

THE

RADIO CONSTRUCTOR

Vol. 23 No. 11

JUNE 1970

3/6



'WAH-WAH' PEDAL UNIT

With the aid of this unit the brilliance of electronic guitar reproduction is enhanced by a continuously variable frequency response controlled by the guitar player's foot

FEATURED
IN THIS ISSUE

SIMPLE ELECTRONIC DOORBELL
CYBERNETIC CYNTHIA

EXCLUSIVE
Motoring
Offer

AC107	14/6	BF115	5/-	NKT129	6/-	OC84	5/-	2N3866	12/-	2N3416	7/6	25320	9/-
AC126	5/-	BF152	13/6	NKT141	7/-	OC123	7/-	2N385A	15/-	2N3525	15/-	25321	6/-
AC127	9/-	BF154	10/-	NKT143	7/-	OC139	5/-	2N388A	15/-	2N3525	21/9	25323	10/-
AC127Z	9/-	BF159	15/-	NKT143	5/6	OC140	7/-	2N404	4/6	2N3528	19/-	25701	8/6
AC128	4/-	BF163	9/-	NKT144	5/6	OC170	5/-	2N410	8/-	2N3606	5/6	25703	12/6
AC176	5/-	BF167	5/-	NKT161	6/-	OC171	6/-	2N458A	25/-	2N3607	4/6	25720	25/-
AC187	12/-	BF173	6/-	NKT162	6/-	OC200	6/3	2N511A	49/6	2N3701	3/3	25732	8/6
AC188	12/-	BF178	10/6	NKT163	5/6	OC201	9/8	2N513A	25/-	2N3703	3/3	251002	10/-
AC117	12/-	BF179	12/6	NKT164	5/6	OC202	18/-		122/6	2N3704	3/3		
AC18	3/6	BF180	6/-	NKT165	6/-	OC203	7/6	2N599	10/-	2N3705	3/-	DIODES &	
AC19	4/5	BF181	6/6	NKT211	6/-	OC204	8/-	2N601	25/-	2N3706	2/9	RECTIFIERS	
AC20	3/7	BF184	7/-	NKT212	6/-	OC205	9/-	2N696	20/-	2N3707	3/-	AA119	2/-
AC21	4/-	BF185	8/-	NKT213	4/-	OC206	10/6	2N696	4/-	2N3708	3/-	AA111	2/-
AC22	2/9	BF194	3/6	NKT214	4/-	OC207	7/6	2N697	4/-	2N3709	3/-	AA212	6/-
AC40	3/6	BF195	3/6	NKT215	4/-	OC309	12/-	2N698	6/-	2N3710	3/-	AA213	2/6
AC41	4/4	BF200	10/6	NKT216	10/-	OC771	19/6	2N706	2/6	2N3711	3/-	BA100	6/-
AC44	8/-	BFX13	5/-	NKT217	13/-	ORP12	9/6	2N706A	2/6	2N3819	8/-	BA110	6/-
AD140	11/6	BFX44	8/-	NKT218	5/3	ORP60	8/7	2N708	4/-	2N3820	18/9	BA111	6/-
AD161	6/-	BFX84	7/6	NKT221	5/6	ORP61	8/-	2N711	7/6	2N3826	6/-	BA112	18/-
AD162	6/-	BFX85	9/-	NKT222	4/-	P346A	5/-	2N715	7/6	2N3854	5/6	BA115	1/6
ADT140	12/6	BFX86	6/6	NKT223	3/6	RA5310AF	2N716	7/6	2N3854A	5/6	BA130	3/6	
AF102	12/6	BFX88	5/-	NKT224	4/6		6/-	2N743	4/6	2N3855	5/6	BA133	2/6
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AF115	5/-	BFY51	3/9	NKT227	5/6	S1M	19/-	2N914	4/6	2N3858	5/-	BY127	4/-
AF116	5/-	BFY52	4/6	NKT228	6/-	54M	33/6	2N918	7/6	2N3858A	6/-	BY234	2/3
AF117	5/-	BFY53	3/2	NKT261	4/3	ST140	3/-	2N929	5/6	2N3859	5/6	BYX10	3/-
AF118	12/6	BFW57	6/-	NKT262	4/3	ST141	9/-	2N929	5/6	2N3859A	6/3	BYX36	6/-
AF121	6/-	BFW58	4/6	NKT264	4/3	ST2	9/9	2N1090	6/6	2N3860	6/-	150	2/6
AF124	6/-	BFW59	5/6	NKT272	4/-	T1407	9/8	2N1091	6/6	2N3866	25/-	BYX36	6/-
AF126	3/6	BFW60	4/6	NKT272	4/-	TIP31A	19/6	2N1131	6/6	2N3877	9/-	300	2/10
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AF178	9/6	BSX21	7/6	NKT275	5/6	T1544	19/6	2N1303	4/-	2N3900A	11/6	600	3/9
AF179	11/6	BSX76	4/6	NKT276	3/6	T1545	3/3	2N1304	5/-		11/6	BY223	26/3
AF180	12/6	BSX77	6/-	NKT279A	2/6	T1546	3/3	2N1305	5/-	2N3903	7/-	BY225	31/9
AF181	8/6	BSX78	6/6	NKT281	5/-	T1547	3/3	2N1306	5/-	2N3904	7/-	BY225	31/9
AF186W	9/-	BSY27	4/-	NKT301	16/-	T1548	3/3	2N1307	7/-	2N3906	7/6	BY212	6/9
AF186G	9/-	BSY29	5/-	NKT302	11/-	T1550	5/6	2N1308	7/-	2N4037	15/-	BY213	5/-
AF239	5/6	BSY32	5/6	NKT303	11/-	T1551	4/-	2N1309	7/-	2N4058	4/6	CG6E	4/-
AFY19	22/6	BSY36	5/-	NKT304	9/6	T1551	4/-	2N1507	4/8	2N4059	5/-	CG6I	2/6
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AS528	8/6	BSY96	5/6	NKT402	15/-	T1561	7/-		29/6	2N4284	3/6	EA403	3/6
AS529	6/-	BSW70	3/6	NKT403	15/-	TSV30C	18/-		6/6	2N4285	3/6	EA404	3/6
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B3M	15/6	BTX42/600	NKT408	15/-	XA102	6/-	2N2148	12/6	2N4288	3/6	EA381	3/6	
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BC113	5/-	C111	NKT1674F	5/-	ZT22	19/-	2N2369	5/6	2N4292	3/6	OA10	3/6	
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"R.C." MILLIVOLTMETER (Jan., p. 342). Our AX10 Printed Circuit accommodates the main part of the circuit (not TR1). With layout drawing and hints, 15/-.

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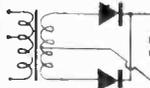
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MT12	12-0-12V	50mA	13/6

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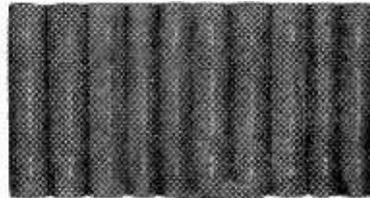
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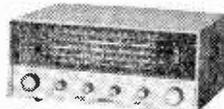
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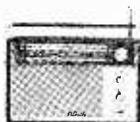
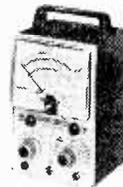


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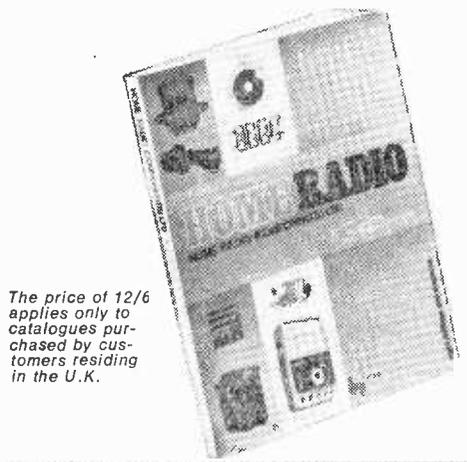
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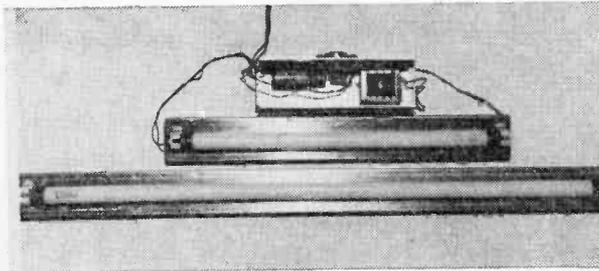
by

H. T. KITCHEN

The two fluorescent lighting assemblies described here give mains-type lighting from a 12 volt battery, thus providing an ideal form of illumination for campers and for boat and caravan enthusiasts. The efficiency of the fluorescent tubes, together with low losses in the voltage step-up circuit, results in a high light level being obtained at a very economical battery current drain

THE TWO LIGHTS ABOUT TO BE DESCRIBED WERE designed to provide a modest, and a high, level of illumination in situations where mains voltages are not available. They will, therefore, be of particular interest to boating and caravanning enthusiasts, who will find the need for a 12 volt accumulator no great hardship as far as transport is concerned. Members of the camping fraternity possessing some form of motorised transport could, in addition, be included in this category.

The lights could also prove most useful to those unfortunates compelled by force of circumstance to undertake car maintenance or repair 'on the village common' or in a garage where, again, mains voltages are not available. In this latter instance, and speaking from personal experience, the writer has found that the soft, virtually shadowless, light obtained from the fluorescent tubes employed is greatly preferable to the 'hard' light produced by a normal incandescent light bulb.



The inverter unit, together with 8 watt and 13 watt fluorescent tubes

Two main precautions have to be observed when using the lights. First, great care is needed to guard against mechanical shock which could fracture the tube. Second, since the case of the transistor employed, being common with its collector, is 'live', it must not be allowed to contact any metalwork which is connected to either side of the supply battery. If necessary, a guard of perforated metal can be easily fabricated to prevent any such short-circuits.

TWO VERSIONS

Two versions of the lights were constructed, one using an 8 watt fluorescent tube, and the other a 13 watt tube. The light output from the 8 watt tube is, clearly, not as high as the light output from the 13 watt tube, but as the consequent current consumption is less it has its compensations. The conversion from one tube to the other is inexpensive and quite simple, requiring only an additional piece of metalwork and the changing of the bias resistor for the transistor.

The heart of both versions of the lights is a very simple but highly efficient direct voltage to alternating voltage inverter, this having the circuit shown in Fig. 1. It comprises a power transistor TR1, the oscillator/step-up transformer T1, two capacitors C1 C2, and a resistor R1. C3 and L1 are not part of the basic inverter circuit and their function will therefore be described later.

The circuit oscillates by virtue of the inductive coupling existing between the collector and base of TR1 by way of the windings of T1. C1 and C2 cause the transformer to resonate at some 12kHz, this being a frequency high enough to be out of audible range; it is certainly never obtrusive or objectionable, at least to people with normal hearing.

The secondaries of T1 provide two outputs, one to feed the filaments at each end of the tube, and one to provide the requisite h.t. for the tube. The 13 watt tube provides a light output of 730 lumens, or 56 lumens per watt. This is a commendably high degree of efficiency and provides an adequate level of illumination in any moderately sized boat, caravan or tent. In a larger area, or where a higher level of illumination is required, two or more lights can be used, the modest current consumption making the use of multiple lights a viable proposition.

The switching waveform, though at the low fundamental frequency of 12kHz, is of a sufficiently high amplitude for its harmonics to cause interference with nearby radio receivers. The position can be further aggravated by the supply leads between the lamp unit and the accumulator acting as a transmitting aerial.

In order to prevent the radiation of these harmonics an r.f. filter is required, and this is the function performed by C3 and L1. The lights will, of course, work quite well without these filter components, but their inclusion is most strongly advocated - unless one wants to be pilloried as an anti-social villain!

COMPONENTS

The circuit, as a complete entity, needs no further comment. Three individual components do, however, require a little additional explanation. These are the

THE RADIO CONSTRUCTOR

transistor TR1, the bias resistor R1, and the filter capacitor C3.

The transistor used in the prototype was an OC35, and it is vitally important to use this transmitter in units built up to the circuit. The reason for this is the relatively high amplitude of the switching waveform, which will rapidly destroy an inferior transistor.

The resistor, R1, provides the transistor with its requisite base bias and requires a smaller value when the unit is used with the 13 watt tube than when it is used with the 8 watt tube. Also, it may require some adjustment in value due to variations of gain in individual transistors within the manufacturing 'spread'. With the 13 watt tube, a nominal value of 330Ω will most probably suit the majority of transistors but this may, on occasion, require altering to the nearest preferred value, on either side, of 270Ω or 390Ω. At the optimum bias value, the 13 watt circuit will consume an input current in the region of 1.2 to 1.4 amps. The range of resistance required in the 8 watt circuit to take up tolerances in transistor gain lies between 330Ω and 430Ω, so a suitable starting value would be 360Ω or 390Ω. At optimum bias, the 8 watt circuit will draw a current in the region of 0.8 to 1.0 amp. At all the values just mentioned, R1 should be a 1 watt component. Should the bias current be insufficient (due to the bias resistor value being too high) the circuit may fail to oscillate or may function at reduced efficiency. Excessive bias current will permit the circuit to function, but at the cost of reduced life in the tube and, possibly, the transistor.

It is the amplitude of the switching waveform which necessitates the inclusion of C3 and L1, which function as a low-pass filter. C3 must have a working voltage rating of some 30 volts, and not the expected 12 volts, to cope with switching transients. Again, an inferior component will break down. The polarity must be carefully observed.

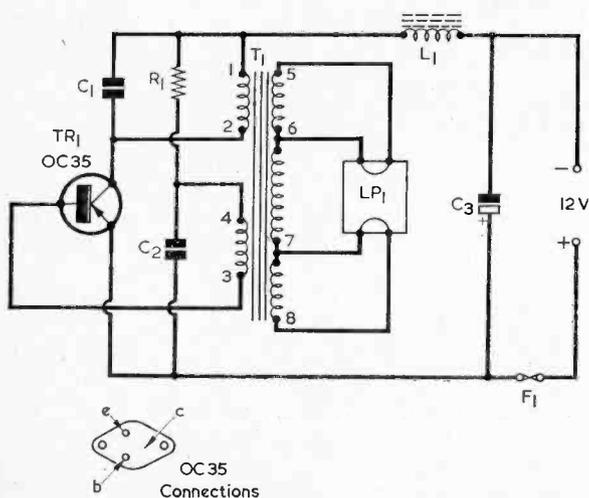
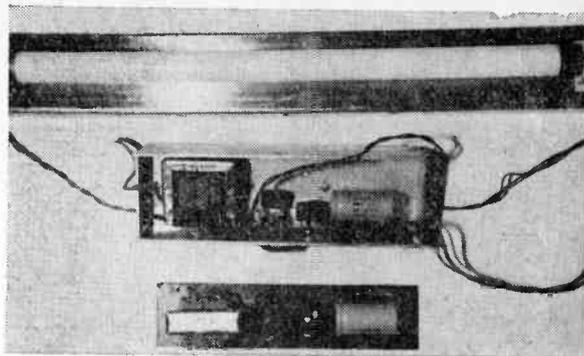


Fig. 1. The circuit of the fluorescent light inverter unit. This circuit is applicable to both the 8 watt and 13 watt versions



Illustrating the assembly of the transistor holder unit and the printed circuit board

CONSTRUCTION

Constructionally, the lights are easy to build, the components being assembled onto the etched circuit board of Fig. 2, which can be easily made at home by the usual methods. Veroboard, or other perforated board, could also be used.

The board shown in Fig. 2 is 13.5cm by 3.25cm, and is not reproduced full-size here for tracing since it is felt advisable that constructors take transformer dimensions from the actual component itself. In any case, the printed pattern is a very simple one and involves little trouble in drawing out. It is important to note that the copper areas must not extend com-

COMPONENTS

Resistor

R1 See text

Capacitors

C1 0.22μF, 160V wkg.

C2 0.22μF, 160V wkg.

C3 250μF electrolytic, 30V wkg.

Inductors

T1 Repanco inverter transformer type TT58 (Henry's Radio Ltd.)

L1 Repanco choke type CH6 (Henry's Radio Ltd.)

Transistor

TR1 OC35

Fuse

F1 36 s.w.g. fuse wire (see text)

Lamp

Lp1 8 watt or 13 watt fluorescent tube, with holders

Miscellaneous

Mica washer and insulating bushes for TR1

Printed circuit board

Aluminium sheet, 12 s.w.g., 20 s.w.g.

Wire, nuts, bolts, etc.

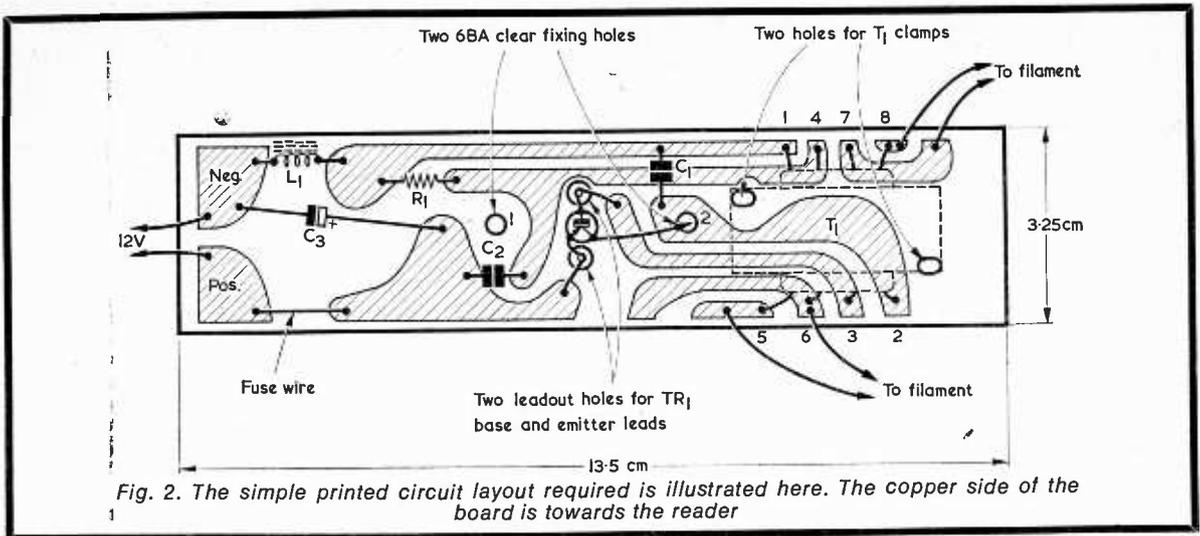


Fig. 2. The simple printed circuit layout required is illustrated here. The copper side of the board is towards the reader

pletely to the board edge at any point because these edges are close to the metalwork in which the board is mounted. The two fixing holes indicated as '1' and '2' have spacing which corresponds to the mounting hole spacing of the OC35 transistor itself. Also, their

positions should correspond to the transistor mounting holes in the metalwork, which will be discussed shortly. The connection to the collector of the transistor is taken directly at mounting hole '2'. The emitter and base leads of the transistor pass through two holes in the printed circuit board, as indicated, being connected to the adjacent copper sections by short lengths of bare tinned copper wire.

A short length of 36 s.w.g. tinned copper wire, which can most easily be obtained as a single strand from a length of commonly used 23 x .0076 wire, is employed for fusing purposes, being soldered directly onto the circuit board as shown. This provides a measure of protection for the circuit. Three pairs of flying leads, two pairs for the tube and one pair (preferably red and black) for the positive and negative battery connections, should be soldered to the board and cut to the required lengths.

The metalwork, shown in Fig. 3, is fairly simple, the only difference between the 8 watt and 13 watt versions being in the length of the tube carriers, this being 31.5cm finished length for the 8 watt tube as against 55cm for the 13 watt tube.

The transistor holder also acts as a heat sink and, if an alternative form of construction is used, the transistor *must have an equivalent area of metal* to conduct heat away from it. The method of attaching the transistor holder to the tube carrier, by means of small self-tapping screws, is the same in both versions.

The transistor is mounted onto the holder using a mica washer and insulating bushes, so that the transistor case is insulated from the holder. A smear of silicone grease on both sides of the mica washer is beneficial. The nuts and bolts must be tightened firmly but not excessively, or fracture of the mica washer and/or distortion of the transistor case will result.

The etched circuit board is secured to the side of the transistor holder by means of the same 6BA bolts, which mount the transistor spacers being used to hold the board away from the inside surface of the holder, and so obviating the possibility of short-circuits. The circuit board must be fairly accurately aligned with the transistor on the side of the holder, so that its base and emitter leads pass through the

THE RADIO CONSTRUCTOR

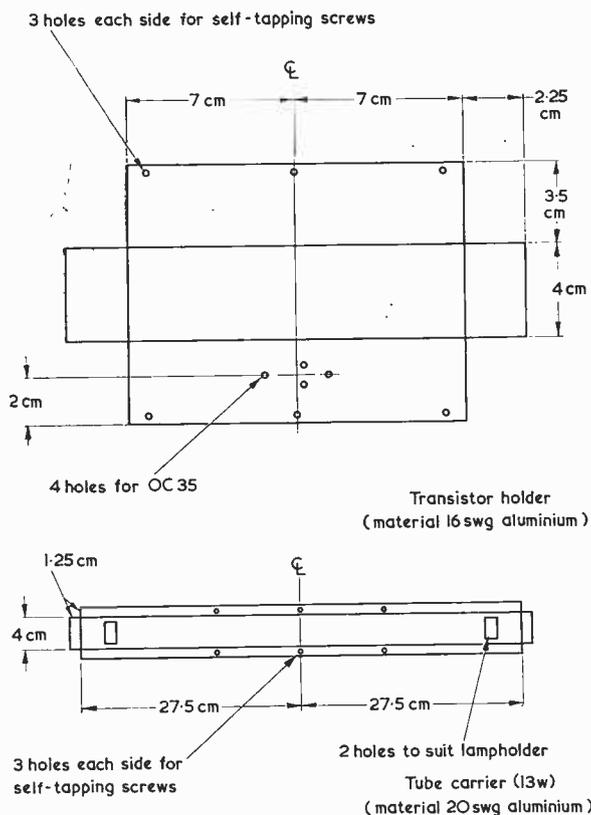


Fig. 3. Dimensions of the transistor holder and tube carrier. The transistor holder sides and ends are bent up to form a box in which the printed circuit board assembly is housed

Midsummer Night's Dream

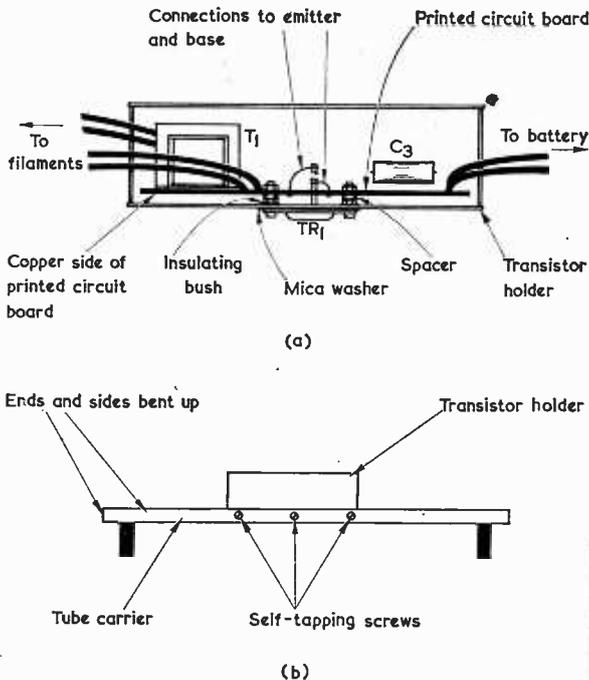


Fig. 4(a). Detail illustrating the manner in which the transistor, transistor holder and printed circuit board are assembled. The transistor case is insulated from the transistor holder

(b). How the transistor holder and tube carrier are assembled together

appropriate holes drilled in the circuit board. Further details showing construction and assembly are given in Figs. 4(a) and (b).

After completion, and prior to being assembled into the holder, the circuit should be checked for satisfactory operation and the value of R1 changed, if required. TR1 *must* be mounted on its holder during these checks. The battery voltage and current should be monitored.

As a final point it is advisable to keep the leads to the battery no longer than is necessary, and to keep them twisted. Remember, also, that the unit will be damaged if the battery is connected with incorrect polarity. ■



JUNE 1970

All of us dream at times I suppose, at least they cost nothing and that is something these days! Some of us have dreams which reoccur from time to time and these are allegedly derived from certain fixations of the mind – at any rate that is the theory. From this, I gather that the premier fixation of my dark and tortuous mind is the ownership of a shack lavishly complete with expensive equipment. Pleasant whilst it lasts, such ethereal bliss probably represents a holiday of the mind and, like all vacations, can be relied upon to have the same mundane termination – a return to the workaday world of harsh reality!

With half of the bedclothes and one foot on the floor of the boudoir, realisation dawns upon the still sluggish mind that the shack equipment consists in reality of a motley collection of surplus, second-hand and hastily home-built units. The latter, all exhibiting a birds nest-like appearance, are fondly imagined to be producing the best attainable results. Alas and alack, lacking here is the stuff my dreams are made of!

Whether the dreams occur during midsummer or midwinter makes little difference – seasonal variations apparently do not alter the mind fixation – it is just that the foot gets colder during the latter period.

Of course, we all have day-dreams during our waking hours, some would term them flights of fancy but either appellation would, I imagine, suffice. In these day-dreams we invariably cast ourselves in the role of the unflinching, honest, forthright and incredibly courageous tall-in-the-saddle hero – a knight in shining armour in fact. One look into a mirror however produces a similar result as awakening from that dream – upon reflection we perceive ourselves as we really are and end up with no magnificent equipment – still less any shining armour!

Countless dreams ago now, an Army acquaintance I shall call Will, simply because it *is* his name and it *does* match the title, confided that he regularly dreamed of setting up a W/T station only to discover he was minus a sectional aerial mast resulting in the transmitter being off the air – a military crime of enormous magnitude. He must have been beset with dark doubts and fears about his future as an unwanted and unpaid lancejack! Like all of us in the W/T Section he was supposed to have checked the issued gear prior to leaving the QM store. Being detained over breakfast – he was a well-known 'twicer' – time was short and his issue presumed complete. As it turned out later, he found himself without the aerial sections.

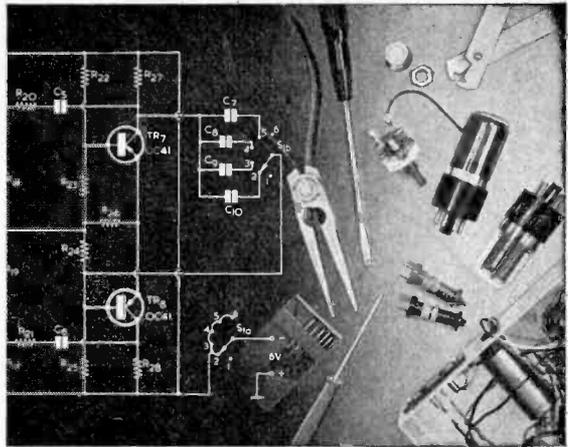
On the Hampshire moors that sunny midsummer, Will had to find a way to overcome the lamentable oversight. With characteristic aplomb he surreptitiously crept to a nearby hedge along which the PBI had strung a landline, snipped out a length, slung one end over a nearby branch and connected the other end to his transmitter. Returning to the severed PBI landline, he gave a few jerks to take up some slack and quickly completed the circuit. Dreams it seems do come true sometimes.

Will, later confiding to me his PBI landline 'borrowing' escapade, met with the obvious response – yes, you've guessed it – "where there's a Will there's a way!"

C.W. ■

SIMPLE VOLTAGE MONITOR

by G. A. FRENCH



THE DEVICE DESCRIBED IN THIS month's article in the "Suggested Circuit" series comprises a simple transistorised unit capable of monitoring input voltage to an accuracy of plus or minus some 0.25 volt. Indications of voltage level are given by the state of illumination of two small pilot lamps, and the circuit has a number of interesting applications. It may for instance be employed to give warning of a rising or falling supply voltage or of changing conditions in an item of equipment having an intermittent fault. If the latter were, say, an a.f. amplifier, it could be provided with a constant input from a signal generator, the output being rectified by a simple diode circuit and applied to the voltage monitor. The amplifier could then be kept 'on soak' whilst other work was proceeded with, it being left to the voltage monitor to give warning when, due to the appearance of the intermittent fault, the amplifier output either decreased or increased.

