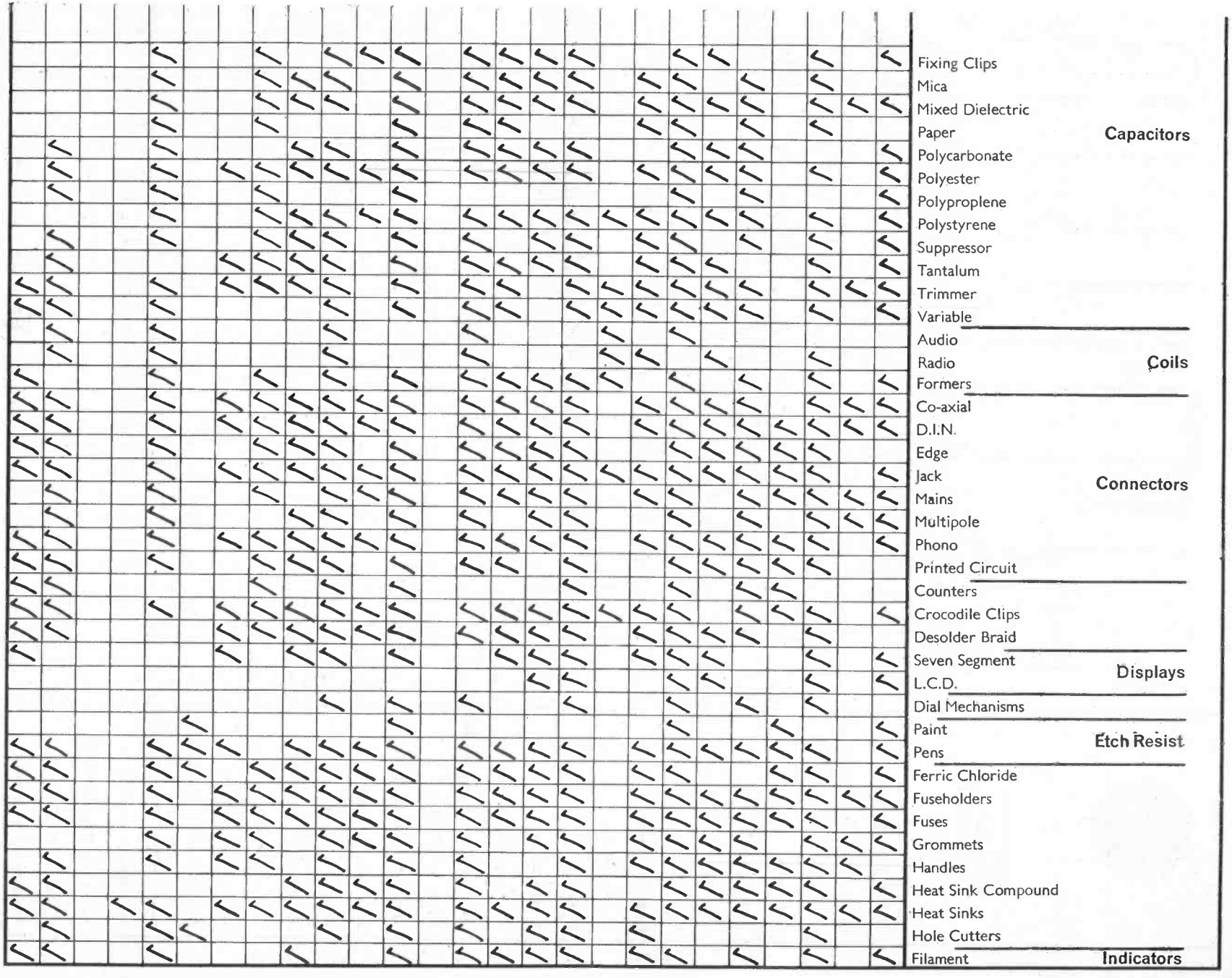
Tandy Corporation		✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Trampus Electronics	✓	✓						✓	✓	✓	✓			✓	✓		✓	✓		✓	✓							✓	✓


Fixing Clips
Mica
Mixed Dielectric
Paper
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Polyester
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Suppressor
Tantalum
Trimmer
Variable
Capacitors
Audio
Radio
Formers
Coils
Co-axial
D.I.N.
Edge
Jack
Mains
Multipole
Phono
Printed Circuit
Connectors
Counters
Crocodile Clips
Desolder Braid
Seven Segment
L.C.D.
Displays
Dial Mechanisms
Paint
Pens
Ferric Chloride
Etch Resist
Fuseholders
Fuses
Grommets
Handles
Heat Sink Compound
Heat Sinks
Hole Cutters
Filament
Indicators

