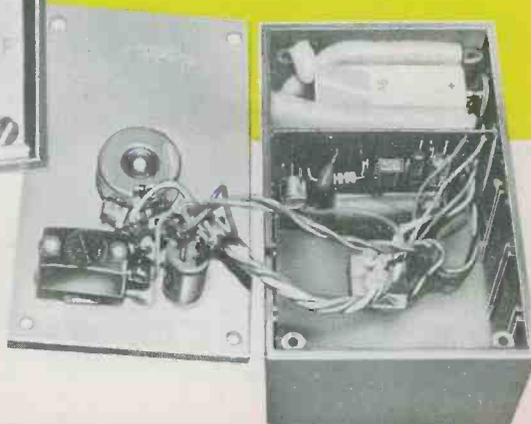
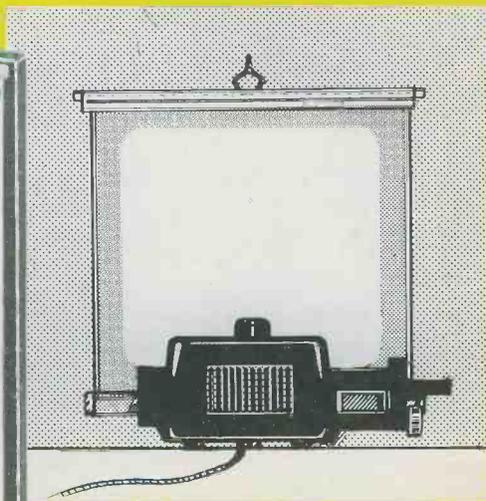
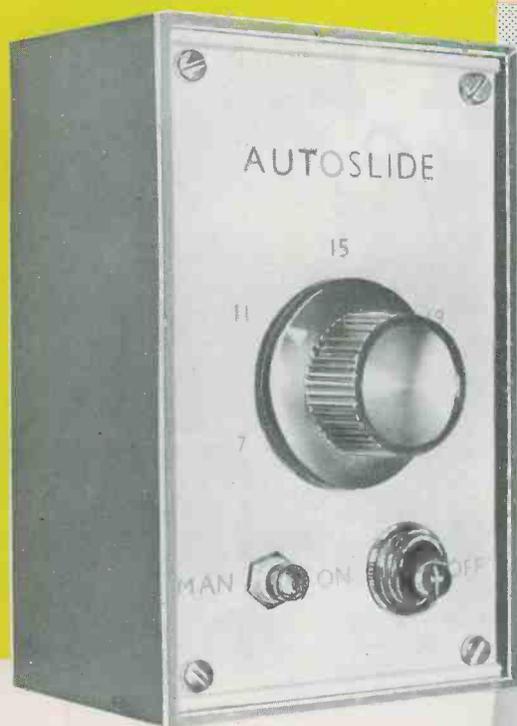


RADIO & ELECTRONICS CONSTRUCTOR

SEPTEMBER 1974

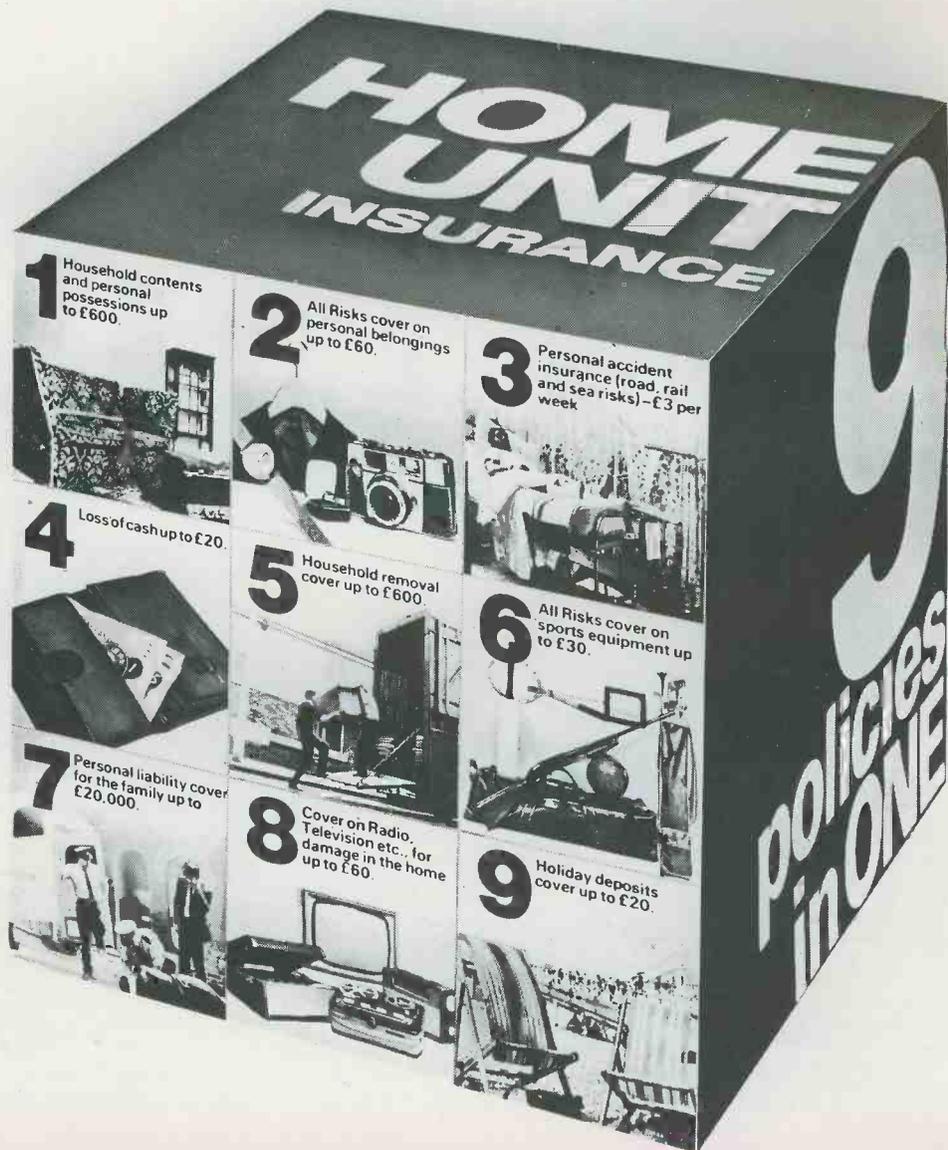
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1.4	42	BY164	45p	Encapsulated with built-in heat sink	
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SR400	1.5	400	8p
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BYX38-600	2.5	600	34p
BYX38-300	2.5	300	26p
BYX38-900	2.5	900	40p
BYX38-1200	2.5	1,200	52p
BYX49-600	2.5	600	34p
BYX49-300	2.5	300	26p
BYX49-900	2.5	900	40p
BYX48-300	6	300	40p
BYX48-600	6	600	50p
BYX48-900	6	900	60p
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Amp	Volt RMS		Amp	Volt RMS	
½	1,600	BYX10	30p	30	LT120
1	140	OSH01-200	28p	0.6	6-110 EC433
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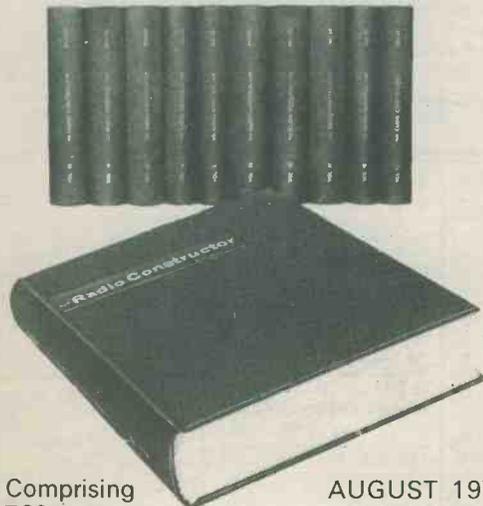
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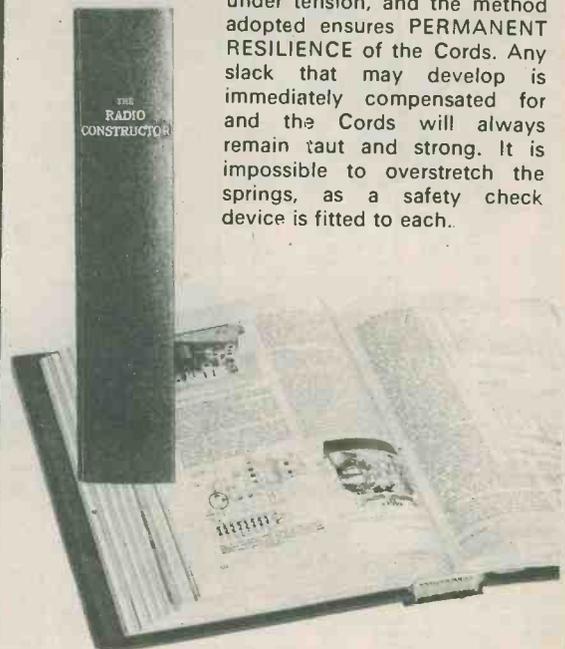
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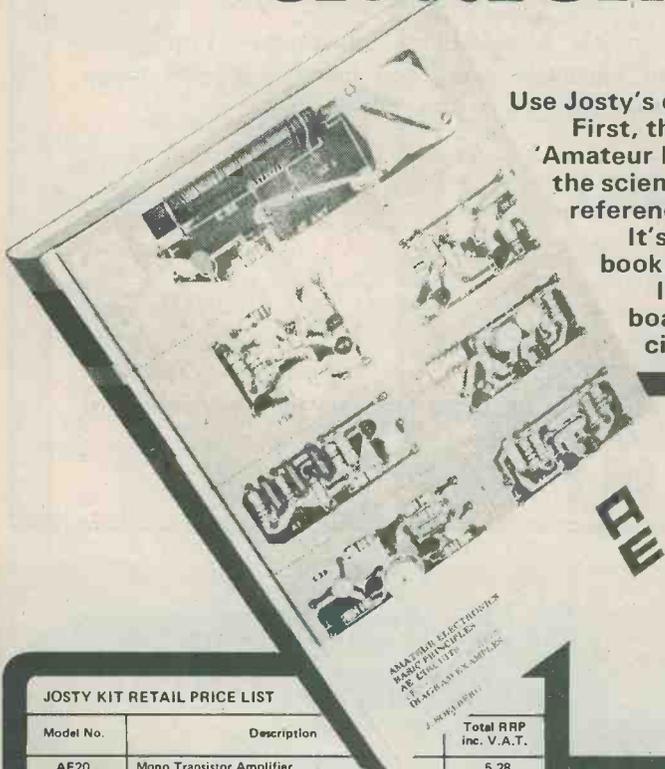


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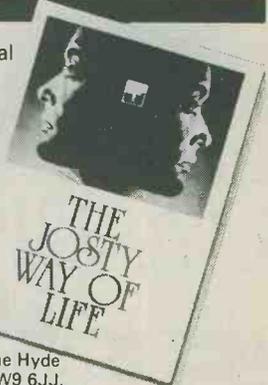
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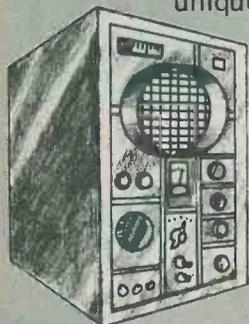
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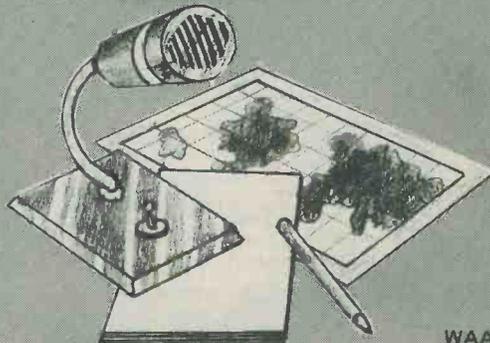
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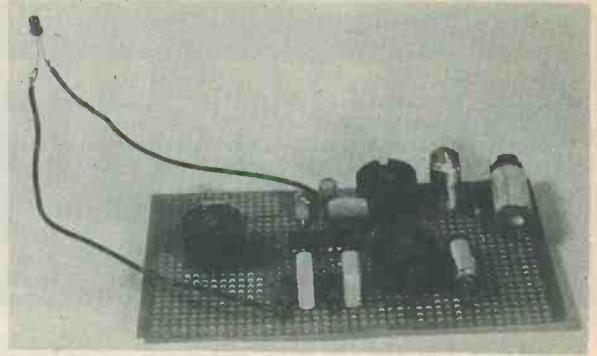
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STEREO STEREO



DECODER

by R. A. Penfold

This stereo decoder unit incorporates the Motorola multiplex demodulator i.c. type MC1307P in conjunction with three home-wound coils and a small number of other discrete components

THIS DECODER IS BASED ON THE MOTOROLA MC1307P integrated circuit, and is of the conventional switching type. The circuit uses few components and is easy to assemble, but prospective constructors should note that an audio millivoltmeter is required for alignment. For best operation a composite input signal of 200 to 400mV is required, and this is readily available from most f.m. tuners.

The MC1307P has very useful performance figures, with a typical channel separation of 40dB at 1kHz, together with a typical distortion figure of 0.5%. It has a built-in stereo indicator lamp driver circuit with a maximum drive capacity of 40mA. The minimum input impedance is 12k Ω (20k Ω typical). The i.c. is encapsulated in a standard 14 pin d.i.l. package.

DECODER OPERATION

The basic stages of the decoder are shown in block form in Fig. 1. An internal circuit of the i.c. is not given, as this is fairly complex and does little to explain the operation of the device. The circuit is given in the data sheet which is normally supplied with the integrated circuit.

The composite input signal consists of three parts. At the transmitter the two signals (i.e. left and right hand channels) are processed by a matrix network, which produces two outputs, which are equal to L+R, and L-R. The L+R signal is used to modulate the main carrier; this is of course equivalent to a mono transmission, and is the part of the transmission used by a mono receiver.

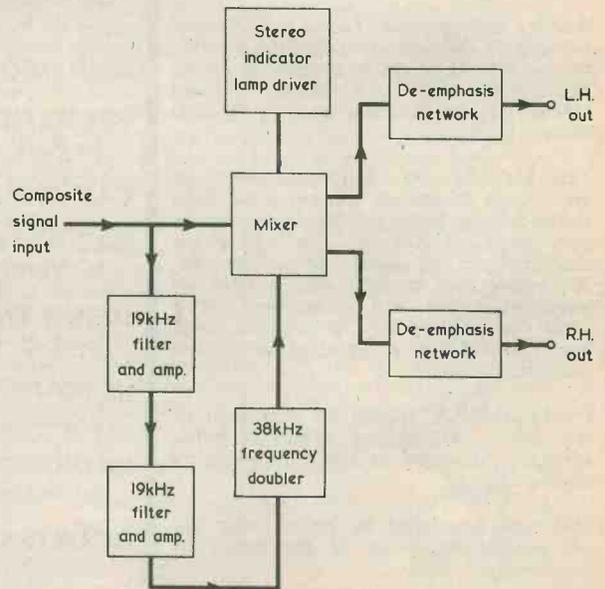


Fig. 1. Block diagram showing the various stages in the decoder unit

There is a 19kHz oscillator at the transmitter, and this lightly modulates the main carrier. Part of the 19kHz signal is frequency doubled to 38kHz, and the L-R signal is modulated onto this. However, the 38kHz carrier is suppressed, and only the L-R modulation is passed on to modulate the main carrier.

As is shown in Fig. 1, the 19kHz signal is filtered from the rest of the signal by means of two filter and amplifier circuits, and is then passed through a frequency doubler to give a 38kHz signal. This is next passed to a mixer circuit where it combines with the composite input signal. The suppressed 38kHz carrier in the transmitted signal is reintroduced and is modulated by the L-R signal.

The mixer section in the MC1307P combines the two signals to produce the original left and right hand channels. Mathematically, the process can be shown as:

$$(L+R) + (L-R) = 2L$$

$$(L+R) - (L-R) = 2R$$

As with the majority of decoders, part of the 38kHz signal is amplified and used to operate an indicator lamp, this becoming illuminated to show the presence of a stereo transmission.

To give a better signal-to-noise ratio the transmitted f.m. signal, both in mono and in stereo, has a certain amount of treble boost, or pre-emphasis. A treble cut, or de-emphasis, circuit is then employed at the receiver to obtain the correct frequency response. The de-emphasis circuit normally appears immediately after the discriminator in a mono tuner, and it must be removed if a stereo decoder is coupled to the tuner output as, otherwise, it would cause considerable attenuation of the 19kHz signal and the L-R modulation (which extends from about 23 to 53kHz). The signal, without de-emphasis, is fed to the stereo decoder, and de-emphasis circuits are then fitted at the left and right hand outputs of the decoder.

CIRCUIT

A complete circuit diagram of the decoder is shown in Fig. 2. Anyone familiar with decoders employing discrete components will immediately notice how few parts in comparison are required here.

C7 is the input coupling capacitor. The signal passes through an emitter follower in the i.c. to the first 19kHz filter, which is given in Fig. 2 by L2 and C2. C8 provides d.c. blocking. The signal is then passed to a common emitter amplifier in the i.c. and then out to the second 19kHz filter, consisting of L1 and C1.

The filtered signal passes through three further transistor stages in the i.c. and is then applied to the 38kHz tuned circuit formed by L3 and C3. The doubled 19kHz signal thus appears across this tuned circuit. The internal transistor which feeds the 38kHz tuned circuit also provides an input for the stereo indicator lamp drive section, and in the present circuit a light-emitting diode type TIL209 is employed instead of a filament bulb. R1 and C6 couple to the input of the lamp drive section of the i.c., whilst R5 limits the current which flows in the light-emitting diode.

The left and right hand audio outputs appear at pins 11 and 12 respectively, with R2 and R3 acting as collector loads for internal differential amplifiers. C4 and C5 are the de-emphasis capacitors.

The circuit operates from a supply of approximately 9 to 12 volts. With a 10 volt supply, current consumption is about 12mA or more and 20mA on stereo with the l.e.d. illuminated.

There is no need to switch off the unit during mono transmissions. It can be left in circuit and will provide identical outputs on the two channels.

The components required are quite readily obtainable. The MC1307P integrated circuit is available from Arrow Electronics, Ltd., 7 Coptfold Road, Brentwood,

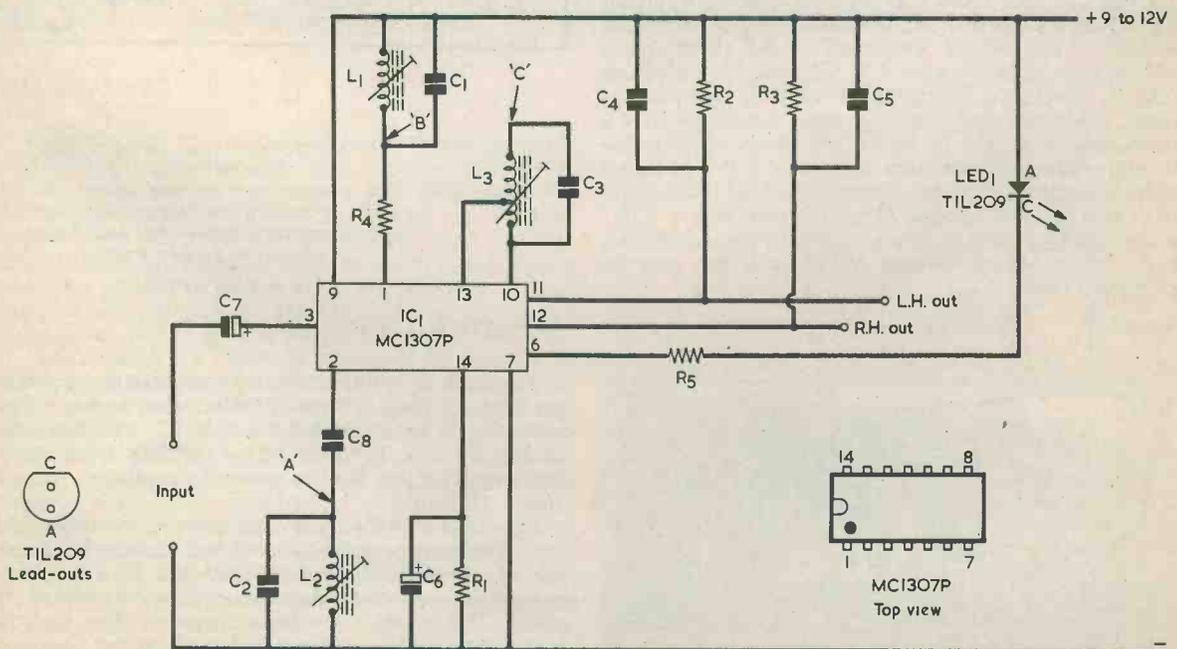


Fig. 2. The circuit of the stereo decoder. The light-emitting diode, LED1, becomes illuminated on reception of a stereo transmission

COMPONENTS

Resistors

(All $\frac{1}{4}$ watt 10%)

R1	4.7k Ω
R2	3.3k Ω
R3	3.3k Ω
R4	220 Ω
R5	820 Ω

Capacitors

C1	0.01 μ F polystyrene, 2 $\frac{1}{2}$ %
C2	0.01 μ F polystyrene, 2 $\frac{1}{2}$ %
C3	0.0022 μ F polystyrene, 2 $\frac{1}{2}$ %
C4	0.015 μ F polyester, side wires
C5	0.015 μ F polyester, side wires
C6	5 μ F electrolytic, 20 V.Wkg.
C7	10 μ F electrolytic, 20 V.Wkg.
C8	0.047 μ F polyester, side wires.

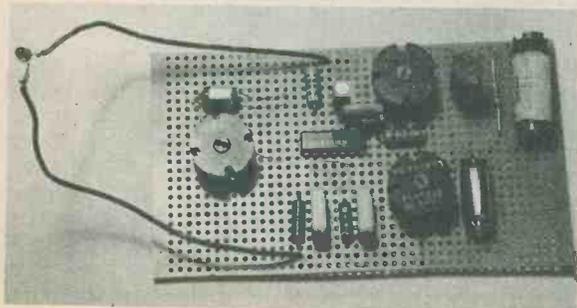
Semiconductors

IC1	MC1307P (Motorola)
LED1	TIL209 (Texas)

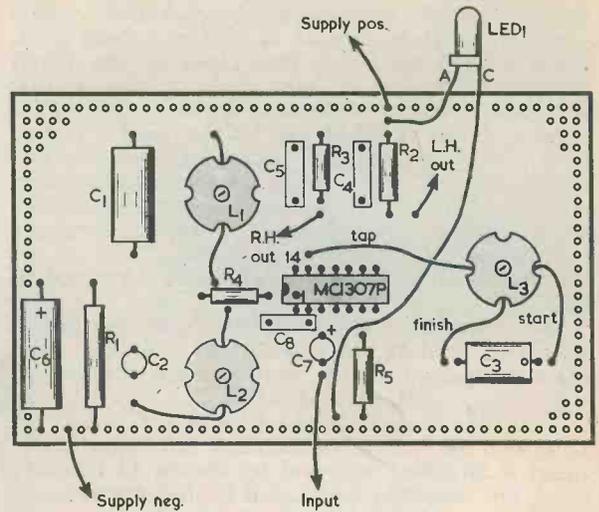
Miscellaneous

- 3-off pot cores type LA2552
- 0.1 in. matrix plain s.r.b.p. panel (see text)
- 38 s.w.g. enamelled copper wire

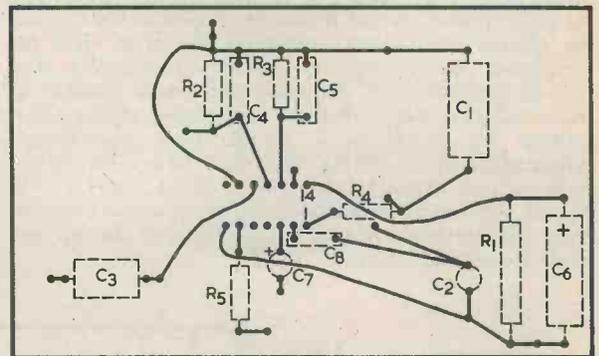
Essex. Three pot cores type LA2552 are needed for L1, L2 and L3, and these may be obtained from Arthur Sallis Radio Control, Ltd., 28 Gardner Street, Brighton, Sussex. The author employed R.S. Components polystyrene capacitors for C1, C2 and C3, and these may be purchased from retailers of R.S. Components parts. It is important that these three capacitors have a tolerance of $\pm 2\frac{1}{2}$ % or better. Finally, a mains transformer offering a secondary voltage of 7-0-7 or 8-0-8 volts is required if it is intended to provide the decoder unit with its own supply. A transformer with a 7-0-7 volt secondary rated at 80mA is listed by Henry's Radio, Ltd., under Model number MT98, and this may be employed here.