The circuit is flexible enough to permit either one or both of the lamps being replaced by a relay coil, or by any other load capable of being driven by a transistor. If a relay, or relays, is used, the relay contacts can be wired up to cause an alarm or buzzer to sound, or to set in operation a circuit capable of correcting the variation in voltage which was detected by the monitor.

BASIC CIRCUIT

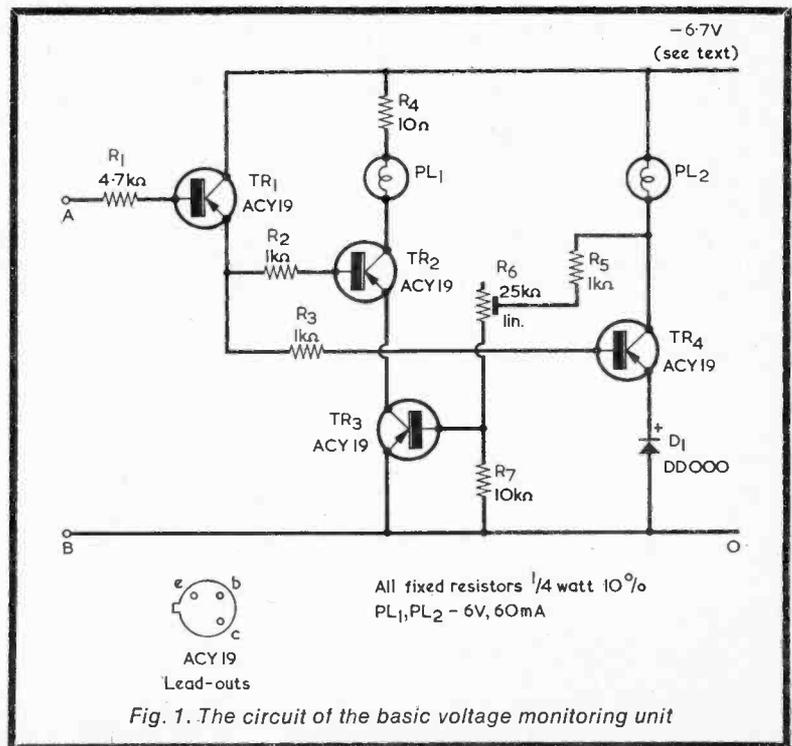
The basic circuit of the voltage monitor appears in Fig. 1. All the four transistors shown here are germanium types. The input terminals are at the points marked A and B

and we can commence an examination of circuit operation by assuming that point A initially has the same potential as point B and that point A then acquires a gradually increasing negative voltage.

When point A has the same potential as point B, transistor TR1 is cut off. So also, since no voltage is applied to their bases, are TR2 and TR4. As there is, in consequence, no collector current in either TR2 or TR4, pilot lamps

PL1 and PL2 are not illuminated. Unlike the three just referred to, the remaining transistor, TR3, is hard on, it receiving the requisite base current from the negative supply line via the non-illuminated lamp PL2, and resistors R5 and R6.

Terminal point A now starts to go negative of terminal point B, whereupon TR1 commences to act as an emitter follower, its emitter being slightly positive of its base. At a negative potential of about



0.4 volts at point A, the emitter voltage of TR1 is such that base current commences to flow in TR2. The figure of 0.4 volts represents the sum of the base-emitter voltage drop in TR1, the base-emitter voltage drop in TR2 and the collector-emitter voltage drop in the hard-on TR3. As point A continues to go negative, base current in TR2 increases, causing a continually increasing collector current in this transistor and the illumination of pilot lamp PL1. The process continues until PL1 is lit with maximum brightness.

No base current has, up to now, flown in TR4, this being due to the fact that silicon diode D1, in TR4 emitter circuit, does not permit forward current to pass until a forward voltage of about 0.6 to 0.7 appears across it. Thus, of the two pilot lamps only PL1 is illuminated.

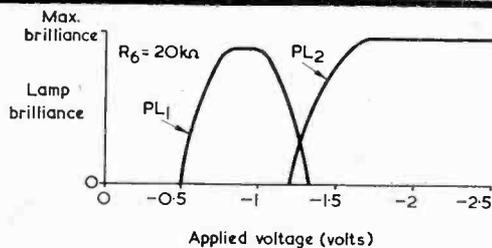
If point A is taken still further negative again, it will be found that, at about 1 volt, base current commences to flow in TR4. This figure of 1 volt is made up of the sum of the base-emitter voltage drop in TR1 (slightly increased now due to the TR1 emitter current flowing to TR2 base), the base-emitter voltage drop in TR4 and the forward voltage drop across D1. As point A goes still further negative, base current in TR4 increases, causing pilot lamp PL2 to light up and the voltage at the collector of TR4 to fall. This falling voltage results in decreasing base current in TR3 until, when PL2 is lit at full brilliance, TR3 cuts off. As

no current is now available for TR2 emitter, pilot lamp PL1 becomes extinguished. An increasing negative excursion at point A has no further effect on the circuit, apart from causing an increasing base current in TR4, which is already hard on.

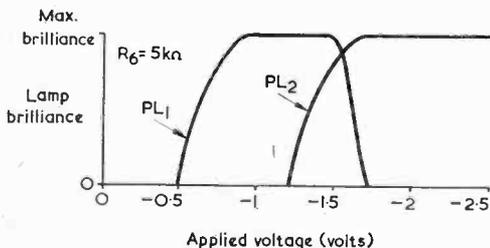
Summing up the operation of the circuit we may see that, if point A initially has the same potential as point B, neither of the pilot lamps lights up. As point A is gradually made more and more negative with respect to point B, pilot lamp PL1 becomes illuminated and then, at a higher negative voltage, pilot lamp PL2. Illumination in PL2 causes pilot lamp PL1 to extinguish.

PILOT LAMP ILLUMINATION

Figs. 2(a) and (b) illustrate the action of the circuit in terms of actual pilot lamp illumination. These curves were drawn by visual examination of pilot lamp brilliance against input voltage at terminal point A, as observed with the prototype circuit. As is to be expected, the lamps commence to glow (and therefore cause the curves to rise above zero brilliance level) for input voltages slightly higher than the 0.4 and 1 volt figures just mentioned, this being due to the fact that a significant collector current has to flow before the filaments achieve a radiating temperature. Fig. 2(a) shows the results obtained when R6 of Fig. 1 is adjusted to insert 20k Ω into circuit, and it will be seen that



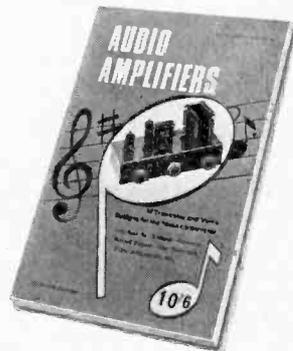
(a)



(b)

Fig. 2(a). The performance provided by the prototype circuit with R6 adjusted to insert 20k Ω
 (b). The monitor is capable of offering a different mode of operation when R6 is adjusted to insert 5k Ω

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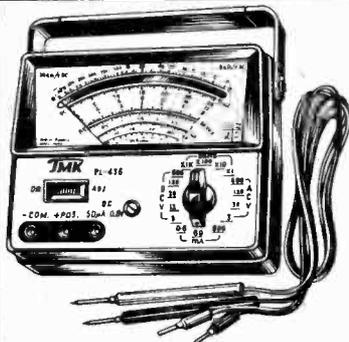
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PL1 is almost completely extinguished when PL2 commences to glow. In Fig. 2(b), R6 is set up to insert 5kΩ into circuit, and PL1 only commences to extinguish when PL2 is nearly fully illuminated.

The curves of Figs. 2(a) and (b) represent near-limiting cases of circuit operation. If the value of R6 is increased much above that which produces the curves of Fig. 2(a), the maximum illumination offered by PL1 reduces, because TR3 is not then held hard on. As may be seen from Fig. 2(a), the maximum visible brilliance available from PL1 is a little lower than that offered by PL2, thereby indicating that TR3 is already beginning to enter the state where it is not fully conductive. However, the loss of illumination evident in PL1 is marginal only, and is certainly not enough to

detract from the usefulness of the monitoring device.

If the value of R6 is made much lower than that which results in the curves of Fig. 2(b), pilot lamp PL1 does not extinguish when PL2 lights up, this being due to the fact that TR3 still obtains sufficient base current to remain conductive after TR4 has been turned hard on.

Although, as was just mentioned, Figs. 2(a) and (b) illustrate near-limiting cases, the circuit conditions they represent are perfectly stable and the device will work continually and reliably at either of the two settings of R6. What is more, Figs. 2(a) and (b) demonstrate that the voltage monitor may operate in one of two modes. In the mode of Fig. 2(a), both lamps are extinguished for voltages below about 0.5 volts. Over the range of

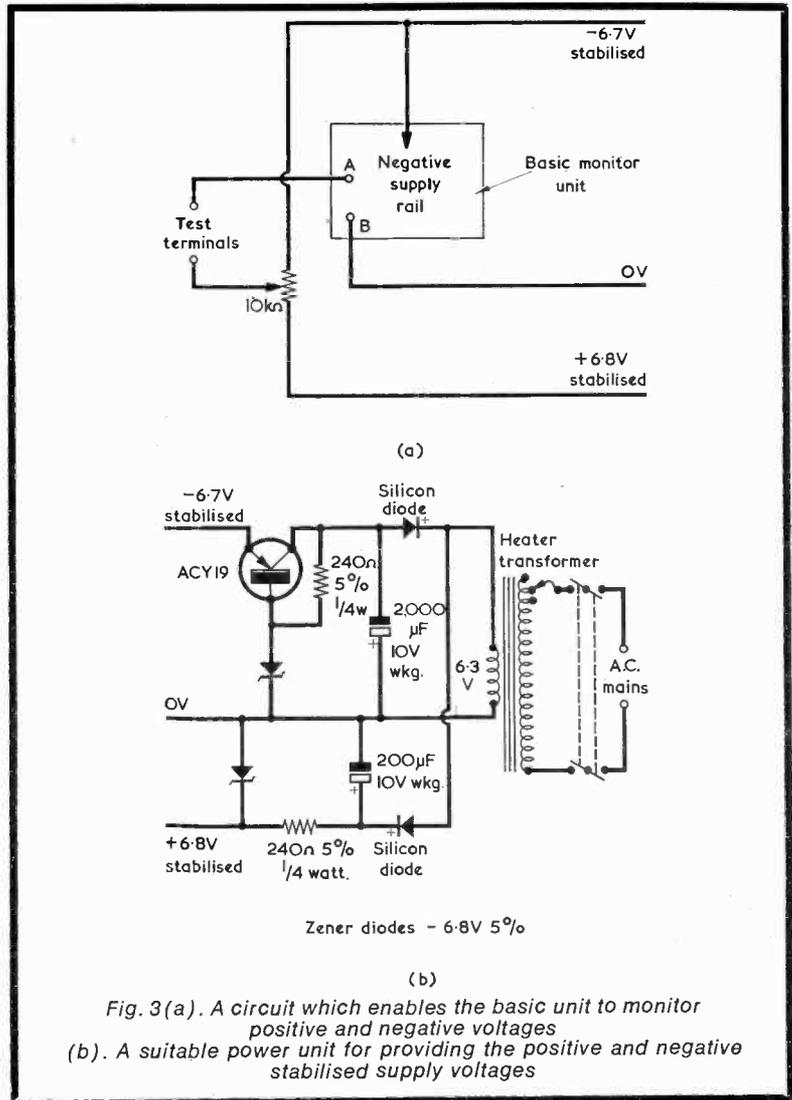


Fig. 3(a). A circuit which enables the basic unit to monitor positive and negative voltages
 (b). A suitable power unit for providing the positive and negative stabilised supply voltages

about 0.6 to 1.2 volts only PL1 is noticeably illuminated and, for voltages above about 1.2 volts, only PL2 is noticeably illuminated. The existence of a 'central' monitored voltage (plus or minus some 0.3 volts) can then be indicated by illumination in PL1. If the monitored voltage goes positive of the 'central' voltage both lamps extinguish whilst, if it goes negative, only PL2 becomes illuminated.

In the mode shown in Fig. 2(b), the 'central' monitored voltage may correspond to the range (between about 1.25 and 1.7 volts) where both lamps are noticeably illuminated. If the voltage goes positive of this range, first PL2 extinguishes, followed later by PL1. If the voltage goes negative of the range, PL1 extinguishes. Working in the Fig. 2(b) mode confers the advantage that the voltage can be monitored within closer limits than occurs with the Fig. 2(a) mode.

COMPONENTS AND CIRCUIT VALUES

In Fig. 1 the two pilot lamps are M.E.S. types rated at 6 volts and 60mA. (These are available from Home Radio under Cat. No. PL7). Lamps drawing currents larger than 60mA must not be used, as they may cause the transistors to suffer excessive dissipation.

Transistors type ACY19 were employed in the prototype and offer a good choice so far as the characteristics required here are concerned. It should be mentioned that the ACY19 has a maximum reverse base-emitter voltage rating of 12 volts only, whereupon care should be taken to ensure that this voltage is not accidentally exceeded when coupling terminal point A to the voltage which is to be monitored. The base of the ACY19 is, incidentally, internally connected to the transistor metal case.

It might be considered that a silicon transistor would be preferable in the TR1 position, since it would offer lower leakage currents.

However, the base current drawn by TR1 in the prototype was less than 20 μ A over the input voltages shown in Figs. 2(a) and (b), whereupon it can be assumed that the germanium transistor specified represents a reasonable practical choice.

The function of R1 is to limit current flow between terminal points A and B when the monitor power supply is turned off. Without R1 in circuit, terminal point B would then be coupled to terminal point A via D1, the emitter-base diode of TR4, R3 and the emitter-base diode of TR1. For most input voltages likely to be encountered, R1 should limit the current which may then flow to, at worst, a milli-amp or two.

Resistors R2 and R3 are also limiting resistors, and have the secondary function of preventing possible interaction between the base circuits of TR2 and TR4. D1 can be any silicon diode, such as the Lucas DDOOO specified, which is capable of passing a forward current of 60mA.

R5 is another limiting resistor, and it prevents excessive base current in TR3 if R6 should be accidentally set to insert too low a resistance. There is a possibility that R6 may not offer sufficient control if the particular ACY19 employed in the TR3 position has an unusually high gain. In this instance it will be found that R6 cannot insert enough resistance to enable the condition of Fig. 2(a) to be achieved. If this occurs, the value of R6 should be increased to, say, 50k Ω .

R4 is inserted in the supply to PL1 to produce approximately the same voltage drop (when PL1 is fully illuminated) as is given by D1 in the PL2 circuit.

The supply voltage is specified at the rather unusual figure of 6.7 volts. This is a nominal figure which ensures approximately correct lamp operation, and represents the supply voltage which should be aimed for when employing a stabilised mains

power unit. Battery operation is not very attractive because current consumption, at around 60mA for either bulb, is rather high. In practice, the circuit works perfectly reliably for supply voltages between 7 and 5 volts. Differing supply voltages naturally vary the light level offered by the pilot lamps, but they do not greatly affect the test voltages at point A, relative to point B, which cause lamp illumination or extinction. The latter are mainly governed by the forward voltage drops in the base-emitter junctions of the transistors concerned, and in D1.

VOLTAGE APPLICATION

Several different methods of applying the voltage to be monitored to terminal points A and B are feasible, the most flexible approach being illustrated in Fig. 3(a). Here, the basic monitor unit has its own 6.7 volt stabilised supply, a second 6.8 volt supply providing a stabilised voltage that is positive of terminal B. The circuit is capable of monitoring voltages on the upper test terminal of up to 4.5 volts positive and 7.5 volts negative by suitable adjustment of the 10k Ω potentiometer. The circuit to be monitored is connected to the test terminals, after which the 10k Ω potentiometer is adjusted to the position which causes pilot lamp PL1 to be illuminated (for Fig. 2(a) mode working) or PL1 and PL2 to be illuminated (for Fig. 2(b) mode working). Any variation in voltage at the test terminals is then indicated by change in lamp illumination, as already discussed.

Individual experimenters will have their own ideas for producing the stabilised voltages required by the arrangement shown in Fig. 3(a). A practical example of a suitable circuit is given in Fig. 3(b), this employing a 6.3 volt mains heater transformer. Both the zener diodes shown in Fig. 3(b) are small 6.8 volt types with a tolerance of 5% and a dissipation rating in excess of 50mW. ■

SATELLITE NAVIGATION SYSTEM

S. G. Brown Ltd., Watford, Herts., a subsidiary of Hawker Siddeley Dynamics, has obtained international selling and distribution rights for Magnavox satellite receiver systems. These enable the position of ships, aircraft or land vehicles anywhere in the world to be accurately fixed using data from the U.S. Navy's navigation satellite system.

This equipment is invaluable for accurate ship-board navigation, oceanography and geophysical exploration. The Magnavox system can be interfaced with other navigational equipment to the users' requirements.

S. G. Brown Ltd., who signed the agreement with the Magnavox Company of Fort Wayne, U.S.A., in February, offer a sales and service organisation to support this equipment in most parts of the world.

JUNE 1970

BI-PAK LOW COST IC's

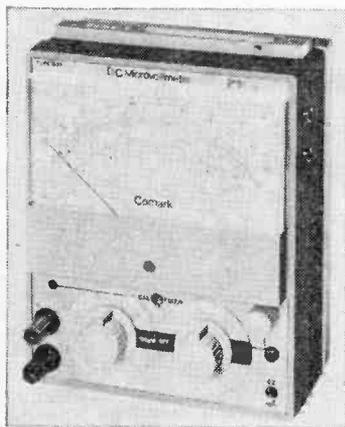
A complete range of Digital T.T.L. Integrated Circuits has now been launched by Bi-Pak Semiconductors to cover the popular 74N service of logic units. These will be available in the dual-in-line plastic package at approximately half the normal distribution price. The range includes gates, flip-flops and complex units such as divide by 16 four bit binary counters, shift regulators and decimal decoders plus mixie tube drivers.

Bi-Pak hope to publish in the near future enough circuitry for building computers, calculators, etc., using the Integrated Circuits mentioned. Bi-Pak say their aim is to further reduce the cost for amateur electronics.

Full details and prices are available from:- Bi-Pak Semiconductors, P.O. Box 6, Ware, Herts.

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VARIABLE AND FIXED SENSITIVITY D.C. MICROVOLTMETER



The new Comark D.C. Microvoltmeter Type 1221 has a maximum sensitivity of 30 microvolts f.s.d. and gives a resolution of 0, $3\mu\text{V}$ per division on a 120mm scale. It has 12 fixed calibration ranges from $100\mu\text{V}$ f.s.d. to 30V f.s.d., accurate to $\pm 2\%$ of f.s.d. A continuously variable sensitivity control, which does not affect the calibration of the fixed ranges, increases the sensitivity to a maximum of x3 on all ranges, permitting direct read-out in engineering units. The meter may be switched to centre zero or left zero.

A d.c. output, proportional to meter reading, of 1V for f.s.d. at 2mA is provided, permitting the instrument to be used as an inexpensive pre-amplifier for digital voltmeters or chart recorders.

Input resistance is $1,000\text{M}\Omega$ per volt on the $100\mu\text{V}$ to 300mV ranges and a constant $10\text{M}\Omega$ on the 1V to 30V ranges. The input offset current can be adjusted to less than 1 millimicroamp and the amplifier zero drift is less than $3\mu\text{V}$ per $^{\circ}\text{C}$. Input overload protection is provided on all ranges, permitting inputs up to 15V to be applied without damage on the $100\mu\text{V}$ to 300mV ranges and up to 200V on the remaining ranges.

The 1221 is powered by readily available dry cells and is produced in three styles: portable, laboratory and panel mounting.

666

SURGE INDICATOR

Until recently it has been extremely difficult to obtain economical indication of the magnitudes of transients.

In instances where electrical or electronic engineers require an indication of the magnitude of a transient, it is not essential to use exacting equipment such as storage oscilloscopes to enable him to take the necessary evasive action.

It is now possible to read the amplitude of a transient directly by use of the Surge Indicator recently introduced by Erskine Laboratories Ltd.

It markets in the U.K. at £25, carriage paid, at which price it should prove of particular interest to designers, manufacturers and other users of semi conductor and relay switching equipment.

The manufacturers claim that their Surge Indicator can save its cost in a millionth of a second, as in that time, transients can cause irrevocable damage, to electrical or



electronic equipment incorporating semi conductor triacs, thyristors, transistors and diodes. Alternatively, equipment such as computer assemblies can give spurious output data.

With the Erskine Surge Indicator, it is possible to determine the source of the transient and take corrective action accordingly. For example, by using the indicator it is possible to determine, experimentally, the most effective suppression network, across a relay coil, bearing in mind the "trade off" against operating and release times.

Erskine Laboratories, having been established for more than 30 years, is one of the pioneers in the development of electronic equipment including Oscilloscopes, Wave Guides and Miniature Tape Recorders.

PRESSURE ON SPACE

We apologise to those readers whose requests have not yet appeared in our feature *Can Anyone Help?* Their requests have not been overlooked but have taken their place in the queue.

The reason for the pressure on space is due to our policy of giving more and more information and value for money. The number of items in the Contents Lists nowadays exceed 20 items per issue. There can be few magazines with so much text for such a modest cover price.

CONSTERNATION IN THE HOME

'There has often been speculation about which of a loving wife's announcements produces most consternation in her partner's breast; high among the contenders are the well-known but slightly hackneyed "I gave your wardrobe a good clear-out today" and "I've pulled out all the weeds from that new flower-bed"'. - From a husband speaking in BBC Woman's Hour.

To which we would add "I tidied up your shack today".

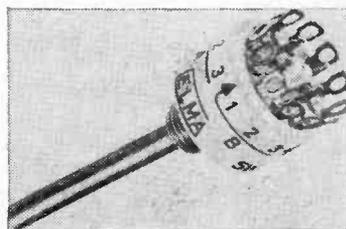
01 ELMA ROTARY STUD SWITCH

The Elma sub-miniature rotary stud switch now features an improved case in glass filled polycarbonate as shown below. This tough material is unaffected by most common solvents and is more easily marked with numbers to aid wiring.

The switches are now available with special tags for direct emplacement in printed circuit boards, and may be supplied with screwdriver slots instead of shafts.

As a further service, a range of different torque settings is available. The standard torque is 200 gm/cm, but 400 and 600 gm/cm can be supplied to order.

The Elmer 01 switch uses a high quality ceramic wafer and gold plated stud contacts. Contact resistance is better than 5 milliohms.



THE RADIO CONSTRUCTOR

COMMENT

AMATEUR RADIO LINKS "SHUT-IN" OPERATORS

In an age when satellites make communications swifter and more extensive than ever before, it can be surprising to discover that some people are still cut off from their fellow men by physical handicaps. For the deaf and the blind there are hearing aids, Braille printing and similar devices to help overcome disabilities. Yet other ailments can shut in the victim from the world – unless he is determined not to be left out, and some physically sound friends respond to that determination.

We have from time to time referred to the work of the Radio Amateur Invalid Bedfast Club in helping the physically handicapped people in this country who have, or develop, an interest in Amateur Radio.

We now give some news of a similar organisation in the U.S.A. In San Ysidro, a city in California close to the Mexican border, two young men, victims of a crippling disease, became amateur radio operators. The identical twin brothers, Henry and Jack Johnson, are only able to talk, move their eyeballs and control a capillary nerve in one arm. But now, thanks to the efforts of a group of dedicated radio amateurs, they are able to talk to the four corners of the earth.

As a result, there is now a radio network linking handicapped operators around the world. The organisation, called International Handicappers' Net (IHN), grew out of a conversation with the disabled twins and a Lieutenant Commander Ray E. Meyers, a retired Navy communications officer.

It was the Johnson brothers who suggested starting a radio network of handicapped amateurs along with the possibility of listing the members so that others might immediately recognise fellow members.

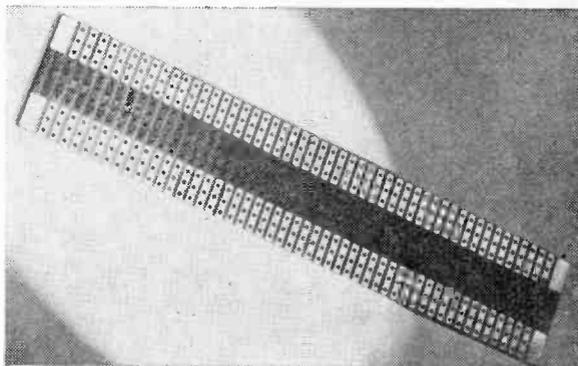
Because the physical handicaps include a wide range of crippling conditions, the unhandicapped members have resorted to a variety of systems of instruction in addition to creating ingenious devices to meet individual difficulties in handling transmission and reception of messages.

Voice-controlled relays permitting an armless operator to send intelligible code, radio controls which can be turned on and off by the flick of an eyelid, a device to enable a bedridden operator to manage his controls by air pressure blown through a flexible hose, are examples.

If you would like to help the somewhat similar organisation in the U.K., details can be obtained from the Honorary Secretary of the Radio Amateur Invalid Bedfast Club, Mrs. Frances Woolley, 331 Wigan Lane, Wigan, Lancs.

JUNE 1970

VERO STRIP



Vero Electronics Ltd., of Chandler's Ford, Hampshire, have recently introduced a new type of terminal board which has been designed as a simple and inexpensive mounting strip for discrete components. These can be mounted across the width of the board or alternatively along its length to effect cross-connection.

The mechanical and electrical specifications of the materials used enable the board to withstand a maximum working voltage of 2KV, whilst still maintaining an insulation resistance of one hundred thousand megohms between adjacent copper pads. These features make the board suitable for all applications where a conventional tagstrip or group board might be used.

The dimensions of the Vero strip are such that they can be mounted in standard die-cast boxes.

A number of terminal pins are also available which can be used in conjunction with the Vero strip where such additional facilities are required.



"All I can get on this set tonight is interference"!

SIMPLE ELECTRONIC DOORBELL

by
H. WILLIAMS

The extremely simple audio oscillator described here offers a tone which varies with supply voltage. Components are not at all critical and the device can be employed as a 'doorbell' or for any other application requiring an electronic 'buzzer'

THE SIMPLE PROJECT DESCRIBED in this article was designed to take the place of a rather unpleasant-sounding doorbell that finally packed up. The circuit was built up entirely from available components which most constructors will already have in the junk box. One facility incorporated in the design was that the note emitted from a call at the back door was different from that produced by a call at the front, thus saving wasted journeys which had occurred on several occasions with the previous bell.

Apart from the use described here for the circuit there must be many others, for it is simply an electronic 'buzzer' whose pitch can be varied with the applied supply voltage.

THE CIRCUIT

The circuit of the 'doorbell', shown in Fig. 1, could hardly be simpler. Also, as will be seen shortly, the components required could hardly be less critical.

When a voltage, either 6 volts or 9 volts, depending upon which button is pushed, is applied to the circuit, C1 rapidly charges up through R1 and T1 primary. When a certain charge in C1 is reached, TR1 switches on. This transistor is essentially in the collector-base circuit of TR2 which is in consequence also turned on. TR2 starts to discharge C1, thereby turning off TR1 which, in turn, switches off TR2. C1 starts to charge again, thus starting the cycle once more.

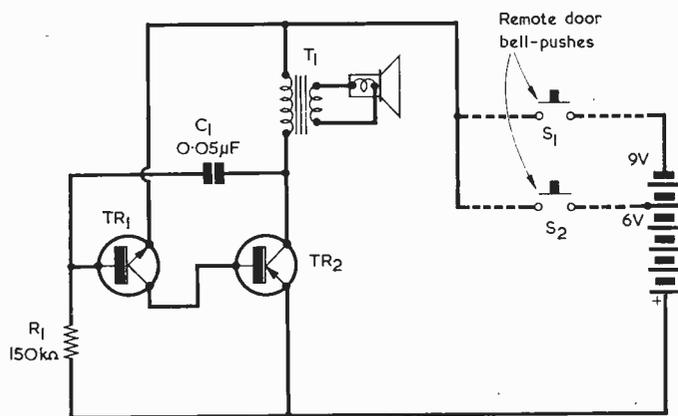
From this description it will be seen just how non-critical the components are. A wide combination of resistors and capacitors may be used and will produce the same note, this being dependent upon the time constant of the network rather than on the individual values. As shown in Fig. 1, the author's circuit

employed a 150kΩ resistor for R1 and a 0.05μF capacitor for C1.

The transistors themselves are equally non-critical as long as one is n.p.n. and the other p.n.p. When actually switched on, TR2 passes a relatively high current, but many transistors will handle currents way above their rated ones for short periods, such as the time that a doorbell is actually rung. Constructors who are prepared to risk the possibility of breakdown could use a small transistor for TR2. If an OC81, on the other hand, is employed, the bell can be rung permanently with no danger of overheating, even without a heat-sink for the transistor. TR1 may be a 2N2926, or similar.