Supplement to
EVERYDAY ELECTRONICS
April 1977

	Indicators								Loudspeakers						Modules		Potentiometers								Relays				
	L.E.D.	Neons	Interference Suppressors	Knobs	Light-Activated Switches	Light Dependent Resistor	Loudspeaker Cabinets	Miniature	Audio	High Power	Grille	Kits Construction	Meters	Microphones	Audio	R.F.	Carbon	Wirewound	Slide	Presets	Skeleton Presets	Printed Circuit Boards	Probes	Regulators	General	Heavy Duty	Miniature	Reed	Solid State
Arrow Electronics	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
B. Bamber Electronics				✓									✓			✓	✓	✓						✓	✓	✓	✓	✓	
B. H. Components Factors	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Bi-Pre-Pak	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓			✓	
J. Bull (Electrical)	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Chromasonic Electronics	✓			✓		✓		✓				✓			✓		✓		✓	✓	✓	✓		✓			✓	✓	
The Components Centre	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Crescent Radio	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓				✓		
Denco (Clacton)				✓																									
Doram Electronics	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Electrovalue	✓	✓	✓	✓		✓	✓	✓	✓		✓		✓				✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	
Greenweld Electronics	✓	✓		✓		✓		✓					✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Home Radio (Components)	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Josty Kit (UK)												✓																	
LRS Electronic Supplies	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Magenta Electronics	✓	✓	✓	✓				✓			✓	✓					✓			✓	✓	✓							
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P.B. Electronics (Scotland)					✓							✓										✓							
Radio Component Specials	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓					
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Trampus Electronics	✓	✓		✓	✓	✓		✓				✓	✓	✓			✓			✓		✓	✓	✓	✓		✓	✓	

Resistors								SEMICONDUCTORS: Diodes									I.C.S.												Transistors										
Carbon	High Stability	Light Dependent	Metal Film	Network	Oxide	Power	Wirewound	General Purpose	High Power	High Voltage	E.H.T.	Bridge Rectifiers	Zener	Light Emitting	Photo	Variable Capacitance	Linear	Audio	Digital Logic	Opto Couplers	Regulators	C.M.O.S.	L.S.I.	Op. Amps	Timers	R.F.	V.H.F.	U.H.F.	Unijunction	F.E.T.	General	High Power	High Frequency	P.U.T.	Insulating Kits	Diacs	S.C.R.S.	Triacs	Sleeving
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Supplement to
EVERYDAY ELECTRONICS
April 1977

	Sockets			Soldering					Switches											Transformers				Wire		
	Integrated Circuit	Relay	Transistor	Solder	Solder Tags	Irons	Solenoids	Spindle Couplings	Dual-In-Line	Foot	Illuminated	Lock	Micro	Push Button	Reed	Rocker	Rotary	Slide	Thumbwheel	Toggle	Terminal Blocks	Thermistors	Audio	Low Voltage	Transfers	Connecting	Extra Flexible	High Temperature	Tinned Copper
Arrow Electronics	✓	✓	✓	✓	✓	✓			✓		✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓			
B. Bamber Electronics				✓		✓	✓						✓		✓			✓			✓								
B. H. Components Factors	✓		✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bi-Pre-Pak	✓		✓	✓	✓								✓			✓	✓	✓		✓				✓					
J. Bull (Electrical)	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			✓
Chromasonic Electronics	✓			✓	✓	✓			✓					✓		✓	✓	✓		✓		✓		✓		✓			
The Components Centre	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓
Crescent Radio	✓			✓	✓	✓							✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		✓	✓		✓
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Electrovalue	✓	✓	✓	✓	✓	✓		✓			✓		✓	✓	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓		✓
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Home Radio (Components)	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓		✓	✓		✓
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LRS Electronic Supplies	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
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A. Marshall (London)	✓		✓	✓	✓	✓			✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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Orchard Electronics	✓		✓	✓	✓	✓							✓	✓			✓	✓	✓	✓	✓	✓		✓		✓	✓		
P.B. Electronics (Scotland)	✓																												
Radio Component Specials	✓		✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
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Trampus Electronics	✓	✓	✓	✓	✓	✓	✓						✓	✓									✓	✓	✓	✓			✓