A view looking down on the decoder unit



(a)



(b)

Fig. 3 (a). The component side of the perforated board

(b). The reverse side of the board. To assist in tracing the wiring, resistors and capacitors above the board are shown in broken line

CONSTRUCTION

The unit is constructed on a rectangular piece of perforated s.r.b.p. ('Paxolin') sheet, this having a hole matrix of 0.1 in. The board has 42 by 25 holes, but is not sold in this size. It has to be cut carefully from one of the larger 0.1 in. boards currently available, using a Junior Hacksaw.

Figs. 3(a) and (b) show both sides of the board. All the components except the coils are initially fitted into the positions shown in Fig. 3(a), their lead-out wires being bent over at 90 degrees on the underside of the panel. The i.c. pins are bent outwards. The lead-out wires and i.c. pins are then soldered together as shown in Fig. 3(b), which shows the board turned over horizontally so that C3 appears at the left and C6 at the right. Take great care when soldering the i.c. pins as these are fragile and easily damaged. Where leads are

too short to reach one another, insulated link wires are used to connect them together. Also, leads passing close to each other should be insulated with p.v.c. sleeving. The light-emitting diode, which is positioned away from the board at the end of two flexible leads, must be connected with correct polarity or it will not light up.

COILS

The three coils are home-wound in the LA2552 pot cores just referred to, and all have a winding consisting of 335 turns of 38 s.w.g. enamelled copper wire. Wind L1 and L2 first, as these have no tap. Dismantle the pot core, and place the plastic bobbin on an arbor of some sort, such as a pen or pencil. Leaving a lead-out of about 2 in., wind 335 turns of the wire around the bobbin, tightly and as neatly as possible. This is important, as there is only just enough room for the wire on the bobbin. Then cut the wire, leaving a second 2 in. lead-out, and reassemble the pot core.

L3 is wound in much the same way but, after winding 300 turns, stop and scrape a small amount of insulation from the wire. Solder a thin lead about 3 in. long to this point for the tap lead-out, and then add the remaining 35 turns. Ensure that the solder joint at the tap is smooth and free of spikes which could cut into the enamel of adjacent turns and produce a short-circuit thereby. The 35 turn section of the coil connects across pins 10 and 13 of the integrated circuit. Although L3 has the same number of turns as L1 and L2, it operates at double the frequency due to its lower value tuning capacitor, C3.

The most simple method of mounting the pot cores is to glue them to the board, the adhesive being applied to the metal stub on the underside of the core. However, the notes on alignment which follow next should be read before finally dealing with the cores. Construction is now completed by connecting the coils into circuit. Ensure that the connections to L3 are correct.

ALIGNMENT

With the unit connected to a suitable power source and with a transmitted multiplex input available from an f.m. tuner, connect a sensitive audio millivoltmeter between test point 'A' (see Fig. 2) and the negative supply rail.* The millivoltmeter should have an input d.c. blocking capacitor of 0.1 μ F or more. If not, such a capacitor should be added externally in series. Adjust the core of L2 to peak the reading in the meter. A small screwdriver can be used to adjust the core.

Next connect the meter to test point 'B' and adjust the core of L1 to peak the reading. Then transfer the meter to test point 'C' and peak the core of L3. L1 and L2 should have a fairly well-defined setting at which they peak, but the setting in L3 is likely to be less critical. Ensure that the two halves of each pot core are firmly together during this procedure.

Once the unit has been roughly aligned, and it has been ascertained that it is working correctly the two halves of each core can be glued together using a thin

*An a.c. millivoltmeter suitable for this application, and having a low input capacitance and ranges from 0-1mV to 0-500mV, was described in Radio and Electronics Constructor for August 1973. This was 'A.C. Millivoltmeter' by A. P. Roberts - Editor.

layer of adhesive. Then repeat the alignment procedure a couple of times, to ensure that everything is peaked up. If it is felt that input capacitance in the millivoltmeter may be causing detuning when it is connected to the test points, the effect of making final adjustments with a series capacitor in the meter input of the order of 500pF or less may be tried.

FINAL POINTS

It should be noted that it is not possible to align the decoder using the stereo indicator as a tuning indicator since this has an integral triggering circuit which causes it to be either fully on or fully off with no intermediate state. If the unit is to be used with a valve f.m. tuner it will probably be necessary to attenuate the input signal. This is easily done by connecting a 100k Ω pre-set variable resistor in series with the input of the decoder.

It must be remembered that the de-emphasis circuit in the tuner must be disconnected before attempting to use the decoder. The de-emphasis circuit will normally be a simple treble-cut circuit immediately following the tuner discriminator. It should be borne in mind that there will be a worsening of the signal-to-noise ratio on stereo as a wider bandwidth of the tuner is being used. Consequently the aerial requirements for a stereo signal will be somewhat more stringent. An aerial which enables just satisfactory mono reception to be given will not allow the reception of acceptable stereo. It may even be necessary to fit a higher gain aerial for stereo than is used for mono.

In some cases it may be possible to obtain the power supply for the decoder from the tuner in which case a supply bypass capacitor of some 50 μ F or more should be connected across the positive and negative decoder supply input points and mounted reasonably close to the decoder. If the supply cannot be obtained from the tuner, the simple mains power supply unit shown in

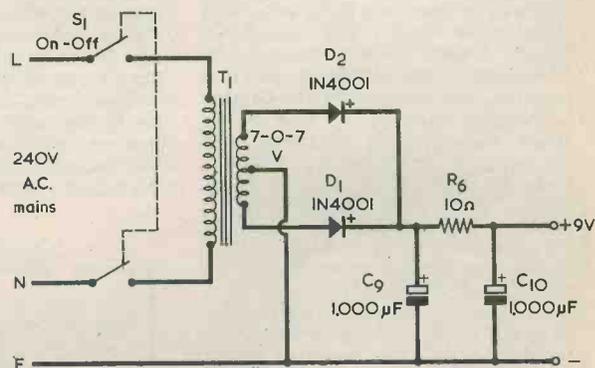
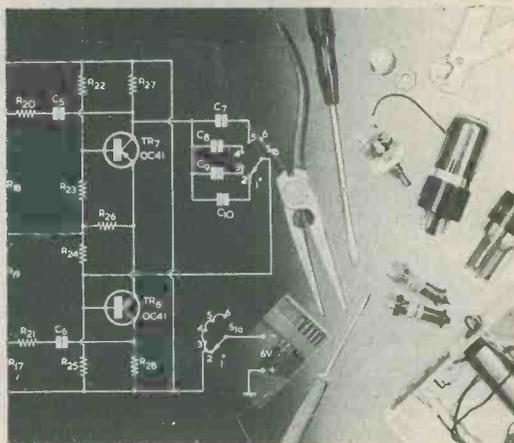


Fig. 4. A suitable mains power supply unit offering an output on load slightly higher than 9 volts. A mains transformer with an 8-0-8 volt secondary, which would give an output on load of about 10.5 volts, could also be used

Fig. 4 can be built, with C10 being positioned close to the decoder. The parts for this supply unit are not included in the Components List. The absolute maximum supply voltage rating for the MC1307P is 22 volts, and care must be taken not to exceed this. In general, the unit should be operated at supply voltages between 9 and 12 volts only. ■

ELECTROLYTIC CAPACITANCE METER

The need arises occasionally to measure the value of electrolytic capacitors. Typical situations in this respect occur when the marking of a capacitor has become obliterated or when it is desired to select a capacitor which is reasonably close to a specific capacitance from a batch having the very wide tolerance on value which is customary with these components.



by G. A. FRENCH

THE CAPACITANCE METER TO BE described in this article is capable of measuring capacitance values from 5 to 5,000 μ F, and can be used to check capacitors capable of withstanding 5.5 volts across their terminals. Since a device of this nature is liable to be used occasionally only, the design is strictly angled towards economy of components. An indicating meter is required, but this can be an ordinary multimeter switched to read 50 or 100 μ F full-scale. An advantage with the circuit is that it can be calibrated by means of simple resistance measurements. What may be considered a possible disadvantage is that the circuit must be powered by a 6 volt battery having low internal resistance, which means that the battery should be a fairly large type and that it should also be new. The device can alternatively be supplied by a 6 volt regulated supply having a current capability of 300mA or more. It should be emphasised that high currents flow for very short periods only, these occurring when the capacitor under test is being charged. The average current consumption lies between about 5mA and 1mA according to the range selected.

HALF VOLTAGE CHARGING

To appreciate how the capacitance meter functions it is first of all necessary to examine the circuit shown in Fig. 1. Here we have two capacitors, CX and CY, connected via series resistors RX and RY to a battery which, for ease of explanation, we

shall say has a voltage of 6 volts. The value of CX is equal to that of CY, and the value of RX is equal to that of RY. When the switch is open, both capacitors are discharged.

Immediately after the switch is closed, CX commences to charge via RX and CY commences to charge via RY. Since the two pairs of components have equal values it follows that the voltage across CX is always equal to the voltage across CY, with the result that the voltage across both capacitors will become equal to 3 volts, or half the supply voltage, at the same instant.

As a matter of incidental interest, the time taken by a capacitor to charge via a series resistor to half the supply voltage is very nearly equal to 0.7 times the time constant of the two components. Thus, at a single instant after closing the switch in Fig. 1, the voltages at points A and B will be equal with respect to the negative supply rail, and will also be equal to half the supply voltage.

We will get the same result if, say, we double the value of CX and halve the value of RX. This is because the time constant of the new components will still be the same as the time constant of CY and RY. Time constant is equal to the capacitance multiplied by the resistance, with the consequence that the half supply voltage effect will be given for any values of capacitance and resistance provided that the product of CX and RX is equal to the product of CY and RY. If the time constants are different the two points A and B will still acquire the same potential at some instant after the closure of the switch, but that potential will not be equal to half the supply voltage.

The circuit of Fig. 1 is developed, in Fig. 2(a), by the addition of three diodes. We shall assume, to start with, that these three diodes are all 'perfect' components; that is to say, that they have infinite reverse resistance and zero forward resistance. They pass no reverse leakage current and there is zero forward voltage drop across them when they conduct. As in Fig. 1, the

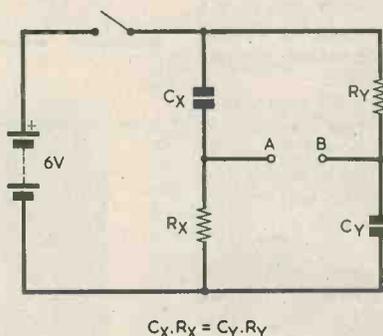


Fig. 1. In this circuit, points A and B reach half supply potential at the same instant after closure of the switch

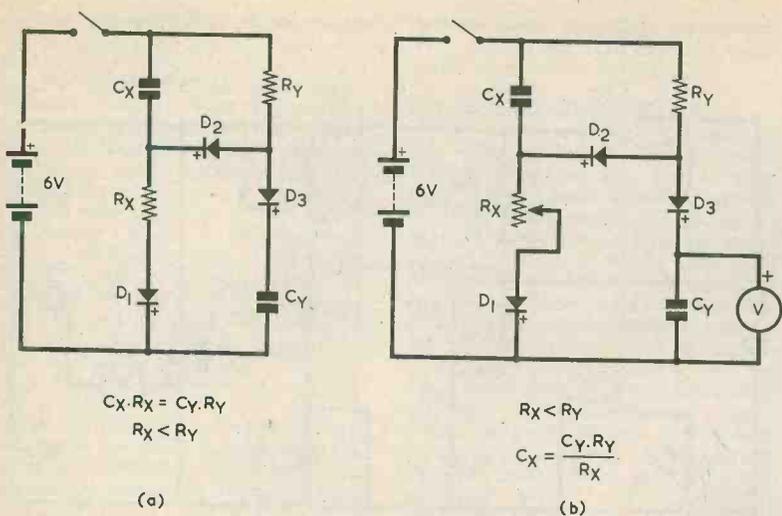


Fig. 2 (a). The three diodes shown here cause CY to remain charged at half the supply voltage when the charging run is complete
 (b). Developing the circuit of (a) to enable it to be the basis of a capacitance meter

product of CX and RX is equal to the product of CY and RY. A requirement of the new circuit is that RX must be lower in value than RY.

At the instant of closing the switch, CX and CY are discharged. Because of the equal time constants, the voltages across the capacitors increase at an equal rate. For the time being, D1 and D3 have no effect on the charging rates, and they function merely as forward biased diodes with zero forward voltage dropped across them. The voltages across the capacitors increase until they approach the half supply voltage level. When these voltages are less than half the supply voltage, D2 is reverse biased because the upper terminal of CY is negative of the lower terminal of CX. This situation is maintained until both capacitors reach the half supply voltage condition. As soon as the voltage exceeds half the supply voltage, the upper terminal of CY goes marginally positive of the lower terminal of CX, whereupon diode D2 conducts. The charging current through RY which flowed into CY is now diverted via D2 into RX. Since RX is lower in value than RY, RX continues to cause the lower end of RY to go negative, whereupon diode D3 becomes reverse biased and no further charging current flows into CY. This, in consequence, remains charged at the half supply voltage. CX continues to charge via RX and the charging process comes to an end when the voltage across CX is equal to the voltage across RY in the potential divider given by RY and RX in series.

To sum up the situation so far, the effect of closing the switch in Fig. 2(a) is to cause a charging process to occur

which results in CY holding a charge which is equal to half the supply voltage across its terminals. The important point to be taken up here is that CY will only be left with half the supply voltage across its terminals when the time constants of the two pairs of components are equal. If the time constants are unequal then the final voltage across CY will be other than half the supply voltage. Another point to be mentioned is that, since RX is lower in value than RY, capacitor CX is higher in value than CY. In practice it is possible to make CX very much larger than CY whilst retaining equal time constants, and this feature is of considerable advantage as we shall see when we later examine the complete circuit of the capacitance meter.

PRACTICAL DIODES

It was assumed just now that the three diodes were 'perfect' rectifiers, but in practice this is of course impossible. Germanium diodes cannot be used in the design because their leakage currents, when reverse biased, are too high, and so the three diodes have to be silicon diodes with their inevitable forward voltage drops of approximately 0.6 volt.

Fortunately, these forward voltage drops do not alter the ability of the circuit to cause CY to become charged to half the supply voltage. When CY is at half supply voltage, the voltage at its upper terminal is 3 volts above the lower supply rail, whereupon the voltage at the anode of D3 (and that at the anode of D2) is 3.6 volts above the lower rail. When CX is, simultaneously

charged to half supply voltage, its lower terminal is also 3 volts above the lower supply rail. Since the anode of D2 is 3.6 volts above the lower rail, this diode is on the point of becoming fully conductive. Thus the changeover which leaves CY charged to half supply voltage takes place in the same manner as was described before, the only difference being that it occurs when the anodes of D2 and D3 are 3.6 volts above the lower supply rail instead of, as was assumed earlier, being 3 volts above the lower supply rail.

The introduction of D3 into the charging circuit for CY means that, before the circuit changeover at half supply voltage, the charging voltage available for this capacitor is 6 volts minus the 0.6 volt dropped across D3. D1, the third silicon diode, is introduced into the charging circuit for CX to retain the balance between the two charging circuits. The charging voltage for CX is then, like that for CY, equal to 6 volts minus the 0.6 volt dropped in a conducting silicon diode.

We can now take development to a further stage, whereupon we arrive at the circuit shown in Fig. 2(b). Here, RX is made a variable resistor and a voltmeter is connected across CY. RX is adjusted until a setting is found which causes the voltage across CY to be equal, after a charging run, to half the supply voltage. When this occurs the time constants are equal, whereupon the product of CX and RX is the same as the product of CY and RY. As can be seen from the equation in the diagram, CX is then equal to the product of CY and RY divided by RX. CX can be the capacitor whose value we wish to measure, whereupon we can find this from the values of CY, RY and RX. If CY is made equal to 1µF, as it is in the practical circuit, the value of CX, in microfarads, is equal to RY divided by RX.

PRACTICAL CIRCUIT

The practical working circuit of the capacitance meter appears in Fig. 3. Here, CX becomes the test capacitor whose value is being measured, and CY is the 1µF capacitor, C1. The two capacitors are discharged via S1(a) and S1(b) when this switch is in the 'Off' position. Resistors R1 and R2 are inserted in the discharge circuits to limit current flow and to prevent sparking at the switch contacts. RX now becomes the variable resistor VR1 in series with current limiting resistor R3. VR1 is calibrated over a range of resistance in this component and R3 from 20 to 200Ω. Resistor RY is either R4, R5 or R6, according to the position of range switch S2. Diodes D1, D2 and D3 have the same circuit positions as they had in Figs. 2(a) and (b).

The voltmeter of Fig. 2(b) has to have virtually an infinite input impedance because it has to indicate the voltage across C1 after the latter has become charged. If the voltmeter

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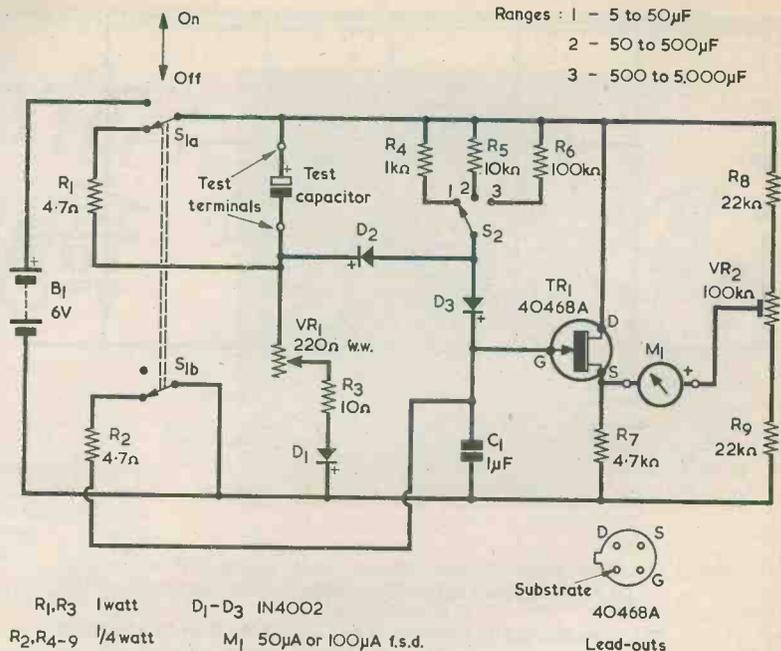


Fig. 3. The complete working circuit of the capacitance meter

input impedance is too low the capacitor will simply discharge into the voltmeter as soon as its charging voltage is removed. This problem is overcome by coupling the upper terminal of C1 to an insulated gate m.o.s.f.e.t. functioning as a source follower. The voltage on the source of the f.e.t. is coupled to the negative terminal of meter M1, the positive terminal of which connects to the slider of pre-set potentiometer VR2. VR2 is set up such that the meter gives a reading of zero current when the potential on the gate of TR1 is 3 volts positive of the negative supply rail. For voltages on the gate that are negative of 3 volts the meter then gives a forward reading in excess of zero current and for voltages on the gate that are positive of 3 volts the meter gives a reverse reading. Ideally, M1 should be a centre-zero meter having a sensitivity of 50-0-50μA or 100-0-100μA, and such an instrument could be used if the constructor so desired. However, the writer feels that the expense of a permanently connected centre-zero meter is hardly justified in a simple instrument of this type, and that a more economic approach consists of providing two terminals to which a standard multimeter can be connected when required. The meter is switched to read 50μA or 100μA full-scale, and it is assumed that the meter needle has sufficient travel below the zero current calibration point to indicate that the current in its coil is in the reverse direction.

The range switch S2 can be any small 3-way rotary switch, and on Range 1 it

allows the 1kΩ resistor R4 to take up the function of RY in the previous circuits. Since test capacitance, in microfarads, equals R4 divided by the resistance inserted by VR1 and R3 (20 to 200Ω), the Range 1 maximum is 1kΩ divided by 20Ω, or 50μF, and the Range 1 minimum is 1kΩ divided by 200Ω, or 5μF. On Range 2, S2 selects the 10kΩ resistor R5. Since this is 10 times the value of R4, Range 2 covers 50 to 500μF. The 100kΩ resistor, R6, selected on Range 3 is 10 times the value of R5, and so Range 3 covers 500 to 5,000μF.

The on-off switch S2 must have a break-before-make action. A d.p.d.t. toggle switch would be a satisfactory choice here.

To operate the capacitance meter, the test capacitor is connected to the test terminals with correct polarity. S1(a)(b) is in the 'Off' position. S1(a) (b) is then turned to 'On' and the meter reading is observed. If the meter reading indicates reverse current, S1(a)(b) is returned to 'Off' and the resistance inserted by VR1 is reduced. S1(a)(b) is again set to 'On' and the meter reading checked. When the meter gives a forward indication, this signifies that the resistance inserted by VR1 has to be increased. The process is repeated until a setting in VR1 is found which causes the meter to give a zero, or near-zero, reading when S1(a)(b) is set to 'On'. The value of the capacitor is then read from the scale fitted to VR1. This process may appear to be laborious but in practice it can be carried out very quickly. If

the first two settings in VR1 are near the opposite ends of its range, one should cause a reverse reading and the other a forward reading in the meter. These readings will then indicate that the desired setting for VR1 is between these two extremes and it is not at all difficult or time-consuming to find a final setting in VR1 which gives a zero, or near-zero, reading in the meter. On Ranges 1 and 2 the rate of charge in C1 is sufficiently high to enable the meter to give a virtually immediate reading after S1(a)(b) has been set to 'On'. C1 charges at a lower rate on Range 3 and the meter reaches its final reading a fraction of a second after S1(a)(b) has been put to the 'On' position.

The reason why a reverse current reading in the meter indicates that the resistance inserted by VR1 has to be reduced is due to the following chain of events. If VR1 inserts too high a resistance the test capacitor charges at too slow a rate, allowing C1 to charge to a voltage higher than the half supply voltage level before diode D2 becomes conductive and the circuit changeover takes place. The voltage applied to the gate of TR1 is thus positive of the half-supply voltage, and the source of TR1 is in consequence positive of the potential which corresponds to half supply voltage at the gate. The negative terminal of the meter is thus positive of its positive terminal and the meter gives a reverse current reading. Conversely, too low a resistance in VR1 results in C1 acquiring too low a charge before the changeover, with a consequent forward reading in the meter. It is helpful to wire up VR1 such that the resistance it inserts into circuit reduces as its spindle is turned clockwise. This gives a psychological link with meter de-

flexion, since the effect of turning VR1 'to the right' is to cause the meter needle to move 'to the right'.