Any speaker impedance between 3Ω and 80Ω can be used and in fact T1 is not strictly necessary. The loudspeaker, even with as low an impedance as 3Ω, can be connected directly between the collector of TR2 and the negative rail. However, the omission of the transformer will result in the battery being exhausted far quicker. The note emitted depends partly upon the collector load of TR2 and if T1 is left out, R1 will have to be increased to something like 680kΩ. T1 may be any transistor output transformer having a ratio of the order of 4.5 : 1.

The pitch of the note depends on the applied voltage, and the author employed a 9-volt grid-bias battery as this can be readily tapped at 6 volts. If difficulty is experienced in obtaining a grid-bias battery, a



TR₁ - 2N2926, etc.

TR₂ - OC81, etc.



2N2926

Lead-outs



OC81

Lead-outs

Fig. 1. The circuit of the electronic 'doorbell'

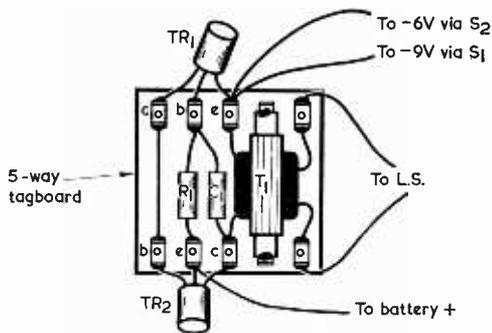


Fig. 2. The smaller components may all be assembled on a 5-way tagboard, as shown here

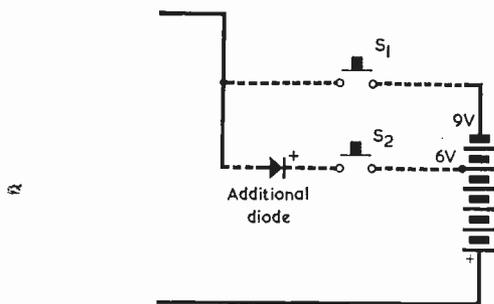


Fig. 3. If desired, a diode may be inserted in the 6-volt supply circuit to protect the battery when both buttons are pressed simultaneously

9-volt battery may be used for push-button S1 and a separate 6-volt battery for S2. A further alternative consists of connecting three 3-volt cycle lamp batteries in series to provide 9 volts and taking a tap from these at 6 volts.

The loudspeaker can be mounted in any conveniently sized cabinet, and the components are so few in number that they are easily mounted on a 5-way tagboard screwed to the side of the case. A suitable layout is given in Fig. 2. Standard 2-wire bell flex is run from the battery to the push-buttons, the return wires being connected to the tagboard as shown.

A final point is concerned with the fact that, if both push-buttons in Fig. 1 happen to be pressed at the same time, the 9-volt terminal of the battery is short-circuited to the 6-volt tapping. The author did not consider the possibility of both buttons being pressed simultaneously as being sufficiently high to merit taking any precautions here. If desired, however, the battery can be protected by inserting a diode, which may be either germanium or silicon, in series with the 6-volt circuit, as illustrated in Fig. 3. When both buttons are pressed at the same time the diode becomes non-conductive, and a 9-volt supply is applied to the oscillator circuit. ■

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Crystal Calibrator No. 7, Mk. II — A. Owen, 102 Constable Road, Ipswich, Suffolk — loan of handbook, circuit and modification information.

Cossor TV Model 916 — M. D. Smith, 39 Ox Lane, Harpenden, Herts — loan or purchase of circuit diagram or manual.

Jason FM Tuner. — Dr. F. D. Trevarthen, 10 Hertford Road, Digswell, Welwyn, Herts — loan of booklet "FM Tuners for Manual Operation" (now out of print) containing details of the EF80 tuner.

BC454B Receiver. — P. J. Green, Courtyard House, Chelsfield Village, Nr. Orpington, Kent — loan or purchase of circuit diagram or manual for this receiver.

CRT CV1526 (3EG7). — J. B. Lawrence, 88 High Street, Kelvedon, Colchester, Essex — details of pin connections and a suitable supply network for this c.r.t. — removed from an Indicator Unit Type 26.

Hallicrafter S53A Receiver. — D. A. Hay, 80 Underwood, New Addington, CRO 9EH, Surrey — loan or purchase of manual and any details of modifications for 160 metre band and S meter.

R1475 Receiver. — R. J. Jackson, 11 Alexandra Road, Mortlake, London, SW.14 — loan or preferably purchase of manual.

Wobbulator Type 41B1. — 240/93847. L/Cpl Harrison, J., Signals Plt, HQ Coy, 1 Para, Bruneval Barracks, Aldershot, Hants — circuit, manual or any information on this instrument — made by Samwell and Hutton.

Eddystone-Constructors Manual. — Major W. H. Inchbold-Stevens, 'Bhim-Tal', 47 New Road, Northbourne, Bournemouth, Hants — would like to obtain a copy of this pre-war publication.

Indicator Units 221 and 152. — A Wooldridge, 38 Stannard Road, Norwich, Norfolk — manuals, circuits or any information, loan or purchase. ■

FOR THE SWL . . .

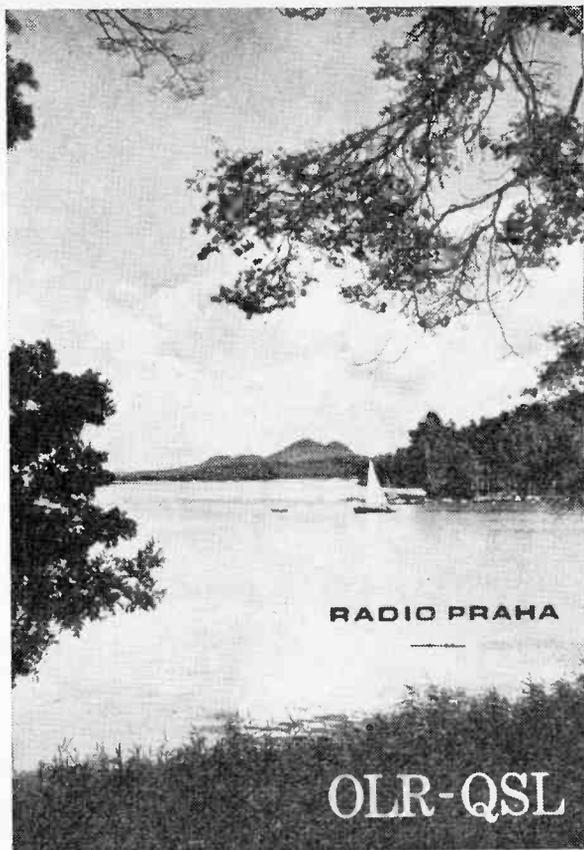
STARTING ON THE BROADCAST BANDS

There are, perhaps, some short wave listeners who would like a change from amateur band listening and many beginner short wave listeners who wish to take up broadcast band listening but who are all loth to do so because of the apparent complexity of it all. The many broadcast bands, constantly changing broadcast schedules, periodic frequency alterations and, probably the most difficult problem of all, spot frequency readings and station identifications all tend to make life difficult for the broadcast band listener.

Although broadcast band listening is a much more difficult proposition and represents a much greater challenge than amateur band listening, it is perfectly possible to make a start providing one is equipped with a 1MHz crystal oscillator. It is assumed, of course, that the beginner is equipped with a communications receiver and a simple aerial and earth system. The receiver bandset dial must exhibit reasonably correct frequency readings.

For the beginner short wave listener, a simple aerial array is all that is required when making a start on surveying the various broadcast bands, complex switchable systems of several aeriels being erected later as one progresses with the hobby and, naturally, becomes ambitious to receive various parts of the world with the maximum possible efficiency.

In the first instance, a long wire 'Inverted-L' type of aerial, erected as high as possible and with as much length as is practicable at the particular location, would prove adequate. The length of wire should be positioned in such a manner that it is as clear of such earthed objects as trees, metal pipes and gutterings as possible. Those having small gardens need not despair - it is not absolutely essential to erect a very long length of wire - one of 33ft., including the down-lead, will suffice. To gain additional length, those would-be broadcast band listeners suffering from restricted space for aerial erection purposes may care to site the wire around the confines of the garden. In this manner, the aerial would form three sides of a square or rectangle when viewed in plan form. Alternatively, a similar arrangement would be that of running the wire, at the far end, parallel with the pole to within 3 or 4 feet of the ground - suitably spaced from the pole by means of a wooden strut and an insulator at the lower end.



A QSL card received from Radio Prague, Czechoslovakia, for a report on the English programme radiated at 1900GMT on 7345kHz

At the house end of the aerial wire, a similar arrangement could be made. The point to remember is that no angles in the wire should be less than 90°. In other words, avoid sharp bends when erecting an aerial wire.

The earth lead from the receiver should be kept short and be secured at the other end to a copper pipe driven into moist soil as deep as possible.

The 1MHz crystal oscillator unit represents the minimum requirement for obtaining band-edge frequency marker points. If one is to eventually become a dyed-in-the-wool broadcast band operator, recourse must be had either to a 100kHz crystal oscillator with the additional facility of a 10kHz multivibrator or a BC221 frequency meter. Frequency charts for each broadcast band can be drawn up with the aid of crystal standards, spot frequencies being plotted against bandspread dial readings once the bandset dial has been correctly set at the band-edge indicated by the 1MHz crystal oscillator.

WHERE TO START

Where to make a start is, of course, a matter of opinion but it is suggested that the beginner could not do better than commence activities on the 16 metre band (17700 to 17900kHz). The band-edge crystal oscillator (1MHz) will provide a marker point

at 18MHz and from that frequency, the bandspread dial will tune through the 17MHz range and terminate at a frequency determined by the 'swing' of the bandspread capacitor fitted to the receiver.

For the following guide (see Table) a day and time period was chosen when most beginner listeners would be able to operate - Sunday at 1155GMT (1255 clock time).

The brief survey that follows was undertaken during March and represents only 25 minutes spent on the band, from 1155 to 1220GMT. Although some schedules are likely to change before this appears in print, it does provide some indication of what may be heard on this band during the time period stated. All the stations are comparatively easy to receive and should present no difficulty to the beginner.

TABLE

Freq.	GMT	Station	Details
17850	1220	Bucharest, Roumania	Commentary in English
17820	1155	Sackville, Canada	Forces programme in English
17770	1215	Rome, Italy	Programme for Eastern Europe
17705	1205	BBC, London	News in English
17700	1210	Moscow, USSR	News in English
17670	1208	Cairo, UAR	Talk in Arabic
17640	1209	Cairo, UAR	Arabic music

Six countries are listed in the Table and each of these will reply with a QSL card to a comprehensive report from a listener. Once the beginner has spent some time on this band, got the 'feel' of it and has surveyed it sufficiently to make out a frequency/dial reading graph, he will most probably have caught the 'bug' of broadcast band listening and go on to other bands and greater endeavours. ■

TAKE IT FROM THERE!

Greater endeavours? Why not have a try at some of the exotic South American stations? There are many experienced Broadcast band Dx'ers who specialise in the reception and identification of transmissions coming from these sunnier climes. Many of these stations have low power, often 1kW or less, the reception and identification of which represents a feat of no mean order.

For the beginner there are fortunately a few South American stations that have a comparatively high power which may be more easily logged. Listen around 0330 to 0500GMT for the following:- 4955kHz HJCQ Radio Nacional, Bogata, Colombia (50kW), closing at 0500GMT; 4965kHz HJAF Radio Santa Fé, Bogata (2.5kW - although suspected to have more power); 4970kHz YVLK Radio Rumbos, Caracas, Venezuela (10kW) and 4980kHz YVOC Ecos del Torbes, San Cristobal, Venezuela (10kW).

JUNE 1970

NOW HEAR THESE

Times = GMT

Frequencies = kHz

● CYPRUS

The Cyprus Broadcasting Corporation has recently been heard testing from 1900 to 2000 on **9715**.

● JAPAN

The General Service of NHK can be heard at 0700 on **17855** (100kW). The European Service is from 0800 on **17825** and **21535** (both 100kW).

● NIGERIA

Benin City has been heard by our Listening Post at 0447 on **4932** (10kW) with religious service in English. Schedule is from 0430 to 1230.

● ECUADOR

Our Listening Post reports taping HCDY4 Radio Iris, Esmeraldas, at 0447, closing with National Anthem and identification on **3378** (0.25kW).

Also taped by our Listening Post, HCOT1 Radio Zaracay, Santa Domingo, at 0533 with three chimes and identification on **3390** (2kW).

● INDONESIA

8FK24 Pakanbaru (10kW) is reported to have moved from **5955** to **5845** and has been logged when signing off at 1616.

● MALI

Bamako is testing new transmitters from 0600 to 0800 on **5995** and **9710**. Later in the day **5995** is replaced by **7100**.

● AUSTRALIA

The Radio Australia transmitter at Lyndhurst has been heard testing on **6100** from 0845 to 1215 with English programme directed to Asia. Also in parallel on **7205**. R. Australia can also be heard on a new channel of **21605** in English from 0800 to 1000.

● CHINA

Sinkiang Provincial Radio, Urumchi, has been heard on **6280** at 1500 in Chinese dialect.

● TRUCIAL OMAN

The Voice of the Coast, Sharjah, is reported to have increased power to 10kW, radiating its Home Service programme on **6040**.

● BRAZIL

Radio San Carlos, Sao Paulo, operates on **2410** (0.5kW) from 0900 to 0200.

● KUWAIT

Radio Kuwait has been heard by our Listening Post on **4967** (10kW) at 1900 with identification and English programme.

● ANGOLA

CR6RZ Emissora Official has been logged by our Listening Post at 2043 on **3375** (10kW) with programme of light music.

Acknowledgements to our own Listening Post and SCDX. ■



CYBERNETIC CYNTHIA



(PART 1)

by

L. C. GALITZ

This article is the first of a two-part series describing an electronic device having artificial intelligence. Cynthia, short for CYberNeTic Highly Intelligent Animal, is an electronic 'snail' who displays rudimentary reasoning power in her reactions to external stimuli. The device takes advantage of simple electronic logic circuits, and the more venturesome experimenter may wish to add his own ideas to those employed here

MAN HAS ALWAYS HAD AN INBORN DESIRE TO build something emulating himself, and attempts at this have ranged from the simple lever, which amplifies physical strength, to the electronic computer, which amplifies mental strength. However, none of these efforts could have the term 'intelligence' attributed to them. The giant computer is only faster than the human brain and, by itself, has less intelligence than a peanut. A computer coupled with a man can be called intelligent. Yet, few machines exist which can be called intelligent by themselves; machines which make decisions regarding their environment and themselves.

The machine described in these articles has the basic rudiments of intelligence - yet we must start somewhere. Cynthia is an electronic 'snail'. Like her biological equivalents, she is a nervous creature.

Touch the top of her shell and her head will pop in. A few seconds later her head will pop out again, thinking that the 'danger' has gone. If you do the same again, she will put her head in again and, as before, after she thinks the danger has gone, she will pop her head back out once more. She will do this for about six times, depending on the duration of the tactile stimulus, and the interval between stimuli. Eventually, however, on touching the top of her shell, her head will stay put. Her 'reasoning' tells her that something or somebody has touched the

top of her shell several times; yet, there has been no danger associated with it, i.e. she hasn't been hurt. Therefore, the something or somebody must be friendly. Hence, she needn't waste 'muscular' energy putting her head in (to save it from damage were the originator of the stimulus dangerous), so she keeps it out.

Being an animal of short memory, if you leave her for about half a minute, she will have forgotten about you and, on receiving a tactile stimulus, she will repeat the action of putting her head in, waiting a few seconds, and then putting it out again. However, she will not have forgotten completely and, this time round, it will take her less time to learn that you are friendly.

There are two other modes of operations possible with the circuit to be described. These alter her attitude to stimuli completely, and are brought about simply by transposing either one, or a pair of wires. They will be described later in Part 2.

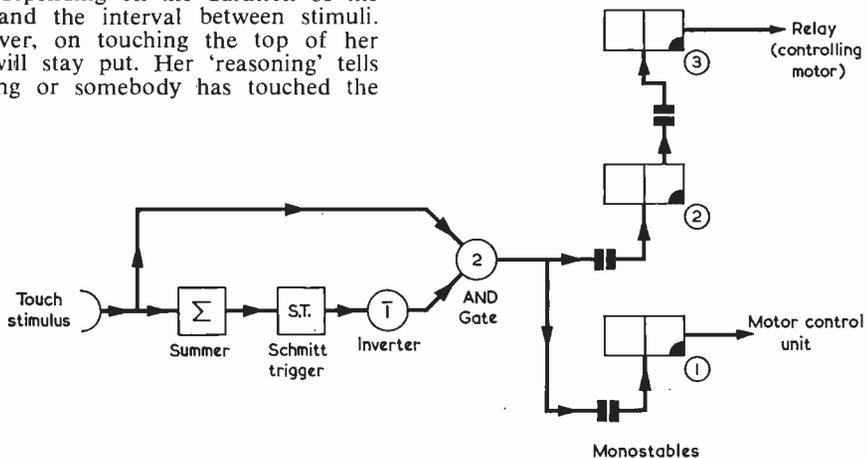


Fig. 1. Block diagram illustrating the operation of the cybernetic 'snail'

BLOCK DIAGRAM

It will be seen from Fig. 1 that when a touch stimulus is applied to the input of the circuit, and assuming there is a 1 on the lower input of the And gate, then there will be a 1 output from this gate. This will trigger Monostables 1 and 2 via their differentiating capacitors. When Monostable 2 reverts to its stable condition it will trigger Monostable 3.

The output of Monostable 1 passes to a motor control unit, which arranges to put the snail's head in. The head is driven in this direction for approximately one second. Meanwhile, Monostable 2 has gone quasistable for about three or four seconds. When it reverts to its normal state, it triggers Monostable 3 which couples to the relay driver transistor. The Monostable has a quasistable period of about two seconds. This two second pulse drives the relay, which reverses the polarity of the motor supply and drives the motor. Thus, Cynthia puts her head back out again. Summing up the role of the Monostable circuitry; on receiving an output 1 pulse from the And gate, Cynthia puts her head in, pauses for approximately three seconds, and then puts her head out again.

At the beginning, we assumed that there was a 1 on the lower input of the And gate. Let us next see what in fact happens in the circuitry before this And gate.

On receiving a tactile stimulus, a pulse is fed to the summer or integrator. This is rather a fancy name for a capacitor in series with a resistor! As each pulse appears, the capacitor charges up a little. While there is no pulse it slowly discharges. When pulses arrive in quick succession (once every ten seconds for instance) the capacitor has little time to discharge much, and the voltage across it increases gradually until it reaches a certain critical level. Fig. 2 shows the voltage across the integrating capacitor plotted against time, along with the pulses from the tactile sensor (which is, actually, a microswitch).

The output of the summer goes to a Schmitt Trigger, which gives an output 1 only when the voltage on the input exceeds a certain critical level. Thus, when the capacitor charges up sufficiently, the output

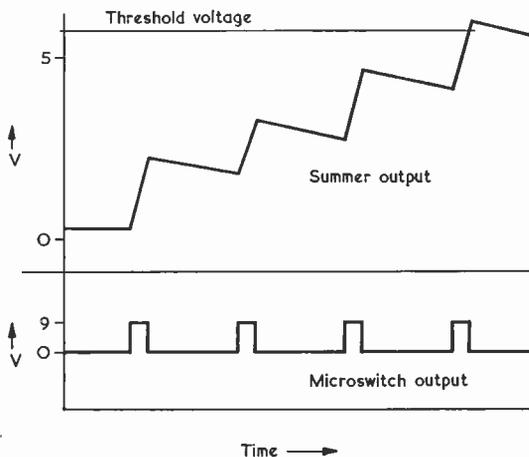
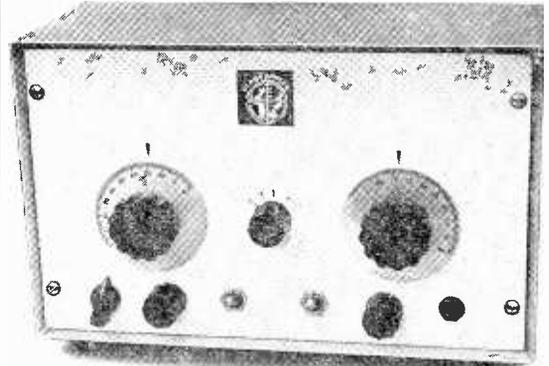


Fig. 2. Waveforms given around the micro-switch and summer circuits

RADIO CONSTRUCTOR

JULY ISSUE



4-BAND SUPERHET



This communications-type design offers reception over two short wave ranges, medium and long waves and incorporates a h.f.o. stage and an i.f. gain control. The complications of oscillator and aerial tuned circuit wiring are eradicated by the use of a ready-wired 4-band coilpack.

The circuit exhibits the following line-up:- ECH81 frequency changer, 6BA6 i.f., OA81 detector, 12AT7 a.f. amplifier/b.f.o., 6AM5 output and BY100 rectifier.

MINIATURE STABILISED POWER UNIT

This will deliver 1.5 to 9 volts d.c. at currents up to 50mA and incorporates an overload protection circuit which enables the maximum output current to be limited from 5 to 50mA. A simple manual voltage limiter is also included.

'DISCOVERY' S.W. RECEIVER

This design was featured in our March issue and proved to be a popular design for beginner constructors. In Further Notes, simple modifications are described which result in the addition of bandspread and headphone reception.

PLUS

★ OTHER PROJECTS & FEATURES

★ DATA SHEET No. 40

ON SALE 1st JULY

RADIO CONTROL FOR MODELS



RADIO CONTROL FOR MODELS

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More than 200 illustrations—circuits, working diagrams, photographs & tables. Each page is packed with information.

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This book is basically an amalgamation of "Radio Control for Model Ships, Boats and Aircraft" and "Radio Control Mechanisms". Additional material has been added on Multi-Channel Operation; Transistorised Radio Control Receivers—Simple and Three-Channel; A Compact Efficiency Aerial; Deac Battery Information; Licence Conditions, etc.

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BLOCK LETTERS PLEASE

of the Schmitt Trigger becomes 1. This is taken through an imaginary inverter (why it's imaginary will be explained later) to the input of the And gate.

Summing up the operation of the circuit before the And gate: normally there is an output 1 from the 'inverter', so tactile input pulses will trigger the monostables. However, after several pulses in quick succession, the output of the Schmitt Trigger becomes 1, making the lower input of the And gate 0. Thus, no tactile input pulses get through to the monostable circuitry. After a while, the integrating capacitor discharges below the threshold voltage, and the Schmitt Trigger output becomes 0 again, and pulses can once more get through to the monostables. As there is still an appreciable charge on the integrating capacitor, it will take less time for the Schmitt Trigger to fire again if tactile stimuli are reapplied to the circuit.

It would be thought that the Schmitt Trigger would switch off almost immediately after the voltage across the integrating capacitor fell below the threshold voltage. There has been incorporated, however, a certain 'backlash' in the Schmitt Trigger's operation by having unequal collector resistors. In other words, the threshold voltage required to fire the Trigger is higher than the threshold voltage required to bring the Trigger back to its normal mode of operation. This is analogous to the operation of the common or garden neon tube. Fig. 3 shows details of the Schmitt Trigger operation.

THE CIRCUIT

The full circuit is shown in Fig. 4. Comparison of this with the block diagram given in Fig. 1 shows that the circuit is almost a direct translation of the block diagram, using only standard building blocks, namely: And gate; Schmitt Trigger; monostable, relay driver. The only unusual parts of the circuit are the summer, and the output connection from the Schmitt Trigger.

S2 is the tactile input - a microswitch which feeds pulses through diode D1 to the summing capacitor C1. The voltage on TR1 base represents the output of the summer, and, as TR1 operates in the common collector mode, the voltage on TR1 emitter is virtually identical with that on TR1 base. R1 is part of the And gate formed by D2, D3 and R11, and is necessary to tie down the voltage on the anode of D2 to something like 6 volts when no pulse from the microswitch is coming through. Were it not for R1,

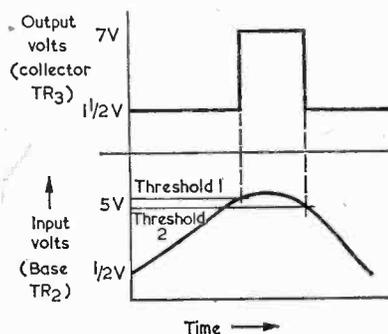


Fig. 3. Operating conditions at the Schmitt Trigger
THE RADIO CONSTRUCTOR

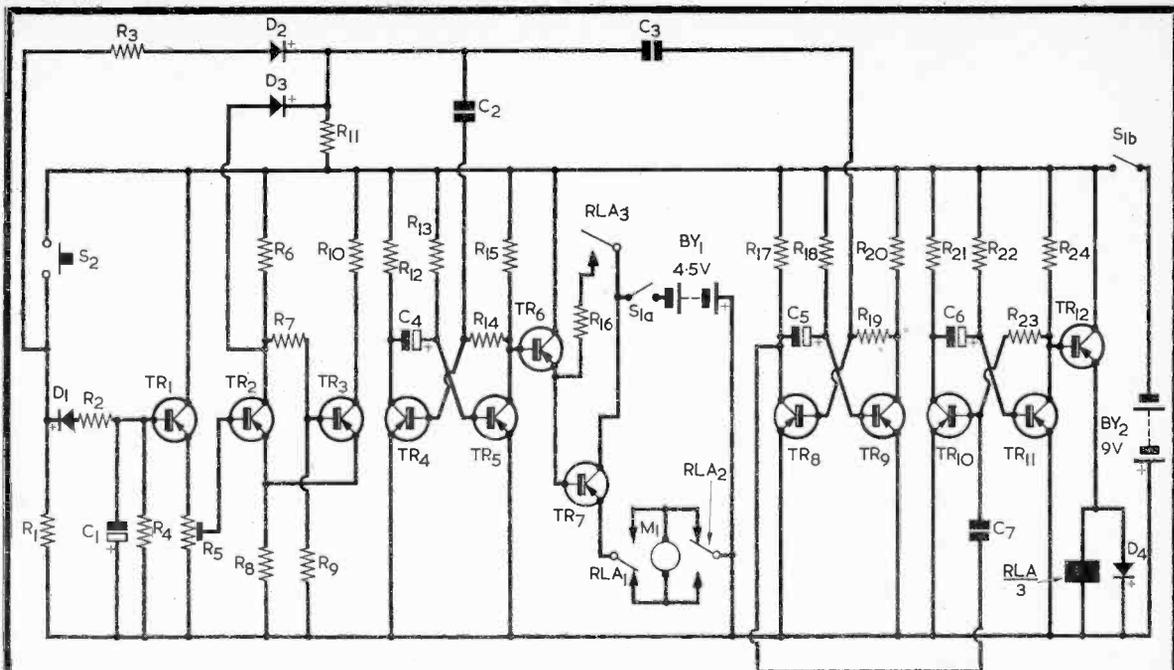


Fig. 4. Complete circuit diagram for the cybernetic model

Resistors

(All fixed values $\frac{1}{2}$ watt 10%)

R1	2.2k Ω
R2	6.8k Ω
R3	39k Ω
R4	See text
R5	10k Ω potentiometer, preset or variable
R6	6.8k Ω
R7	22k Ω
R8	390 Ω
R9	10k Ω
R10	3.9k Ω
R11	3.9k Ω
R12	2.7k Ω
R13	See text
R14	22k Ω
R15	2.7k Ω
R16	150 Ω
R17	2.7k Ω
R18	See text
R19	22k Ω
R20	2.7k Ω
R21	2.7k Ω
R22	See text
R23	22k Ω
R24	2.7k Ω

Capacitors

C1	500 μ F electrolytic, 10V wkg.
C2	0.1 μ F polyester, 125V wkg.
C3	0.1 μ F polyester, 125V wkg.
C4	100 μ F electrolytic, 10V wkg.
C5	400 μ F electrolytic, 10V wkg.
C6	400 μ F electrolytic, 10V wkg.
C7	0.1 μ F polyester, 125V wkg.

Semiconductors

(See text for further details on semiconductors)

TR1 to TR6	Any p.n.p. transistor, e.g. OC71 or surplus
TR7	Power p.n.p. transistor, e.g. OC26
TR8 to TR11	Any p.n.p. transistor, e.g. OC71 or surplus
TR12	Any p.n.p. transistor capable of energising relay
D1 to D4	Any diode, e.g. OA81 or surplus

Switches

S1(a) (b)	d.p.s.t. toggle
S2	Microswitch with operating lever

Motor

M1	Small 4.5 volt motor (see text)
----	---------------------------------

Relay

RLA	G.P.O. Type 3000 relay, 100 Ω coil, 2 changeover contacts, 1 make contact (see text)
-----	---

Batteries

BY1	4.5 volt battery, e.g. Ever Ready 1289 or 126, or equivalent
BY2	9 volt battery, e.g. Ever Ready PP7 or PP9, or equivalent

Miscellaneous

Tag board, turret-tag board, or tagstrips	(see text)
Knob	(if R5 is variable resistor)
Pulley	
Elastic band	
Plywood, Perspex, brackets, etc.	as required

COMPONENTS

the And gate would not work. Because of R1, D1 is necessary to prevent the charge leaking away from C1. R3 is required to cut down the voltage fed to the And gate, seeing that only the minutest pulse is required from this gate to trigger the monostables.

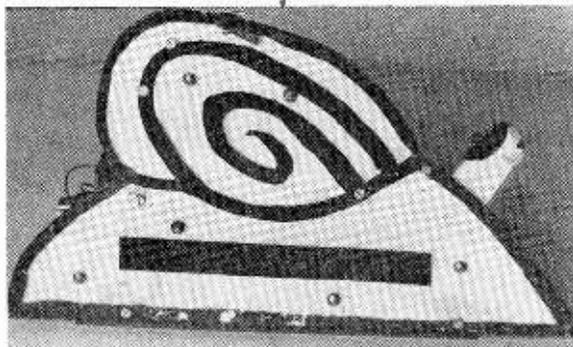
The output of TR1 is fed to the Schmitt Trigger via R5. This variable resistor sets the threshold at which the Schmitt Trigger fires, and hence the number of stimuli needed before the threshold voltage is reached. The normal output of a Schmitt Trigger is taken from the second collector, i.e. TR3. However, seeing that the inverted function of the Schmitt Trigger is required, instead of adding another transistor stage to invert the output, it is simpler to take the output from the first collector, whose output is the opposite to that of the second collector. This output acts as the lower input of the And gate.

The output of this And gate triggers Monostables 1 and 2. The output of Monostable 1 (TR4 and TR5) passes to TR6, again in the common collector mode, which drives the power transistor TR7. This in turn drives the motor in one direction via the normally closed contacts of relay RLA.

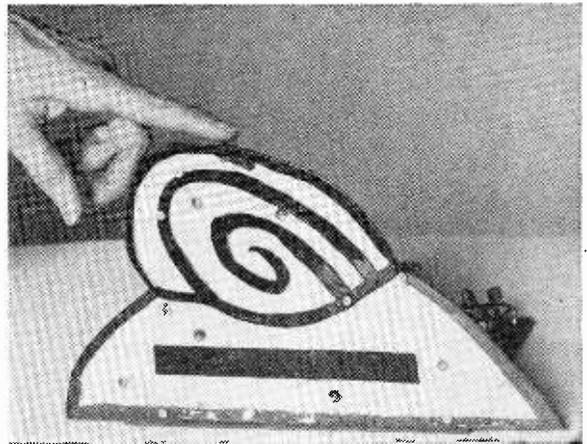
TR8 and TR9 form Monostable 2, along with associated components, and TR10 and TR11 form Monostable 3. The output of Monostable 3 passes to TR12, the relay driver. Diode D4 is wired across the relay coil in the usual manner to prevent transient voltages damaging TR12. Operation of relay RLA closes contacts RLA3, causing the base of TR7 to go negative and switching this transistor on. Simultaneously, contacts RLA1 and RLA2 change over, reversing the motor. Thus the motor is driven in the opposite direction for a short time.

It will be noticed that two separate power supplies are used - one for the electronics and other for the motor. The reason for this is that, if the motor and electronics were powered from the same source, motor transients would trigger the monostables via the power supply line. The author had enough trouble with one monostable triggering all the others even though the other two had no inputs! Trouble of this nature may be experienced with the monostable circuitry and, depending on how serious it is, the following cures may prevent monostables triggering spuriously.

1. Put a large value electrolytic capacitor (e.g. 1000 μ F 15V wkg.) across the supply rails.
2. Strap resistors across the first base-emitter junction of the offending monostable (i.e. TR4, TR8 or



Cynthia, being a curious animal, normally has her head projecting out of her shell



When Cynthia's shell is touched she initially pops her head in for safety. After continued stimuli, however, she uses her reasoning power to assess the magnitude of the possible danger

TR10). The value of the resistance could be about 47k Ω .

3. Failing all this, the only other alternative lies in decoupling the monostable from the power supply line, as in Fig. 5. This would have to be done to each offending monostable separately.

COMPONENTS

The resistors and capacitors are standard, and are as specified in the Components List. The values of R4, R13, R18 and R22 are found experimentally, and the process involved is discussed in Part 2. R5 may be a preset or variable potentiometer fitted with a knob. Once it has been set up it does not need any further adjustment unless a change in Cynthia's reactions is required. The hardware needed, listed under 'Miscellaneous', is also described in Part 2.

The semiconductors used in the prototype were of the unmarked untested variety which can be purchased from several firms advertising in this magazine. Apart from TR7 and TR12, all the transistors may be small p.n.p. germanium or silicon types. The OC71, etc., will be suitable. TR7 should be a p.n.p. power transistor, such as the OC26, whilst TR12 should be any p.n.p. type capable of passing the relay coil energising current. The transistors may be either germanium or silicon. However, where two transistors are used in conjunction with one another, as in the Schmitt Trigger and the monostables, they should both be of the same variety.

The diodes may similarly be either germanium or silicon. It would, perhaps, be preferable to use all germanium or all silicon diodes in the circuit, with D2 and D3, in particular, both being of the same type.

The relay employed by the author was a surplus G.P.O. Type 3000 having a 100 Ω coil. Any similar component capable of energising reliably at a little less than 9 volts will be satisfactory. It requires two changeover contact sets and one make contact set.

The motor can be of almost any variety operating on 4.5 volts, and does not have to be very powerful.

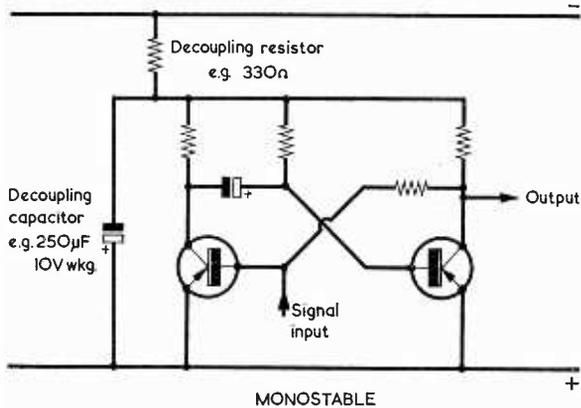


Fig. 5. If necessary, power supply decoupling may be added to individual monostable stages, as shown here

A wide selection is available from Ripmax Ltd., 80 Highgate Road, Kentish Town, London, N.W.5. A particularly suitable type is the Ripmax EM405 motor, which is intended for operation on 1.5 to 6 volts. This can be obtained at all good model shops.

Batteries are specified in the Components List, but it may be found more convenient to use a stabilised mains unit. Indeed, it may be worth constructing one of these units if work is to be carried out with cybernetic projects - one can use up a lot of PP9's testing relay-driven circuits! The author has built up a unit specifically for the testing of the electronic modules, this being the supply described in 'In Your Workshop' in the December 1967 issue of *The Radio Constructor*.

(To be continued)

VACATION SCHOOL RF ELECTRICAL MEASUREMENT PRACTICE

An IEE vacation school on radio frequency electrical measurement practice is to be held at the University of Kent, Canterbury, from the 6th to 18th September 1970.

The aim of the school is to review the latest practices in the field, and will mainly be of interest to senior workers in, and supervisors of, measurements laboratories.

A minimum of mathematical treatment is planned, and the emphasis of the school will be on practical aspects of the subject. Some thirty lectures will be given during the vacation school, and these will be supplemented by group discussion periods.

Further details and registration will be available in due course from the Secretary, I.S(SE), IEE, Savoy Place, London WC2R 0BL.

JUNE 1970

CURRENT SCHEDULES

Times = GMT

Frequencies = kHz

★ WINDWARD ISLANDS

The Windward Islands Broadcasting Service schedule is as follows:- To Eastern Caribbean from 1545 to 1800 on **9550**, from 1545 to 2245 on **5015** and from 2155 to 0215 on **4280**. To Jamaica from 1545 to 1800, from 1845 to 2245 on **15105** and from 2315 to 0215 on **11970**. To the British Isles from 1945 to 2130 on **21690**.

★ TOGO REPUBLIC

Radio Lomé schedule as follows:- From 0530 to 0900, 1200 to 1400 and from 1630 to 2300 on **6155** (4kW). From 0530 to 0800, 1730 to 2300 on **5047** (100kW). From 0800 to 0900, 1200 to 1400 and from 1630 to 1730 on **7265** (100kW). On Saturdays, schedule is extended from 1400 to 1630 and on Sundays from 0530 to 2300 continuous.

★ MALAGASY REPUBLIC

Tananarive broadcasts an Overseas Service from 1330 to 1430 on **17730** (100kW).

★ KUWAIT

Radio Kuwait is now on **21685** (50kW) from 1300 to 1910. A parallel transmission can also be heard on **21590** (10/250kW) from 0900 to 1700 and from 1800 to 1910. From 1700 to 1800 this transmitter moves to **21605**. R. Kuwait also signs on in English on **15405** at 1600 and closes at 1900.

★ CONGO BRAZZAVILLE

Radio Brazzaville relays the ORTF English programme Paris Calling daily from 2015 to 2100 on **15190** (50kW). Broadcasts in French from Brazzaville, may be heard till 2100 on **3232** (1.5kW), **4800** (4kW) and on **7105** (4kW). Other channels in parallel are: **5970** (4kW), **9730** (15kW) and **11725** (50kW).

★ NEW ZEALAND

ZL5 Wellington on **17770** (7.5kW) relays the Home Service from 2000 to 0545 with ZL21 **15110** (7.5kW) in parallel directed to the Pacific Islands from 2000 to 2230. Relays the BBC news at 2000. Broadcasts to the Pacific from 0600 to 0845 from ZL7 are now on **6080** (7.5kW) and ZL2 on **9540** (7.5kW). To Australia from 0900 to 1145 on **9520** ZL7 and **11775** ZL3 (both 7.5kW). Wellington can also be heard after midnight over ZL4 on **15280** (7.5kW).

★ POLAND

The Polish Pathfinders station at Warsaw is now on **6950** (5kW) with programmes in Polish on weekdays from 1100 to 1700 and on Sundays from 0900 to 1700. Test transmissions in English and French after 1700.

★ UNITED ARAB REPUBLIC

As a result of the recent test transmissions from Cairo in the 31 metre band, the European Service is now on **9655** with the English programme at **2145**.

★ SWEDEN

Changes effective until September are as follows: To South Asia in English, Swedish and French from 1400 to 1530 on **17840**; to Middle East in English and Swedish from 1600 to 1700 on **15240**; to Far East in Russian and English from 2015 to 2115 on **11705** and to Western North America in French, English and Swedish from 0300 to 0430 on **11705**.

Acknowledgements to our own Listening Post and SCDX.

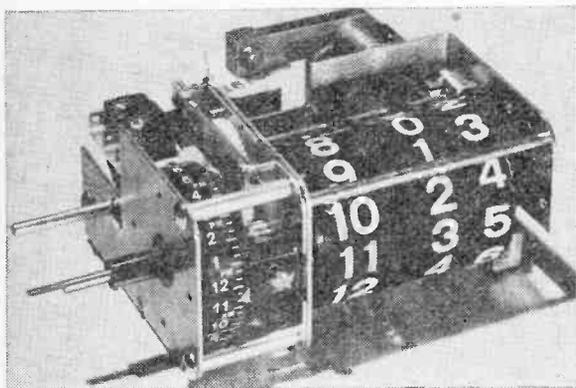
TRADE REVIEW . . .

● DIGITAL CLOCK DISPLAY MECHANISM

Recently introduced to the U.K. market, the ITT Digital Clock Display Mechanism is a synchronous-motor-driven digital time indicator. It incorporates an alarm setting which, operating a change-over microswitch, permits any desired warning device to be energised at the appropriate time.

The time indication is for a twelve-hour clock, divided into minute intervals. The alarm graduation is for 24 hours at 10-minute intervals.

The figures are white on black ground, 7.6 mm in height. The standard model operates off 240v. 50 Hz; other a.c. ratings are available. Approximate dimensions are: width 82 mm; height 38 mm; depth 75 mm.



● NEW RADIO TRANSMISSION AERIAL

A newly designed multi-band radio transmitting-receiving aerial is being marketed throughout the world by J-Beam Engineering Limited, of Northampton. The new aerial, developed from conception to production by J-Beam Engineering, and known as the Triple Three, is constructed almost entirely from specially fabricated aluminium welded tube supplied by Alcoa Britain – a subsidiary of Aluminium Company of America.

Each Triple Three consists of an 18-foot aluminium boom with three 36-foot aluminium element rods. It is designed to provide amateur radio operators with a three-band beam with performance on each band equal to that of a single-band beam.

Welded aluminium tube is used for the aerial in preference to other materials because of its extreme lightness – for all its size, the Triple Three weighs only 55 lbs. – its rigidity and its natural resistance to corrosion under constant exposure to the weather. Special fabricating is performed by Alcoa Britain to tailor the welded tube to Triple Three specifications. This includes tapering, swaging (narrowing of the tube diameter in steps to enable sections to be joined by fitting one inside the end of another and adjusting telescopically) and internal de-finning, which provides a smooth interior for each element tube. ■

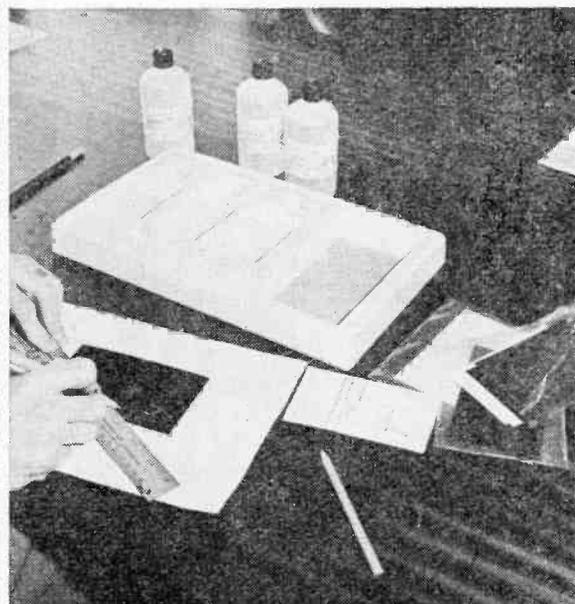
INSTANT PROTOTYPE PRINTED CIRCUITS

In only a few minutes and by a simple additive process, inexpensive 'printed circuitry' can now be produced without the tiresome need for master layouts, costly photo-negatives and time consuming etching treatments.

Cirkitrite Limited, a London based company, have achieved this break-through by developing a process by which electrically conductive patterns can be produced by direct application of a special pen to selected areas. This could revolutionise the production of prototypes for experimental purposes.

The principle of the Cirkitrite process is simple: a chemical contained in the Cirkitrite pen is applied directly to specially prepared materials which are subsequently immersed in a metal reducing solution. Since the chemical provides a catalytic surface to the selected areas only, the chemical reduction of metal is confined to those areas – even when the whole material is immersed in the reducing solution. Thus an electrically conductive pattern can be drawn directly on to the substrate without the necessity for etching or otherwise removing conductive material from areas where it is not required. It could be termed a process of selective deposition.

A Cirkitrite kit set has been specially produced to demonstrate the principle and at the same time provide sufficient chemicals and materials to produce



A new process developed by Cirkitrite Ltd., enables prototype printed circuits to be produced in minutes without costly photo-negatives and time consuming etching treatments. Using the Cirkitrite kit set, simply draw the desired pattern on to specially prepared plastic panels and develop by immersing in a chemical solution

sample products for experimentation. The kit is supplied in a vacuum formed tray which incorporates a suitable depression for mixing chemicals and processing materials. It will quickly be realised that the process has wide applications if used in conjunction with electro-plating or by employing other techniques well known to the printed circuit industry.

The principles of the operation are as follows: The non-conducting materials (in the kit sets being SRBP and ABS plastic panels) have been specially prepared to accept the chemical contained in the Cirkitrite pen. Finger marking of the surface beforehand should be carefully avoided. When this chemical is applied by drawing the pattern required, the panel is immersed in a metal reducing solution. In the case of Copperite this solution consists of three components mixed together at time of use. This solution deposits true metallic copper only on the areas traced by the pen. The whole operation can be completed in a few minutes.

The panel is now processed, having received a highly conductive pattern of copper in the order of 0.5 micron thickness capable of carrying an electrical current. Due to its thickness the current carrying capacity is limited, but is capable of accepting electroplating current densities in the order of 0.5 amp/dm². The thickness, and therefore the current carrying capacity, can be increased by electroplating or further electrodeless deposition.

The initial deposit, when thoroughly rinsed and dried, has a limited life due to oxidation from the atmosphere but if further treated or electroplated it can be preserved indefinitely.

It is based upon principles used in present day 'through-hole plating' techniques and apart from its practical value in the electronic field it can also be used for the production of electrical patterns, nameplates, signs, etc., to produce attractive designs such as Nickelrite, Silverite and Goldrite. As their names indicate, these are finishes in nickel, silver and gold produced by further electrodeless chemical deposition.

SOME APPLICATIONS

Cirkitrite has an immediate application for the production of prototype printed circuits which can be quickly and cheaply produced for experimental purposes. In some instances the application of the initial Copperite deposit may be adequate and, as previously mentioned, can quickly produce circuits comparable to those manufactured by other more expensive and complicated systems. The deposit produced by the reduction process, though very thin ($6-20 \times 10^{-6}$), enable it to be used for some direct electronic applications.

The process can also be used to modify existing printed circuits or produce selective through-hole connections. Since it can be applied directly by hand (using the Cirkitrite pen) the process can also produce patterns on irregular surfaces and is not confined to flat panels.

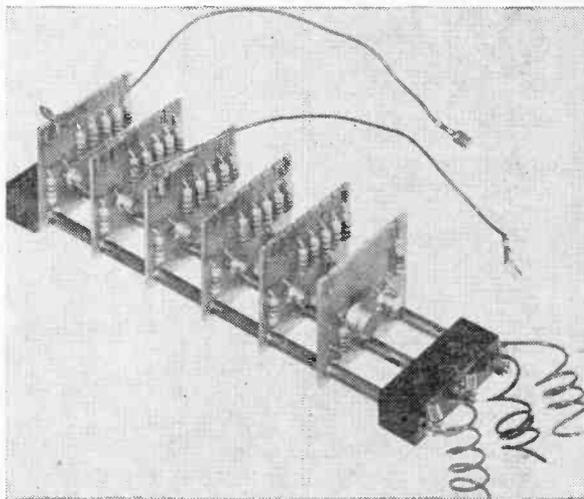
Wider applications are, however, possible. Among these are included Copperite, Nickelrite, Silverite and Goldrite solutions for the electrodeless deposition of the finishes described. Additional solutions are also available for preserving finishes and details of these are available on request from Cirkitrite Limited, c/o Haven Green, Ealing, London, W.5.

TRADE REVIEW . . .

● LOGIC MODULES

Geatronix Ltd. have introduced a complete range of transistor/resistor logic modules with solderless inter-connections. This range is compatible with their existing Norkit system (solder type connections) and is known as Mark II Norkit. Nand, And, Nor and Or gates are available together with bistable units and lamp and relay drivers.

The simple assembly system provides for mounting up to 18 modules in a group and consists mainly of three busbars which pass through eyelets in the



printed circuit board. These busbars serve the dual purpose of holding the assembly rigid and distributing the supplies to each module.

Logic interconnections are made with patching leads having a discrete connector at each end which push into slots in the printed circuit board. Rearrangement of the logic circuit is rapidly achieved by removal and reconnection of the patching leads as desired.

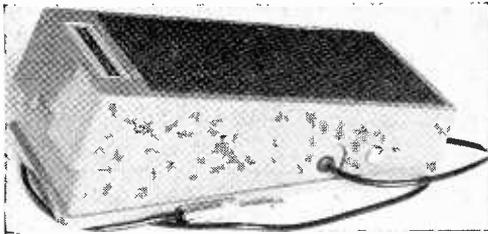
The Mark II Norkit system is believed to provide the most economic and rapid method of assembling prototype logic systems. The complete assembly can be used as a simulator for logic problems or as a permanent solid state controller in a specific application.

Further details can be obtained from Geatronix Ltd., 28 Redstock Road, Southend-on-Sea, Essex.

● TAPE CASSETTE CASE

Adding further to their range of Bib accessories, the Bib Division of Multicore Solders Ltd., of Hemel Hempstead, Herts. (winners of the Queen's Award to Industry) announce the introduction of their Bib 'Five' Tape Cassette Case, reference Size N.

This handy case holds five compact cassettes permanently in their containers, which is the ideal number that can be held easily with one hand, and is a convenient size for keeping in the car, besides for storing cassettes in the home. The container, made from strong p.v.c., has a clear hinged top, through which the cassette titles can be easily seen. ■



‘WAH WAH’

b
R. J. C

THE WAH-WAH PEDAL UNIT DESCRIBED IN THIS article has been designed to enhance the brilliance of electric guitar reproduction by providing a continuously variable frequency response which may be controlled by the guitar player's foot. The result is the well-known 'wah-wah' effect which nowadays backs up the performance of so many leading professional groups.

CIRCUITS AND COMPONENTS

The circuit of the Wah-Wah Pedal Unit appears in Fig. 1, and it will be seen that this includes two transistors type 2N4061 connected in a frequency selective network. This network enables a high degree of amplification to be achieved over a narrow band of frequencies, the latter being selected by potentiometer R7. This potentiometer is mechanically coupled to the pedal, and its setting may in consequence be varied by the instrumentalist's foot. A wide range of pleasing and unusual effects are, therefore, directly under the control of the guitar player.

The guitar is coupled into the Pedal Unit by fitting its plug into jack JK1. The process of inserting the jack plug causes the earthy contact of JK1 to complete the battery supply circuit, whereupon the unit becomes switched on. There is no separate on-off switch. The output is applied to the subsequent amplifier by way of a flexible screened lead fitted with a jack plug.

The complete circuit is powered by a PP3 battery which is contained within the pedal unit. Current consumption is of the order of 1.2mA only, with the result that the battery can be expected to have a considerably long life.

With the exception of R7, all transistors, capacitors and resistors are assembled on a piece of Veroboard with 0.15in. hole matrix. This, in company with a 6-way tagstrip and the battery securing clip is mounted on the metal base plate of the basic pedal assembly. The latter has the same construction as a volume pedal control unit, the pedal coupling to an internal potentiometer by way of a rack and pinion. All the specialised parts required for the Wah-Wah Pedal Unit, including the basic pedal assembly and the input jack, are available from Wilsic Electronics Ltd., 6 Copley Road, Doncaster, Yorks. Also available from this company is a complete kit of parts for making up the unit.

Professional both in appearance and it described here can be quickly and eas at low cost. It is completely self-cor required being provided by an input terminating in a jack

VEROBOARD ASSEMBLY

Construction begins with the wiring up of components on the Veroboard, following the layout given in Fig. 2. (In the Wilsic Electronics kit the Veroboard is provided with the copper strips already cut and the mounting holes drilled. Correct orientation of the board may then be judged from the positions of the two mounting holes, one being further from its adjacent edge than the other).

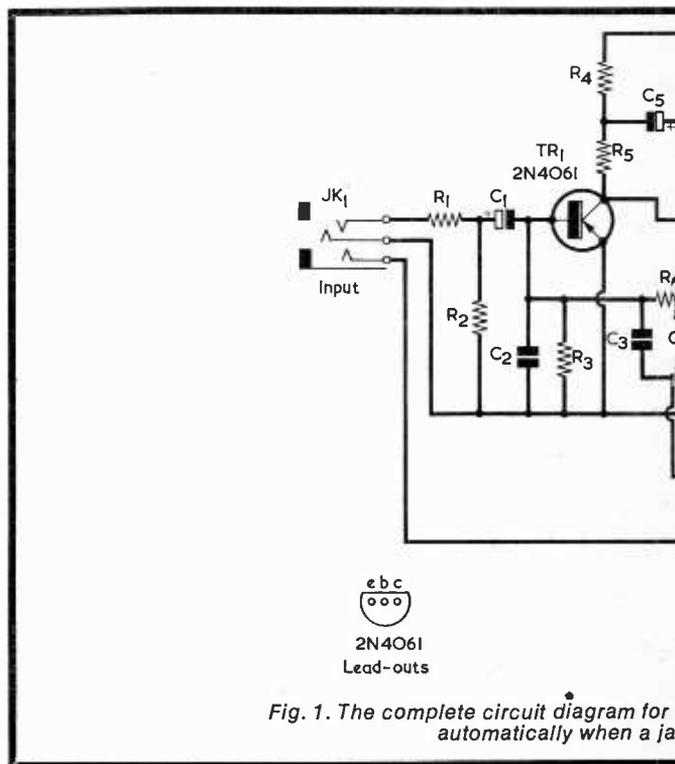


Fig. 1. The complete circuit diagram for automatically when a ja

PEDAL UNIT

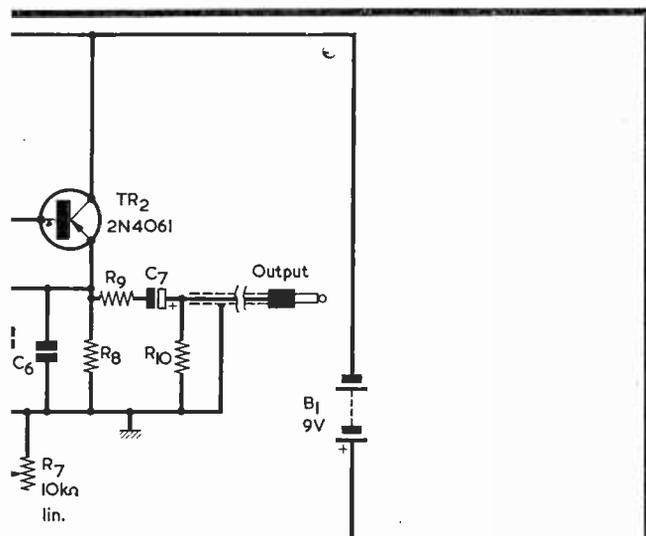


Cover Feature

BORN

performance, the Wah-Wah pedal unit assembled by the home-constructor is a simple, rugged, and reliable unit. It is the only external connections for the guitar, and an output lead for the amplifier

When wiring up the Veroboard, each soldered joint should be made quickly, using only a small amount of solder. Take care to ensure that solder is kept away from adjacent copper strips, where it could cause short-circuits. The transistors should not be overheated when they are being soldered into position or when nearby components are being mounted. A number of the components are mounted vertically, as in Fig. 3. The polarity of electrolytic capacitors is indicated by a plus or minus sign, as applicable,



Wah-Wah Pedal Unit. This switches on when the plug is inserted in JK1

COMPONENTS

Resistors

(All fixed values $\frac{1}{4}$ watt 5%)

- R1 220k Ω
- R2 100k Ω
- R3 100k Ω
- R4 10k Ω
- R5 10k Ω
- R6 470k Ω
- *R7 10k Ω potentiometer, linear
- R8 4.7k Ω
- R9 10k Ω
- R10 100k Ω

* Part of pedal assembly.

Capacitors

(All capacitors miniature types. Electrolytic capacitor voltage ratings are minimum figures — higher ratings may be used if desired.)

- C1 16 μ F electrolytic, 10V wkg.
- C2 0.001 μ F
- C3 0.01 μ F
- C4 0.01 μ F
- C5 16 μ F electrolytic, 10V wkg.
- C6 0.001 μ F
- C7 16 μ F electrolytic, 10V wkg.

Transistors

- TR1 2N4061
- TR2 2N4061

Socket

- JK1 Input jack, with make contact (Wilsic Electronics Ltd.)

Battery

- B1 9-volt battery type PP3 (Ever Ready)

Miscellaneous

- Pedal assembly (Wilsic Electronics Ltd.)
- Veroboard, 0.15in. matrix (see Fig. 2)
- Battery clip (Wilsic Electronics Ltd.)
- 6-way tagstrip (see Fig. 5(a))
- Flexible screened cable
- Jack plug
- Battery connector
- Plastic insulating sheet, 1 $\frac{1}{2}$ x 3 $\frac{1}{4}$ in. (Wilsic Electronics Ltd.)
- 2 half-grommets
- Nuts, bolts, wire, etc.