CHARGING CURRENTS

The initial charging currents in the test capacitor circuit when S1(a)(b) is set to 'On' can be quite high. When VR1 is adjusted to offer, in combination with R3, a series charging resistance of 20Ω , the initial charging current is nearly 300mA. If the internal resistance of the battery is appreciable when compared with the 20Ω figure, the initial charging current in the test capacitor will be significantly lower than it should be, and the capacitance meter will give inaccurate readings. A suitable 6 volt supply would be given by two new 3 volt cycle lamp batteries (Ever Ready No. 800) connected in series. A 6 volt stabilized supply with a current capability of at least 300mA could also be used.

Due to the high initial charging

However, for normal usage it should be quite adequate to use 5% components here, since the components being measured are, themselves, of a nature which has a notoriously wide tolerance on value. Capacitor C1 is a polyester or polycarbonate component. An electrolytic capacitor must *not* be employed for C1.

Potentiometer VR1 is fitted with a pointer, or a pointer knob, behind which is a scale calibrated in terms of capacitance. The scale is made up with the aid of an ohmmeter. The capacitance meter is switched off and the upper end of VR1 track is disconnected from circuit. The ohmmeter is then connected to the lower end of R3 and the upper end of VR1 track so that it indicates the total resistance given by *both* these components. The scale is then marked off by setting VR1 to give specific values of resistance reading and marking the corresponding capacitance values on the scale. Fig. 5 shows a conversion scale for

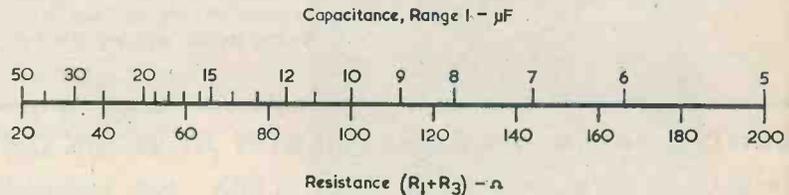


Fig. 5. Conversion chart giving capacitance values corresponding to resistance in VR1 and R3

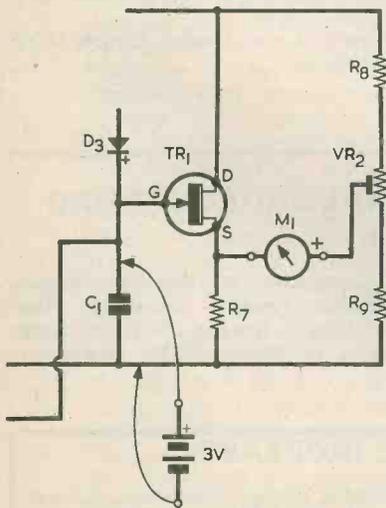


Fig. 4. VR2 is adjusted for zero reading in the meter when the gate of TR1 is 3 volts positive of the negative supply rail

currents it is preferable to make VR1 a wire-wound rather than a carbon component. It should be rated at 3 watts. R3 can be a 1 watt carbon resistor or a small wire-wound resistor. Resistor R1 is rated at 1 watt to allow for the discharge currents from high value capacitors connected to the test terminals.

Potentiometer VR2 can be a skeleton pre-set component, and it is set up for a zero reading in the meter when the gate of TR1 is 3 volts positive of the negative supply rail. Initially, VR2 slider is set to mid-travel and the capacitance meter is then turned on at S1(a)(b). A separate new 3 volt battery is next connected to the gate and the negative supply rail as shown in Fig.4, after which VR2 is carefully adjusted for a zero reading in the meter. The 3 volt battery is removed, and the voltmeter section of the capacitance meter is then set up.

If very accurate results are required, R4, R5, R6 and C1 could all be close-tolerance components, say 1% or 2%.

Range 1, in which 20Ω corresponds at one end to $50\mu\text{F}$ and 200Ω , at the other end, corresponds to $5\mu\text{F}$. The capacitance values are multiplied by 10 for Range 2 and by 100 for Range 3.

Finally, mention must be made of the need for care when wiring in the f.e.t., TR1. The gate insulation of this transistor can be broken down by quite low static voltages, such as those present on an unearthened soldering iron. The author made the f.e.t. the last component to be connected up, and he wired it into circuit after initially short-circuiting the drain, source and gate lead-outs together with a piece of thin tinned copper wire, and then removing this after all the lead-outs had been soldered. An alternative approach is to use a transistor holder and fit the f.e.t. to this after all wiring has been completed. No connection is made to the substrate lead-out, and the can of the f.e.t. should not be allowed to touch a metal chassis or any other connections. ■

NEWS . . . AND

FIRST SECTIONS OF EMI'S £1.25 MILLION ANTENNA ORDER GO ON TEST



Now being erected at EMI's test site in Hayes, Middlesex, are the first three sections of the £1.25 million antenna system which EMI is building for the third-of-a-mile high CN observation and communications tower in Toronto, Canada.

When completed, the antenna complex will radiate most of Toronto's FM and TV broadcasts. The £1.25 million contract is one of Britain's largest ever antenna orders, and was won by the Telecommunications Division of EMI Sound & Vision Equipment Limited.

The three sections at the test site are the first parts of a directional VHF antenna for Channel 5 colour transmissions by the Canadian Broadcasting Corporation, a second directional VHF antenna for Channel 9 colour transmissions by CFTO-TV Ltd, and an omnidirectional UHF array for colour TV transmissions on Channels 19 and 25.

In the picture, riggers are shown at work positioning the antenna elements in the first ring of the VHF Channel 9 array. The outer casing measures 19 ft. in diameter and is part of a glass reinforced plastic radome which will completely enclose the arrays. This is essential to protect the antenna systems during the hard Canadian winter. The complete Channel 9 array will measure 49 feet high and is to be located at a mean height of 1,635 feet. The timber trestle supports the section of g.r.p. radome in place for the tests.

BRITISH SALES TEAM SEE FRENCH AT WORK ON HI-FI

De Banks Electronics, major UK distributors of ERA high fidelity equipment, took its entire sales team to the manufacturer's plant near Paris at the end of March, for a practical teach-in on the company's product range.

The team's job is now to impart their insight to approved ERA-De Banks dealers in Britain so that they, in turn, can give better customer service.

In addition to watching turntables, amplifiers, tuners and speakers being built, the British party were shown units being inspected and tested during production. Amplifiers and tuners, for example, are soak-tested for two days; turntable decks are checked individually,

both mechanically and on wow and flutter meters, before being mounted.

The manufacturers believes in carrying out stringent tests on each individual unit before it leaves the factory. Random selection testing is not considered good enough for equipment of this quality.

A mobile showroom is currently touring Britain, manned by ERA-De Banks staff, giving technical and sales advice to approved dealers.

De Banks Electronics Ltd is at Market House, High Street, Tring, Hertfordshire.



At ERA factory near Paris, British sales team sees model 3033 turntable tested during production. Tony De Banks (second from right) discusses method with Guy le Reverend, ERA production director (extreme right).

INTERNATIONAL BROADCASTING CONVENTION

The Management Committee of the International Broadcasting Convention recently announced that H.R.H. The Duke of Kent is to open IBC'74 at Grosvenor House in London, on Monday, 23rd September, 1974.

COVER PRICE INCREASE

We've have recently incurred further substantial increases in our printing costs and we much regret that, as from the next issue, the cover price will be increased by 3p to 25p.

Annual subscription rates from 1st October will be £3.30 (U.S.A. and Canada \$8.00).

COMMENT

PROGRESS AT NORWICH OBSERVATORY



In our January issue, we gave some details of the observatory being built by members of the Norwich Astronomical Society. The two accompanying photographs show the progress being made.

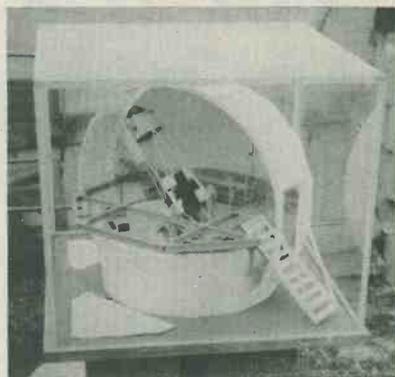
The photo of the astronomical dome was taken on the occasion of the official opening of this dome, which took place on completion of the removal of the Society's 10 inch reflecting telescope from its old site to the new one, and its installation in the new dome.

The new dome and its ancillary buildings were declared open by Mrs. Angela Baldwin, who is a great-great-granddaughter of Sir William Herschel, one of the greatest amateur astronomers of all time. The dome has been named the 'Herschel Dome'.

The other photo is of a model of the second telescope

and its dome, to be constructed by the Society, and as can be seen it presents the Society with a most ambitious project.

It is hoped too, to have a Solar Noise Recording installation at the Observatory in due course, so that visual sunspot observations can be correlated with radio observations. In this connection, Dr. A. C. Gee, G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk, would like to hear from any reader who has had experience of this type of radio equipment or with that for recording Sudden Enhancement of Atmospherics (SEA's).



EVENING CLASSES AND CLUB NEWS

Courses for the Radio Amateurs' Examination will be held at the following venues:-

Acton Technical College, High Street, London W3 6RD. Wednesdays, 6.30-9.00 p.m. Commencing 25th September. Enrolment 12th and 18th September, 6.15-8.15 p.m.

Shelburne Youth Centre Radio Club, (near Holloway Underground Station) Hornsey Road, London N.7. Mondays and Thursdays at 7.00 p.m. Commencing 2nd September.

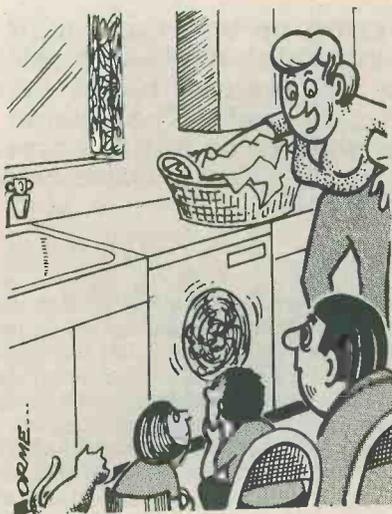
Gosforth Secondary School, Gosforth, Northumberland. Tuesdays and Wednesdays 7.00-9.00 p.m. Commencing this month.

Glasgow College of Nautical Studies, 21 Thistle Street, Glasgow, G5. Tuesdays and Thursdays, 7.00-9.00 p.m. Commencing Tuesday, 10th September. Fee £3.00. Students under 18, free.

Harlow and District Amateur Radio Society Annual Mobile Rally on Sunday 22nd September at Nettleswell Comprehensive School, Harlow. Details can be obtained from B. W. Nappay, Spurway, Sheering, Bishop's Stortford, Herts. CM22 7NB.

It is proposed to form a Durham University Radio Society and a call sign, G4DUR, has been provisionally reserved.

Anyone at all interested should contact Peter Whittle, G4BBU, 1 Blinco Road, Urmston, Manchester, or, during term time, c/o St. Chad's College, South Bailey, Durham.



"I shall be glad when the TV's repaired!"

SELECTIVE RECEIVER

For the L.F. Bands

Part 1.

by

F. G. Rayer, T.Eng. (C.E.I.) Assoc. I.E.R.E.



Front panel layout of the receiver. The tuning indicator is fitted behind the horizontal slot at the left of the central tuning drive

Having no less than eight i.f. tuned circuits, this receiver offers a very high degree of selectivity. Frequency coverage is from 9.5 to 580 metres, bands being selected by means of four sets of plug-in coils. The design is sufficiently flexible to enable the receiver to be initially assembled with some of the stages omitted, these being fitted at a later date.

THE RECEIVER TO BE DESCRIBED IN THIS THREE-PART series was primarily intended for use on the 160 and 80 metre amateur bands, and it has the advantages of bandspread and more than average selectivity. It will also, however, provide excellent results on the higher frequencies, or it may be employed for general coverage or even for medium wave DX reception. The bands actually covered depend on the particular interests of the user. There are some optional features which also depend upon the requirements of the user, these including either a crystal marker for frequency calibration or a pre-amplifier which gives increased sensitivity for operation with a telescopic aerial. Again, the receiver can be fitted with an electronic muting stage to enable it to be used with transmitting equipment. This

is a useful feature but is, of course, not required when activities do not include transmitting.

The basic circuit, without the optional extras, will next be discussed in sections, and this should help to avoid any difficulty for the less experienced constructor. Details of construction and a description of the optional extras will be given in the following two articles. The receiver uses valves rather than semi-conductors, a point which will be appreciated by constructors who still prefer to work with these. In a receiver having the very high gain that is given here it is possible to employ valves in circuit configurations which have been very well tried and proven over a long period of years.

R.F. STAGES

The circuit of the radio frequency amplifier and frequency changer stages is shown in Fig. 1. L1, L2 and L3 are the aerial, r.f. and oscillator coils respectively, and are tuned by VC1, VC2 and VC3, which are the three sections of a 3-gang 310pF bandsetting capacitor. This capacitor is operated by way of a small ball drive.

VC4, VC5 and VC6 are the sections of a second 3-gang capacitor. This provides bandspread tuning of all circuits and is operated by the central reduction drive of the receiver. Each section of this capacitor is 25pF, and the small value allows easy 'opened-out' tuning of the short wave frequencies.

VC7 is a panel operated trimmer. It is peaked for best results with any aerial so that optimum performance is always assured.

VC8 is a similar trimmer, but it is attached internally to the bandset ganged capacitor. No adjustment of this capacitor is necessary once it has been set, unless the plug-in coils, L1, L2 and L3 are changed. When another set of coils is inserted any signal near the high frequency end of the band is peaked by adjusting VC8, and a small knob is fitted for this operation. Provided the coil cores are correctly adjusted, this setting of VC8 will prove satisfactory throughout the band.

TC1 is a trimmer for the oscillator section, and only needs to be set so that VC7 and VC8 can peak up signals within their range of capacitance change. TC1

should not be touched after it has been initially adjusted or the tuning dial calibration will be upset.

The oscillator coils in the L3 position are so made that when any particular coil is inserted the correct padding capacitor, C8, C9 or C10, is brought into circuit. There is no real need to provide a padding capacitor for any range which will not be required. Further details of these capacitors and the bands covered are given a little later in this article.

For stable reception of all modes of signal, the oscillator section of V2 is operated from a 150 volt regulated h.t. supply.

The potentiometer VR1 allows manual gain control of the r.f. amplifier, V1, and also of the i.f. amplifier section of the receiver. Automatic gain control bias is applied by the a.g.c. line through R1 to V1, but not to V2.

A receiver of this type lends itself well to simplification, and the addition of some of its stages at a later date. This approach has the advantage that a working receiver can be made up more quickly. In Fig. 1, V1 and its associated components could be temporarily omitted. Tag 8 of L2 would then be temporarily connected to chassis, and the aerial taken to tag 9 of this coil. Even with V1 omitted the receiver will give an excellent performance, and V1 can be added later without disturbing existing wiring apart from disconnecting pin 8 of L2 from chassis and removing the temporary aerial connection to pin 9.

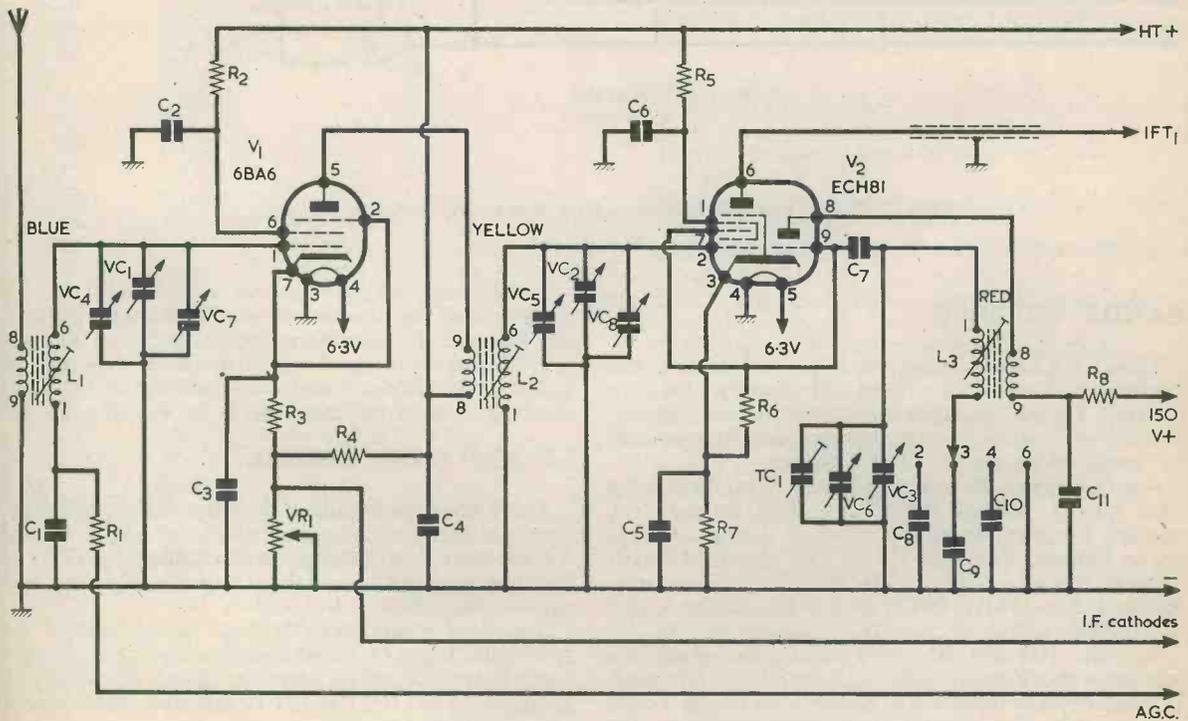


Fig. 1. The r.f. and frequency changer stages of the receiver

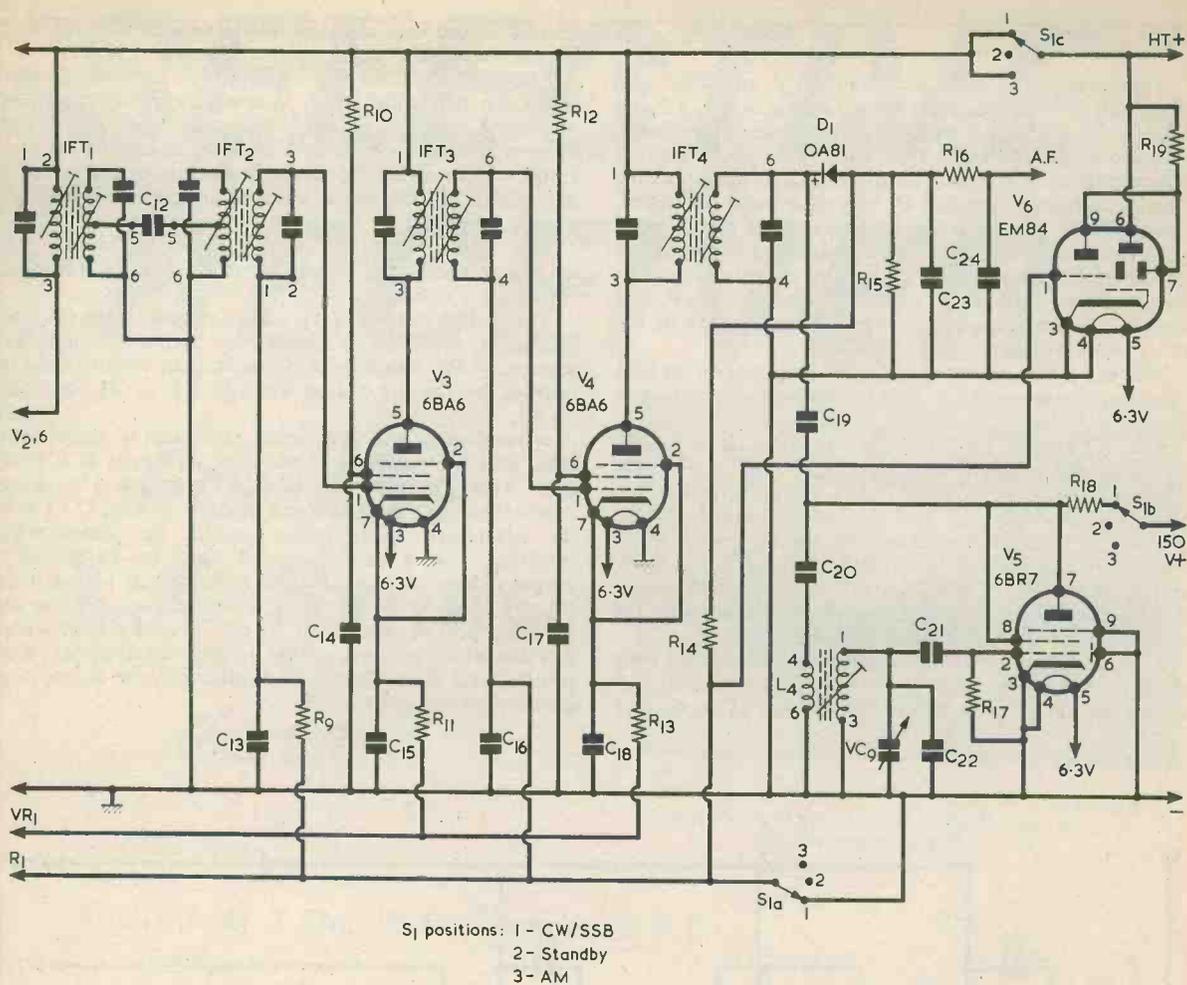


Fig. 2. The i.f. amplifier, detector, b.f.o. and tuning indicator circuits

BANDS COVERED

Coils L1, L2 and L3 plug into B9A valve-holders, and the frequencies which are tuned will depend on the coils inserted. This has the advantage that wiring is simplified, and it is not necessary to incorporate switching or coils for bands which may be of no interest.

A set of three coils is fitted for each band, these being Blue for L1, Yellow for L2 and Red for L3. The maker's range numbers and nominal tuning coverage are as follows: Range 2, 515 to 1,545kHz (580 to 194 metres); Range 3, 1.67 to 5.3MHz (180 to 57 metres); Range 4, 5 to 15MHz (60 to 20 metres); Range 5, 10.5 to 31.5MHz (28 to 9.5 metres).

For the 160 and 80 metre bands, for which the receiver was primarily intended, Range 3 coils are used. If medium wave reception is wanted, the Range 2 coils provide this. For general short wave reception, the Range 4 coils will be most suitable, with Range 5 coils if the higher frequencies are wanted.

The requisite oscillator padding capacitor for each range is automatically provided by connecting the

lower end of the tuned winding of L3 to different pins. On Range 2 the padding capacitor is C8, on Range 3 it is C9 and on Range 4 it is C10. There is no padding capacitor for Range 5 and the lower end of the tuned winding connects direct to chassis by way of pin 6.

I.F. AND B.F.O. STAGES

Fig. 2 gives the circuit of the intermediate frequency amplifier and beat frequency oscillator stages. V3 and V4 are the i.f. amplifiers. The potentiometer VR1 of Fig. 1 controls the gain of these valves by adjusting their cathode bias via R11 and R13.

The two stages provide high amplification and sensitivity. Eight i.f. tuned circuits are present, giving a much greater degree of selectivity than is obtained with simpler circuits. IFT1 and IFT2 are both centre-tapped and are coupled together by C12.