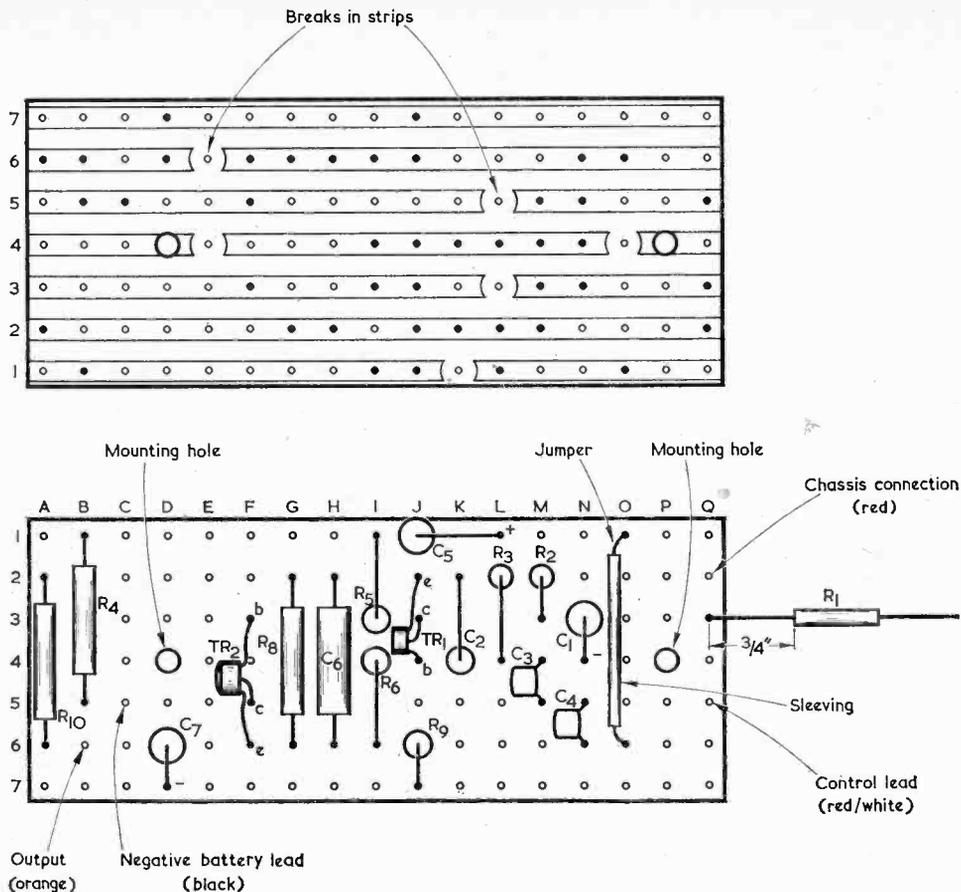
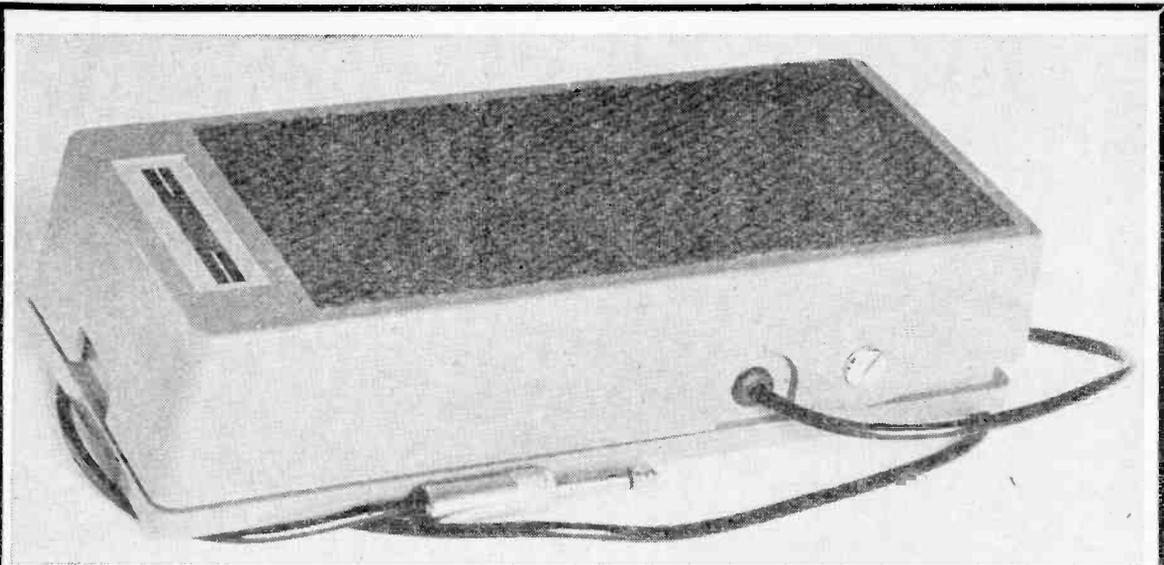


Fig. 2. The copper and component sides of the Veroboard panel

alongside the appropriate lead. The wiring instructions which follow refer to coloured connecting leads, these including a red/white lead. Alternative colours may be used here provided, of course, that the correct connections are made.

The first set of instructions, given in Steps 1 to 23 inclusive, applies to the soldering of components to the Veroboard. It is assumed that the copper strips have already been cut and the mounting holes drilled, as in Fig. 2.

1. Connect R10 (100k Ω ; brown, black, yellow) between holes A2 and A6.
2. Connect R4 (10k Ω ; brown, black, orange) between holes B1 and B5.
3. Connect C7 (16 μ F) between holes D6 and D7. The capacitor is upright, taking up the position shown in Fig. 2, and its negative leads connects to hole D7.
4. Connect up TR2 as follows: base to F3, collector to F5, emitter to F6.
5. Connect R8 (4.7k Ω ; yellow, violet, red) between holes G2 and G6.
6. Connect C6 (may be marked 0.001 μ F or 1,000pF) between holes H2 and H6.
7. Connect R6 (470k Ω ; yellow, violet, yellow) upright between holes I4 and I6.
8. Connect R5 (10k Ω ; brown, black, orange) upright between holes J1 and J3.
9. Connect up TR1 as follows: base to J4, collector to J3, emitter to J2.
10. Connect R9 (10k Ω ; brown, black, orange) upright between holes J6 and J7.
11. Connect C2 (may be marked 0.001 μ F or 1,000pF) upright between holes K2 and K4.
12. Connect R3 (100k Ω ; brown, black, yellow) upright between holes L2 and L4.
13. Connect R2 (100k Ω ; brown, black, yellow) upright between holes M2 and M3.
14. Connect C3 (0.01 μ F) between holes M4 and M5.
15. Connect C4 (0.01 μ F) between holes N5 and N6.
16. Connect C1 (16 μ F) upright between holes N3 and N4, with negative lead to N4.
17. Connect C5 (16 μ F) upright between holes J1 and L1, with positive lead to L1.
18. Fitting sleeving over its length, connect a length of tinned copper wire (a scrap resistor lead will serve) between holes O1 and O6.
19. Connect a 2 $\frac{1}{2}$ in. length of red flexible p.v.c. covered wire to hole Q2. This will later provide the chassis connection.
20. Connect the black battery connector lead to hole C5.



The pedal depressed, taking the slider of the internal potentiometer fully to the end of its track

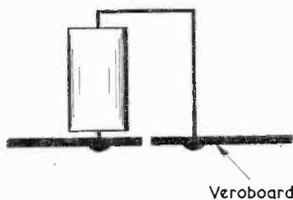
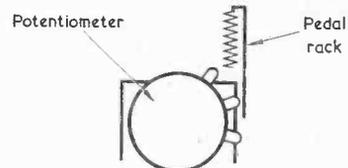
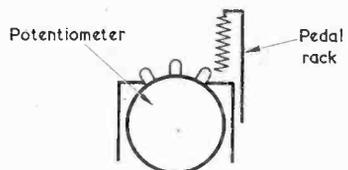


Fig. 3. Vertically positioned components should be mounted neatly, as indicated by this example showing one of the electrolytic capacitors



(a)



(b)

Fig. 4(a). The pedal potentiometer should have the orientation shown here for correct wah-wah operation (b). If the potentiometer tags project in the direction illustrated here, the bush mounting nut should be loosened and the potentiometer rotated to the correct position

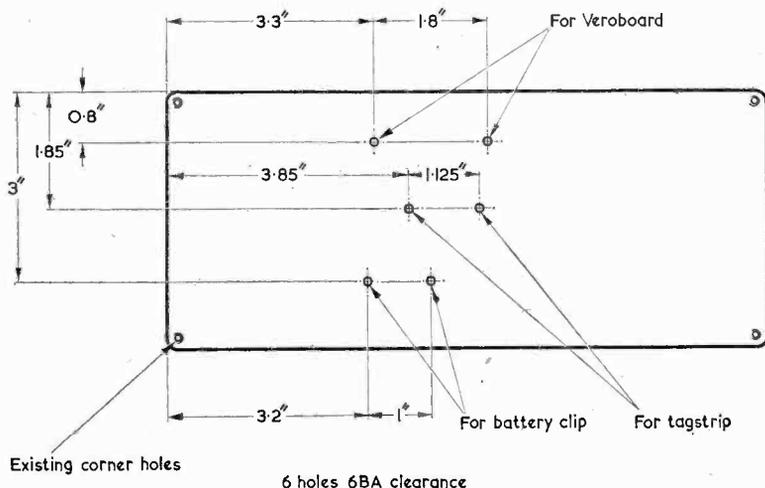
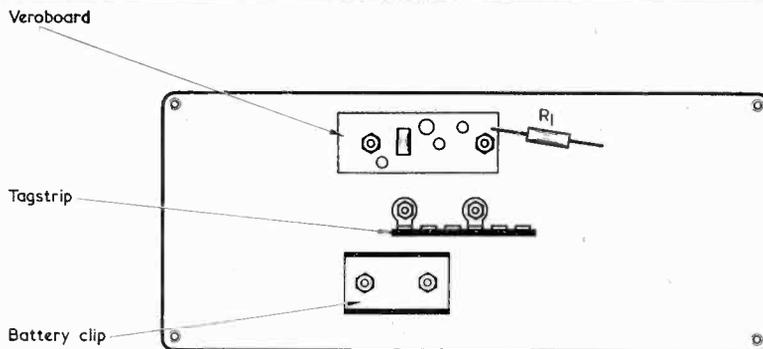
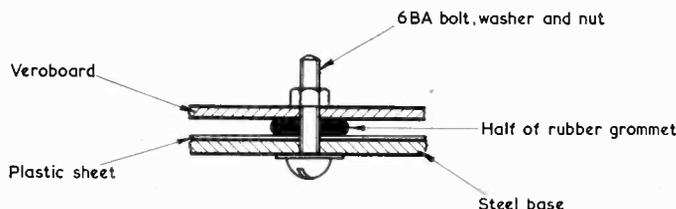


Fig. 5. Drilling details for the pedal base plate. The feet are on the underside, away from the reader



(a)



(b)

Fig. 6(a). The positions taken up by the Veroboard, 6-way tagstrip and battery securing clip. Correct orientation for the Veroboard is indicated by the position of R1
(b). Detail illustrating how the Veroboard is secured to the pedal base plate

21. Fitting sleeving over its lead-out connect one end of R1 (220k Ω ; red, red, yellow) to hole Q3, as shown in Fig. 2. The other end of this resistor is connected later.
22. Connect a 3in. length of orange flexible p.v.c. covered wire to hole B6. This will later provide the output connection.
23. Connect a 2 $\frac{1}{4}$ in. length of red/white flexible p.v.c. covered wire to hole Q5. This is the 'control lead', and connects later to the slider of R7.

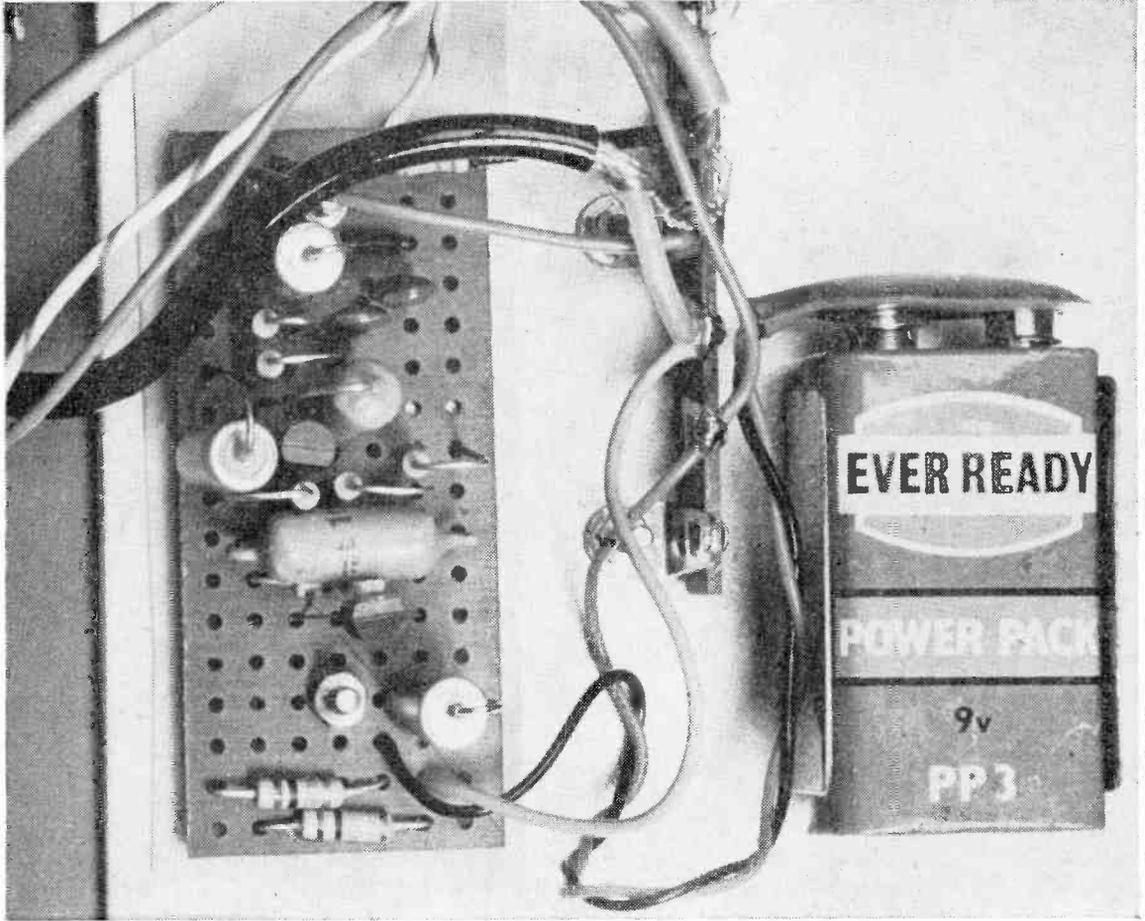
WIRING THE COMPLETE UNIT

The fitting of components to the Veroboard is now complete. All connections should be carefully checked, paying particular attention to ensuring that there are no short circuits between copper strips. The next process consists of fitting the Veroboard and other components to the basic pedal assembly and of wiring these up.

24. Remove the metal base plate of the pedal. This plate is secured by four small screws at its corners.
25. Unsolder the existing connections at the pedal potentiometer. Next check the position of the potentiometer tags. If these project, generally, in the direction of the jack socket, as shown in Fig. 4(a), the potentiometer is mounted in the correct position for Wah-Wah operation. If the tags project directly upwards, as in Fig. 4(b), the potentiometer bush locking nut should be

loosened and the potentiometer rotated, with the pedal fully closed, to the position shown in Fig. 4(a). This adjustment is necessary because, for best Wah-Wah effect, the potentiometer should insert zero resistance into circuit when the pedal is closed.

26. Using a suitable pair of pliers, remove the existing jack socket. This process is eased if the pedal is opened to its fullest extent. Drill or file out the socket hole to $\frac{7}{8}$ in. diameter. Fit socket JK1 to this hole with its tags pointing towards the potentiometer.
27. Place the base plate of the pedal feet-down on a solid surface, then mark off and centre-punch the 6 holes shown in Fig. 5. Drill these holes 6BA clearance. It is important to ensure that the holes are accurately positioned, or the Wah-Wah components may interfere with existing pedal parts.
28. Following Figs. 6(a) and (b), fit the battery securing clip, 6-way tagstrip and Veroboard. The battery clip is mounted with short 6BA screws, and the tagstrip and Veroboard with longer 6BA screws. To prevent short-circuits to the base plate, the Veroboard underside is spaced off by half a rubber grommet at each screw; also, a sheet of plastic is fitted between the grommets and the baseplate surface. See Fig. 6(b).
29. Turn next to Fig. 7, which shows the final wiring steps. Here, the tags on the tagstrip are numbered 1 to 6 for identification in the wiring instructions. Similarly, the three tags of JK1 are



The Veroboard, 6-way tagstrip and battery take up the positions shown here. This illustration should be consulted in conjunction with Fig. 7

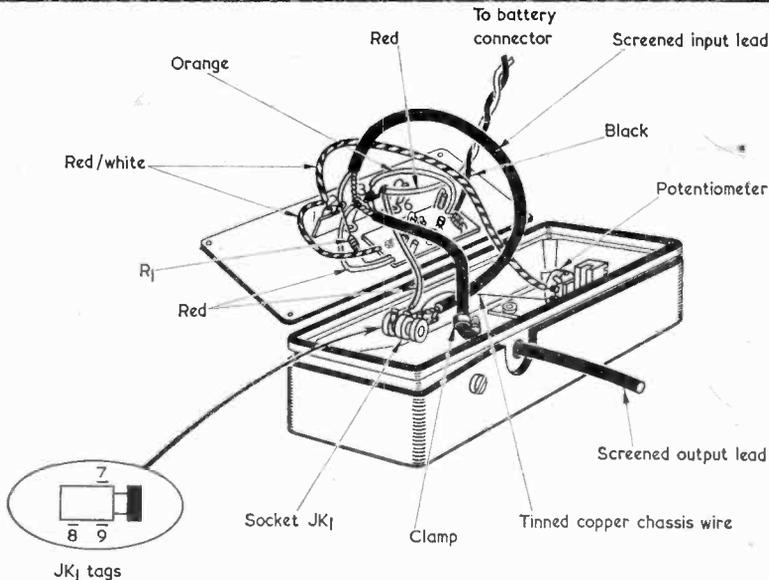


Fig. 7. Final wiring details. The tags of JK1, shown in the inset, point towards the reader

numbered 7, 8 and 9, as indicated in the inset. The jack is shown in this inset with its tags pointing towards the reader. In the wiring steps which follow, soldering at individual connections should only be carried out when expressly stated.

30. Connect the free end of the red/white lead fitted in Step 23 to tag 1 of the tagstrip. Connect a 6½ in. length of similarly coloured wire to this same tag, and solder both connections.
31. Connect the free end of the 6½ in. length of wire, just fitted, to the slider (central tag) of the pedal potentiometer. Solder at this tag.
32. Covering with sleeving and shortening as necessary, connect the free end of R1 (fitted in Step 21) to tag 2 of the tagstrip. Connect the centre wire of a 6 in. length of screened cable to this same tag. Solder both connections.
33. Connect the braiding of the 6 in. length of screened cable to tag 3 (earthed) of the tagstrip. Connect the free end of the red lead from the Veroboard (fitted in Step 19) to tag 3 of the tagstrip.
34. Take up the flexible screened cable already fitted to the pedal and connect its braiding to tag 3 of the tagstrip. This screened cable is now the output lead. Solder all three connections at tag 3 of the tagstrip. Secure the output lead by means of the plastic cable clamp at the centre of the pedal underside such that about 5 in. of cable appears between the clamp and the tagstrip.
35. Connect the centre wire of the output lead to tag 4 of the tagstrip. Connect the free end of the orange lead from the Veroboard (fitted in Step 22) to this same tag. Solder both connections at tag 4.
36. Connect the red positive lead from the battery connector to tag 5 of the tagstrip. Connect a

7 in. length of red p.v.c. covered flexible wire to this same tag. Solder both connections at tag 5 of the tagstrip. (There are no connections to tag 6 of the tagstrip.)

37. Connect the free end of the 7 in. red lead, just fitted, to tag 7 of the input jack JK1. Solder at tag 7.
38. Connect the centre wire at the free end of the 6 in. screened cable (fitted in Steps 32 and 33) to tag 8 of input jack JK1. Solder at tag 8.
39. Connect the braiding at the free end of the 6 in. screened cable to tag 9 of input jack JK1. To this same tag connect one end of a 6 in. length of bare tinned copper wire. Solder both connections at tag 9.
40. Pass the free end of the bare tinned copper wire through the potentiometer tag nearest the metal plate securing the pedal mechanical components. The wire should run directly between the jack tag and the potentiometer tag without being taut. Solder at the potentiometer tag.
41. Continue the bare tinned copper wire on to the metal case of the potentiometer, soldering it to this case. Snip off any excess wire.
42. Insert the battery in its clip as shown in the accompanying photograph, and fit its connector.
43. Positioning the interconnecting leads so that they will not foul any pedal parts, refit the base plate to the pedal assembly and secure in position with the four small screws at the corners.

Wiring-up is complete. There is no necessity to fit an output jack to the screened output lead as this will already be provided.

The Wah-Wah Pedal Unit is now ready for use. As has already been mentioned, it is automatically switched on by the insertion of the jack plug from the guitar. The output of the Pedal Unit then plugs into the main guitar amplifier. ■

FEEDING THE COMPUTER CORRECTLY

How do you make sure a computer has been fed with the right facts? We all know what happens when human errors creep in: gas-bills where the date has been included in the amount to pay. This is a very real problem. Normally, one girl at a keyboard types the information to go in, and then another girl, often at a second machine, types it again. Then the two typings are compared so that errors are found and corrected.

Now an inventor has come up with an idea which saves the second girl and the second machine. The same girl types the same figures twice. Will she make the same mistakes twice? Not with this apparatus, according to a BBC report by Richard Oliver. He explained that the operator does not see the whole original document from which she takes the figures. Instead, on this equipment, called Soval, she sees and types only the parts of the document she is concerned with. Bundles of fine glass fibres, spaced at one end to cover those parts, are brought together at the other end, so that the figures are all arranged in a compact pattern. When she has typed this, the bundles of fibres are automatically changed for a second set, arranged differently, so that the figures appear in a different order. The machine then sorts out the jumbled set and compares it with the original set.

EDUCATIONAL TV FOR CANADA

Canada's first high-power u.h.f. television transmitter will be installed in Toronto jointly by CBC and Marconi this year. The contract, worth \$200,000, was awarded to the Marconi Broadcasting Division through the agency of the Canadian Marconi Company, against severe American competition.

The 55kW Marconi transmitter will be owned and operated by the Canadian Broadcasting Corporation, and leased to the Ontario Department of Education. The Department will use the transmitter for the country's first full-time educational television channel.

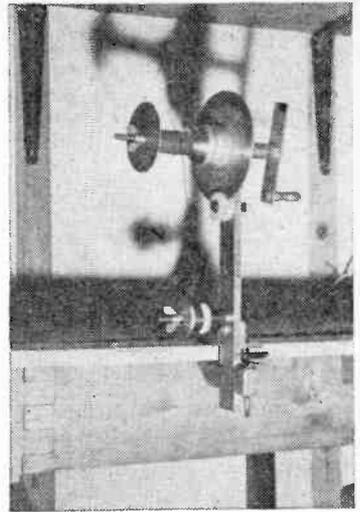
Ontario is the second largest of the Canadian provinces, and has the biggest population. The new educational programme will be aimed at schools, universities and the general public in the area around Toronto, the provincial capital, which houses one-third of Ontario's 7½ million population. Initially the new station, with an effective radiated power of 423kW, will reach about 625,000 viewers who have sets equipped to receive u.h.f. signals, but this new outlet will have a potential audience of more than 2½ million viewers around Toronto, on both sides of Lake Ontario.

The Marconi B7318 55kW transmitter is designed to give the optimum performance in both colour and black and white. It incorporates a Marconi solid state drive together with sound and vision amplifiers which use high-gain 5-cavity klystrons.

COIL WINDER FOR THE HOME CONSTRUCTOR

by
R. P. NEAVE

This simple coil winder may be readily made up by the metal-working enthusiast. The author was able to braze and weld some of the component parts together, but constructors who do not have access to the necessary equipment should still have no difficulty in devising alternative methods of assembly



ANY KEEN HOME CONSTRUCTOR OF radio and electronic apparatus will at some point find that a coil or coils of non-standard variety is required. Since most amateur designed and home constructed projects require a certain amount of cut and try it is usually impossible and almost always disproportionately expensive either to have special coils wound professionally or to buy the 'nearest' standard item available and carry out 'pruning' operations. Since both these methods are long-winded the simple solution is 'to wind your own'.

A large assortment of coil formers is already available in the component catalogues of firms catering for the home constructor, so the remaining items required are, first, suitable wire and, second, some means of winding a coil without permanent deformation of wrists and fingers.

The winder described here was designed and made by the writer, using easily obtainable materials. The dimensions of the various component parts are in no way critical and are open to variation to suit individual preference or the availability of materials. The dimensions given are those of the model constructed by the writer.

COMPLETE ASSEMBLY

The complete winder assembly, with parts named, is shown in Fig. 1.

At the top is the spindle, this being fitted with a winding handle and passing through the spindle bush. Secured to the spindle are a winding head and friction disc, together with a threaded extension rod of $\frac{1}{4}$ in. diameter. The latter is terminated with a washer of $\frac{3}{16}$ in. diameter and a wing nut. The coil

former is secured between the washer and the winding head, the whole extension assembly being capable of accepting formers whose

inside diameter lies in the range of $\frac{1}{4}$ in. to 2in. The winder may, therefore, accommodate all the commoner sizes of coil likely to

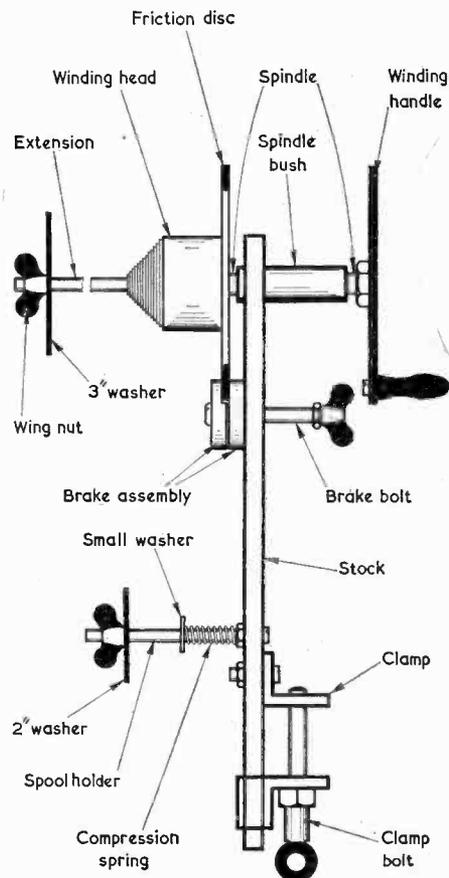


Fig. 1. The complete coil winder, with principal parts named

be required by the average constructor.

The edge of the friction discs runs between two nylon discs, which constitute the brake assembly. These can be tightened up on the friction disc by means of a wing nut. Braking can be adjusted to give any required tension, and the friction disc can be completely locked if it is desired to rest during winding operations.

Below the brake assembly is the spool holder. This takes the spool of winding wire, which appears between a compression spring and a 2in. washer secured by a wing nut.

All these parts are assembled on the vertical stock. At the bottom of this stock is a clamp which is intended for bench mounting. If desired, the bench-mounting clamp can be omitted, the lower end of the stock being held, instead, in a vice. Constructors having a suitable vice available, may prefer to save construction time by using this alternative method holding the stock in position.

In the detailed assembly instructions which are next given, the List of Materials should be consulted, when necessary, in addition to the diagrams.