Diode D1 provides detection and an a.g.c. voltage, and the latter is applied as bias to the r.f. amplifier, and to V3 and V4. The a.g.c. voltage is also used to control the display given by the tuning indicator, V6, this

COMPONENTS

Resistors

(All fixed values $\frac{1}{4}$ watt 10% unless otherwise stated)

R1	100k Ω	R13	100 Ω
R2	47k Ω $\frac{1}{2}$ watt	R14	470k Ω
R3	68 Ω	R15	270k Ω
R4	47k Ω 1 watt	R16	100k Ω
R5	33k Ω $\frac{1}{2}$ watt	R17	47k Ω
R6	47k Ω	R18	33k Ω $\frac{1}{2}$ watt
R7	330 Ω	R19	470k Ω
R8	2.2k Ω $\frac{1}{2}$ watt	R20	1k Ω
R9	100k Ω	R21	100k Ω
R10	47k Ω $\frac{1}{2}$ watt	R22	470k Ω
R11	100 Ω	R23	270 Ω
R12	47k Ω $\frac{1}{2}$ watt	R24	1k Ω 2 watts
R25	5.6k Ω 5 watts		
VR1	10k Ω potentiometer, linear wire-wound		
VR2	500k Ω potentiometer, log, with switch S2		

Capacitors

(All fixed values plastic foil unless otherwise stated)

C1	0.05 μ F
C2	0.02 μ F
C3	0.1 μ F
C4	0.25 μ F
C5	0.1 μ F
C6	0.02 μ F
C7	47pF silvered mica
C8	350pF silvered mica 1%
C9	1,100 or 1,000pF silvered mica 1% (see text)
C10	3,000pF silvered mica 1%
C11	0.01 μ F
C12	5pF ceramic
C13	0.05 μ F
C14	0.05 μ F
C15	0.05 μ F
C16	0.1 μ F
C17	0.05 μ F
C18	0.1 μ F
C19	15pF ceramic
C20	100pF silvered mica
C21	100pF silvered mica
C22	140pF silvered mica (see text)
C23	200pF silvered mica
C24	200pF silvered mica
C25	0.01 μ F
C26	0.01 μ F
C27	32 μ F electrolytic, 350 V.Wkg.
C28	32 μ F electrolytic, 350 V.Wkg.
VC1,2,3	3 x 310pF 3-gang variable, type E3 (Jackson)
VC4,5,6	3 x 25pF 3-gang variable, type 003 or 03 (Jackson)
VC7	25pF variable, type C804 (Jackson)
VC8	25pF variable, type C804 (Jackson)
VC9	15pF variable, type C804 (Jackson)
TC1	30pF trimmer, Philips concentric

Valves

V1	6BA6	V5	6BR7
V2	ECH81	V6	EM84
V3	6BA6	V7	12AT7
V4	6BA6	V8	OA2

Speaker

LS1 3in. 3 Ω 3 $\frac{1}{2}$ in. speaker

Inductors

L1	Miniature Dual-Purpose Coil, valve usage, Blue, ranges as required (Denco)
L2	Miniature Dual-Purpose Coil, valve usage, Yellow, ranges as required (Denco)
L3	Miniature Dual-Purpose Coil, valve usage, Red, ranges as required (Denco)
L4	B.F.O. coil type BFO2/465 (Denco)
IFT1	I.F. transformer type IFT11/465/CT (Denco)
IFT2	I.F. transformer type IFT11/465/CT (Denco)
IFT3	I.F. transformer type IFT11/465 (Denco)
IFT4	I.F. transformer type IFT11/465 (Denco)
CH1	10H smoothing choke, 85ma (Home Radio Cat. No. CLF16)
T1	Valve output transformer, 5,000 to 3 Ω (see text)
T2	Mains transformer, secondaries 250-0-250V at 80mA, 6.3V at 3A, 6.3V at 1A, type MT1 (Douglas)

Diodes

DI	OA81
D2,3	Silicon rectifiers, 1A, 800 p.i.v. (see text)

Switches

S1(a)(b)(c)	3-pole 3-way rotary (see text)
S2	s.p.s.t., part of VR2

Sockets, Plugs

- 1-off B7G valveholder
- 6-off B9A valveholders
- 3-off B7G valveholders with skirts and screening cans
- 1-off B9A valveholder with skirt and screening can
- 2-off insulated sockets or 2-way socket strip for Aerial and Earth
- 2-off insulated sockets or 2-way socket strip for speaker
- 2-off plugs to fit speaker sockets

Drives, Knobs

- 2-off D Type 2-speed drive units (Jackson)
- 1-off Drive type 4103 (Jackson)
- 5-off $\frac{3}{4}$ in. knobs
- 1-off 1 $\frac{1}{8}$ in. knob (optional)
- 1-off small knob

Miscellaneous

- Case, Type 'W', 12x7x7 in. (H. L. Smith and Co.)
- 'Universal Chassis' 10x7x2 in. (Home Radio) incorporating:
 - 2-off 7x2 in. sides (Cat. No. CU136)
 - 2-off 10x2 in. sides (Cat. No. CU139)
 - 1-off 10x7 in. plate (Cat. No. CU188)
 - 1-off Hardware Kit (Cat. No. CU154A)
- 'Universal Chassis' side 5x2 in. (Home Radio Cat. No. CU134)
- Tagstrips (as required)

offering a useful aid to correct tuning and trimming.

After passing through the r.f. filter consisting of R16, C23 and C24, the detected audio signals are fed to the a.f. amplifier.

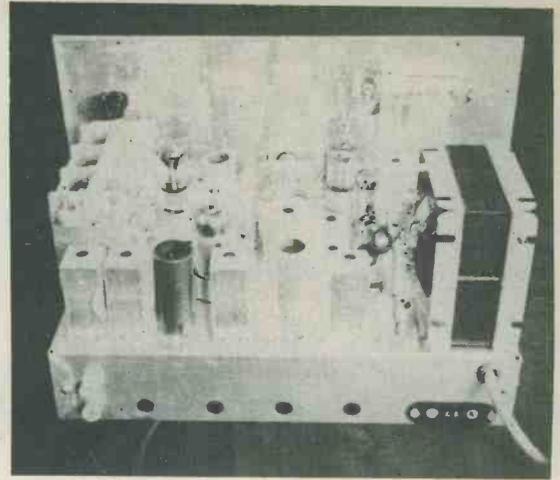
The beat frequency oscillator V5 is not in use during a.m. reception. When it is desired to receive c.w. (morse) or s.s.b. signals, switch S1 is set to position 1, whereupon h.t. is applied to V5 from the regulated supply. The b.f.o. coil, L4, is tuned by VC9, and the signal passed to diode D1 via C19. This allows the b.f.o. to produce an audio heterodyne for the reception of c.w. or to provide carrier insertion for the reception of s.s.b. signals. VC9 is adjusted by means of a small ball drive, to ease tuning here. It should be noted that, whilst V5 is a pentode, it is employed in the present circuit as a triode.

As with the earlier stages of the receiver, some simplification can be made initially. For instance, if the b.f.o. is omitted normal broadcast reception will still be obtainable on all bands, so this stage could be added later to permit reception of c.w. and s.s.b. signals.

V6 is also optional since the receiver can operate without it, and it could be wired in later.

Again, IFT1, IFT2 and V3 may be omitted initially, tag 3 of IFT3 being taken to pin 6 of V2 in Fig. 1. However, the extra gain and selectivity given by the two i.f. transformers and V3 will probably be wanted later.

Since the i.f. transformers are supplied pre-aligned and only require a small final adjustment to peak up signals, this section of the receiver should prove trouble-free. It should be noted that the centre-tapped transformers IFT1 and IFT2 have separate connections



As seen from the rear, the chassis presents an impressive appearance

for one of the windings and internal capacitors, and that their tags 1 and 2 have to be joined together.

Switch section S1(a) puts the a.g.c. out of action for c.w. and s.s.b. reception. The centre position of S1 is for 'Standby'. In this position S1(c) removes h.t. from the r.f. amplifier, frequency changer and i.f. amplifier stages. The valve heaters remain on, so that these stages can be switched on immediately.

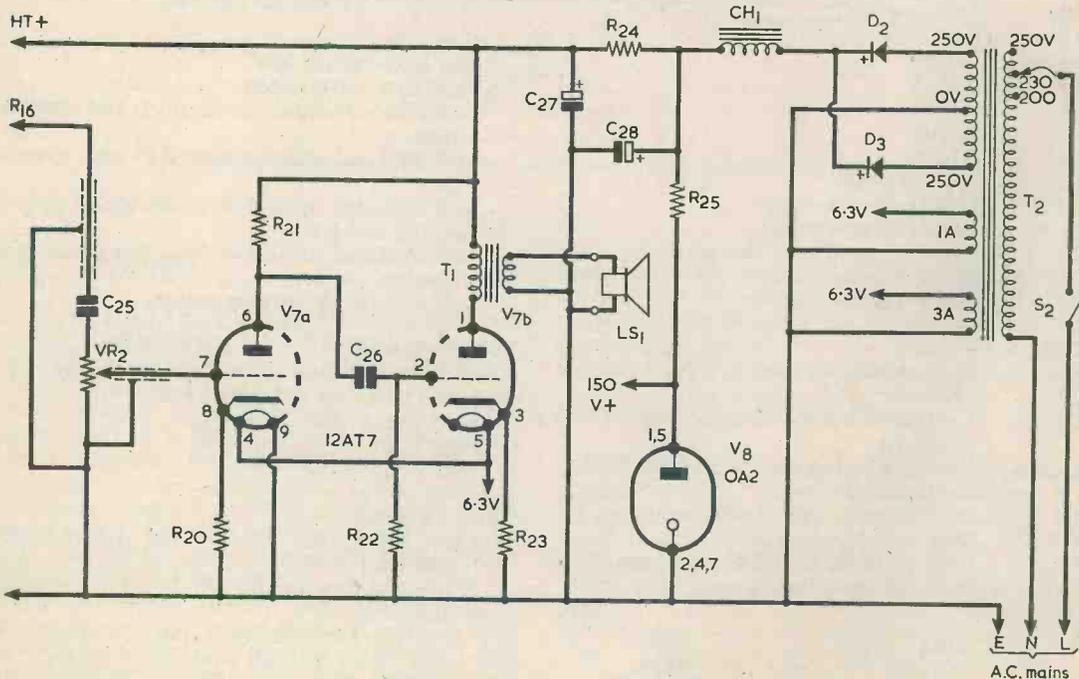
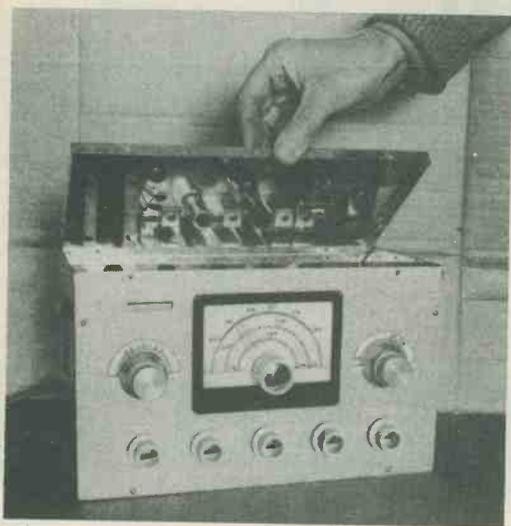


Fig. 3. The a.f. and output stages, together with the power supply and voltage regulator sections



The inside of the receiver is reflected by the underside of the lid when this is raised

A.F. AMPLIFIER

The circuit of the audio frequency amplifier and power supply is shown in Fig. 3. Audio signals pass through C25 to the audio gain control, VR2. V7 is a double-triode, employed as a 2-stage amplifier, and this easily provides enough gain and volume for this section of the receiver. T1 couples to the internal speaker, or to an external speaker.

The mains transformer T2 is used with a choke input smoothing circuit, and it runs cool over long periods of working. V8 provides the regulated h.t. supply for the oscillator and b.f.o. circuits. When S1 is in the 'Standby' position the receiver is inoperative, but h.t. is still applied to the a.f. and voltage regulator circuits.

The anode loads of all the amplifying stages are returned direct to the h.t. positive line, this being bypassed to chassis by C4 of Fig. 1 and C27 of Fig. 3. Despite the absence of individual stage decoupling it was found that the prototype receiver was quite stable. Care should be taken, in receivers built up to the circuit, to employ the same wiring layout as was used by the author.

COMPONENTS

The parts required for the basic receiver without the optional extras, i.e. the crystal marker, pre-amplifier or electronic muting circuit, appear in the accompanying Components List. A few comments need to be made concerning some of the parts.

Capacitor C9 is listed as 1,100 or 1,000pF. The value of 1,100pF is that specified by Denco as the padding capacitor for the Range 3 oscillator coil. If a capacitor with this value cannot be obtained, it could be made up with a 1,000pF and a 100pF capacitor in parallel. Alternatively, a 1,000pF capacitor may be employed on its own, and this will in practice cause only a slight deviation from the ideal tracking condition. Similarly, C22 has the value of 140pF which is specified by Denco for tuning the b.f.o. coil. The author finds that a 150pF capacitor can be used here if a 140pF capacitor cannot be obtained. The 3-gang capacitor, VC1, VC2 and VC3, is listed by Home Radio under Cat. No. VC8. The 25pF 3-gang component, VC4, VC5 and VC6, can be Jackson type 003 or 03. The type 03 version is Home Radio Cat. No. VC2F.

The two rectifiers, D2 and D3, can be any silicon types rated at 1 amp and with a p.i.v. of 800 or more. Rectifiers type 1N4006 will be satisfactory. Transformer T2 is available from Home Radio under Cat. No. TM1, or from Henry's Radio, by whom it is listed as type MT1AT. T1 is any small valve output transformer having an impedance ratio of around 5,000 to 3Ω, or a turns ratio of about 40:1. When mounted, its height should not be greater than 2 in., as it is fitted below a chassis of this depth. The speaker specified for LS1 is that fitted inside the receiver case. If an external speaker is to be used, there is no necessity to obtain LS1.

Turning next to 'hardware', the case type 'W' is available from H. L. Smith and Co. Ltd., 287 Edgware Road, London, W2 1BE. Two Jackson D Type 2-speed drive units are required, these being employed for the bandset and b.f.o. capacitors. They are supplied complete with knob and flexible spindle coupler and are listed by Home Radio under Cat. No. DL3B. The bandspread drive type 4103 has the Home Radio Cat. No. DL2A. The five lower control knobs visible in the photograph of the front of the receiver were Style SK Grey (Home Radio Cat. No. KN85B) in the prototype, and the 1½ in. knob on the bandspread drive was Style PK Grey (Home Radio Cat. No. KN84F). This last knob is optional as it replaces the knob already provided with the drive, and it was chosen to match the SK knobs. The further small knob listed is fitted internally to VC8 and can be any style.

Any other outstanding points concerning the components will be dealt with in next month's article.

(To be continued)

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.

We retain past issues for a period of two years and we can, occasionally, supply copies more than two year old. The cost is the cover price stated on the issue, plus 6p postage.

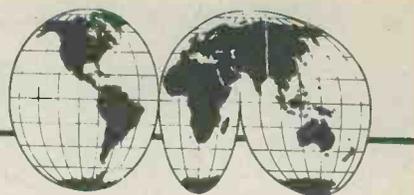
Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.

We regret that we are unable to supply photo copies of articles where an issue is not available.

Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

SHORT WAVE NEWS

FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT

Frequencies = kHz

This is being written as the setting sun of a late summer day slowly sinks beyond the western horizon and I gaze out from the shack window over a vista of Suffolk fields and woodland stretching away into the distance and beyond. Along my line of sight, from east to west, is the solid copper aerial wire. From the eaves just above the shack window to the guyed mast some 132ft distant, the aerial 'top' sways slightly in the light summer breeze often experienced on the East Anglian coast. One's thoughts go back over the years and recall some of the aeriels erected and tried, found wanting and scrapped, adjudged (somewhat empirically) efficient and retained. There have been long ones, short ones, high ones, low ones, some orthodox and others extremely unorthodox.

Extremely unorthodox? Well, take for instance those pre-war experiments with a concoction consisting of various lengths of wire from a few inches to many feet at the other end of which was connected one or more of that now defunct item of 'smallest room' hardware, the cistern copper ball. The eventual 'design' consisted of an aerial the length of the garden, the wire being festooned with half-a-dozen battered but polished copper balls that were a joy to behold. Having read that copper was an excellent material for aeriels, this was an effort to increase the copper content and thus obtain a greater signal input to the O-V-O receiver - after all, I had attained the age of thirteen and was considered by the neighbours to be something of a wireless wizard - didn't I have a new type of 'scientific aerial' in my garden?

CURRENT SCHEDULES

The information published in these schedules is correct at the time of writing but, due to various factors, sudden changes are liable to occur.

● JAPAN

Radio Japan, Tokyo, has an English Service to Europe from 0800 to 0830 on 17710 and on 17825, from 1830 to 1900 on 9700 and on 11960.

● KOREA (NORTH)

Radio Pyongyang operates an External Service in English to Europe from 2000 to 2200 on 3695, 6576 and on 9415. Also in English to the Middle East and Africa from 1800 to 2000 on 3560, 6338 and on 9777.

● POLAND

Radio Warsaw currently lists its English Service to Europe as follows - from 0630 to 0700 on 7285, 9540

and on 9675; from 1200 to 1230 on 7285 and 9540; from 1600 to 1630 on 6095, 7125, 7285 and on 9540; from 1830 to 1900 on 6095, 7125, 7285 and on 9540; from 2030 to 2100 on 7285 and 9540; from 2230 to 2300 on 5995, 6135, 7285 and on 9540.

● VIETNAM (NORTH)

The Voice of Vietnam, Hanoi, offers an English Service to Europe from 1800 to 1900 on 10040 and on 15012.

● KOREA (SOUTH)

Radio Korea, Seoul, maintains a General Service which is also directed to Europe from 0630 to 0700 and from 0900 to 0930 on 9640 and on 11925. A General Service in English, not specified as being directed to Europe, is listed on the same two channels from 1900 to 1930.

● CUBA

Radio Havana radiates to Europe in English from 2010 to 2140 on 15155.

● BULGARIA

Radio Sofia is in English to the U.K. and Eire, from 1930 to 2000 on 6070 and on 9700 and from 2130 to 2200 on the same channels.

● KUWAIT

Radio Kuwait has an English programme from 1700 to 2000 on 11825 and 15415, the latter channel is that for Europe and the former is that for East and South Asia.

● BANGLADESH

Radio Bangladesh has broadcasts in English in the General Overseas Service from 0445 to 0515 on 15455 and 17695; from 1230 to 1300 on 15520; from 1815 to 1900 on 9550 and on 11635 and from 1900 to 1915 on 9550 and on 11635, the latter transmission being a newscast read at slow speed.

● U.S.S.R.

External Services are radiated from various regional centres and to assist the reader in the logging of some of these, the following information is given.

RADIO & ELECTRONICS CONSTRUCTOR

KIEV

Radio Kiev operates in various languages from 1530 to 0100 on many channels but listen for the English broadcast on Mondays, Thursdays and Saturdays from 1930 to 2000 on **6045, 7205** and on **7390**. Most of the listed channels are used from 0030 to 0100 on Sundays, Tuesdays and Fridays during an English transmission to the Americas, listen on **6020, 9690, 11690, 11720, 11735, 11800, 11870, 11980, 12040, 12050, 15210, 15455, 17720, 17775** and on **17900**.

DUSHANBE

Radio Dushanbe operates in Persian and Tadjik from 1400 to 1830 on **7300**.

BAKU

Radio Baku is on the air from 1300 through to 1950 in Persian, Azerbaijani, Turkish and Arabic on **6110** and **9840**. From 1530 to 1600 the additional channel of **9665** is also used and from 1630 to 1700 the added channel is **6120**.

MINSK

Radio Minsk is in Belorussian to Europe from 1800 to 1830 on **7310, 9610** and on **9710** and from 2130 to 2200 on **5960, 7160** and on **7340**.

LENINGRAD

Radio Leningrad may be heard, in Russian for Soviet Fishermen, from 2230 to 2330 on **7250**.

RIGA

Radio Riga operates in Swedish and Latvian from 0800 to 0915 and from 1930 to 2200 on **5935**. From 1000 to 1100 (not on Tuesdays or Fridays) Radio Riga can be heard with the "Atlantika" programme in Russian, also on **5935**.

TALLIN

Radio Tallin can be logged in Finnish from 0800 to 1000 and from 1600 to 1630, in Swedish from 2105 to 2135 and in Estonian from 2135 to 2200, all on **6085**.

TBILISI

Radio Tbilisi is in Georgian to Europe and the Middle East from 1900 to 2100 on **5930**.

TASHKENT

Radio Tashkent is on the air from 1200 to 1800 in English, Urdu, Uigher, Hindi, Persian, Arabic and Uzbek on **7145, 9600, 15115** and on **15460**. The Alama Alma Ata transmitter also radiates these programmes on **5035, 6060, 6135, 11700, 11730** and on **11925**. Try to log the English transmission to South Asia from 1400 to 1430 on **11730, 11925, 15115** and on **15460**.

VILNIUS

Radio Vilnius operates from 2200 to 2300 and from 0030 to 0100 in English and Lithuanian. Listen from 2230 to 2300 when the English Service to Europe and North America is radiated on **9685, 11770, 11790**,

11980 and on **15370**. Channels used by Radio Vilnius are as above plus **12070**.

VLADIVOSTOK

The "Pacific Ocean Radio Station" is in Russian to the Pacific, Far East and South Asia from 0700 to 0800, from 1430 to 1530 and from 1900 to 2000 on Sundays, Wednesdays, Fridays and Saturdays on the following channels. From 0700 to 0800 on **4030, 5015, 6035, 9620, 9645, 9810, 11740, 15105, 15115, 15150, 15190, 15395, 17745, 17805** and on **17890** (also on **7135** in SSB). This transmission also relayed from Magadan on **5940, 7380, 9500** and on **12240**, also from Petropavlovsk-Kamchatka on **4485** and from Yuzhno-Sakhalinsk on **4050**.

From 1430 to 1530 on **7125, 7295, 9590, 9620, 9755, 9780, 11835, 11890** and on **12010**; from 1900 to 2000 on **5015, 7100, 7160, 7170, 7185, 7195, 7275, 7295, 9735** and on **12010**.

AROUND THE DIAL

● INDIA

All India Radio, Delhi, heard with station identification and a newscast of local events at 2100 on the regular **9525** channel. Dehli can also be heard on **11620**, where we logged them recently at 1920 when a talk in English on the subject of Indian cricket was being radiated.

● PAKISTAN

Karachi on **11672** at 1931 when broadcasting a programme of local music and songs.

● U.A.R. (EGYPT)

Cairo on **11630** at 1928 with Arabic-type music and songs.

● ISRAEL

Kol Yisrael, Jerusalem, logged on **9495** at 1935 when we heard a programme in English about U.S. support for Israel in the recent conflicts.

● CHINA

Radio Peking at 1930 on **9550** with identification and "East is Red" at sign-on.

● BRASIL

Radio Nacional de Brasilica on **15245** at 2315 in English with announcements and asking for reports.

● U.S.A.

WINB Red Lion on **15185** at 2115 with an evangelical programme in English.