STOCK AND WINDING HEAD

Fig. 2 illustrates the stock and spindle bush. The stock consists of a length of mild bright steel having the dimensions shown. The three tapped holes below the spindle bush are referred to later. At the top is the spindle bush, this being brazed into a $\frac{1}{4}$ in. hole in the stock. The bush comprises a $2\frac{1}{2}$ in. length of round mild steel with an outside diameter of $\frac{1}{4}$ in.;

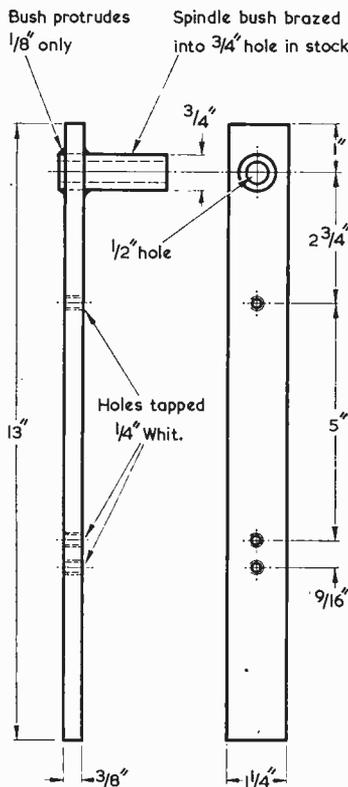


Fig. 2. Side and front views of the stock and spindle bush

of $\frac{1}{4}$ in. round mild steel, being secured by a $\frac{1}{2}$ by $\frac{1}{4}$ in. set screw. At the centre of the 5in. length of flat mild steel is welded a $\frac{1}{4}$ in. Whitworth nut to take the spindle.

The winding head and friction disc assembly is illustrated in Fig. 4. The head was turned from a piece of 2in. round mild steel with a stepped profile to accommodate the inside dimensions of a number of different sized formers. There is no reason, however, why the head should not have a straight taper of 45° or so, should this be preferred. The widest diameter of the head is drilled and tapped $\frac{1}{4}$ in. to take the winding spindle. To this end is also secured the friction disc which consists of a circular disc of 12 s.w.g. mild steel with a $\frac{1}{4}$ in. clearance hole in its centre. The disc is secured to the head by three countersunk machine screws.

The narrower end of the head is drilled and tapped $\frac{1}{4}$ in. Whitworth to take the extension, over which the former of the coil to be wound is fitted. The extension consists of a 4in. length of $\frac{1}{4}$ in. threaded rod. As may be seen from Fig. 1 and the photographs, the coil former is held in place by a wing nut and washer at the end remote from the head. The washer has a diameter of 3in., and a $\frac{1}{4}$ in. hole at its centre.

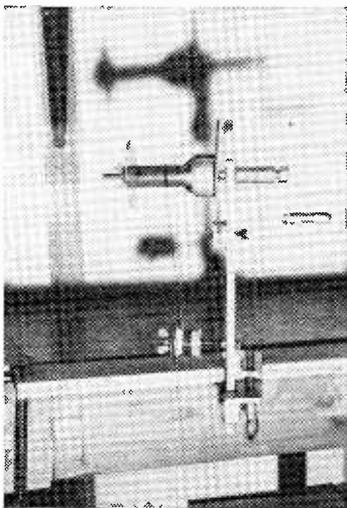
BRAKE ASSEMBLY AND SPOOL HOLDER

The friction brake is made by clamping two discs of nylon of about $1\frac{1}{2}$ in. diameter and $\frac{1}{8}$ in. thickness together, on either side of the friction disc edge, as shown in Fig. 5. They are held together by a $\frac{1}{4}$ in. bolt passing through the uppermost tapped hole in the stock (see Fig. 1). The outer end of the bolt has a wing nut secured to it with the aid of a lock nut. The degree of braking required can then be controlled by adjusting this wing nut.

In the centre tapped hole of the stock is fitted the spool holder. This simply consists of a 4in. length of $\frac{1}{4}$ in. threaded rod, locked against the stock on the inside by a lock nut. As may be seen from Fig. 1 and the photographs, the spool is held at one end by a compression spring bearing on a small washer, and at the other end by a large 2in. washer and a wing nut. The small washer may be $\frac{1}{2}$ or $\frac{7}{8}$ in. I.D. as required. The large washer has a diameter of 2in. and a $\frac{7}{8}$ in. centre hole.

It should be noted that the compression spring is only intended to control winding tension for fine wires. With heavy wires, winding tension is controlled by hand.

THE RADIO CONSTRUCTOR



This view illustrates the winder edge-on, and should be consulted in conjunction with Fig. 1

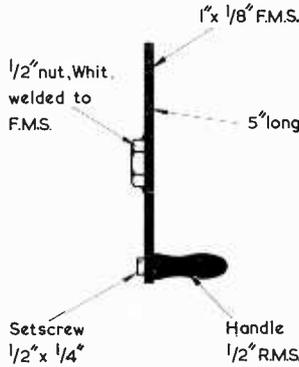


Fig. 3. The winding handle assembly

and it has a $\frac{1}{4}$ in. hole drilled through its centre, as shown.

The spindle passes through the bush and is made of a 4 by $\frac{1}{4}$ in. mild steel bolt with the head removed. Screwed firmly on to it at the outside end is the winding handle assembly, which is illustrated in Fig. 3. This includes a 5in. length of flat mild steel to the dimensions given, the handle proper being turned from a 2in. length

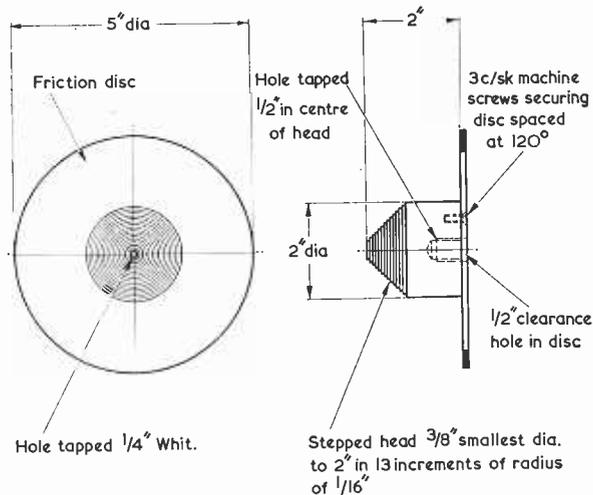


Fig. 4. Front and side views of the head and friction disc assembly

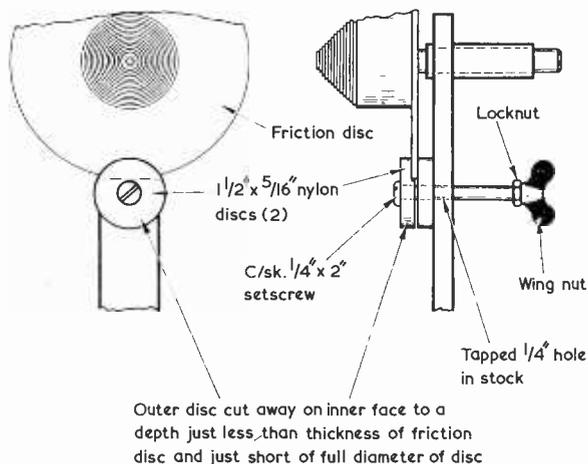
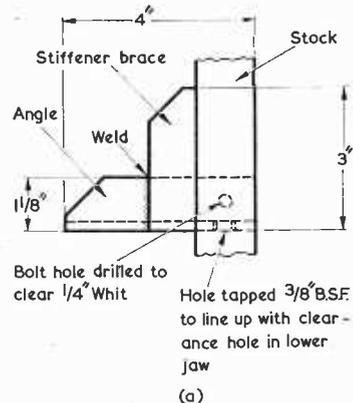
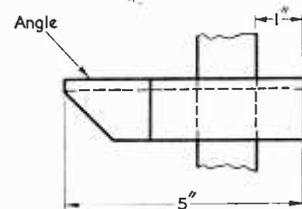


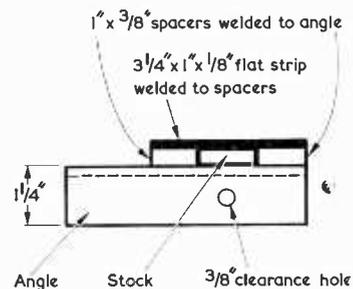
Fig. 5. How the brake discs are assembled in relation to the friction disc



(a)



(b)



(c)

Fig. 6(a). The upper jaw of the clamp
(b). The lower jaw. This is free to slide up and down the stock
(c). The lower jaw, as seen from the bottom end of the stock

CLAMP ASSEMBLY

The clamp assembly appears in Fig. 6 and is made from one 4 in. and one 5 in. length of angle steel having the dimensions indicated.

The upper jaw is shown in Fig. 6(a) and is secured to the stock by a 1/4 in. Whitworth bolt. This passes through the bottom tapped hole in the stock, a nut being added on the inside for additional strength. In Fig. 6(a) the 4 in. length of angle is on the side of the stock away from the reader. Welded to the jaw is a stiffener brace which bears against the edge of the stock. This consists of a 3 in. length of 1 in. by 3/8 in. flat mild steel. Note the 3/8 in. B.S.F. hole for the clamp adjusting screw.

The lower jaw slides up and down the stock and is illustrated in Fig. 6(b) where, once again, the angle is on the side of the stock away from the reader. Welded to the angle are two 1 in. lengths of 1 in. by 3/8 in. flat mild steel; and welded in turn to these is a 3 1/4 in. by 1 in. flat strip. This construction allows the lower jaw to pass up and down the stock, as required. Fig. 6(c) gives a view from the bottom end of the stock.

The clamp bolt is shown in Fig. 7. This consists of a 3/8 in. B.S.F. screw, to the head of which is welded a 1 in. length of 1/2 in. round mild steel to act as an extension piece. The end of this extension is slotted to take a washer, which functions as a 'turn key'.

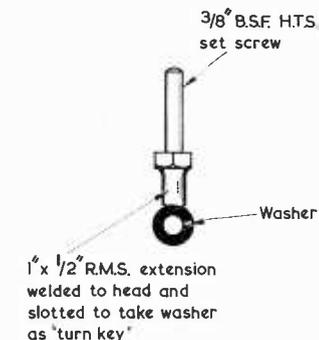


Fig. 7. How the clamp bolt is made up

COMPLETION

When the winder has been completed, it may be given a suitable finish, as required. Suggested finishes are given in the List of Materials.

LIST OF MATERIALS

1. *Stock*
13in. by 1¼ by ½in. mild bright steel.
2. *Spindle*
4in. by ½in. mild steel bolt (head removed).
3. *Spindle Bush*
½in. round mild steel 2½in. long, ½in. hole through centre.
4. *Friction Disc*
12 s.w.g. mild steel, 5in. diameter.
Three ½in. by ¼in. c/s machine screws.
5. *Winding Head*
2in. by 2in. round mild steel.
6. *Extension*
4in. by ¼in. threaded rod.
One washer, 3in. diameter, ½in. hole.
One wing nut, ¼in.
7. *Clamp*
9in. by 1½in. by 1¼ by ¼in. angle steel.
5in. by 1in. by ¼in. flat mild steel.
3¼in. by 1in. by ¼in. flat mild steel.
One mild steel hex. bolt ½in. by ¼in.
One hex. nut ¼in.
8. *Clamp Bolt*
2in. by ½in. H.T.S. set screw.
1in. by ¼in. round mild steel.
Washer ½in. or ¾in. hole by 3/32in. thick.
9. *Spool Holder*
4in. by ¼in. threaded rod.
One ¼in. wing nut.
One ¼in. hex. nut.
1½in. by ⅝in. compression spring (18 s.w.g.)
One washer, 2in. diameter by ⅝in. hole.
One washer, ¼in. or ⅝in. hole.
10. *Brake Assembly*
Two nylon discs, 1½in. diameter by ⅝in. thick.
11. *Brake Bolt*
One 2in. by ¼in. c/s machine screw.
One wing nut, ¼in.
One hex. nut, ¼in.
12. *Winding Handle*
One ¼in. Whit. hex. nut.
5in. by 1in. by ¼in. flat mild steel.
2in. by ¼in. round mild steel.
One ¼in. by ¼in. set screw.
13. *Miscellaneous*
Aluminium primer paint.
Aerosol or crackle type paint for finishing.

CURRENT TRENDS

● D.C. MOTOR SPEED CONTROLLERS

Sapphire Research and Electronics Limited have introduced a range of low cost thyristor speed controllers. Available for d.c. shunt or compound motors up to 3 h.p. the motor speed control is achieved



by armature voltage regulation using a full wave thyristor bridge rectifier. In the 'standard' and 'accurate' units, control is obtained by armature voltage feedback, comparing the voltage across the motor with a speed reference signal obtained from a potentiometer. In the 'accurate' controller a high degree of stability is achieved at low cost by stabilising the field current. Where a very high order of accuracy is required, the feedback signal is obtained from a Sapphire tachometer incorporated in the unit.

All the controllers have a 'soft start' and armature current limit protection. This gives slow acceleration from standstill to the set running speed, and also protects the motor against overload. The motor may be switched by switching the mains supply. The controllers are also protected against a failure in the field circuit.

Sapphire Research and Electronics Ltd., Sapphire Works, Ferndale, Glam., are also prepared to consider special requirements.

● NEW BIB TAPE BOX LABELS

The Bib Division of Multicore Solders Ltd. (winners of the Queen's Award to Industry), of Hemel Hempstead, Herts, announce the introduction of a new line Bib Tape Box Labels, to their range of audio aids and accessories.

At the end of last year Tape Reel Labels, reference Size T/1 and Tape Cassette and Container Labels, reference Size T/3 were introduced into the range, which proved very popular with tape recorder enthusiasts. Now this new pack of Tape Box Labels, reference Size T/2



will act as a further aid to identify recordings within the tape box or container. These labels are supplied in packs of 20, and presented printed in a form which makes them easy to complete, to identify titles, composers, artists, reel number, date and type of tape. Supplied on backing paper in sheet form, so that details may be written or typed before the label is removed from the sheet. These title labels are suitable for 5" or 7" tape containers, and are applied along the edge.

Packed in a plastic bag with attractive header card each pack of 20 has a recommended retail price of 2s. 0d. Available from leading audio dealers.

● METRIX INSTRUMENTS

ITT Components Group Europe has been appointed sole agent in the British Isles for the range of instruments manufactured by IIT Metrix of France.

The range of instruments marketed by IIT Metrix embraces multi-meters (including a new digital model about which further details will be available shortly), electronic voltmeters, oscilloscopes, panel meters and generators (including test pattern generators and a PAL colour bar generator). Instruments for testing electronic components are also available, including an integrated circuit tester.

Further details of the IIT Metrix range of instruments can be obtained from: IIT Components Group Europe, Trading Services, Edinburgh Way, Harlow, Essex. Telephone: 02796 26811, extn. 738; telex: 81146.

THE RADIO CONSTRUCTOR

UNDERSTANDING TAPE RECORDING

IN LAST MONTH'S ISSUE WE discussed the process of recording a signal on to the magnetic tape of a tape recorder. We saw that, assuming there are no losses in the recording system at the higher frequencies, the primary requirement of the recording amplifier is that it should offer a 'flat' frequency response at all frequencies to be recorded, the output of the amplifier being expressed in terms of the signal *current* it causes to flow in the record head. When high frequency losses are taken into account, however, this flat response has to be modified by applying a treble boost at the higher frequencies in the range of frequencies to be recorded, the boost being added mainly to compensate for self-demagnetisation in the tape and, to a lesser extent, to overcome high frequency losses in the record head. We saw also that, as recording frequency increases, the lengths of the 'magnets' created in the tape reduce until they approach the width of the record head gap itself, whereupon there is a limit to the highest frequency that can usefully be recorded. Finally it was noted that, with normal record heads, this frequency is considerably higher than that at which tape self-demagnetisation starts to become significant, and that it is the latter which is mainly catered for by the treble boost.

PLAYBACK

To reproduce the previously recorded signal, the tape is drawn past a playback head at the same speed as was employed during recording. The playback head has the same basic construction as the record head, having a rear gap and a very narrow front gap together with a coil made up of windings on the two halves of its core. In low cost domestic recorders a single head is, in fact, used for both the record and playback functions.

If the signal recorded on the tape is a simple sine wave (as was the

by W. G. Morley

This second article in our series on tape recording examines the process of playback and discusses the amplifier response curves that are required if the overall frequency response from recording through to playback is to be maintained 'flat'

one we applied to the tape in last month's article) we can assume that we have created in the tape a series of imaginary bar 'magnets', as shown in the upper section of Fig. 1(a). The arrow inside each magnet in this diagram indicates the direction of magnetic field (assumed by convention to flow from South to North inside a magnet) and the length of each magnet corresponds to a half-cycle of the sine wave signal. Unlike conventional bar magnets, the

magnets in the tape have maximum field strength at their centres, with zero field strength at their extremities.

We can reproduce the magnetic field strength along the tape in the form of a graph, as in the lower section of Fig. 1(a). This graph has the same appearance as an electrical sine wave. Zero magnetic force corresponds to the points where one magnet changes over to the next and, also, to the points



A typical example of a modern high performance tape recorder. The model illustrated here is the Grundig TK144 complete with microphone

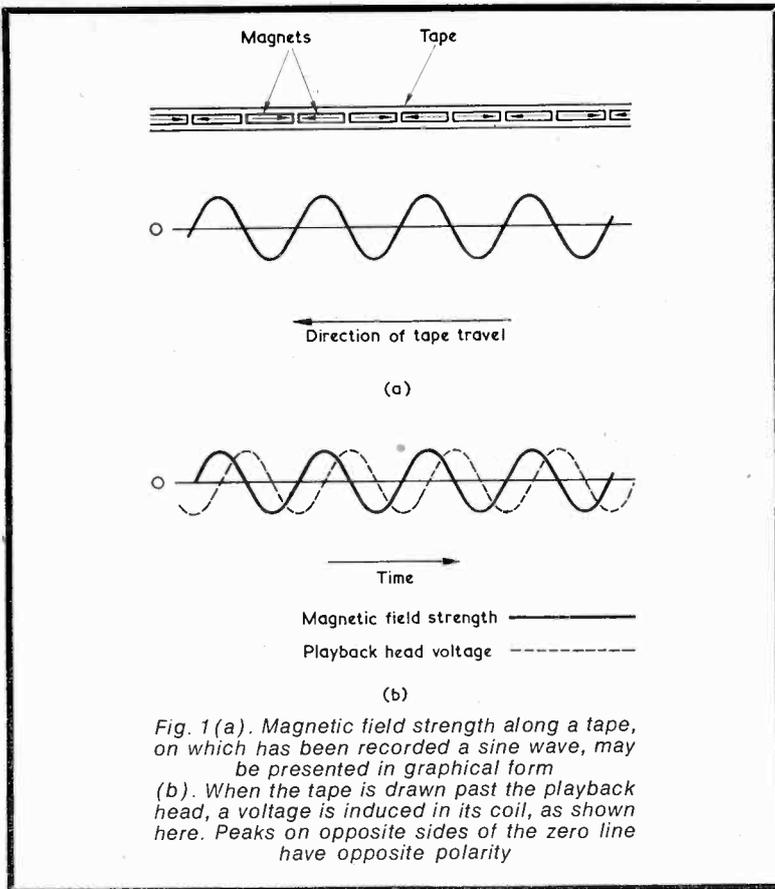


Fig. 1 (a). Magnetic field strength along a tape, on which has been recorded a sine wave, may be presented in graphical form
 (b). When the tape is drawn past the playback head, a voltage is induced in its coil, as shown here. Peaks on opposite sides of the zero line have opposite polarity

where the direction of field changes over. The peaks in the graph indicate maximum magnetic force, and the points in between trace out the change in magnetic field strength between a peak of one polarity and the succeeding peak of opposite polarity.

As the tape is drawn past the gap of the playback head, the magnets in the tape cause lines of magnetic force to appear in its core, these corresponding in amplitude and direction to the changing field strength in the tape and, in consequence, to the situation depicted by the graph in the lower section of Fig. 1(a). As a result, a voltage is induced in the playback head coil. Now, in accordance with simple generator theory, the amplitude of the induced voltage varies according to the rate of change of magnetic field strength and its polarity corresponds to the direction in which the magnetic field is changing.

Fig. 1(b) illustrates the voltage induced in the coil of the playback head. At the peaks in the curve which depicts magnetic field strength there is, for an instant, no change in strength, whereupon no voltage is induced in the coil. Immediately

after each peak there commences a change of magnetic strength, the rate of change increasing to a maximum as the curve passes through the zero line. The consequence is that the voltage induced in the coil is at maximum when the curve representing mag-

netic field strength is at zero and is itself at zero when the curve representing magnetic field strength is at maximum. Thus, we have induced in the coil an alternating voltage which, by inspection, has the same frequency as the sine wave current which originally created the magnets in the tape. As may be seen, the voltage is effectively shifted in phase by 90° from the magnetisation due to the original recording signal current.

If the original sine wave current applied to the record head had (whilst maintaining the same frequency) varied in amplitude, the strength of the magnetic fields in the magnets created in the tape would have likewise varied, and there would then be a corresponding variation in the rate of change of magnetic field strength from one magnet to the next as the tape is drawn past the playback head. This would cause a similar variation in the amplitude of the voltage induced in the playback head coil. In consequence, the voltage at the playback head not only has the same frequency as the original sine wave current but also exhibits corresponding variations in amplitude. It may be shown further that, assuming no distortion is introduced in the recording and playback processes, the voltage induced in the playback head coil is, like the original recording current, a sine wave.

PLAYBACK RESPONSE

When discussing, just now, the fact that the amplitude of the playback head voltage corresponds to the amplitude of the recording head current, the proviso was made that the recording signal is maintained at the same frequency when its amplitude changes. The reason for

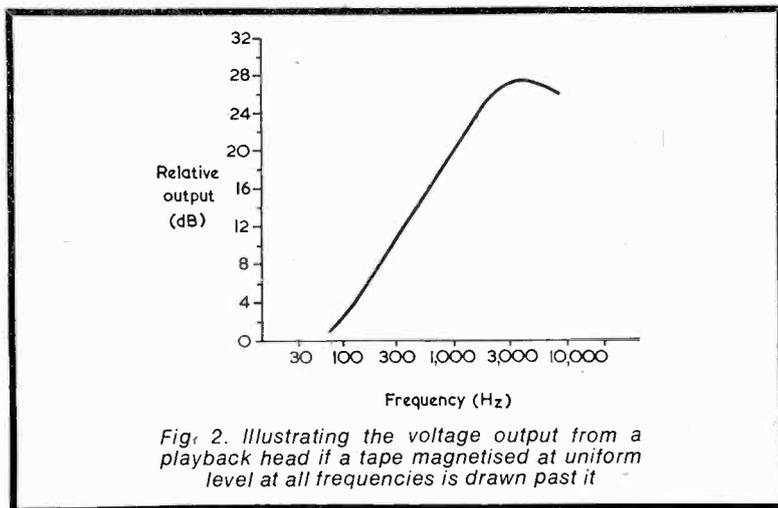
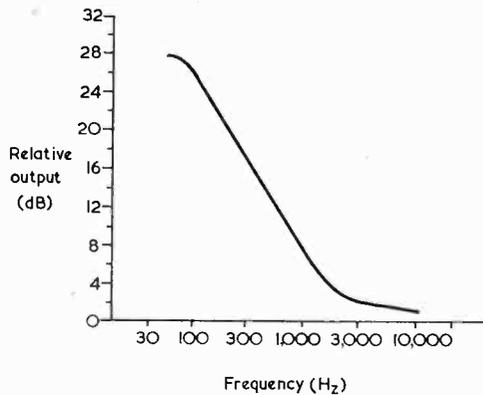
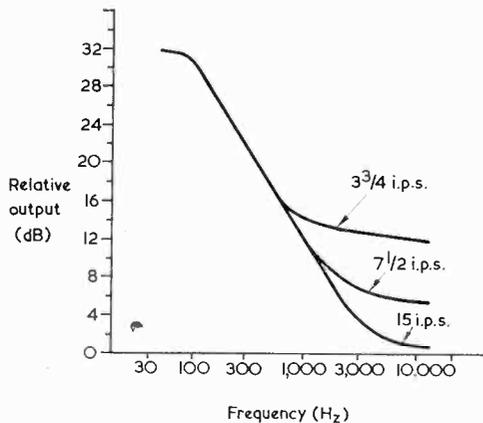


Fig. 2. Illustrating the voltage output from a playback head if a tape magnetised at uniform level at all frequencies is drawn past it

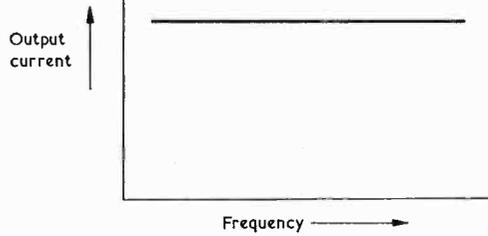


(a)

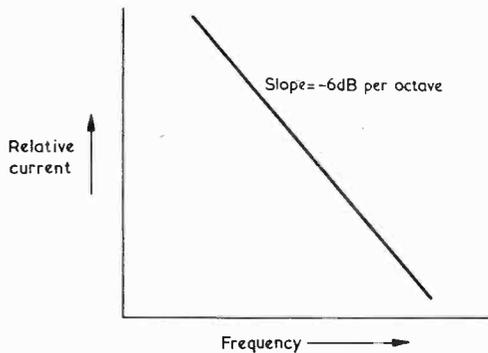


(b)

Fig. 3 (a). Bass boost in the playback amplifier, as illustrated here, compensates for the playback head response shown in Fig. 2 (b). Recorders having more than one tape speed normally offer a different playback amplifier response for each speed



(a)



(b)

Fig. 4. In an 'ideal' tape recorder system the record amplifier would have the straight line response curve shown in (a) and the playback amplifier the linear falling response shown in (b) over all the frequencies to be handled. It is the falling-off in efficiency at the higher frequencies which, in practice, necessitate that these response curves be modified to those illustrated earlier

introducing this condition is that the playback head offers a response which varies considerably with frequency.

Let us assume that the tape drawn past the playback head has had recorded on it, over one section, a sine wave having a frequency of say 100Hz, this being followed by a second section on which has been recorded a sine wave of 200Hz at the same amplitude. It is obvious that the 200Hz section of tape will cause the rate of change of magnetic field strength in the core of the playback head to be twice that given by the 100Hz section of tape. Since the voltage induced in the coil of the playback head varies according to the rate of change of magnetic field strength, the voltage amplitude at the playback signal will be twice that resulting from the 100Hz signal.

This is an inherent and unavoidable feature of playback head functioning and may be summed up by stating that when (assuming no losses) a tape magnetised at uniform level at all frequencies is drawn past it, the voltage output offered by the playback head doubles when frequency doubles. A typical playback head response is illustrated in the curve shown in Fig. 2 where, over the range of 75 to 2,000Hz, playback voltage output increases by 6dB per octave. This last statement should not confuse the beginner: '6dB' corresponds to a voltage ratio of 2 to 1 (actually, 1.995 to 1) and an 'octave' is the interval between two frequencies having the ratio of 2 to 1. Above 2,000Hz the increase in output amplitude with increase in frequency tends to reduce, this being the result of losses due to gap width, losses in the head, and

similar factors. At around 4,000Hz the losses become greater than the inherent 6dB per octave rise, and the response commences to fall.

The response curve of Fig. 2 is representative of what may be expected at a tape speed of 7½ in. per second. If the tape is run at a lower speed, say 3½ in. per second, losses due to playback head gap width become evident earlier, and the 6dB rise per octave commences to reduce at a lower recorded frequency. Conversely, for a tape speed of 15 in. per second the increase of 6dB per octave continues up to a higher frequency than occurs at 7½ in. per second.

It is necessary to correct the frequency response offered by the playback head and this is achieved by a filter circuit or circuits in the playback amplifier which apply a bass boost, as illustrated in Fig. 3(a). The curve in Fig. 3(a) com-

EQUALISATION

It will be helpful next to briefly consider the recording and playback amplifier response curves for an ideal tape recording system in which there are no high frequency losses due to tape demagnetisation or to shortcomings in record or playback head performance.

In this ideal system, all signal frequencies in the range to be recorded would be amplified by a record amplifier having a 'flat' response, as evaluated in terms of current output flowing in the coil of the record playback head. The appropriate record amplifier response curve appears in Fig. 4(a), and consists of a straight horizontal line.

The response of Fig. 4(a) would, in our ideal system, result in uniform magnetisation of the recording tape at all frequencies in the range being handled. The ideal playback amplifier will then require the response curve illustrated in Fig. 4(b). This is, once more, a straight line, and it shows that maximum gain is provided at the lowest frequency to be handled, this gain falling, at the rate of 6dB per octave, to the highest frequency in the range being reproduced. This curve exactly counterbalances the unavoidable 6dB rise per octave in output voltage amplitude from the playback head.

In this ideal system an overall 'flat' response is obtained over the entire chain from signal input to record amplifier, through record and playback, to the signal output from the playback amplifier.

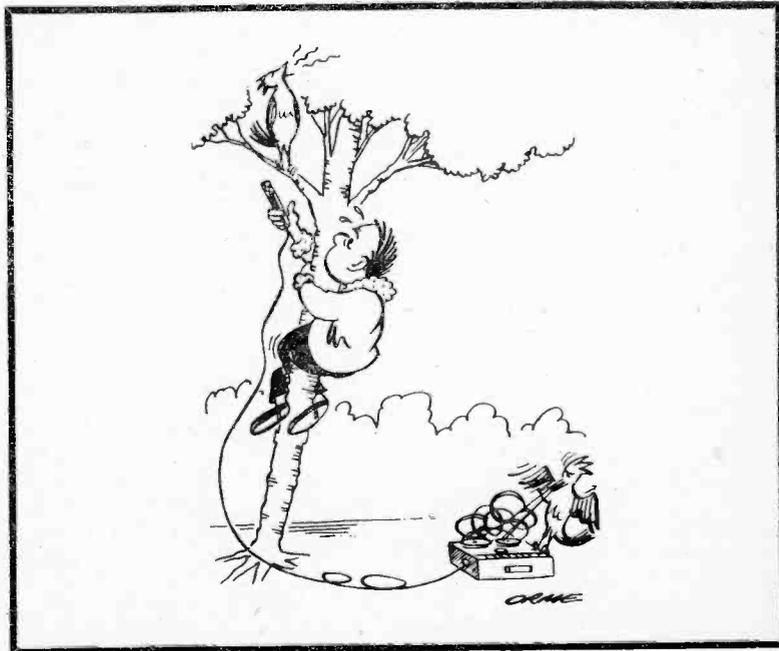
(Continued on page 703)



Some of the Scotch magnetic tape products manufactured by the 3M Company. These include No. 41 splicing tape, One-Five Special letter tape, No. 51 sensing tape, tape clips, No. 24 leader tape, self-threading reels, spare spools and a Scotch accessory kit (comprising splicer, splicing tape in dispenser, white leader tape with cutter and 10 tape clips)

plements the curve of Fig. 2 by indicating maximum gain at 75Hz, the gain decreasing at 6dB per octave to around 2,000Hz, after which the curve flattens off. Thus, the reduced low frequency response given by the playback head is compensated for by the amplifier response and the overall response of the combination of playback head and amplifier should be 'flat' from 75 up to some 3,500Hz or so.

Playback amplifiers in recorders having more than one tape speed may offer different response curves for the different speeds. A representative example is illustrated in Fig. 3(b). The curves shown here readily demonstrate the fact that the highest frequency which may be usefully recorded rises considerably as tape speed increases. At 3½ in. per second the bass boost section of the curve is abandoned after only 800Hz whereas, at 15 in. per second, the bass boost section carries on up to 4,000Hz, thereby indicating that the 6dB rise per octave from the playback head is still in evidence up to this frequency.



THE RADIO CONSTRUCTOR

RECENT PUBLICATIONS



QUESTIONS AND ANSWERS ON TRANSISTORS, Third Edition. By Clement Brown. 96 pages, $4\frac{1}{2}$ x $6\frac{1}{2}$ in. Published by Butterworth & Co. (Publishers) Ltd. Price 10s.

This pocket hard-cover book appears in the Newnes-Butterworth 'Questions and Answers' series, and it is interesting to note that the author has also written several of the other titles, these being 'Questions and Answers on Electronics', 'Questions and Answers on Computers' and 'Questions and Answers on Audio'.

The 'question and answer' approach is generally acknowledged as representing an efficient and attractive method of presenting technical information, since it enables the text to be broken up into small individual sections, each devoted to a particular aspect of the overall subject. The technique is very successfully exploited in the book under review, in which descriptions of quite complex functions are presented with economy and clarity. The subject matter covers a wide spectrum in the field of semiconductors, ranging from diodes to integrated circuits, and there are a large number of clear diagrams. Obviously, each item dealt with cannot be discussed in depth, but then that is not the purpose of the present book.

'Questions and Answers on Transistors' will be particularly useful as an introductory reference book for the beginner who is just starting to interest himself in transistors and allied semiconductor devices.

TELEVISION ENGINEERING, PRINCIPLES AND PRACTICE, VOLUME THREE, Second Edition. By S. W. Amos, B.Sc., C. Eng., M.I.E.E., D. C. Birkinshaw, M.B.E., M.A., C.Eng., F.I.E.E. and K. H. Green, C.Eng., M.I.E.R.E. 268 pages, $5\frac{1}{2}$ x $8\frac{1}{2}$ in. Published by Iliffe Books Ltd. Price 70s.

There are four volumes in the textbook 'Television Engineering'. Volume One deals with television fundamentals, camera tubes, television optics and electron optics; Volume Two deals with video frequency amplification; and Volume Four deals with general circuit techniques. Volume Three, under review, deals with waveform generation and is now in its second edition, having been extensively revised to include information on circuits based on transistors and to bring the subject matter otherwise up to date. All four volumes of 'Television Engineering' are written by senior members of the B.B.C. Engineering Division.

Volume Three describes the generation and application of the different waveforms encountered in television work. The treatment is largely descriptive in nature and employs a minimum of mathematics. The first part of the volume examines the waveforms used in television equipment and their application in a camera channel, after which Parts 2 to 5 inclusive deal respectively with sine waves, rectangular waves, sawtooth waves and parabolic waves. Part 6 provides three short appendices which cover aspects of valve input impedance and exponential curves, and the book ends with a good cross-referenced index.

A work with an authorship such as the present volume has can be expected to be authoritative and this is, indeed, the case. A particularly valuable feature is that circuits and functions are described at a level which can be appreciated and understood by anyone having an interest in television engineering, whether this be from the design, maintenance or, even, hobbyist viewpoint. The text is backed by more than 150 diagrams, these depicting circuits or waveforms as applicable.

LUMINESCENT SCREENS, PHOTOMETRY AND COLORIMETRY. By J. Kamler, M.Sc. 204 pages, $6\frac{1}{2}$ x 8 in. Published by Iliffe Books, Ltd. Price 60s.

This book was first published in Poland, and the present revised edition is an English translation edited by D. G. C. Jones, B.Sc., Ph.d. The purpose of the author is to bring together in a unified way the different experimental concepts which have evolved for evaluating the performance of luminescent screens and, as such, is of particular interest in the sphere of colour television. The book commences with a description of the luminous properties of phosphors and luminescent screens, together with testing methods, then continues to radiation measurement, the spectrophotometry of phosphors, colour measurements, phosphor afterglow measurements and measurements of the electro-optical parameters of luminescent screens.

Under these general headings there is a very considerable wealth of information and the text is full of practical facts discussed with an admirable conciseness. Mathematics are used, wherever necessary, to elucidate processes and properties.

The field covered is of a specialised nature and the book will be of greatest worth to the professional engineer or to the student whose work is concerned, in general, with luminescence and phosphorescence and, in particular, with the measurement of the properties of phosphors employed in colour television cathode ray tubes. ■

In your workshop



This month Smithy the Serviceman returns to the subject of constant current devices, paying particular attention to their applications in conjunction with capacitance. After a theoretical discussion on a sawtooth generator having an exceptionally linear waveform, he turns to a practical project, and he and Dick construct and set up a simple but highly effective reaction timer

“DO YOU,” ASKED SMITHY suddenly, “feel like knocking up a little experimental circuit for me?”

The Serviceman drained his disgraceful tin mug of tea then placed it on his bench with a gesture of finality. There was at least half-an-hour of lunch break outstanding, and both he and Dick had finished their mid-day meals.

“If you like,” said Dick obligingly. “What’s the circuit for?”

“It’s for a reaction timer,” replied Smithy. “It can be used for measuring the reaction time of people to different stimuli.”

“That sounds interesting,” commented Dick. “Is there any special reason for making up the circuit?”

“I want to use it to check out, in practice, some fresh ideas I’ve been having recently concerning constant current devices,” explained Smithy. “You remember that we played around with devices of this nature a few months ago.”*

CONSTANT CURRENT DEVICE

“I do, indeed,” said Dick promptly. “We had a transistor operating as a constant current device, and we put it in the common cathode circuit of two a.f. valves. Amongst other things, it enabled us to build a push-pull output stage where the output valves did their own phase-splitting.”

“That’s right,” agreed Smithy, pulling his note-pad towards him and beckoning his assistant over. “Before telling you about my present ideas, which are for a completely different application, I think

it would be helpful for both of us if I were to just briefly recap on the basic manner in which a transistor functions as a constant current device. This might help us to get our thoughts orientated in the right direction. To get a constant current from a transistor, you operate it in grounded base. The collector current resulting from any given emitter current is then virtually constant over all the collector voltages within the ratings of the transistor.”

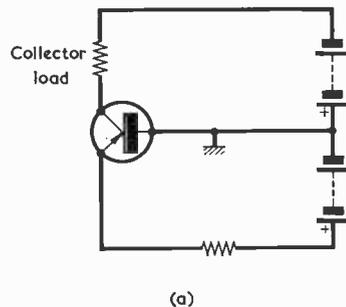
Smithy scribbled out a sketch of a grounded base transistor and its collector voltage-collector current characteristics. (Figs. 1a and (b)).

“In the set-up we used last time,” Dick reminded him, “we didn’t incorporate a separate supply for the emitter current.”

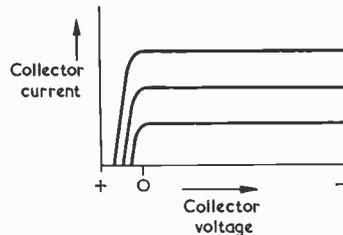
“True enough,” agreed Smithy. “What we did was to tie the base to a fixed potential by connecting it to a zener diode or to a forward-biased silicon diode. (Figs. 2(a) and (b)). With the zener diode the constant current transistor can be either a germanium or silicon type, but with the forward-biased silicon diode the transistor must be germanium because the stabilised voltage across the diode has to be greater than the base-emitter voltage drop in the transistor. With these arrangements, we altered emitter current by varying the resistance in the emitter circuit. This set-up is very useful because it makes the constant current device capable of operating from a single positive and a single negative supply rail. An important requirement of the current in the zener diode, or in the forward-biased silicon diode, and its series supply resistor, is that it should be comfortably in excess of the base current required by the transistor, this base current being equal to the desired collector current divided by the current gain of the transistor. And, to finalise on what we discussed previously, the current flowing in the emitter circuit is equal to the desired collector current plus the base current.”

“I remember all that,” replied Dick a little impatiently. “I’m a little puzzled, though, as to where a constant current generator comes in so far as a reaction timer is concerned.”

“It comes in,” said Smithy, “because what I’m interested in at the moment is the behaviour of a constant current device when it’s used in conjunction with capacitance. I’m shortly going to show you that a circuit including a constant current device and a capacitor offers one of the simplest and most linear rising or falling voltage waveform generators that you can possibly get. Before I do that, though, just take a quick look at this sketch of a simple RC circuit coupled to a battery and switch. (Fig. 3(a)). If the capacitor in this circuit is initially discharged when the switch is closed, what sort of rising voltage characteristic do you get across the capacitor?”



(a)



(b)

Fig. 1 (a). Collector supply and emitter bias polarities for a p.n.p. transistor in the grounded base mode. These are reversed for an n.p.n. transistor (b). A typical family of collector voltage-collector current characteristic curves for grounded base operation, these being applicable to three different emitter currents

THE RADIO CONSTRUCTOR

* See “In Your Workshop” in October and November 1969 issues.

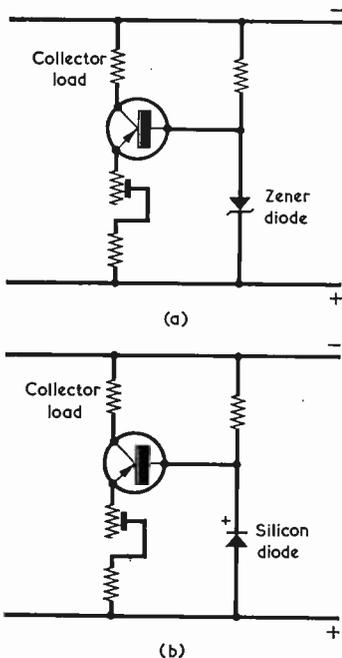


Fig. 2(a). The grounded base transistor may be employed as a constant current device operating from standard supply rails by holding the base voltage stable with the aid of a zener diode

(b). With germanium transistors, the base voltage may alternatively be held stable by a forward biased silicon diode

"You get a rising voltage," replied Dick, picking up Smithy's pen and adding a further sketch to the top sheet of the note-pad, "which follows an exponential curve with time." (Fig. 3(b)).

"Right," said Smithy briskly, as he retrieved his pen. "Now, let's replace that resistor with a constant current device. (Fig. 4(a)). With a resistor, the charging current flowing into the capacitor reduces all the time because the voltage across the resistor, and hence the current which flows through it, becomes smaller as the capacitor charges up. This effect is what produces the exponential charging curve. With a constant current device, though, there is a completely different state of affairs. The device allows only the constant current to flow into the capacitor, this being maintained regardless of the voltage across the capacitor. In consequence, the rate of change of voltage across the capacitor remains unaltered all the time it is charging up and the final outcome is that the voltage across the capacitor increases in completely linear fashion. Instead of the exponential curve

given with the series resistor, you get a perfectly straight line!" (Fig. 4(b)).

"Gosh," said Dick, gazing at Smithy's diagram. "That's something I hadn't thought of before."

"It is rather impressive, isn't it?" said Smithy. "One possible application which immediately suggests itself after seeing that characteristic is the use of a constant current device in a sawtooth generator."

Smithy tore the top sheet off his note-pad and scribbled out a circuit on the sheet underneath. (Fig. 5).

"This is an example of what I mean," he went on. "What I've shown here is a multivibrator which couples to an output transistor, TR3. The mark and space ratio of the multivibrator is such that TR3 is cut off during most of the cycle, and is hard on for the remainder. The sawtooth appears across capacitor C3. When TR3 is hard on this capacitor is short-circuited and discharges to nearly zero voltage. When TR3 is cut off, however, the capacitor is allowed to charge via the constant current transistor, TR4, whereupon the circuit produces a completely linear rising voltage. Output amplitude is controlled by a variable resistor in the emitter circuit of the constant current transistor. If the constant current is varied by altering the value of the emitter resistance, the amplitude of the output voltage waveform will similarly vary."

"That," pronounced Dick, "is rather a neat circuit."

"It could certainly form a useful circuit for experimenters," responded Smithy. "However, I don't want to spend any more time on it for the present, and I'd prefer to get back to constant current devices and capacitors in general. By the way, I said just now that the constant current device can provide a linear falling voltage waveform as well as a linear rising voltage waveform. The falling voltage is given if the constant current device is connected across a charged capacitor such that it allows a constant discharge current to flow."

"Fair enough," remarked Dick. "Incidentally, how do you work out the time constant given by the combination of capacitor and constant current device?"

"There isn't one!" chuckled Smithy. "With a constant current device and a capacitor you simply have a straightforward and constant change in voltage. If the change is an increase, this carries on until the voltage across the capacitor is very close to the applied supply voltage. After that it stops, of course, because the constant current device doesn't have enough voltage across it to allow the constant current to flow."

"Well," persisted Dick, "if you don't have a time constant, how

do you work out the change in voltage with respect to time?"

"You refer to it in terms of volts change per second," explained Smithy. "The rate of change of

$$\text{volts per second is equal to } \frac{I}{C},$$

where I is the current in amps and C is capacitance in farads. Or you can have current in microamps and capacitance in microfarads if you find this easier for calculations."

"Blimey," said Dick. "That's a dead simple formula, isn't it?"

"It is," agreed Smithy. "To take an example of its use, let's say that we have a constant current of 5mA charging a capacitor of 100μF. 5mA is equal to 5,000μA, so the expression, using microamps and

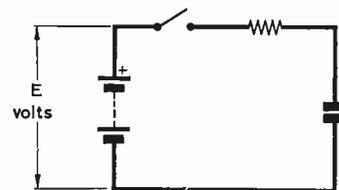
$$\text{microfarads, gives us } \frac{5,000}{100}.$$

The voltage across the capacitor rises, therefore, at 50 volts per second."

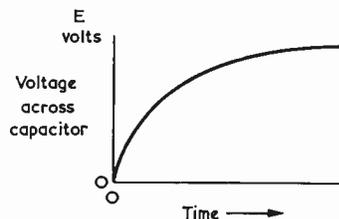
"I see," said Dick musingly. "Is there anything else in the general line I should know concerning constant current devices in conjunction with capacitance before we get started on this reaction timer of yours?"

REACTION TIMER

"I don't think so," said Smithy, reaching for his note-pad once more. "So we can now get weaving on the timer without further delay."



(a)



(b)

Fig. 3(a). An RC circuit in which the capacitor charges to battery voltage via a resistor

(b). The voltage across the capacitor follows the familiar exponential charging curve after the switch is closed

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I'll start off by sketching out a simplified circuit, because this will make it easier to explain some of the points of operation."

The Serviceman quickly sketched out the diagram. (Fig. 6).

"Here we are," he remarked. "Basically, the whole timer project is extremely simple. The supply is provided by a 12 volt battery and this couples, via a constant current device and a push-button whose contacts open when it is pressed, to a 1,000 μ F capacitor. For the sake of illustration we will say, for the time being, that the constant current device passes 10mA. One section of a double-pole switch connects across the capacitor, whilst the other section couples to a stimulus circuit."

"Stimulus circuit?"

"A circuit which gives visual or aural warning of the start of a timing period," explained Smyth. "It could consist of a bulb and battery in series or an a.f. oscillator feeding a loudspeaker, or any similar sort of thing. Connected across the capacitor is a very high impedance voltmeter having an f.s.d. of 10 volts. And that, so far as this simplified diagram is concerned, is the lot!"

"Just that?"

"Just that," repeated Smyth.

"I'll next ask you to tell me the rate of change of voltage across the capacitor, bearing in mind that the constant current is 10mA and that the value of the capacitor is 1,000 μ F."

"Let's see now," said Dick musingly. "I'll put the 10mA into microamps first, which gives me a current of 10,000 μ A. So the formula becomes

$$\frac{10,000}{1,000}$$

The rate of

change of voltage is 10 volts per second, then."

"An excellent bit of calculation," approved Smyth, "and perfectly correct, too. Let's next assume that I'm going to check your reaction time to a visual stimulus. I'll connect a battery and bulb to the stimulus arm of the double-pole switch, and set this switch to the position where the bulb is not lit and the 1,000 μ F capacitor is short-circuited. I'll then ask you to push the press-button as soon as you observe the bulb lighting up."

"This is getting really intriguing," remarked Dick. "Go on, Smyth!"

"At some unexpected moment," continued Smyth, "I am, unseen by you, going to throw that double-pole switch. This will immediately light up the bulb and take the short-circuit off the 1,000 μ F capacitor, whereupon the voltage across the capacitor will start rising at the rate of 10 volts per second. As soon as you observe the bulb light up you push the

press-button. This will stop the capacitor charging and the voltage across it at that instant will then be indicated by the voltmeter. Since the voltage rise is a linear 10 volts per second, the voltmeter will indicate the fraction of a second which has elapsed between my throwing the switch and you pressing the button. If it reads 4 volts, then the time that has elapsed will be 0.4 seconds. Got it?"

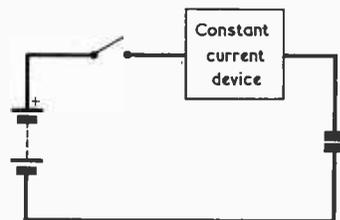
PRACTICAL CIRCUIT

"I'll say I have," responded Dick eagerly. "I can see that we could have quite a bit of fun with this gadget. How about the practical circuit?"

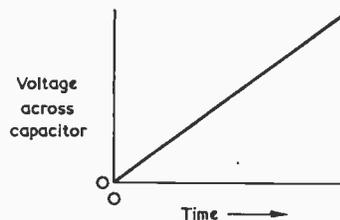
"Give me a couple of minutes," replied Smyth, "and I'll get that sorted out for you as well."

Smyth concentrated, then proceeded to draw out the full circuit diagram of the reaction timer. After some minutes had elapsed, he leaned back and, with a proud gesture, indicated the fruits of his labours. (Fig. 7).

"Here it is," he pronounced, "the practical circuit of my reaction timer. The constant current device is the germanium transistor, TR2, and the base of this transistor is held at a fixed potential by means of the forward biased silicon diode, D2. There'll be a steady voltage of about 0.6 across this diode, which is well in excess of the 0.2 volt that appears across the base-emitter junction of TR2."



(a)



(b)

Fig. 4(a). A circuit in which the capacitor charges via a constant current device

(b). The voltage across the capacitor rises in linear manner

THE RADIO CONSTRUCTOR

"Fair enough," commented Dick, gazing searchingly at the circuit. "Incidentally, what's the 22Ω resistor for?"

"Do you mean R2?"

"I do."

"It's function," replied Smithy, "is to ensure that you don't put a dead short-circuit across the capacitor when switch S1 is set to Position 1. The 22Ω resistor limits the discharge current to a value which won't harm the electrolytic."

"Hang on a minute," said Dick suspiciously. "The switching is different from what you put in your simplified circuit. In the simplified diagram the switch shorting out the electrolytic was part of a double-pole component. In the present circuit you've combined the two switches in the single-pole component you've marked as S1."

"The reason for doing that," said Smithy, "is that, in the practical

emitter follower, which means that the voltage on its emitter is equal to the voltage on its base minus the base-emitter voltage drop. Since R1 has a value of 10kΩ, the meter will give an f.s.d. reading when there's 10 volts on TR2 emitter. The fact that M1 is calibrated from zero to 1 provides an incidental advantage here, since the calibration then corresponds directly to time in seconds."

"There seems to be a snag here," said Dick suddenly. "Now, let's make quite certain I've got my facts right. The general idea is that, after putting S1 to Position 2, you stop the capacitor charging by pushing press-button S2, isn't it?"

"That's correct."

"Whereupon the milliammeter will indicate the voltage that was acquired by the capacitor as you press the button?"

"True," agreed Smithy. "The

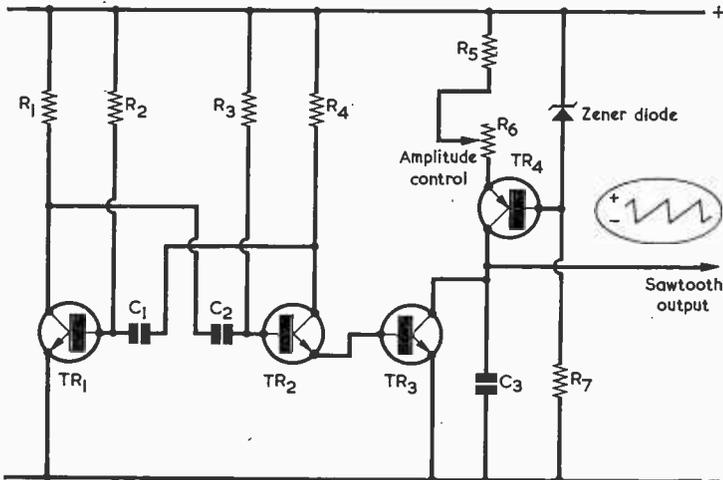


Fig. 5. Smithy's suggestion for a sawtooth generator offering a very linear waveform. (This circuit, which has not been checked in practice, provides an interesting experimental project)

version of the circuit, it's necessary to use a switch which is very quiet and quick in operation. It's got to be quiet, of course, because the chap who's having his reaction time checked will otherwise respond to the aural stimulus given by the click as it changes over. An ideal component for S1 is a changeover microswitch, which is both quick and quiet in operation. However, changeover microswitches are usually available in single-pole only, which explains why I've combined the capacitor and stimulus circuits in the manner I've shown in the circuit."

"I see," commented Dick thoughtfully. "Now, where's the 0-10 volt voltmeter?"

"That's provided by TR1, R1 and the 0-1mA meter, M1," replied Smithy. "TR1 functions as an

needle of the milliammeter swings over from zero to f.s.d. in 1 second, which is far too quick to allow readings to be evaluated directly. When you press the button you 'freeze' the meter needle at the reading it held at the instant of pressing the button."

"But," protested Dick, "that's where the snag comes in. So far as I can see, the meter needle won't 'freeze'. All that will happen is that the 1,000μF capacitor will discharge because of the base current drawn by TR1 and because of its own leakage resistance. The meter needle will just slowly drop back to zero."

"There will be a gradual discharge from the electrolytic," admitted Smithy. "But the meter needle should still remain steady at the reading it had when you pressed the button for quite a con-

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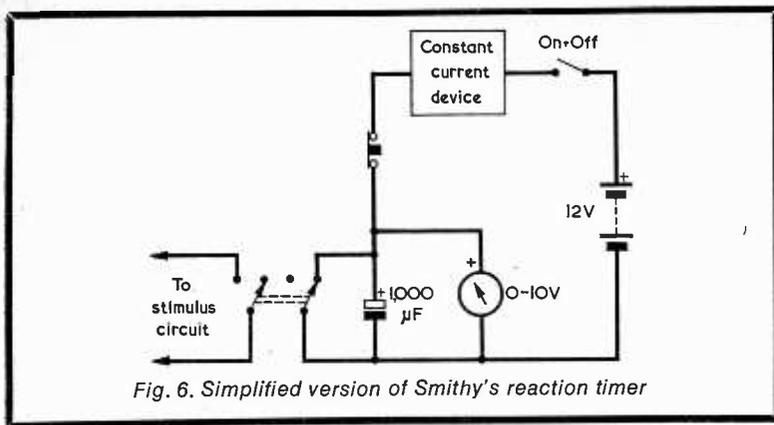


Fig. 6. Simplified version of Smithy's reaction timer

siderable period. TR1 is a very high gain silicon transistor, and the current drawn by its base should be negligibly low. If the electrolytic capacitor is a good quality component, it should have a very low leakage current, too. Incidentally, I've specified it as a 25 volt working component, because experience indicates that electrolytic capacitors exhibit surprisingly low leakage current when used well below their nominal voltage rating."

"Well," said Dick, obviously not entirely convinced, "I think I'll see how that bit of circuit operation works out after I've made up the timer! There's another point, too. How can you be sure of getting hold of an electrolytic whose capacitance is exactly 1,000µF?"

"You can't," replied Smithy cheerfully. "In fact, as you know yourself, most electrolytics have a tolerance on nominal value of the order of -20 to +50 per cent."

"There you are, then!"

"If," continued Smithy patiently, "you'd just let me finish, I would be able to tell you that the exact value of the capacitor, provided that it's fairly near to 1,000µF, isn't important. As I'll be showing you shortly, there's a simple setting-up procedure which takes into account the fact that the actual capacitance of the electrolytic won't be exactly equal to its nominal value."

"Oh."

"Okay?"

"Yes, I think so," replied Dick doubtfully. "Wait a minute though, there's another thing that's puzzling me. What's the silicon diode D1 for?"

"To counterbalance the voltage drop in the base-emitter junction of TR1," said Smithy. "D1 is forward-biased by way of R3 and it drops about the same voltage as appears across the base-emitter junction of TR1, thereby allowing the meter to give a true zero reading when the electrolytic capacitor is discharged. Since D1 is biased fairly heavily in the forward direction, the voltage across it will probably be

a slight bit higher than the voltage drop in the base-emitter junction of the transistor, whereupon the meter will give a very small forward deflection when the capacitor is short-circuited. This can be corrected for by a wee touch to the zero-adjust screw of the meter. Any more questions?"

COMPONENTS

"Not so far as circuit functioning is concerned," said Dick. "Are there any special points to watch out for with regard to the components?"

"Not really," replied Smithy. "None of the components are exceptionally critical. Let's go through them according to their types. So far as semiconductors are concerned, both D1 and D2 are

small silicon diodes, such as the Lucas DDOOO. D1 has to pass about 12mA and D2 has to pass about 1.2mA. TR1 should be the type specified, or a very similar equivalent. TR2 is not quite so critical, but the ACY19 still represents a good reliable choice in practice. All the resistors can be 1/4 watt 10% components but you want to be a bit careful so far as R1 is concerned."

"Is R1 a close-tolerance resistor?"