● MONTE CARLO

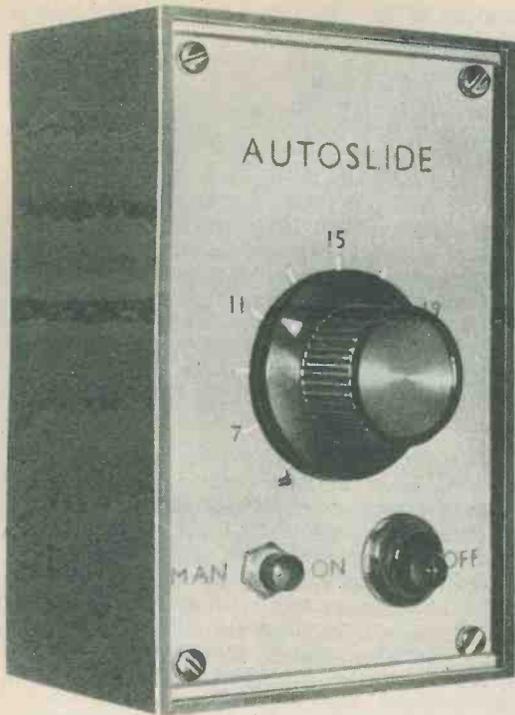
Trans-World Radio on **9525** at 0958 with identification and announcements at closure of programme in English.

● HUNGARY

Radio Budapest at 1945 on **9833** with a programme in English, also at 2145 on a later occasion.

● EQUATORIAL GUINEA

Bata at 2112 on **4926** with OM giving a talk in Spanish, also heard with African-type music and then with local pops until sign-off at 2130.



The 'Auto-slide' timer unit is housed in a neat plastic case

AUTO-

AN AUT

SLIDE

A timer unit which allows projectors to automatically change slides at intervals of 5 to 20 seconds

by S. A

NEXT TIME YOU GET OUT THOSE HOLIDAY SLIDES AND set up the projector for a show, wouldn't it be nice if you could just load the slide magazine and then allow the projector to get on with showing the slides by itself? It would, of course, be possible to control the projector with a signal from a tape recorder by using an electronic tape-slide sync. attachment, but a simpler and rather more economical arrangement can often be quite satisfactory. The production of a simple electronic control unit, by means of which the slides can be changed automatically every few seconds, is a relatively straightforward project. In this article an electronic slide change control unit is described which gives a pre-set time delay between slide changes. The delay is variable from about 5 to 20 seconds as desired.

SLIDE CHANGE MECHANISM

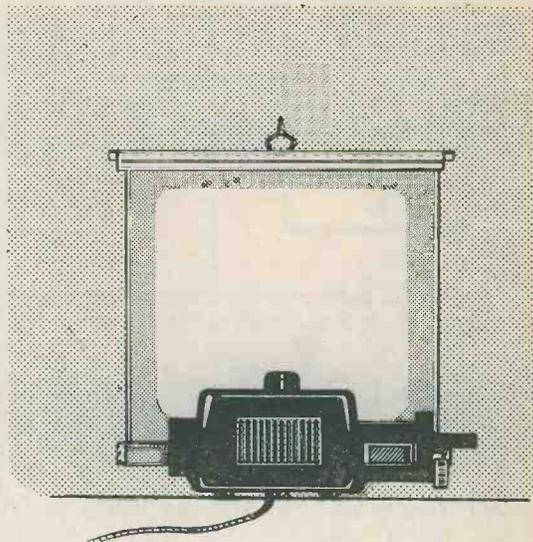
Many modern slide projectors have an automatic slide change mechanism which can be remotely controlled by a push button switch. Usually this mechanism is driven by a small motor similar to the type used in tape recorders. A basic circuit diagram of the system is



Inside layout of the block, which is cut from the front panel. The panel fits into the

'SLIDE'

OMATIC TIMER



Money



unit. The 2-way terminal
from a longer terminal strip,
of the Veroboard panel.
external grooves in the case

COMPONENTS

Resistors

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

R1	220k Ω
R2	15k Ω
R3	470 Ω
R4	100 Ω
VR1	1M Ω potentiometer, linear

Capacitors

C1	22 μ F tantalum bead electrolytic, 16 V.Wkg.
C2	0.1 μ F, 600 V.Wkg.

Integrated Circuit

IC1	NE555V or equivalent
-----	----------------------

Triac

CSR1	TAG302-400
------	------------

Switches

S1	s.p.s.t. toggle
S2	Press-button, push to make

Battery

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

Miscellaneous

Case, 'Zippy' type P2
2-way terminal block
Battery connector
Veroboard, 0.1 in. matrix
Knob

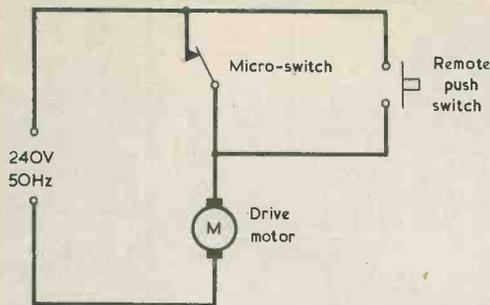


Fig. 1. The basic projector circuit which allows remote changing of slides

shown in Fig. 1. For the sake of simplicity the resistors and diodes, normally fitted to provide dynamic braking of the motor, have been omitted from the diagram.

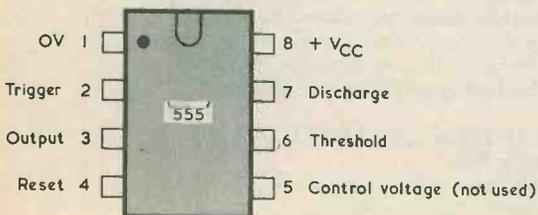
A microswitch S1 which is operated by the slide change mechanism controls the supply to the drive motor. This switch is so arranged that it breaks the motor supply when the slide change operation is complete and the new slide is set up in the projector gate.

To start a new slide change sequence the contacts of the microswitch are momentarily short circuited by the external control push button S2. This allows the motor to start running and, as the slide change mechanism gets under way, the microswitch is released and its contacts close. The motor will continue to run after the push button has been released and the slide change goes on to completion.

To achieve continuous automatic slide changes the external electronic control unit must simulate the action of the remote push switch at intervals of a few seconds.

DELAY TIMING CIRCUIT

Timing in electronic circuits is frequently determined by charging, or discharging, a capacitor through a resistor. The associated electronic circuitry required to produce suitable pulse outputs can be conveniently packaged in an integrated circuit. In this case the Signetics type NE555V timer circuit, or one of its direct equivalents, is used. This device comes in an eight pin dual-in-line package and its pin connections are shown in Fig. 2.



Basically the 555 timer circuit contains a flip-flop switch and two level sensing comparator circuits, which are used to trigger the flip-flop into its 'on' or 'off' state as required. In addition the circuit contains a switching transistor controlled by the flip-flop. This transistor is turned on when the flip-flop is in its 'off' state and can be used to discharge the timing capacitor.

Each of the level sensing circuits compares the voltage at its input against an internally generated reference level. The input to the first comparator is called the 'trigger' input. When the voltage applied to this input is less than one-third of the supply voltage level the comparator switches and triggers the flip-flop into its 'on' state. At this point the output voltage from the 555 will rise to the supply voltage level. The input to the second comparator is called the 'threshold' input. In this case the comparator becomes activated when the input voltage applied rises above two-thirds of the supply voltage. This second comparator resets the flip-flop to its 'off' state and causes the output voltage from the 555 to fall to zero.

To obtain a continuous series of output pulses the 555 is connected as shown in Fig. 3. Here the two comparator inputs are joined in parallel and fed by the voltage across the timing capacitor C. This capacitor is then made to charge and discharge through resistors R1 and R2.

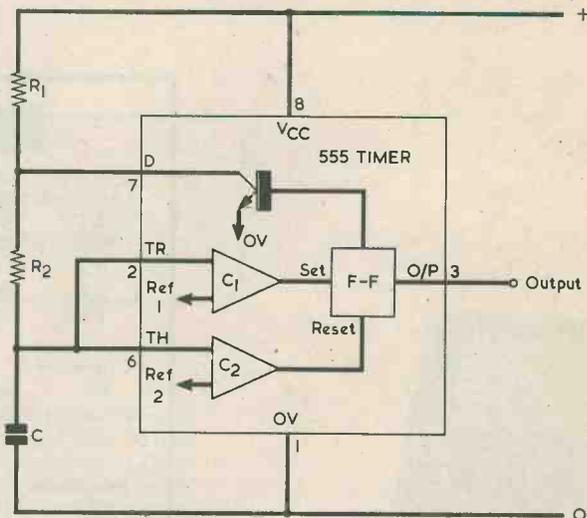


Fig. 3. The internal circuitry of the i.c. shown in simplified form

Suppose we start with the capacitor discharged and the voltage across it at zero. Since the input to the 'trigger' comparator is below one-third of the supply voltage the flip-flop switches 'on'. The discharge transistor then turns off and allows the capacitor to charge towards the supply voltage through the resistors R1 and R2. The capacitor voltage rises until it reaches two-thirds of the supply level when the 'threshold' comparator is activated and the flip-flop turns 'off'. At this point the discharge transistor turns on again and the capacitor discharges through R2 and the transistor.

When the voltage across the capacitor falls below one-third of the supply voltage the flip-flop turns 'on' once more and the cycle begins again. The circuit will therefore oscillate continuously and produce a series of output pulses at regular intervals.

To initiate a slide change a short pulse of about a quarter second duration is required. This short pulse is obtained whilst the capacitor discharges and its length is governed by the time constant of C and R2. The interval between the pulses determines how long a slide will remain on the screen and is governed largely by resistor R1 which is much larger than R2. By making R1 variable the time delay between slide changes can be adjusted as required.

POWER SWITCH

Although a relay, energised from the output of the 555 circuit, could be used to simulate the action of the remote push button switch, it was felt that a solid-state electronic switch would be more compact and possibly more reliable.

Slide change drive motors are normally run from the alternating mains supply to the projector. The high voltages involved tend to rule out the use of a simple transistor as a switch, but a thyristor could be used to switch the motor supply. When a thyristor is turned on, by applying a positive voltage to its gate electrode, it will conduct but will only pass the positive half-cycles of the supply. A thyristor switch was initially tried in the prototype unit but it was found that, due to the half-cycle conduction, the amount of power supplied to the motor was insufficient to ensure reliable operation.

An alternative switch device is the triac which is in effect two complementary thyristors connected in parallel. This device, when turned on, conducts both half-cycles of the supply and therefore transmits full power to the motor. A triac can be triggered by either a positive or negative voltage applied to its gate but generally a negative input signal gives more consistent operation. Because the triac conducts in both directions its other terminals are called the 'Main Terminals', the one near the gate being 'number 1'. The windings of the motor present an inductive load to the triac switch and large voltage transients can be produced when the triac switches on or off. To prevent breakdown or even destruction of the triac a transient suppressor made up from a resistor and capacitor is wired across the main terminals.

CONSTRUCTION

The complete circuit of the timer unit is given in Fig. 4. Most of the components can readily be mounted on a small piece of Veroboard. This should be of the 0.1 inch matrix type to match with the pin spacing of the integrated circuit. A suitable layout for the board is shown in Fig. 5. The breaks in the copper tracks of the Veroboard can be made either by using the Vero cutter tool or by carefully using a $\frac{3}{16}$ in twist drill. The dimensions of the piece of Veroboard shown are designed to allow it to be fitted into a 'Zippy' type P2 plastic case. If an alternative case is used the Veroboard should be cut to fit the case being used. After assembly is complete check that no solder has run between the copper tracks to produce unwanted short-circuits between tracks.

A PP3 size transistor radio battery is used to provide the 9 volt supply for the 555 circuit. It is mounted

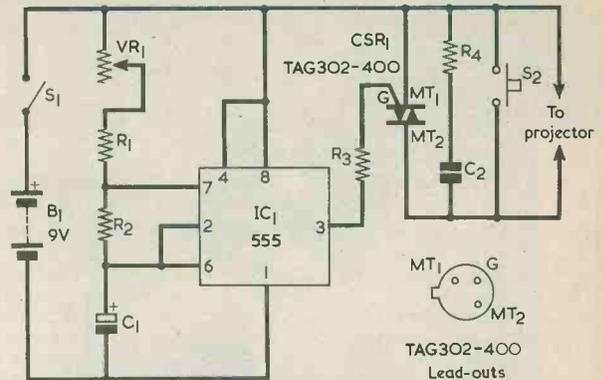


Fig. 4. The circuit of the automatic slide timer

between the circuit board and one end of the case and is held in position by foam plastic packing.

A tantalum bead type electrolytic capacitor should be used for the timing capacitor C1 since it is essential that this capacitor has a very low leakage current. The timing resistor for the delay between slide changes is made up from a fixed resistor and a 1 MΩ linear track potentiometer. This potentiometer is mounted on the front panel of the case. A switch for the battery supply and a push-button switch are also mounted on the panel. The push-button switch can be used for manual operation of the slide changes if automatic operation is not

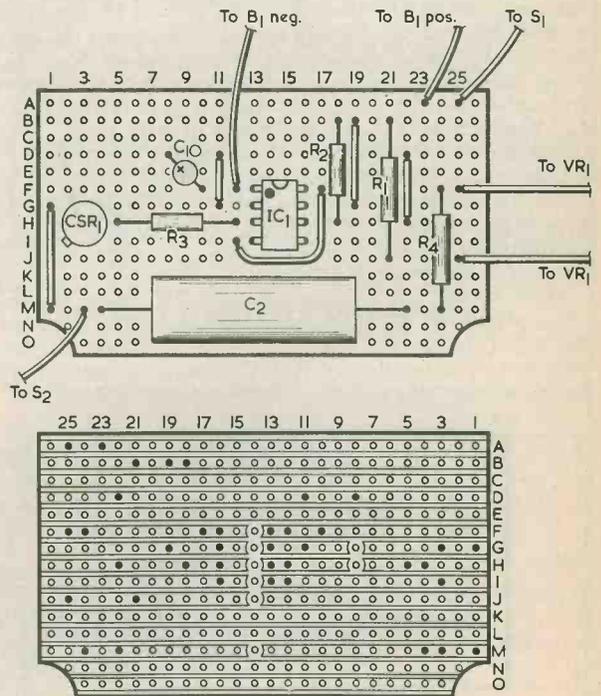
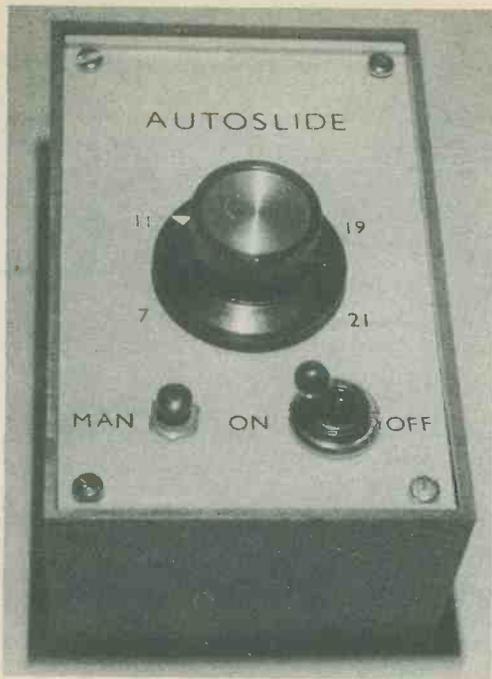


Fig. 5. Component and copper sides of the Veroboard panel. The lower corners are cut away to allow leads from the battery and the projector to pass



Another view of the completed timer unit

required. Drilling details for the front panel are given in Fig. 6.

Turning again to Fig. 5, there are a few points here which require amplification. The Main Terminal 1 of the triac connects to the Veroboard at hole I3, the gate at hole H4 and the Main Terminal 2 at hole G3. The lead from hole A25 connects to one tag of S1. The other tag of S1 connects, at the front panel, to the upper end (as seen in Fig. 4) of VR1 track. The lead from hole F25 also connects to the upper end of VR1 track. The upper end of VR1 track connects, further, to one tag of S2 and to one terminal of a 2-way terminal block which takes the two wires from the projector. The lead from hole M3 connects to the other tag of S2 and to the other terminal of the 2-way terminal block. The slider of VR1 connects to the Veroboard at hole J25.

With respect to components, the 555 timer i.c. is available as the NE555V, MC1455P, LM555CN or as the R.S. Components '555 Type' timer. The last can be obtained from retailers of R.S. Components parts. The tantalum bead electrolytic capacitor required for C1 is

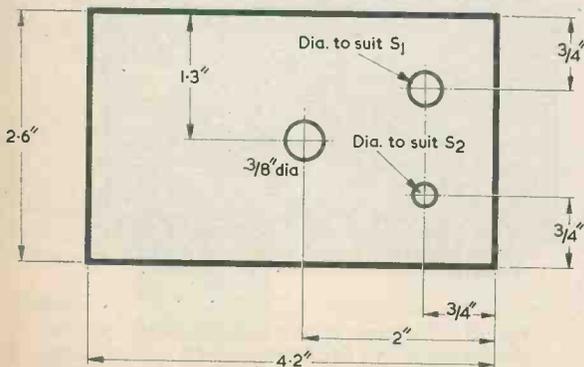
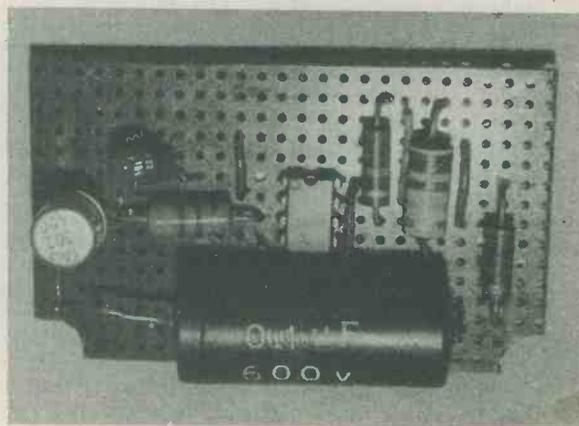


Fig. 6. The front panel of the case is drilled as shown here

listed by Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. The 'Zippy' case type P2 is available from a number of suppliers, including Swanley Electronics, 32 Goldsel Road, Swanley, Kent, BR8 8EZ. The switch employed in the S2 position should have insulation suitable for mains voltages. The author employed an R.S. Components miniature push-to-make 1-pole push-button, but the exact type used is not critical. The triac type TAG302-400 has a maximum forward voltage rating of 400 volts and a maximum r.m.s. current rating of 2 amps. It is available from Electrovalue Ltd.

OPERATION

The two wires that originally connected to the remote push switch of the projector system are now connected to the 2-way terminal block, whereupon they become coupled to the Main Terminals of the triac. The wires can pass through a hole in a side or end of the case. Before connecting the projector to the mains, switch on the battery supply and check with a meter that the output voltage at pin 3 of the 555 falls momentarily to zero every few seconds. Check that varying the timing control, VR1, varies the timing between pulses. Now the projector supply can be switched on and a check made



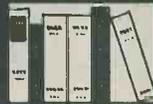
The components assembled on the Veroboard panel

that the slide change mechanism is actuated by the timer unit. Because of tolerance in the value of the electrolytic capacitor the time scale on the potentiometer needs to be calibrated with the capacitor actually used. Alternatively a simple 0 to 10 scale can be used on the timing control.

To hold a slide on the screen the battery supply switch is turned off until a new slide change is required. By using the push-button on the unit a slide can be manually started whether the battery is switched on or not.

The author's projector is a Boots Automatic Turbo 'Q1' type, which is basically similar to the Gnome range of slide projectors. The current drawn from the PP3 battery in the timing unit is approximately 5 to 6mA for all time settings. There is a short pulse of current up to about 25mA when the slide change occurs but this has little effect on the mean current drain. Battery life for a PP3 is about 10 to 15 hours. ■

RECENT PUBLICATIONS



BASIC AUDIO SYSTEMS. By Norman H. Crowhurst.
246 pages, 215 x 135 mm. (8½ x 5½ in.) Published by Foulsham-Tab Ltd. Price £1.60.

This title is in the Foulsham-Tab list of American texts with an introductory chapter for English readers.

Norman H. Crowhurst is a well-known writer on hi-fi matters in the U.S.A., and the present book shows his competent grasp on the subject. However, the accent here is more on audio in general and the book is intended mainly to deal with the overall field of sound recording and reproduction rather than with the minutiae of hi-fi design. The treatment is at a basic level and will appeal in particular to the reader who wishes to learn the fundamentals of sound systems. The book does not hesitate to refer to the historical development of a particular technique where this is of interest or assists in explanation.

The book commences with a chapter on the nature of sound, this being followed by chapters on microphones and loudspeakers, and on binaural and stereo systems. Further chapters deal with recording storage and transmission media, amplifying devices and methods, distortion and feedback. The final two chapters discuss basic electronic sound reinforcement and reproduction systems and the solutions to such problems as acoustic feedback and reverberation.

Also published by Foulsham-Tab Ltd., and having the same presentation and page size, are the following books.

MODERN ELECTRONIC TROUBLESHOOTING. 262 pages. Price £1.30.

Consisting of material which previously appeared in the American magazine 'Electronic Technician/Dealer', this book gives practical advice on fault-finding in domestic entertainment equipment, including radios, monochrome and colour television receivers, and tape recorders. The approach is essentially down-to-earth, and the volume is intended for the working service engineer who derives his livelihood from quick and accurate troubleshooting.

CONNECTING DIAGRAMS FOR INDUCTION MOTORS. By A. C. Roe.
138 pages. Price £1.20.

Dealing with an unusual subject, this book gives connection diagrams which show the wiring for 2 phase and 3 phase lap wound induction motors.

The diagrams cover 4, 6, 8, 10 and 12 pole windings. There are, in all, 72 diagrams and these are listed in two tables which classify them in sections comprising 2 phase, 3 phase star and 3 phase delta systems. Where necessary, details are given for carrying out electrical and mechanical checks on the windings.

UNDERSTANDING AND USING THE VOM AND EVM. By John Cunningham.
198 pages. Price £1.50.

The letters 'VOM' in the title of this book stand for 'volt-ohm-milliammeter', and they constitute the common American abbreviation for what we refer to as a multimeter. 'EVM' is short for 'electronic voltmeter', and this description takes in valve voltmeters, f.e.t. voltmeters and digital voltmeters.

The book provides considerable detail on its subject, dealing first with the design of the test instruments themselves and then going on to discuss their use in measuring voltage, current, resistance and power. Also dealt with are decibel measurements, and the checking of batteries, semiconductors and capacitors. Next described is the role of the testmeter in checking car, valve and solid-state circuits. The concluding chapters in the book cover measurements in industry, miscellaneous applications, accessories and maintenance.

The treatment is non-mathematical, and the few formulae and calculations that appear are included to provide completeness only.

MODEL CAR RACING ... BY RADIO CONTROL. By George Siposs.
230 pages. Price £1.40.

Radio control has its devoted followers in the U.K., the main interest being centred in radio controlled aircraft and boats. However, in America the radio control scene has also taken in the racing of radio controlled model cars.

The volume under review is not really a book about the electronics involved in model car racing, but is more concerned with the assembly, maintenance and operation of radio controlled cars. Indeed, the reader need have only a negligible knowledge of electronics, and it is assumed that he will fit ready-made commercially available control gear into the models he assembles. (So far as available equipment in this country is concerned, it may be mentioned that the suppliers of Heath-kits list a range of radio control equipment in their latest catalogue, including a model racing car. Their address is Heath (Gloucester) Ltd., GL2 6EE, Gloucester).

The book is mainly concerned with the mechanics of racing model cars, but there are also sections on preparation and etiquette for race meetings, the art of driving and the organisation of race club activities. An attractive feature of the book is that it is profusely illustrated with photographs of cars and car mechanisms, and of race activities.



TOUCH ACTIVATED

This device switches an external circuit alternately on and off as a sensing plate is touched

by A. P. Roberts

TOUCH SENSITIVE SWITCHES, WITH WHICH IT IS ONLY necessary for the operator to touch a sensor to initiate the switching action, are becoming increasingly popular. This is probably because of their novelty value as they often have no moving parts, as occurs with a conventional push-button. If it is desired that a number of contacts or a changeover circuit be activated then a relay may be needed at the output, but even then the moving parts of the relay are remote from the touch plate sensor.

A conventional approach in devices of this nature operates on the principle illustrated by Fig. 1. This diagram shows an emitter follower input stage without a base bias resistor which is directly coupled to a Schmitt trigger. The electrodes of the touch plate are connected between the base of the emitter follower and the upper supply rail. As the circuit stands, the transistor is cut off and only minute leakage currents flow. The voltage across the emitter resistor, R_E , will be extremely small and will not activate the Schmitt trigger. If a finger is placed on the touch electrodes, the consequent resistance applied between these will cause a small bias current to flow to the base of the emitter follower. An amplified emitter current will flow through R_E , causing a voltage to appear across this resistor which is sufficiently high to change the Schmitt trigger to its alternate state. The Schmitt trigger will then turn on the controlled circuit coupled to its output.

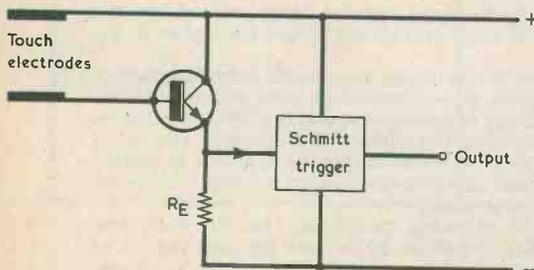


Fig. 1. A possible method of operation for a touch activated switch

The Schmitt trigger is incorporated to ensure that the controlled circuit is either definitely on or definitely off, with no intermediate state.

One obvious shortcoming with the arrangement of Fig. 1 is that the controlled circuit is turned on only when the sensor is touched, and that it turns off again when the finger is removed. A possible remedy could consist of replacing the Schmitt trigger with a bistable circuit. However, this would still not be suitable for many applications as, once triggered, the bistable circuit would latch on in the triggered state, and so touching the sensor would have no further effect on the device.

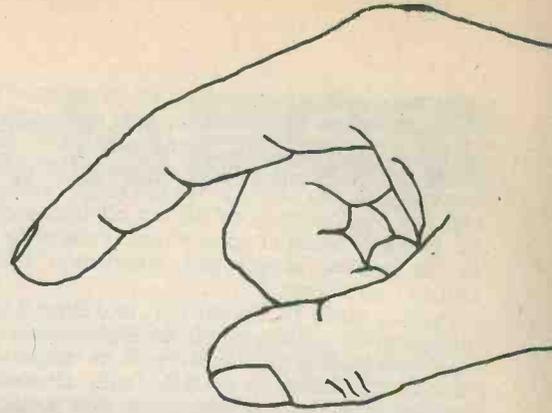
FLIP-FLOP CIRCUIT

The touch sensitive switch evolved by the author uses a flip-flop, or divide-by-two circuit. With this type of circuit, touching the sensor causes the output of the device to change state and remain in that state until the sensor is touched again, whereupon it changes back to its original condition. The circuit of the device is shown in Fig. 2.

Instead of an emitter follower, a compound amplifier incorporating the two directly coupled transistors, TR1 and TR2, is employed at the input to give increased sensitivity. Normally, only a very small leakage current flows in these transistors, and the collector of TR2 is virtually at the same potential as the positive supply rail. If the sensor is touched, the base current in TR1 causes an amplified collector current to flow into the base of TR2, whereupon the latter becomes conductive and its collector voltage drops nearly to the potential of the lower supply rail.

TR3 and TR4 appear in the flip-flop circuit. When the supply is initially switched on both TR3 and TR4 will commence to pass current, but one will turn on faster than the other. For the sake of illustration, let us say that it is TR3 which turns on faster. As TR3 turns on, the voltage at its collector will fall, and this will reduce the base bias current applied to TR4 via R2. TR4 collector voltage will in consequence rise, giving a greater base bias current to TR3 via R3, and thereby causing TR3 to become more conductive. This regenerative action will continue very rapidly until TR3 is turned hard on and TR4 is fully cut off.

SWITCH



COMPONENTS

Resistors

(All $\frac{1}{4}$ watt 10%)
 R1 8.2k Ω
 R2 10k Ω
 R3 10k Ω
 R4 5.6k Ω
 R5 68k Ω
 R6 68k Ω

Capacitors

C1 10 μ F electrolytic, 16V Wkg.
 C2 10 μ F electrolytic, 16V Wkg.

Semiconductors

TR1 2N4061
 TR2 2N2926G

TR3 2N706A
 TR4 2N706A
 D1 OA91
 D2 OA91
 D3 OA91

Relay

RLA1 relay, with contacts as required (see text)

Switch

S1 s.p.s.t. toggle

Miscellaneous

Veroboard, 0.1 in. matrix
 9-volt battery
 Battery connector

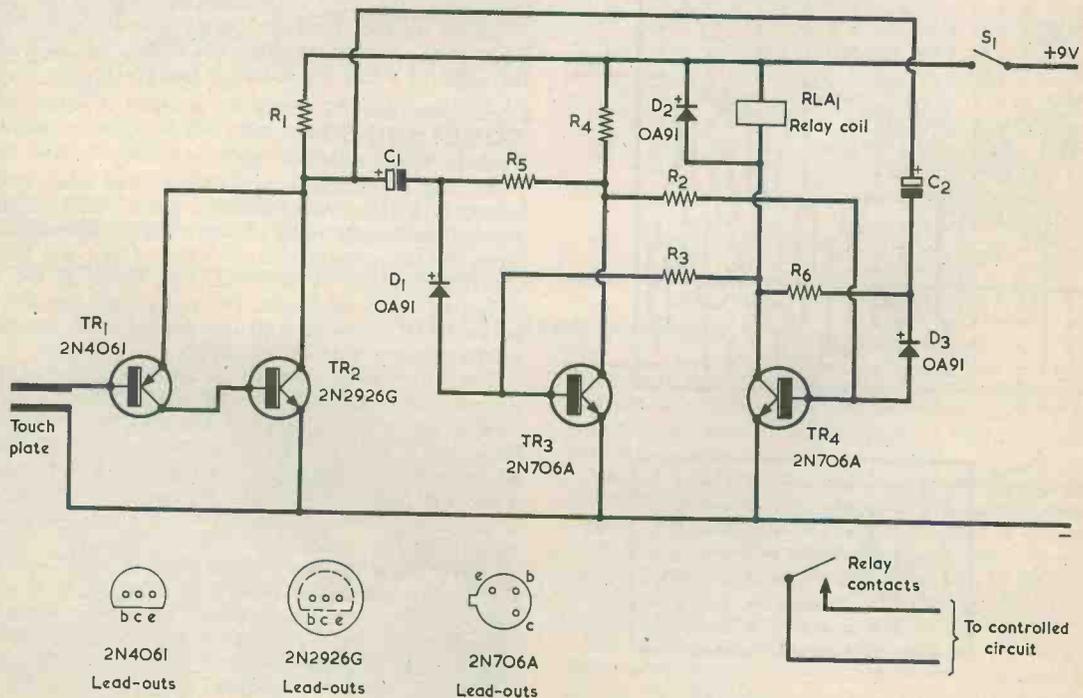


Fig. 2. The touch activated switch circuit described in this article. This incorporates a flip-flop which changes states each time the sensor is touched

At the same time, the voltage on the positive terminals of C1 and C2 is virtually the same as that on the positive supply rail. Since TR3 is turned hard on, its collector is close to the negative supply potential, whereupon C1 becomes charged nearly to the full supply voltage via R1 and R5. The collector of the cut off transistor TR4 is, on the other hand, at approximately the same potential as the positive supply rail, whereupon C2 acquires virtually no charge.

Further, since TR3 is hard on, and since it is a silicon transistor, its collector will be slightly negative of its base, whereupon diode D1 will be slightly forward biased. The collector of TR4 will, alternatively, be positive of its base by nearly the full supply voltage, whereupon D3 will be reverse biased.

In order to make the flip-flop change states it is necessary to feed a negative pulse to the base of whichever transistor is turned on. In our present example this is TR3. The negative pulse initiates a second regenerative action, resulting in TR3 being turned off and TR4 turned on.

When the sensor is touched, a suitable negative pulse is produced across R1, and this is coupled to TR3 base via C1 and D1, and to TR4 base via C2 and D3. Since C1 is charged nearly to the full supply voltage, the base of TR3 will be taken well negative of the lower supply rail and it will become cut off. Because C1 has a

negligibly small charge, the base of TR4 will not be taken sufficiently negative for this transistor to cut off and it will be capable of being turned on by the rising collector voltage of TR3.

Thus, touching the sensor causes TR3 to turn off and TR4 to turn on. As soon as the finger is taken off the sensor, the collector voltage of TR2 rises once more to nearly the full positive supply voltage. This time, C2 takes up a charge via R6 and R1, whilst C1 discharges via R1, R5 and R4. If the sensor is touched again, the charged C2 will cause TR4 to turn off and TR3 to turn on, whereupon the circuit reverts to its original state.

We have assumed that it is TR3 which turns on when the 9 volt supply is switched on. In practice, it could be either TR3 or TR4. If, after the supply is applied, the transistor which turns on is not the desired one, the sensor is touched once, bringing the circuit to the required condition. After this, the flip-flop will change alternately from one state to the other each time the sensor is touched.

When TR3 is turned on it causes relay RLA1 to energise. This relay then switches on the controlled circuit as required. Diode D2 is included to prevent the formation of a high back e.m.f. across the relay coil when it releases. The relay employed by the author was a non-standard type with a coil resistance of 700Ω and was capable of energising at the voltage available. Alternatively, a P.O. 3000 relay with a 500Ω coil could be used. P.O. 3000 relays made up to customer's specification are available from L. Wilkinson (Croydon) Ltd., Longley House, Longley Road, Croydon. Any other type of relay having a coil resistance of 500Ω or more, and which is capable of energising at slightly less than 9 volts, may also be employed in the circuit.

The current drawn by the unit is approximately 1.5 to 2mA when the relay is de-energised, and is the current required by the relay coil when this is operated. An additional current slightly in excess of 1mA flows through R1 when the sensor is touched.

CONSTRUCTION

All the components apart from the relay and the on-off switch are mounted on a piece of 0.1 in. matrix Veroboard having 19 by 17 holes. This is shown, as seen from the component side, in Fig. 3. Only one break in the copper strips is required, this being at the point indicated in the diagram. Do not forget the link wire between TR2 emitter and the copper strip connecting to the negative side of the supply.

The touch plate consists of another piece of 0.1 in. matrix Veroboard, this having 13 by 7 holes. Alternate copper strips are connected together by link wires as indicated in Fig. 3, the two sets of strips being coupled to the input points on the larger piece of Veroboard. The touch plate is mounted with its copper side outward, and it is only necessary to touch any two adjacent strips to activate the device.

It is possible to use a printed circuit board touch plate, but the author found that such a board gave inferior results. One problem is that the copper areas of a printed circuit board soon become tarnished, and do not then allow a good contact to be made. The copper strips of the Veroboard do not corrode nearly as quickly.

The prototype is used as a touch-operated wave-change switch for a medium and long wave a.m. tuner. It is very sensitive and the slightest touch on the sensor is sufficient to operate it.

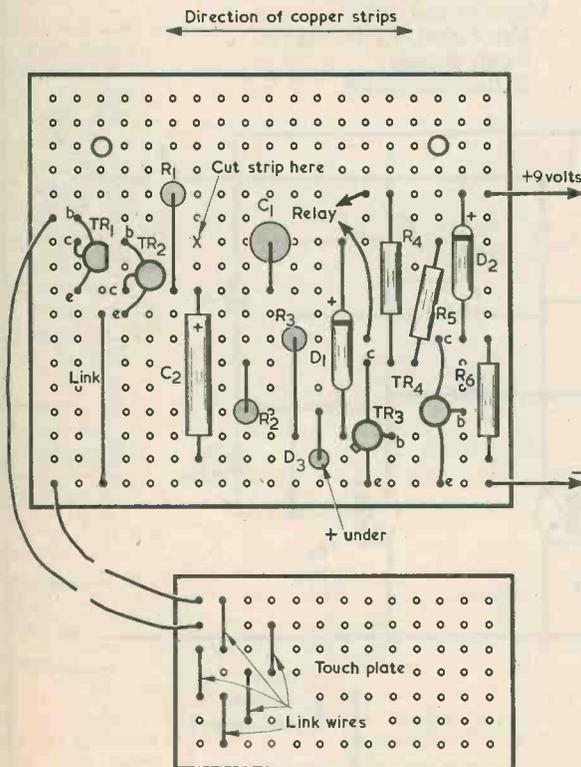
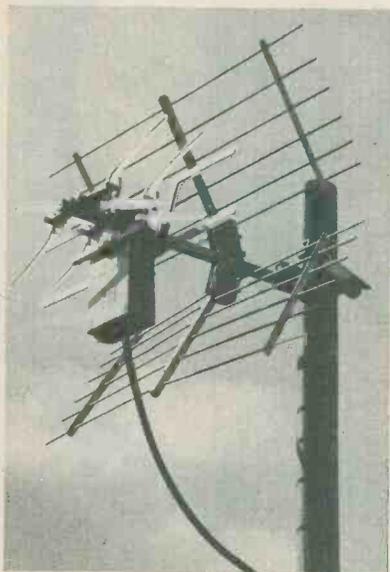


Fig. 3. Most of the components are mounted on a piece of Veroboard with the layout shown here. The touch plate consists of a second piece of Veroboard

New Products



FUBA XC 311 AERIAL

The range of XC 311 aerials manufactured by Fuba of West Germany and distributed in the UK by Audio Workshops Ltd of 29 High Street, Robertsbridge, Sussex, measures only 50 cms in width by 43 cms (maximum) in length, yet gives a truly remarkable improvement in colour signal reception over competitors.

This eleven element unit has been developed to meet the needs of a market demanding brilliant reception on medium and near-distance transmitter areas – and results from over 15 years of development work by Fuba's professional engineers throughout the world.

Simple to erect, with all joints interlocking simply for permanent fixture, the XC 311 has a protective coating on all aluminium parts, and cadmium plating on all steel parts for protection against corrosion and rust.

The range incorporates Fuba's new AKV 450 amplifier which has important unique advantages over normal UHF amplifiers.

The power to operate the amplifier is fed up the coaxial cable by the TKN 22 power supply unit (220–240 volts AC input, 24 volts DC output, positive earth).

REED SWITCH

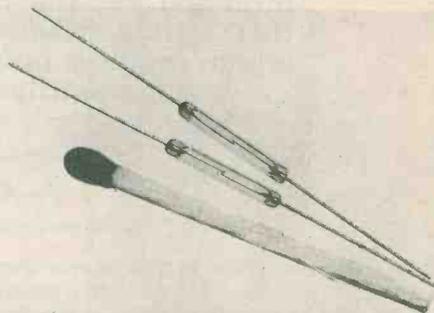
The TRA-293 reed switch has been specifically designed for use in dual-in-line reed relays, and other applications where small size is essential.

The glass diameter of TRA-293 is only 0.090 ins. and the glass length is 0.600 ins.

The switch is rated at 10 watts, 250 milliamps and a breakdown voltage of 250 volts.

The total sensitivity range available from stock is 15–50 A.T. in 10 A.T. bands.

Further details are available from FR Electronics, Switching Components Group, Wimborne, Dorset.



CASSETTE HEAD CLEANER



A newly-designed Scotch cassette head cleaner from 3M features a special thin-base cleaning material which requires just one 15-second pass at 40-hour operating intervals.

Made by 3M in America, the cleaner is supplied in a silver and black bubble-packed library case for exclusion of dust. The pink coloured cleaning tape is designed to take up oxide or any other debris accumulating on the magnetic heads, rollers or capstans, and to polish these components for maximum recording efficiency and freedom from dropouts.

3M states that each cleaner will provide about 24 cleaning operations under normal conditions, and thus will last for 960 hours – 40 days – of continuous recorder operation in either record or playback mode. A card insert has full operating instructions and provisions for checking off the number of times the cleaner has been used.

Recommended retail price, including VAT, is 99p.

TRANSFILTER I.F. AMPLIFIER

by P. R. Arthur

Intended for the more experienced constructor, this article describes a transfilter i.f. amplifier which requires only one i.f. transformer. A useful a.f. amplifier circuit is also discussed

A NOTABLE SIMPLIFICATION IN THE DESIGN AND ALIGNMENT of i.f. amplifiers for transistor superhets can be achieved by the use of transfilters in place of i.f. transformers. Transfilters are resonant ceramic devices and the type used in the circuit to be described have different type numbers for operation at specific frequencies in the range of 455 to 500kHz. The transfilters employed here may be either TO-02B (465kHz) or TO-02D (470kHz). The latter type is available from Henry's Radio, Ltd.

The circuit is presented to show the more experienced constructor the manner in which transfilters can be connected in an i.f. amplifier. To give a complete picture, the mixer-oscillator stage of the associated receiver is included in the circuit, but it has to be pointed out that this uses a Weyrad ferrite aerial and oscillator coil. Since Weyrad (Electronics) Limited have now ceased production of parts for the home-constructor market, it is possible that readers may not be able to obtain these two components, with the consequence that the circuit cannot be presented as a constructional project for a complete superhet. The more knowledgeable constructor should, however, be able to use different ferrite aeriels and oscillator coils, whereupon a mixer-oscillator stage incorporating these alternative components can couple into the first transfilter in the same manner as with the present circuit.

CIRCUIT DIAGRAM

The complete receiver circuit appears in Fig. 1. The mixer-oscillator stage uses the Weyrad components just referred to in a standard circuit configuration. S1(a)(b) is the wave-change switch. When this is set to medium waves, S1(a) selects the appropriate base coupling winding, L2, whilst S1(b) short-circuits the long wave tuned winding, L3. On switching to long waves, S1(a) selects the long wave base coupling coil, L4, and S1(b) takes the short-circuit off L3 thereby causing L1 and L3 to be connected in series. S1(b) also connects C5 across the oscillator tuned coil, thereby making this operate at the lower frequencies required for long wave reception.

The intermediate frequency is taken off at the upper end of the oscillator coil collector coupling winding, this being coupled directly to the input of the first transfilter TF1. As can be seen, the coupling circuit is extremely simple. A similarly simple circuit couples the output of TF1 to the first i.f. transistor, TR2. The collector of TR2 couples directly to the input of transfilter TF2, whose output in turn connects to the base of TR3.

Transfilters possess secondary resonances at frequencies other than their nominal frequency, and it is necessary to employ a standard i.f. transformer before the detector to filter out the responses at these secondary

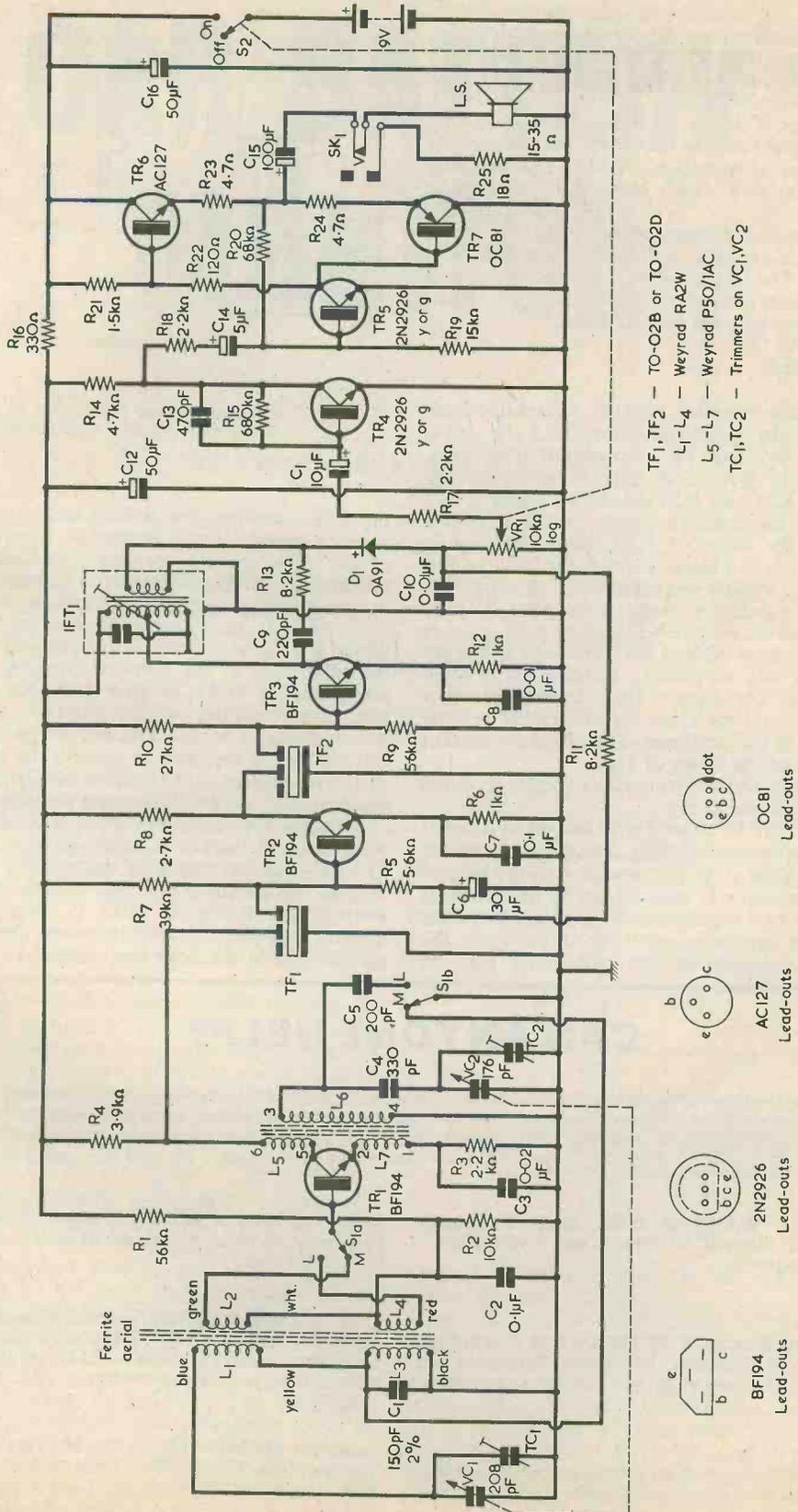


Fig. 1. Circuit diagram of the receiver. TF1 and TF2 are the two transformers

frequencies. The i.f. transformer can be any single tuned type suitable for coupling to a diode detector, such as the Denco IFT14. The Denco transformer is intended for operation at 470kHz. C19 and R13 were required in the author's circuit to prevent instability, and are not needed if the circuit functions satisfactorily without them. Should they be necessary, the connections to the i.f. transformer secondary should be experimentally transposed to find which method of connection gives best results.

Diode D1 detects the intermediate frequency signal and also produces an a.g.c. voltage for application to TR2 via R11. The a.g.c. voltage is negative and increases with signal strength, thereby causing a reduction in the positive bias fed to TR2 base.

A.F. AMPLIFIER

The a.f. amplifier section is quite straightforward, with TR4 being the input transistor, TR5 the driver transistor and TR6 and TR7 the output transistors. C13 is included to give good stability in the circuit. The junction of R23 and R24 should be about 4 to 5 volts positive of the negative supply rail. If it is at a higher voltage, the value of R20 should be slightly reduced and, if it is at a lower voltage, the value of this resistor should be slightly increased.