"It doesn't have to be close-tolerance," said Smithy, "but you want to avoid using a resistor whose value is very much higher than 10kΩ or you may find that the meter needle only just reaches f.s.d. when the capacitor has completely charged. If possible, try and select a resistor whose value is a little below 10kΩ. If you don't have an accurate ohmmeter it might be better to play safe here and use a 9.1kΩ 5% resistor for R1 instead of the 10kΩ resistor I've shown in the diagram. Which reminds me of another point. If you're using a multi-testmeter switched to a 1mA range for the meter, R1 should definitely be 9.1kΩ or, at least, significantly lower in value than 10kΩ. This is because the terminal resistance presented by a testmeter switched to read 1mA f.s.d. will be quite a lot higher than is given by a 0-1mA meter of the panel-mounting type. Incidentally, I think I should mention at this stage that the final setting-up operation for the timer takes up tolerances in the value of R1 in addition to variations in the value of the electrolytic

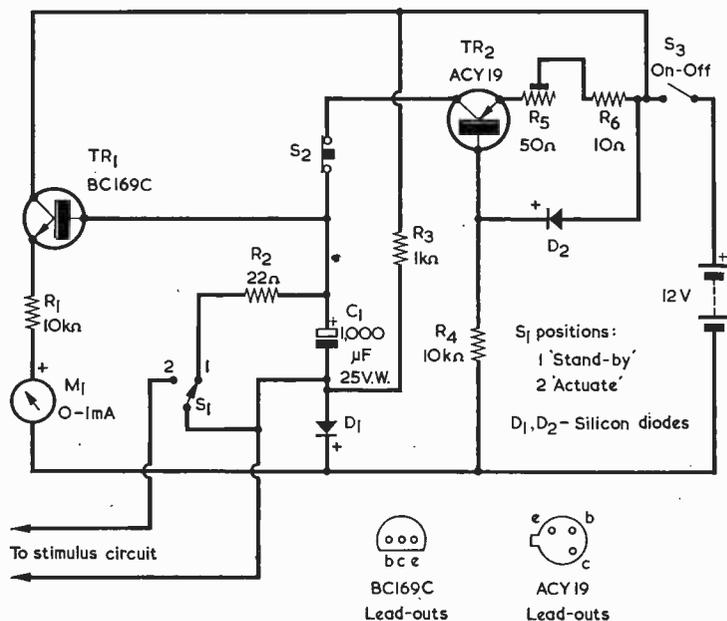


Fig. 7. The complete circuit of the reaction timer. The current drawn from the 12 volt battery is of the order of 22mA

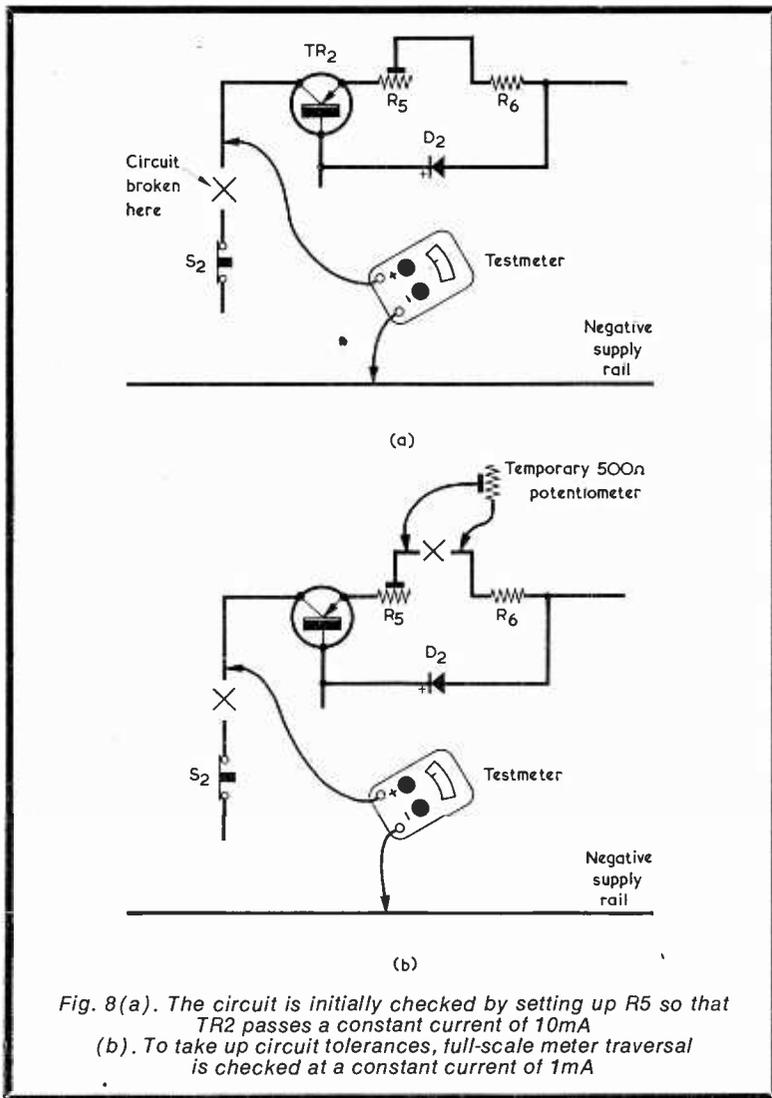


Fig. 8(a). The circuit is initially checked by setting up R5 so that TR2 passes a constant current of 10mA
 (b). To take up circuit tolerances, full-scale meter traversal is checked at a constant current of 1mA

100mA between the collector of TR2 and the negative supply line, then set up R5 for 10mA."

Smithy made the required connection (Fig. 8(a)), then adjusted R5 to insert maximum resistance. He switched on cautiously by means of S3, ensuring that he could switch off again quickly if, due to a fault condition, the meter indicated excess current. However, the meter needle did nothing other than rise sedately to slightly less than 5mA. Smithy adjusted R5 for a reading of 10mA, then switched off again at S3.

"This," he remarked, "is just a try-out. Now, temporarily connect the collector of TR2 to S2."

Dick made the connection, after which Smithy set S1 to Position 1 and closed S3 again. The 0-1mA meter in the timer circuit gave a very small forward indication. Smithy returned the needle exactly to zero by means of the meter zero-adjust screw. He then set S1 to Position 2. The meter needle moved fairly rapidly to the right, stopping at its f.s.d. end-stop. Smithy put S1 to Position 1, whereupon the meter needle returned to zero again. Smithy set S1 to Position 2 once more, pressing S2 quickly afterwards and holding it down. The meter needle held steady for a few moments at about 0.4, then gradually began to fall slowly to the left.

"I told you that would happen," remarked Dick accusingly. "The electrolytic starts discharging as soon as you press the button."

"Tush," reproved Smithy. "Tush! These are early days yet, mate."

Smithy put the circuit through its paces about a dozen further times, stopping the meter needle at various points on the scale. Gradually, the tendency for the meter needle to fall after S2 had been

capacitor."

"Ah," said Dick. "That capacitor is pretty well the only component you haven't mentioned."

"Then I'll do so right now," responded Smithy: "The electrolytic capacitor *must* be a reliable new component of good manufacture. The whole success of the circuit depends on the goodness of this component."

Satisfied with Smithy's answer, Dick rose, picked up the circuit diagram, and walked purposefully towards his bench.

"I'll start by knocking up this circuit right now," he announced. "I should be able to wire it up quite quickly on a small piece of tagboard hitched onto a bit of ali to hold the switches and press-button."

"Okey-doke," said Smithy equably. "So far as construction is concerned, the connection to the

slider of the 50Ω pot in the emitter circuit of TR2 should be of a temporary nature only. This is because it has to be unmade to allow an extra component to be inserted during setting-up. Oh yes, and the same applies to the lead from the collector of TR2. Leave the wire from this collector completely unconnected at switch S2 during wiring up."

The clatter of tools and soldering-iron from Dick's bench soon indicated that constructional work was in process. In a surprisingly short time, Dick announced that he had completed the assembly of the circuit. Smithy walked over to inspect his assistant's handiwork.

"Very good," he commented approvingly. "We'll initially check the circuit out by setting up the constant current transistor to give us 10mA. To do this we connect a testmeter switched to read 50 or

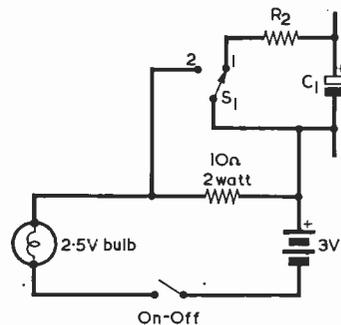


Fig. 9. A suitable stimulus circuit, wired up to S1. This uses a separate battery and the on-off switch shown here could be ganged, if desired, with S3 in Fig. 7. The value of the resistor shown as 10Ω may need adjustment to suit some bulbs

pressed disappeared, and it eventually remained completely steady at all settings whilst S2 was pressed.

"That's more like it," remarked Smithy, pleased. "I don't know how long that 1,000 μ F electrolytic capacitor has been in store, but it is now beginning to get properly 'formed' due to its use in this circuit. I'll run the timer another ten times or so to make certain that the capacitor is reliably 'formed', after which we'll get the circuit properly set up."

SETTING-UP

After the further runs, Smithy declared himself satisfied with the condition of the electrolytic capacitor.

"Right," he remarked. "The next job is to set up the circuit so that it accommodates the actual capacitance of the electrolytic. As I said a few minutes ago, this process will also take up tolerances in R1 as well. Now, the speed at which the meter needle is moving at present is far too fast for us to check visually and so we shall next slow it down by reducing the constant

current to 1mA. Will you therefore, Dick, once more remove the connection from TR2 collector to S2 and, also, insert a 500 Ω pot in series with R6 and R5?" (Fig. 8(b)).

Dick found a suitable potentiometer and carried out Smithy's bidding.

"Good," said the Serviceman, "we'll next set up for a constant current of 1mA."

Smithy connected the testmeter between TR2 collector and the negative supply rail and, after switching on, adjusted the temporary 500 Ω potentiometer for a reading of exactly 1mA. He next removed the testmeter and asked Dick to remake the connection at S2. Smithy then switched on and cycled the unit once more. This time, the movement of the meter needle was very much slower.

"I suppose," said Dick, watching the meter needle with fascinated eyes, "that the length of the period is now of the order of 10 seconds."

"It is," confirmed Smithy. "What we have to do next is to measure the period which exists between the instant of operating S1 and the instant at which the needle passes

the f.s.d. point on the meter scale."

Carefully looking at the second sweep hand of his watch, Smithy checked the time needed for the meter needle to fully traverse its scale. He repeated this operation several times, then diverted his gaze away from his watch.

"As near as dammit," he announced, "the period is 13 seconds each time. This means that, for a full scale traversal in one second, we'll need a constant current of 13mA."

"13mA? How d'you make that out?"

"The present rate of change of voltage across the capacitor," explained Smithy, "corresponds to a full scale traversal of the meter needle in 13 seconds. We want to increase the rate of change of voltage so that full needle movement occurs in one second. The rate of change of voltage must therefore be increased 13 times, which necessitates a similar increase in the constant current charging the capacitor. At present it's 1mA, and so we must multiply it up to 13mA."

"I see now," said Dick brightly. "Of course it has to be multiplied 13 times!"

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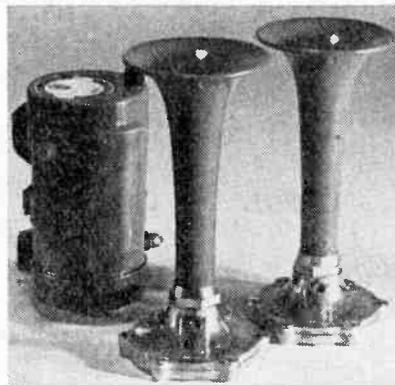
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"That's the idea," commended Smyth. "If it had happened that, with the 1mA constant current, full scale traversal had occurred in, say, eight seconds, then the final constant current we'd require would be 8mA. The great advantage of setting-up the timer circuit in this manner is the fact that only three easy measurements are required, two being of current and one of time. Anyway, we're on the last lap now. So, remove the temporary 500Ω pot, connect R6 properly to the slider of R5, and once more disconnect the connection at S2 from TR2 collector."

After Dick had carried out these instructions Smyth connected the testmeter to the circuit in the same manner as for the original 10mA constant current adjustment. This time, however, he adjusted R5 for exactly 13mA. He then switched off at S3, took up Dick's soldering iron and, with an air of finality, permanently connected the lead from TR2 collector to the tag at S2.

"Setting-up," he announced, "is complete. From now on, that meter will give a linear indication of elapsed time, with f.s.d. corresponding to exactly one second. All we've got left to do now is to add a bulb and battery for the stimulus circuit."

"I've been thinking about the bulb and battery," said Dick. "Isn't there a possibility that there'll be a very slight delay before the bulb lights up to full brilliance after it has been switched on?"

"That *could* happen, I suppose," replied Smyth. "However, any possible delay in bulb illumination can be reduced to a minimum by keeping the filament just glowing when it's switched off by means of a resistor across the switch. The bulb

should then achieve full brilliance almost immediately after switch S1 is operated." (Fig. 9).

"I wonder," commented Dick pensively, "what value of resistance will be required."

"That," replied Smyth, "is a matter for experiment. Incidentally, I should use an ordinary torch bulb rather than, say, a radio pilot lamp, as the latter types tend to have somewhat sluggish filaments."

FINAL TRY-OUT

Dick very quickly had the bulb circuit wired up, and he found that the value of resistance required to keep the bulb just glowing was 10Ω. When this resistor was short-circuited the bulb attained full brilliance, so far as could be perceived, virtually instantaneously.

"Good," said Smyth. "Let's now take a measurement of your reaction time."

After Smyth had switched on the reaction timer at S3, Dick positioned himself alongside it with his finger on the press-button, and concentrated on the just-glowing bulb. Smyth's hand, out of Dick's sight, hovered over switch S1, which was now in Position 1. Suddenly the bulb glowed brightly. Taken slightly unawares, Dick jammed his finger down on the button.

"Don't take your finger off," warned Smyth, "or the meter needle will carry on to f.s.d."

They both looked at the meter. It indicated 0.6 seconds.

"Blimey, you're slow," commented Smyth. "Most people have reaction times of about a third of a second."

"Let's have another go, Smyth," pleaded Dick. "I wasn't quite prepared then."

"As you like."

After several further attempts Dick became more practised, and he found himself continually scoring a reaction time of approximately 0.3 seconds. Then he and Smyth changed positions. Much to Dick's chagrin, the Serviceman scored 0.28 at the very first attempt and continued with a steady 0.25 seconds on each further occasion.

"You must," grumbled Dick, "have a whole length of your nervous system shorted out somewhere. Nevertheless, this is a jolly useful gadget. It's just the sort of thing that's required to convince boozey car-drivers who think that their reactions are speeded up after a few drinks how misguided they are."

"It is, indeed," agreed Smyth. "And the circuit, with slight modifications including, perhaps, a change in the constant current to accommodate different timing periods, also has quite a lot of potential applications in production and experimental engineering."

Smyth glanced at the Workshop clock, and started.

"Blow me," he gasped, "we've wasted nearly an hour of working time playing around with this gadget. I'm now going to have a timing reaction myself, and this consists of announcing an immediate return to work!"

Whereupon the Serviceman, completely deaf to the protests of his assistant, picked up the reaction timer and deposited it out of sight in the cupboard under his bench; after which he devoted himself to the hardest task so far, that of chivvying the reluctant Dick back to a proper consideration of his function as a supposedly full-time radio and TV service engineer. ■

UNDERSTANDING TAPE RECORDING

(Continued from page 694)

In practice, such an ideal state of affairs cannot be achieved, the main failing being the losses at high frequencies due to tape demagnetisation, and to losses at the record and playback heads. The ideal curve of Fig. 4(a) has, in consequence, to be modified by the introduction of treble boost to overcome these losses. And the ideal curve of Fig. 4(b) has to be modified by causing its falling section to cease at or around the frequency where high frequency playback losses begin to become significant. It will be noted that the practical response curves we have seen up to now more closely approach those for ideal conditions as tape speed increases.

JUNE 1970

The procedure of applying treble boost to the record amplifier, and bass boost to the playback amplifier is described as *equalisation*. This is a blanket term which covers any electronic process whose aim is that of reducing distortion (in the present instance frequency distortion, i.e. unequal amplification of all frequencies) with the aid of suitable filters.

NEXT MONTH

In next month's issue we shall turn our attention to the bias signal which is applied to the record head during recording. ■

CHINESE EARTH SATELLITE

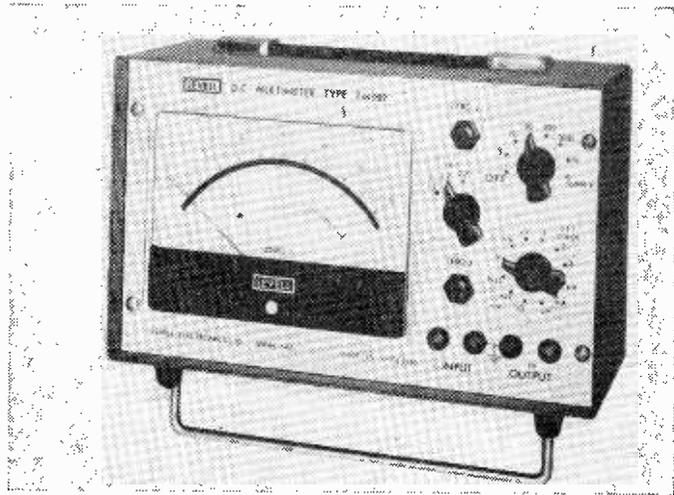
Our Listening Post reports taping the Chinese satellite signals from 2010 to 2022GMT on 28th of April. The signals were first heard, barely audible, on a measured frequency of 20009kHz at 2008GMT and rapidly gained in strength to peak at S9 with rapid flutter QSB to S7. The signal strength was best at 2017, rapidly declining till 2025, by which time signals had faded out into the noise level.

The transmission consisted of a single tone oscillator rendering of the tune "The East is Red" continuously repeated.

703

Radio Topics

By Recorder



The D.C. Multimeter type TM9BP, currently manufactured by Levell Electronics, Ltd.

SOME SKILLS, ONCE ACQUIRED, are never forgotten.

Particularly high amongst these is the ability to send and receive morse code. I appreciate that some would-be amateurs these days deprecate the necessity for learning morse and, whilst I do not want to be drawn into *that* controversy, I do feel that a working knowledge of the code can be a definite asset to anyone who is seriously interested in short wave Dx reception. Also, skill with morse can be acquired fairly easily, particularly if one is a member of a local club where morse instruction sessions are held from time to time.

STUMBLING BLOCK

I would suggest that the main stumbling block encountered by those who start to learn the code from scratch is the tendency to concentrate excessively on character recognition. This point applies particularly to the reading of morse, where the actual recognition of the morse characters should be relegated, as it were, to the back of the mind. To quote a parallel instance, there are plenty of people who can type at surprisingly high speeds simply with the first finger of both hands. They have never been *trained* to type but have, due to the requirements of business or correspondence, tapped out documents and letters on a typewriter over the years as and when required. Initially, these self-taught typists would have had to look at the keyboard all the time to select the keys required. After a period, however, they found that the process

of typing had become automatic, whereupon they became capable of rattling off page after page with hardly a glance at the keys at all. Learning the morse code should follow the same lines. At first the individual characters have to be recognised, just as occurs in the first stages of one-finger typing, after which the learner gradually changes to automatic recognition of the characters, and finally writes down the morse message just as though it had been dictated to him in normal language. The great secret of learning morse is to relax and let the natural ability of the brain to respond to new stimuli take over. It is surprising how soon a good reading speed can be obtained by proceeding in this manner. Another point to bear in mind is that if, during the reception of a morse message, the odd character is missed, just forget it. Trying to remember what the character was whilst further characters are being received only gets the mind flustered.

Most of my own morse-bashing experience occurred in the Services where I was expected, as a sideline, to be able to take over from full-time operators. It was then that I discovered the uncanny ability of c.w. signals to break through quite fantastically high interference. The ear itself acts a 'filter' here and tends to ascribe a particular characteristic to the required signal that enables it to be isolated from those around it. Also, one can quite often identify the sender of a morse code signal after having become used to his 'fist'. Morse characters with exact length and spacing are excellent to receive, but some operators tend to

acquire an individual rhythm which pervades all the messages they send. Their transmissions, whilst not exactly the copy-book morse that would be sent by a machine, deviate only slightly from the mathematical ideal and can be a veritable pleasure to copy.

After which, all I can now do is to offer the best of wishes to those who are currently engaged in learning the dah-de-dah-dit, dah-dah-dah, dah-dit-dit, dit!

D.C. MULTIMETER

The accompanying photograph illustrates the latest d.c. multimeter, type TM9BP, available from Levell Electronics, Ltd.

This instrument contains a high gain chopper stabilised d.c. amplifier, with entirely solid-state circuitry, which is powered by a PP9 battery having a life of 1,000 hours. When used as a microvoltmeter, it offers ranges from $3\mu\text{V}$ f.s.d. to 1kV f.s.d., with the high input resistance of $1\text{M}\Omega$ per μV up to 10mV , greater than $10,000\text{M}\Omega$ from 30mV to 1V and $100\text{M}\Omega$ above 1V . An alternative application is as a picoammeter, whereupon ranges from 3pA f.s.d. to 1A f.s.d. are available. The multimeter may also be employed as a null detector, with a maximum sensitivity of $1.5\text{--}1.5\mu\text{V}$; as an ohmmeter, with linear ranges from 3Ω f.s.d. to $1,000\text{M}\Omega$ f.s.d.; or as a d.c. amplifier, with a maximum gain of 333,300 and a maximum output of 1V into $1\text{k}\Omega$.

The type TM9BP multimeter is available, at £93, from Levell Electronics Ltd., Park Road, High Barnet, Hertfordshire. ■

THE RADIO CONSTRUCTOR

LATE NEWS

★ AMATEUR BANDS

● ICELAND

Amateur transmissions from this country are not usually plentiful but in recent weeks things have livened up with three stations becoming very active on 14MHz s.s.b. Listen for TF2WKF, TF2WKI and TF2WKP.

● NICARAGUA

Normally prefixed YN, some stations may be heard using the HT prefix. HT1FR was heard to give his QTH as POB744 Managua.

● NETHERLANDS ANTILLES

Several stations are currently active from Curacao, one notable s.s.b. signal being that of PJ1CL, heard giving his QTH as POB738.

● BOTSWANA

A2CAH has been heard on 14MHz s.s.b. giving his QTH as POB17, Gaborones.

● JORDAN

Active to date is JY1, heard on 14MHz s.s.b. around 1700 to 1830 GMT. JY1 is the callsign of King Hussein, POB 1055, Amman.

● IRAN

Those readers who need this country should listen for EP2FB and EP2TW, both currently active on 14MHz s.s.b.

● TOP BAND

For those who can read the 'dots and dashes' much Dx fare has been around of late in the c.w. portion of the band. In addition to many OK1's we have heard OK2BIT, OK3CHL, OL5ANG, OL6AMQ and OL8ANL.

★ BROADCAST BANDS

● MEXICO

XERMX Radio Mexico has changed frequency from 9535 to 9745. Also on 6055 and 11720 in parallel. Sign off is at 0500.

● TAHITI

Radio Tahiti, Papeete, has been heard signing on at 0230GMT instead of the usual 0300 on 11835 immediately after R.Sweden signs off on the channel.

● YUGOSLAVIA

Radio Belgrade now radiates a short wave listener programme in English on the first Tuesday of each month from 1830 to 1900 on 6100, 7200 and 9620. Reports are requested.

● SUDAN

Radio Omdurman now uses the following channels: 4994, 6150 (20kW); 7200 (120kW), 9505 (50kW) and 11835 (120kW), with 15170 (50kW) as a stand-by frequency.

● ISRAEL

Kol Yisrael may be heard with an English programme from 2045 to 2130 on 9009 and 9625. A 20kW transmitter is in parallel on 9725.

● ALBANIA

Radio Tirana can be heard with an English programme at 2015GMT on 7065 (50/240kW).

● INDIA

All India Radio, Delhi, can be logged with an English programme at 2015 on 7215 (10/100kW).

Acknowledgements to our own Listening Post and SCDX.

EDDYSTONE RECEIVERS FOR METEOROLOGICAL WORK

The British Meteorological Office has ordered 22 general purpose v.h.f. receivers, Type 990R, from Eddystone Radio. They are largely intended for use with radiosonde equipment, to receive information on meteorological conditions in the upper atmosphere from radiosonde balloons and rockets.

The Eddystone 990R receiver was first introduced at the end of 1967, as a replacement for the highly successful 770R equipment. It provides a completely solid-state equipment with a unique free-tuning range from 27MHz to 240 MHz.

The receivers will be used for radiosonde work at meteorological stations in the United Kingdom and overseas. They will receive information on temperature, pressure and humidity transmitted from both the conventional balloon-carried type of radiosonde, and a free-falling type which is ejected from a rocket. This latter type is useable at more than 200,000 feet and transmits f.m. signals. ■

JUNE 1970

LAST LOOK ROUND

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If your meters don't centre-zero and you want to build a bridge circuit how the Dickens do you overcome the problem? Buy a new meter?

Hoard your hard-earned lolly and miserly scrimp together the simple rectifier circuit in *Unusual Null Indicator* to be featured next month.

Scrooge would have rolled over this one!

SAVING FOR INTEREST ?

If you want to measure the vital statistics of Millivolt, you'll have to meter in our next issue! *Solid-State A.C. Millivoltmeter* offers a wide frequency coverage, sensitivities from 10mV f.s.d. to 100V f.s.d. in five switched ranges with a relatively small number of components.

Another interesting design and money saver. Milli was always the former but hardly ever the latter!

SAVING GRACE ?

Never mind about Milli - what about Cybernetic Cynthia on page 672 of this issue? Beauty is only skin deep, or so we are led to believe. Although snail-like Cynthia displays few charms and won't come out of her shell, she at least has the saving grace of intelligence - albeit artificial - but then, often as not, so has beauty! ■

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(Continued on page 709)

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(Continued on page 711)

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(Continued from page 709)

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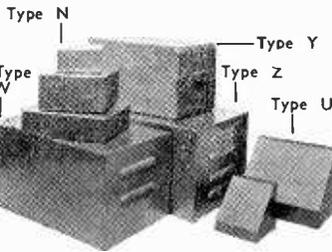
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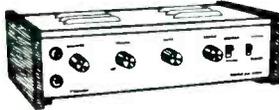
The Table lists the more commonly employed abbreviations, from M to Z, which are encountered in electronic work.

mA	milliampere	r.m.s.	root mean square
mA/V	milliamperes per volt	R/T	radio telephony
m.f.	medium frequency	RTTY	radio teletype
mH	millihenry	Rx	receiver
MHz	megahertz (= 1,000,000 cycles per second)	s/c	short-circuit
m.k.s.	metre-kilogramme-second system of units	s.c.c.	single cotton covered
m.o.	master oscillator	s.f.	signal frequency
mV	millivolt	s.h.f.	super high frequency
m.w.	medium wave	s.p.d.t.	single pole, double throw
MΩ	megohm	s.p.s.t.	single pole, single throw
nF	nanofarad	s.r.c.	single rayon covered
n.f.m. or n.b.f.m.	narrow-band frequency modulation	s.s.b	single sideband
o/c	open-circuit	s.s.c.	single silk covered
osc.	oscillator	s.w.	short wave
P	power	s.w.g.	standard wire gauge
p.a.	public address or power amplifier	s.w.r.	standing wave ratio
p.a.m.	pulse amplitude modulation	T/R	transmit-receive
p.c.m.	pulse code modulation	t.f.f.	tuned radio frequency
p.d.	potential difference	TVI	television interference
pF	picofarad	Tx	transmitter
p.f.m.	pulse frequency modulation	u.h.f.	ultra high frequency
p.i.v.	peak inverse voltage	V	volt
p.m.	pulse modulation or phase modulation	VA	volt-ampere
p-p	peak-to-peak	v.d.r.	voltage dependent resistor
p.p.m.	pulse position modulation or parts per million	v.f.	video frequency or voice frequency
p.r.f.	pulse repetition frequency	v.f.o.	variable frequency oscillator
p.t.f.e.	polytetrafluoroethylene	v.h.f.	very high frequency
p.u.	pick-up	v.l.f.	very low frequency
p.v.c.	polyvinyl chloride	W	watt
Q	quality factor	Wh	watt-hour
R	resistor or resistance	w.p.m.	words per minute
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r.f.	radio frequency	X	reactance
r.f.c.	radio frequency choke	Z	impedance

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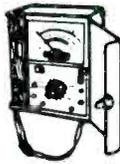
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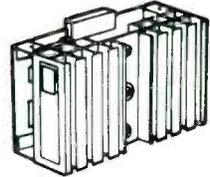
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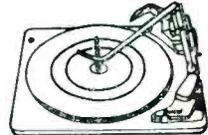
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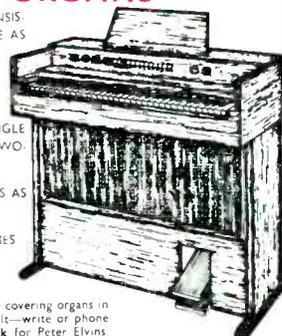
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