The speaker impedance may be between 15 and 35Ω, a greater power output being given with a lower impedance component. Socket SK1 provides an output suitable for an 8Ω earphone, resistor R15 being included to raise the output load impedance to a satisfactory level and to allow a comfortable volume level to be given in the earphone. The quiescent current of the receiver is of the order of 5MA.

The tag layout of the two transfilters employed in the receiver circuit is given in Fig. 2.

The i.f. stages may be aligned with the aid of a signal generator or with received signals. The signal generator output is coupled via an 0.1μF capacitor to the base of TR1 and the generator is then set up to the resonant frequency of the two transfilters. Volume control VR1 should be set to maximum, and the output from the signal generator should be just sufficiently high to

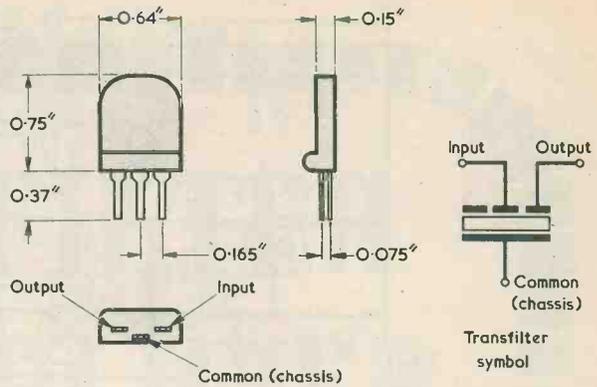


Fig. 2. Dimensions and tag layout of the transfilters type TO-02B and TO-02D

produce a comfortably audible tone from the speaker. A weak input signal is needed as, otherwise, the a.g.c. circuit will come into operation and mask the effects of alignment. If the receiver output increases as alignment proceeds, signal generator output is reduced accordingly. IFT1 is first adjusted for maximum output, after which the signal generator frequency is varied slightly on either side of the nominal frequency, keeping the alignment of IFT1 in step with the altered signal generator frequency, until a frequency is found which gives maximum output. This process ensures that the i.f. transformer is resonant at exactly the same frequency as the transfilters, and takes up possible small errors in the frequency calibration of the signal generator.

Virtually the same procedure is used when aligning with received signals. A weak signal is picked up and IFT1 aligned for maximum output. The receiver tuning is then varied on either side of the original setting, keeping the tuning of IFT1 in step. This similarly ensures that the i.f. transformer and the transfilters are all resonant at the same frequency. ■

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 for 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.

Rumanian-made 'WAMAIA' radio, model Electronica 3651T - G. C. Haswell, 13 New Street, Lydd, Kent - Information required.

Hallicrafter Receiver S27 1100/358 AM-FM 27-150 MHz in 3 Bands - B. Shilvock, 95 Mellish Road, Walsall, WS4 2DF - Circuit diagram and/or any relevant information.

R1481 - M. Gibson, Parsons Croft, Hever, Edenbridge, Kent - Coil details, also for 136 MHz.

Radio Filmstrips - M. J. Seward, 7 St. Olafs Road, Hill Head, Stratton, Nr. Bude, Cornwall - Required for local radio club.

C.T. 388 Cintel R.C. Oscillator and Automatic Frequency Monitor - A. S. Harvey, 53 Layton Road, Bridgemary, Gosport, Hants., PO13 0JG - Manual, or any relevant information, purchase or borrow.

Lafayette HA700 - M. J. Markey, 4 Harrison Way, Lydney, Glos. GL15 5BN - Loan of Manual for photocopying return in 14 days.

CAR BATTERY MONITOR

by Vincent S. Evans, G4AVT

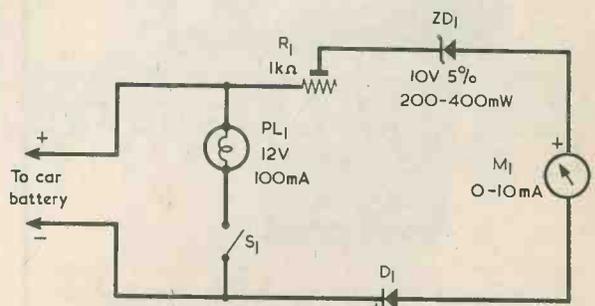
An expanded scale voltmeter which will be particularly helpful for the amateur transmitter operating mobile from his car

THIS UNIT IS VERY USEFUL TO THE CAR OWNER AS IT NOT only offers a voltage reading of the car battery, but also gives a good indication of its 'general health' as well. It has particular application to the licensed radio amateur if the car battery is employed to supply a transmitter and receiver. It is intended for use with a 12 volt car system.

SUPPLY VOLTAGE

When working 'mobile' or 'static-mobile' in the car it is very desirable to have a continuous indication of supply voltage. While the engine is running one should be able to see that the battery voltage on charge has not gone too high, whereupon it could cause damage in the transmitter or receiver. At the same time, one needs to ensure, while working 'static', that the battery has not been excessively drained and that its voltage is not too low.

An ordinary voltmeter is not entirely suitable for monitoring battery voltage as the scale length occupied by the all-important 11.5 to 13 volt segment is too small for quick and convenient observation. The monitor unit described here is so arranged that the whole meter scale extends from about 10 volts at the left-hand end to 15 volts at the right-hand end, with the result that the range of voltages in which one is most interested is widely spread out. The range of 10 to 15 volts is chosen because it nicely brackets the minimum and maximum voltages the battery is likely to give, these being 10.5 and 14.5 volts. Also, the 12.5 volt point is brought towards the central part of the scale. Two important voltage levels are 11.5 volts under load and 14.5 volts. The 11.5 volt condition indicates that it is time to stop trans-



The circuit of the car battery monitor. The meter needle is deflected for battery voltages from around 10 volts to 15 volts

mitting, whilst 14.5 volts is the maximum supply voltage for many 12 volt rigs.

The circuit of the unit is shown in the accompanying diagram. M1 is a 0-10mA meter and in series with it is a 10 volt zener diode. This diode prevents current flow in the meter until the battery voltage exceeds the zener voltage. Thus, the meter needle remains at the left-hand end of its scale for voltages below the zener voltage. Pre-set potentiometer R1 is adjusted so that the meter needle is deflected to the right-hand end of the scale when the battery voltage is 15 volts. Assuming that the actual zener voltage is at its nominal value of 10 volts,

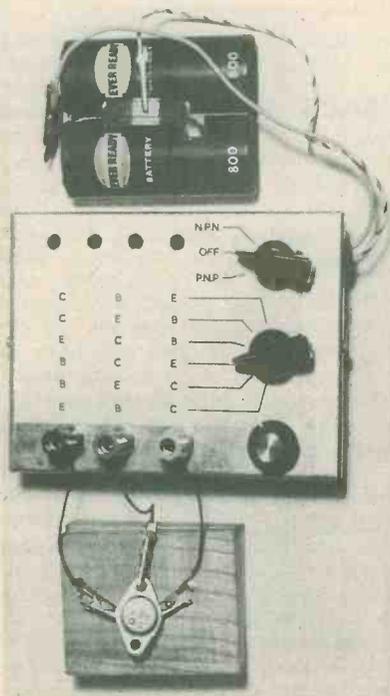
RADIO & ELECTRONICS CONSTRUCTOR

OCTOBER ISSUE FEATURES

TRANSISTOR LEAD-OUT LOCATER

Part 1

By J. R. Davies



This article describes the circuit operation of a unit which is capable of identifying the base, collector and emitter leads of any normal bipolar transistor, and which also indicates whether it is p.n.p. or n.p.n. The following article will describe construction and setting up.



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RADIO & ELECTRONICS CONSTRUCTOR

R1 should be set to drop 5 volts at 10mA, or 0.01 amp, whereupon, from Ohm's Law, the resistance required is 5 divided by 0.01, or 500Ω. In practice, the zener voltage will not be exactly 10 volts but will be within 5% of that voltage, with the result that R1 has to be a pre-set variable resistor to take up the zener voltage variations. Adjusting R1 will also allow for the slope resistance of the zener diode, the internal resistance of the meter and the forward resistance of D1. R1 can be a skeleton pre-set potentiometer.

Diode D1 is a protective diode and prevents current flow through the meter if the unit should happen to be connected to the car battery with reversed polarity. Under these conditions ZD1 would function as an ordinary forward biased silicon diode and, without D1 in circuit, would allow an excessive current to flow in the meter. D1 can be a germanium or a silicon diode, and its main requirements are that it should be capable of passing a forward current of 10mA and that its p.i.v. should be greater than 15 volts. If germanium, the diode can be OA79, OA81, OA86 or similar. Any small silicon rectifier may be used if it is desired to employ a silicon diode. The choice of diode here will be helpful if the zener diode is at one or other extreme of its tolerance on zener voltage. If it is at the low end of its tolerance the zener voltage will be around 9.5 volts, and a silicon diode in the D1 position will drop a further 0.6 volt. Should the zener diode be at the top end of its tolerance at about 10.5 volts then D1 can be a germanium diode, giving a low forward voltage drop.

ADDITIONAL COMPONENTS

Additional components in the circuit are S1 and PL1. The bulb in the prototype was a 12 volt 100mA m.e.s. type, and can be used to illuminate the meter when operating after dark.

Assembly may be carried out in any manner chosen by the constructor. The components in the author's unit were mounted and wired up on a 6 by 3 in. panel, which was then fitted to a 6 by 3 by 2½ in. aluminium chassis which thus provided a housing.

The scale of the meter has to be recalibrated with the aid of another voltmeter and the simplest method of doing this is to connect the input of the unit and the second voltmeter in parallel to the output of a variable voltage power supply. Initially set R1 to mid-travel and adjust the output of the power supply around 10 volts to find the voltage at which the meter needle commences to be deflected. If this voltage indicates that the zener diode is close to either end of its voltage tolerance than D1 may be changed to silicon or germanium as required. Then adjust R1 to insert maximum resistance into circuit and set the power supply output to 15 volts. Reduce the resistance inserted by R1 until the meter reads full-scale deflection. Finally calibrate the meter for voltages between the two outside readings.

In the absence of a variable voltage supply, calibration can be made in 1.5 volt steps by tapping into a number of dry batteries and cells in series at the appropriate points. The second voltmeter is still required as the voltage per cell will not be exactly 1.5 volt.

The process of removing the meter movement from its case to recalibrate the scale must be carried out with care as it is easy to damage the movement. Constructors who prefer not to risk such damage may leave the meter as it is and affix a conversion chart alongside it on the front panel. ■

USING THE TBA820 POWER AMPLIFIER

by J. B. Dance, M.Sc.

The integrated circuit type TBA820 can be employed as an audio amplifier feeding a loudspeaker, and it has the advantage that it can be operated at low supply voltages. Details of performance and typical working circuits are given in this article

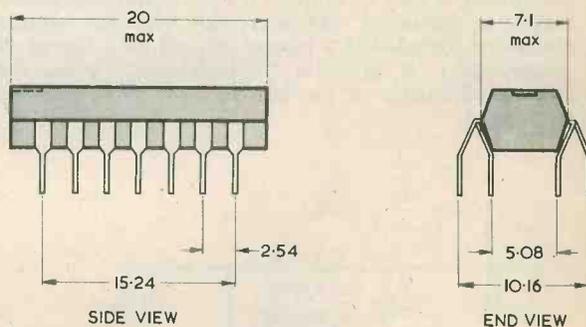
IF ONE REQUIRED AN AUDIO POWER AMPLIFIER A FEW years ago, one would either make one using discrete components or purchase a ready-made amplifier on a circuit board. Nowadays it is much more convenient to obtain an integrated circuit power amplifier, since one can use it together with a few other components to make a complete high gain power amplifier. The use of an integrated circuit also has the advantage that a much more compact unit can be made.

There are now quite a number of audio amplifier integrated circuits on the market and each has its own particular characteristics. This article describes the SGS-Ates type TBA820 integrated circuit and its use. The TBA820 can provide an output power of up to 2 watts into an 8Ω loudspeaker when it is operated from a 12 volt supply or the same power into a 16Ω loudspeaker when operated from a 16 volt supply. It is very suitable for use in portable radio receivers, small tape recorders and record players, car radio receivers, and similar equipment.

The TBA820 device has the advantage that it can operate properly at power supply voltages down to at least 3.5 volts. It will operate at even lower voltages than this, but distortion then increases.

THE TBA820

The TBA820 is a quad-in-line integrated circuit with the shape shown in Fig. 1. Alternate pins on each side of the plastic body of the device are bent so that their lower ends are at different distances from the body; if one looks at it from one end one therefore sees four lines of connecting pins as shown in Fig. 1. Hence the name 'quad-in-line'. The dimensions given in Fig. 1 are in millimetres. It will be recalled that 2.54 mm. is equal to 0.1 inch.



All dimensions in mm.

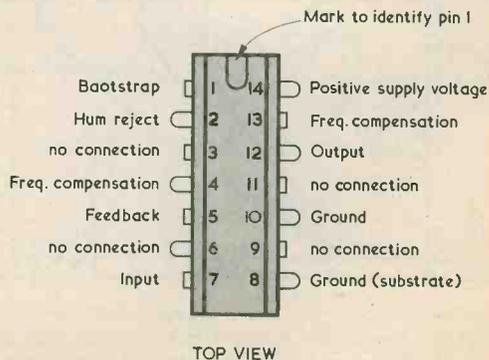


Fig. 1. Pin spacing and connections for the TBA820 audio amplifier integrated circuit

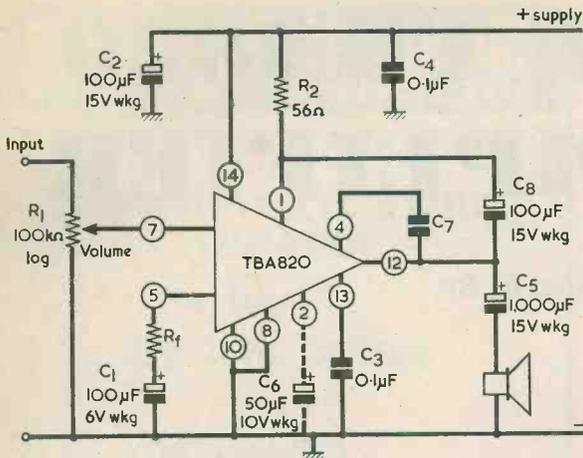


Fig. 2. The simplest circuit in which the TBA820 may be used

BASIC CIRCUIT

The basic amplifier circuit for the TBA820 is shown in Fig. 2, the connections to the i.c. being those of Fig. 1. The input impedance of the device itself is high, but the inclusion of a resistor R1 across the input is essential; this resistor determines the input resistance of the circuit. Capacitive coupling must be employed if the source of signal voltage contains a steady voltage on which the alternating signal is superimposed.

The use of the capacitor C6 will prevent appreciable amounts of hum on the power supply line from reaching the output; it may be omitted if a well-stabilized power supply is employed. However, this capacitor should always be included if a battery is used as a source of power, since it prevents 'motorboating' when the internal resistance of the battery rises as it becomes discharged.

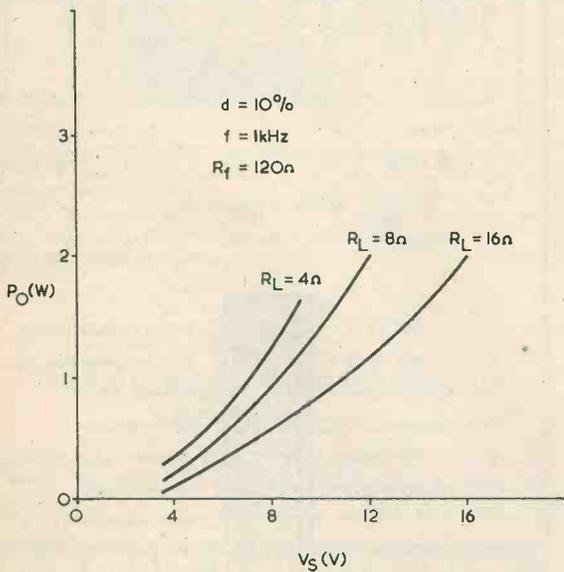
OUTPUT POWER

The maximum output power which can be obtained from the circuit depends on the supply voltage and the loudspeaker impedance; typical values are shown in Fig. 3(a). If a 9 volt supply is employed, an output power of 1.2 watts can be obtained with an 8Ω loudspeaker or a power of 1.6 watts with a 4Ω loudspeaker. The power supply voltage should not exceed about 9 volts with a 4Ω loudspeaker or the device may become over-heated. If the supply voltage falls to 3.5 volts, a power output of 0.22 watt can be obtained into a 4Ω loudspeaker. Although this may appear rather small, it is adequate for portable radio receivers. The curves of Fig. 3(a) are taken when the total harmonic distortion reaches the 10% level.

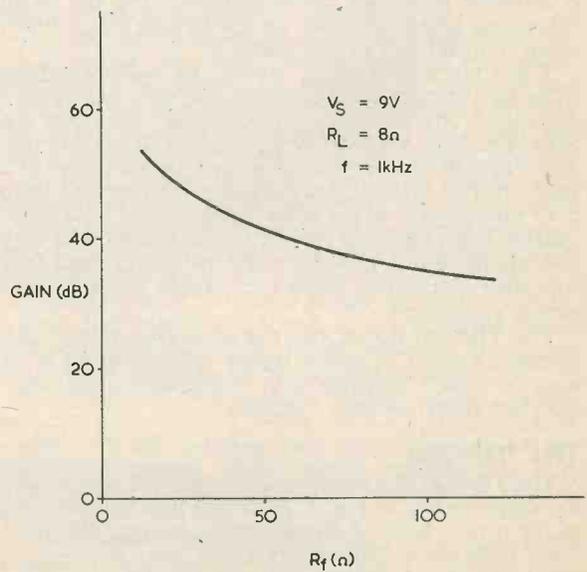
The internal output stage of the TBA820 functions in the quasi-complementary Class AB mode. A signal taken from the output passes to the bootstrap connection at pin 1 and enables high positive half-wave swings to be obtained at the output.

A self-balancing stage is incorporated in the integrated circuit. This ensures that the output voltage at pin 12 is kept at an average value of half the supply voltage for any value of the supply voltage between 3.5 and 16 volts. The capacitor C5 blocks this steady voltage, but allows the alternating output signal to pass through the loudspeaker. Lowering the value of C5 causes the bass response to be reduced. The self-balancing circuit ensures that symmetrical excursions of the output in the positive and negative directions can occur and leads to maximum undistorted output power.

No heatsink for the TBA820 is required in Fig. 2 (or in any of the other amplifier circuits given in this article). However, the power supply voltage should not exceed 16 volts with a 16Ω load, 12 volts with an 8Ω load or 9 volts with a 4Ω load.



(a)



(b)

Fig. 3 (a). The maximum power output for various supply voltages and speaker impedances
(b). The gain given for different values of feedback resistor

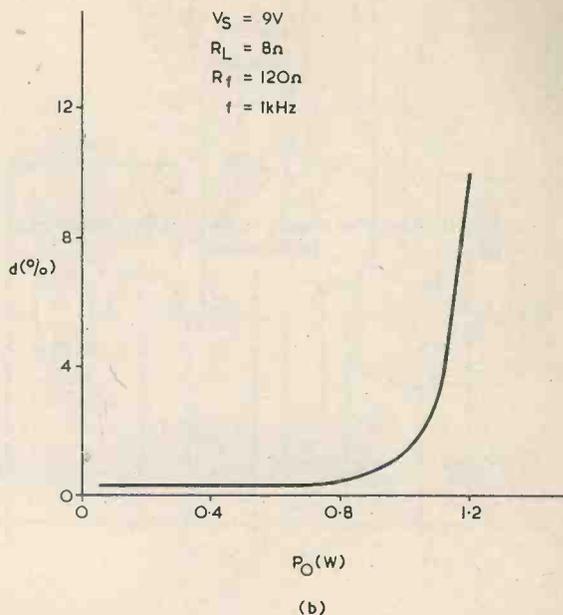
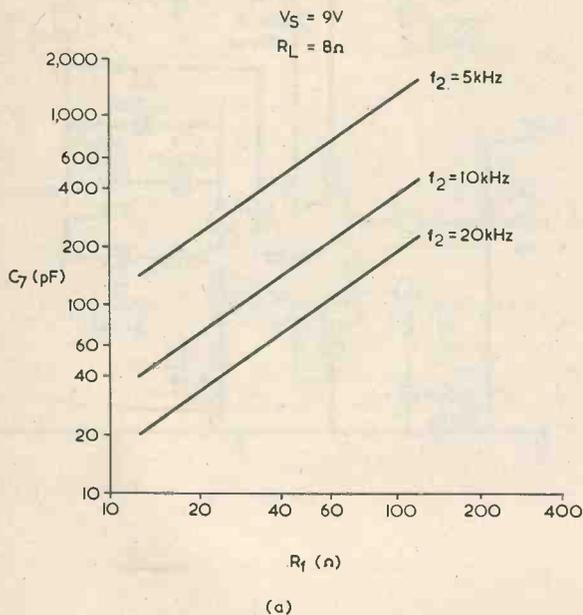


Fig. 4 (a). The effect of C_7 on cut-off frequency
 (b). Total harmonic distortion plotted against output power

GAIN

The voltage gain is determined by the value of resistor R_f . A $6k\Omega$ internal resistor from the output of the device provides feedback to pin 5; the smaller the value of R_f , the less the amount of feedback and the greater the gain. R_f should not exceed 390Ω for a 9 volt supply or 270Ω for a 12 volt supply or saturation of the input may occur.

The gain is equal to 1 plus 6,000 divided by R_f . For example, if R_f is 100Ω the voltage gain is 61. The gain is plotted in db against the value of R_f in Fig. 3(b).

FREQUENCY RESPONSE

The upper frequency response is determined by the values of C_7 and the feedback resistor R_f . The value of C_7 required for various values of the upper cut-off frequency and various values of R_f is shown in Fig. 4(a).

The distortion is plotted against output power in Fig. 4(b) for the case where an 8Ω loudspeaker is employed with a 9 volt supply and the value of R_f is 120Ω (giving a voltage gain of 51 or 34db). It can be seen that the distortion remains very low until the output power reaches about 1 watt, after which it rises very rapidly indeed with the onset of clipping. Cross-over distortion is not present in this device.

The quiescent current taken by the i.c. under no-signal conditions is typically $4mA$ at a supply voltage of 9 volts.

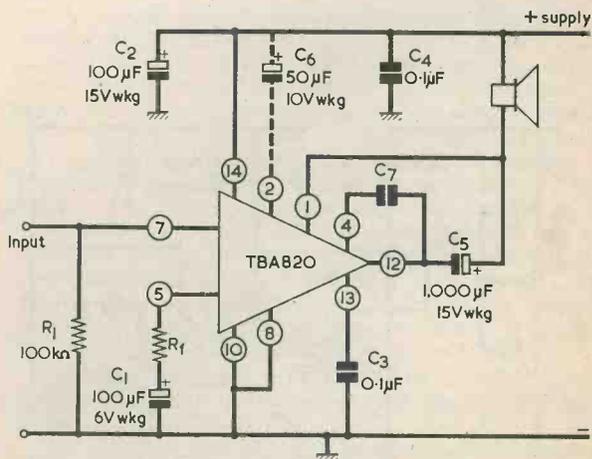
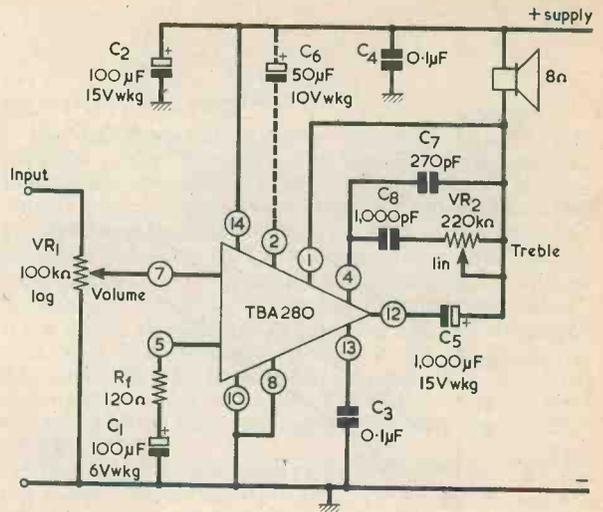


Fig. 5 A TBA820 circuit which allows one terminal of the speaker to be earthed to chassis

Fig. 6. Amplifier circuit with a simple treble cut tone control



LOUDSPEAKER EARTHED

The circuit of Fig. 5 provides a similar performance to that of Fig. 2, but one side of the loudspeaker is earthed to chassis. An extra capacitor, C8, and resistor, R2, are required in this circuit to provide the bootstrap feedback signal to pin 1 of the device. A variable resistor is employed for R1 to provide volume control. The hum rejection capacitor, C6, should be connected between pin 2 and chassis in this circuit. The loudspeaker impedance and the values of C7 and Rf should be selected in the same way as with the circuit of Fig. 2.

As in Fig. 2, capacitor C3 is included to prevent high frequency oscillations.

TONE CONTROLS

A simple circuit for the TBA820 which provides a variable upper cut-off frequency is shown in Fig. 6. Treble cut is provided by means of the potentiometer VR2. As the value of this variable resistor is increased from zero to 220kΩ, the frequency at which the response is 3db down increases from 4kHz to 20kHz. Thus it forms a very satisfactory filter for hiss or high pitched whistles.

A circuit with tone controls in the input is shown in Fig. 7. It should be noted that optimum functioning of this circuit will be obtained only if the output impedance of the circuit which feeds it is less than 22kΩ. The circuit

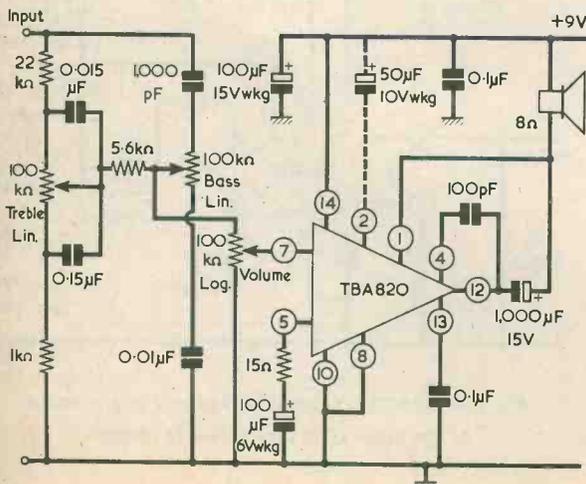
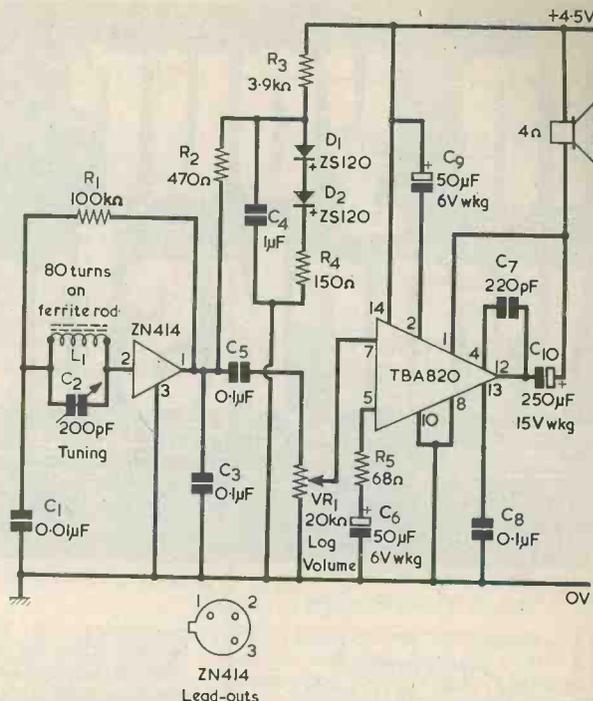


Fig. 7. A circuit incorporating full bass and treble cut and boost controls

Fig. 8. A simple low voltage medium wave receiver



provides both bass lift and cut and treble lift and cut. The maximum lift or cut is about 16db at 100Hz in the bass and at 15kHz in the treble region.

The input sensitivity of the circuit of Fig. 7 is reduced by the tone control network. An input of about 190mV is required for an output power of 1.2 watts. (The circuits of Figs. 2 and 7 require an input of 16mV when R_f is 33Ω, and 60mV when R_f is 120Ω, for an output of 1.2 watts.)

PRACTICAL POINTS

Circuit leads can be soldered directly to the pins of the TBA820, taking the usual care which is needed when making connections to a device of this nature. It is very convenient to pass the i.c. pins through the holes in a plain perforated s.r.b.p. ('Paxolin') sheet having an 0.1 in. matrix, such as the Lektrokit Chassis Plate No. 4. This is Lektrokit part no. LK 141, and is available from Home Radio under the same Cat. No.

Alternatively, the device may be plugged into a 14 pin quad-in-line socket. A 14 pin quad-in-line socket is listed as Type No. DRQ-7 by Electrovalue Limited, 28 St. Judes Road, Englefield Green, Egham, Surrey, TW20 0HB.

RADIO RECEIVER APPLICATION

As the TBA820 is an integrated circuit audio amplifier which is particularly suitable for use with low power supply voltages it seemed that it might form a useful radio receiver, in conjunction with the well-known Ferranti ZN414 integrated circuit, for the medium wave band. This did indeed prove to be the case.

The use of the ZN414 with other integrated circuit audio power amplifiers has already been discussed in detail in this journal,* and therefore relatively brief

details will be given here.

The circuit of the receiver is shown in Fig. 8. The coil L1 consisted of 80 turns of 28 s.w.g. enamelled copper wire close-wound on a $\frac{1}{8}$ in. diameter ferrite rod 4 in. long. The two silicon diodes D1 and D2 provide a fairly stable supply voltage to the ZN414 circuit; the battery voltage can fall to 3 volts with little effect on the performance other than a reduced output power. If diodes type ZS120 cannot be obtained, any small silicon rectifier, such as the 1N4002, can be employed instead. Capacitor C3 must be wired close to the lead-outs of the ZN414.

The component values in Fig. 8 have been chosen on the assumption that a small loudspeaker will be employed and that the bass response will therefore be limited. If this is not the case, the value of C10 (and possibly of C5) may be doubled in order to obtain better base from a suitable speaker. A 4Ω loudspeaker is specified in Fig. 8. However, at the low supply voltage of 4.5 volts, a 3Ω loudspeaker will be quite satisfactory in its place if a 4Ω component cannot be obtained.

A battery voltage of 4.5 volts was employed with this circuit, this being about the minimum for which a reasonably good performance from the TBA820 can be expected. If only two dry cells are employed instead of three, so as to give a power supply of 3 volts, the performance will deteriorate rapidly if the battery voltage falls. Readers who wish to employ a 3 volt supply should reduce the value of R3 to 2.7kΩ.

This type of circuit is probably one of the simplest designs which can operate from such low voltages and drive a loudspeaker.

The TBA820 device is available by mail order from Electronic Component Supplies (Windsor) Ltd., Thames Avenue, Windsor, Berkshire.

*M. J. Darby, 'Radio Receivers Using Two Integrated Circuits', Radio and Electronics Constructor, Dec. 1973, Jan. 1974.

In your workshop



This month Smithy the Serviceman, aided as always by his able assistant, Dick, leaves the pains of servicing for a few moments and indulges in the pleasures of simple logic. In so doing he unfolds the story of the Fox, the Hen and the Corn

"I'M FED UP."

Dick chewed the last of his lunch-time sandwiches and gazed moodily across the Workshop.

"Fed up?"

"Yes, fed up," repeated Dick bitterly. "I'm fed up with fixing radios, and I'm fed up with fixing TV's and I'm fed up with fixing record-players. They've all got the same old tiresome faults in them - things like broken-down capacitors, burnt-out resistors and wires come adrift. When I originally started working at this servicing lark I looked forward to a really exciting future. Instead of that, all I find is that everything electrical and everything electronic is just dead boring."

EXERCISE IN LOGIC

Smithy drank from his tin mug.

"Well," he remarked sympathetically, "we do get tedious spells in servicing just the same, I suppose, as you do in most other jobs. But even so things aren't always quite as monotonous as you seem to imagine they are."

"So far as I'm concerned they are," persisted Dick. "All this morning I've done nothing else but track down dead easy snags which you can spot as soon as you take the back off the set. What I want is something to inspire my imagination."

"Do you, indeed?" replied Smithy.

"Well, in that case I may be able to help you. I'm in a position to show you something that will demonstrate that even a simple electrical device can cover a field which is vastly removed from routine trouble-shooting. In the meantime, though, I'd be obliged if you'd get me a spot more tea."

Smithy drained his mug, then handed it over to his assistant. Following a custom of long standing, Dick took the mug over to the sink and replenished it from the motley array of utensils which

constituted the Workshop culinary effects. When he returned, he found that the Serviceman had placed on his bench a rectangular plastic case. On the front panel of this were mounted a number of slide switches and two pilot lamps, one having a green lens and the other a red lens. (Fig. 1).

"Hallo, what's this?"

"It's a gadget which a friend of mine has lent me," replied Smithy, "and it's the electrical device I mentioned just now. Despite its simplicity, it represents quite a crafty exercise in logic."

Dick looked interested.

"What's it supposed to do?" he asked. "And why are the switches marked up with such peculiar functions?"

"You'll find out soon," promised Smithy. "For the moment I'll tell you that this device represents an old problem that's often presented to

children as a puzzle. It's the problem of the man, the hen, the fox and the corn, and I can remember trying to tackle it when I was a kid, And that's going back a bit!"

"I seem to remember something along those lines when I was at school, too," said Dick, frowning. "Doesn't it have something to do with crossing a river?"

It was obvious that Dick had already forgotten his earlier dissatisfaction with electrical and electronic matters.

"It does," confirmed Smithy, taking up his mug and sipping at its contents. "The puzzle is that there's a man, a hen, a fox and some corn on one side of a river, which we can say is the south side, and that the man wants to take all three over to the other side. The first difficulty he has to put up with is that he's only got a small boat, with the result that either he can cross the

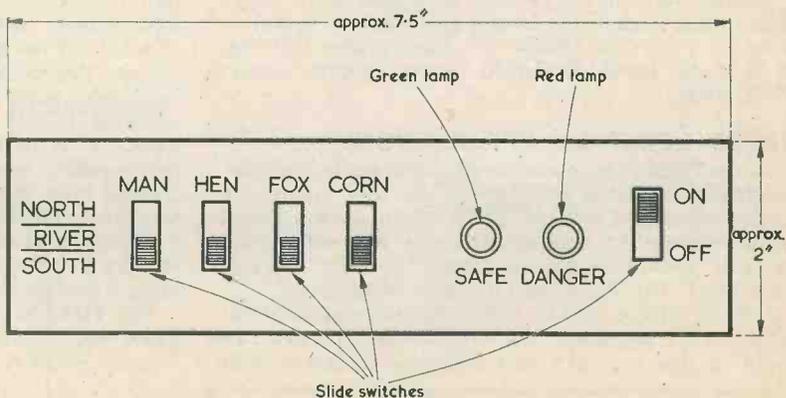


Fig. 1. The front panel layout of the switching device described by Smithy

river on his own or he can cross the river with only one of the three things."

"You mean," put in Dick, "that he can only cross over with, say, the hen on its own, but that he couldn't cross over with the hen and the fox?"

"That's right," confirmed Smithy. "The boat just isn't big enough to take more than himself and either the fox, the hen or the corn. Now we come to his second difficulty. Whilst the man is present, the hen and the fox behave themselves. But as soon as the man leaves them the fox is liable to attack the hen and the hen is liable to eat the corn. The man has to get all three of them over the river without either of these possibilities cropping up."

"I'm with it," remarked Dick, looking once more at the plastic case with the slide switches. "Are those switches intended to represent the crossing of the river?"

"Yes," stated Smithy. "As you can see, the switches can be in a position corresponding to either the south or the north side of the river. All four switches corresponding to the man, the hen, the fox and the corn are now on the south side of the river. Let's switch the gadget on."

Smithy moved the fifth slide switch to the 'On' position. The green lamp glowed.

"Now, that green lamp," continued Smithy, "indicates that the situation is safe. Because the man is present on the south side of the river, the fox will not attack the hen and the hen will not eat the corn. Let's say that the man crosses over on his own to the north side."

Smithy slid the "Man" switch up to the "North" position. The green lamp extinguished and the red lamp glowed instead.

"Blimey," said Dick, impressed. "I suppose that the red lamp lighting up means that the situation is dangerous."

"That's right," concurred Smithy. "The situation is dangerous because, with the man on the north side of the river, not only can the fox attack the hen but the hen can also eat the corn."

Smithy returned the "Man" switch to the "South" position. The green lamp became illuminated and the red lamp went out.

CROSSING THE RIVER

"Stap me, Smithy," said Dick enthusiastically, "this really is something! Can I have a go?"

"By all means," replied Smithy. "See if you can get all four switches to the north side of the river without the situation becoming dangerous at any time."

"This should be dead easy," pronounced Dick confidently. "Now let's see how to start. I think I'll move the man and the fox over first."

Dick pushed the "Man" and the "Fox" switches to the "North" position. At once the green lamp extinguished and the red lamp lit up.

"Darn it," snorted Dick irritably,

"I'm in danger already."

"Of course you are," chuckled Smithy. "You've left the hen and corn unsupervised by the man, whereupon the hen starts to eat the corn. Try again."

Dick returned the two switches to the "South" position, causing the green lamp to light up once more. Experimentally, he moved the "Man" and the "corn" switches to "North" and again the red lamp came alight. Hastily, he returned the switches to their former position.

"I was obviously wrong there," he admitted. "If the man and the corn are over on the north side, the fox can have a go at the hen. I'll move the man and the hen over."

Dick actuated the two switches. The green lamp remained illuminated.

"You're getting the idea," said Smithy encouragingly. "Even when the man is away, the fox won't eat the corn. What's your next move?"

"I suppose I'd better get the man back to the south side again," said Dick uncertainly, "so that he can pick up something else."

"Go on then."

Dick moved the "Man" switch back to "South." The green lamp still stayed lit up.

"I'll have him take the fox over next," he announced, his confidence returning.

He moved the "Man" and the "Fox" switches over to "North". The green lamp still glowed.

"This is too easy," he stated boastfully. "All I've got to do now is get the man back to pick up the corn."

He put the "Man" switch to "South", and the red lamp at once lit up. Hastily Dick returned the "Man" switch to "North", whereupon the red lamp went out and the green lamp became illuminated again.

"What did I do wrong there?"

"You left the fox and the hen on their own on the north side," explained Smithy. "As soon as the man went to the south side the fox could attack the hen."

"This is a bit more complicated than I thought," said Dick ruefully. "I'll have to think about it for a minute or two."

He scratched his head and scowled ferociously at the plastic case. Suddenly, his brow cleared.

"I've got it," he said excitedly. "I'll send the man back to the south side with the hen."

He quickly set the "Man" and the "Hen" switches to "South" and looked at the lamps expectantly. The green lamp was still alight.

"What I do next," he stated, "is take the man and the corn over to the north."

Quickly, he actuated the switches. The green lamp continued to glow.

"You're getting the hang of it," commented Smithy. "What's your next move?"

"I take the man back to the south side," said Dick. "This will leave the

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fox and the corn on their own on the north side, but that's all right because the fox won't eat the corn. Then I finally take the man and the hen back to the north side again."

Dick moved the "Man" switch and then the "Man" and the "Hen" switches. The glow from the green lamp continued uninterrupted.

"How about that?" stated Dick triumphantly. "I've now got all four switches over to the north side without having gone into a situation of danger at any step."

"Very good," commended Smyth. "Actually, there are two ways of carrying out the operation. One of these is the method you chose. The other is for the man and the hen to go over to the north side first and then for the man to return. He then goes over with the corn and comes back with the hen. After that he takes the fox over and returns for the hen."

"It's a cute little puzzle," said Dick. "I must say that solving it is a lot more fun when you do it with these switches. Does the red lamp light up for all dangerous situations?"

"It does," confirmed Smyth. "As you can check, if you like, by setting the switches to any dangerous state of affairs."

"There must," pronounced Dick, "be some really complicated wiring inside that box. After all, it has to cater for quite a lot of different combinations. How many components are there in addition to the switches?"

"There's only one other component," stated Smyth, "and that's the battery which powers the lamps."

"Are the switches special types?"

"No," replied Smyth. "They're just

standard double-pole double-throw slide switches. I'll show you the circuit."

The Serviceman leaned over to the back of his bench and produced a piece of paper. This had a circuit diagram on it, which he showed to Dick. (Fig. 2).

"Well," said Dick, as he examined the diagram, "there doesn't seem to be a great deal of wiring. It still isn't very clear to me how it works, though. What are those letters 'D' and 'S' for?"

"All the points marked 'D' are joined together," exclaimed Smyth. "'D' stands for 'Danger' and is the coupling to the red light. In the same way, all the points marked 'S', which stands for 'Safe', are joined together, giving the coupling to the green lamp."

Dick studied the circuit.

"It still seems rather involved to me," he remarked.

"All right, then," said Smyth.

"Let's see what happens with a few trial combinations. For a start, we can examine circuit operation when the four slide switches are at 'South'. Turning on the on-off switch causes the positive side of the battery to be connected to the centre contact of S1(a). A circuit is then set up via S1(a) and S2(a) to point 'S' and therefore to the green lamp. In consequence the green lamp lights up. Let's next choose a dangerous situation. This could consist for instance of setting the 'Hen' and 'Fox' switches to the 'North' position, leaving the 'Man' and 'Corn' switches in the 'South' position. There would then be a circuit from the positive side of the battery through S1(a) at 'South', S2(a) at 'North' and S3(a) at 'North' to point D, and thus to the

red pilot light. This would then light up. Okay?"

Dick rubbed his chin reflectively.

"I think so," he responded uncertainly. "But there's something queer here."

"How come?"

"Well," said Dick, "when you switched on with all the switches at 'South', the circuit to the green lamp was made just through S1(a) and S2(a). S3 and S4 didn't even enter the picture. And then when you put the 'Hen' and the 'Fox' switches to 'North' the circuit was completed by way of S1(a), S2(a) and S3(a). This time, S3 came into use but there was still no mention of S4."

"There was no need to involve S4," replied Smyth. "If the hen and the fox are on their own on one side of the river it doesn't matter where the corn is. The hen and the fox on their own constitute the dangerous situation. However, there are several situations which do involve all four switches. One of these is when you have the man and the fox on the south side and the hen and the corn on the north side. There is then a circuit from the positive terminal of the battery through S1(a) at 'South', S2(a) at 'North', S3(a) at 'South' and S4(a) at 'North' to point 'D' and thence to the red light."

TRUTH TABLES

Dick sighed.

"It's no good, Smyth," he said despairingly. "I'm still baffled by all this. Some situations require only two switches, others require three switches and there are further ones which use all four switches. I simply do not get it."

"Fair enough," commented Smyth. "If you don't understand how the circuit operates then the best thing to do will be to draw up a truth table which shows all the eventualities which the switching system has to cope with. So let's make up a truth table for our present puzzle."

Smyth leaned over and picked up his note-pad. Taking a pen from his pocket he drew up five columns. (Fig. 3).

"Now, this truth table," he went on, "has four columns for the man, the hen, the fox and the corn. The fifth column will be for 'Safe' or 'Danger' as the case may be. We'll start off by dealing with all the situations in which the outcome is 'Safe'."

"The first one there," said Dick, "must obviously be the one when all four are on the south side of the river."

"Righty-ho," said Smyth obligingly. "I can enter this by putting the letter 'S' for 'South' in the first four columns. There will also be a similarly safe situation when all four are on the north side of the river. So the second line of the truth table can consist of the letter 'N' for 'North' in the first four columns."

Smyth entered the first two lines of

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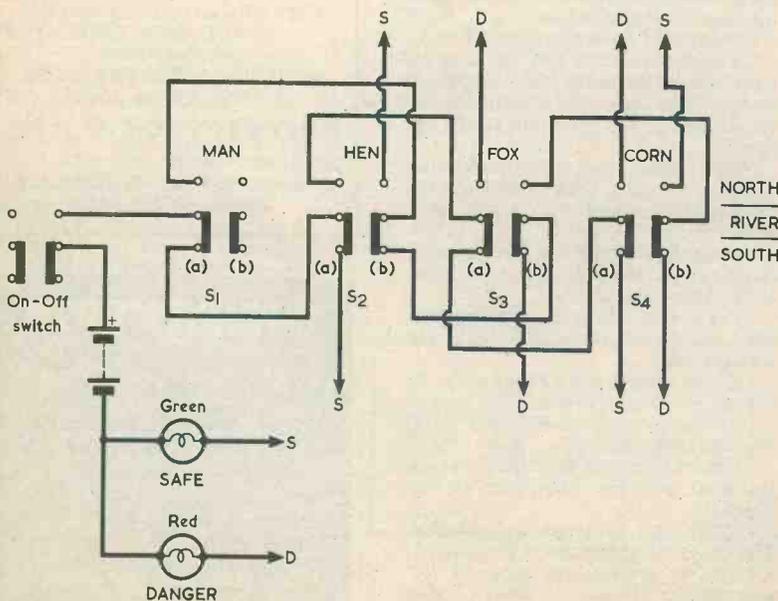


Fig. 2. The circuit of the device. No connections are made to S1(b)

MAN	HEN	FOX	CORN	SAFE/DANGER
S	S	S	S	SAFE
N	N	N	N	SAFE
S	S	N	N	SAFE
N	N	S	S	SAFE
S	S	S	N	SAFE
N	N	N	S	SAFE
S	S	N	S	SAFE
N	N	S	N	SAFE
S	N	S	S	SAFE
N	S	N	N	SAFE

Fig. 3. Truth table for all the 'Safe' situations to which the switches can be set

the truth table.

"Another safe situation," stated Dick thoughtfully, "will be given when the fox and the corn are on one side of the river and the man and the hen are on the other side."

"Good," commended Smithy, entering the next two lines. "Now, let's think of some more safe conditions.

Ah, yes! We can get two more in which the man, the hen and the fox are on one side and the corn is on the other."

"And," put in Dick keenly, as Smithy scribbled the last two entries into the truth table. "You can have another two lines where the man, the hen and the corn are on one side and the fox is on the other. How many lines in the truth table does that make?"

"Eight," replied Smithy, putting down his pen.

"That must be the lot then."

"No, it's not," said Smithy. "We're forgetting the result of the second move in solving the puzzle. This is given when the hen is on one side of the river and the man, the fox and the corn are on the other side. That gives us the last two situations in which the outcome is 'Safe'."

Smithy entered the last two lines into the table. He then tore the top sheet from his pad and drew up a further five columns. (Fig. 4).

"We'll do a truth table for all the dangerous situations now," he announced. "The hen and the fox together on their own constitute 'Danger', so we can have this state of affairs for the first two lines."

"Another dangerous set-up," remarked Dick, as Smithy wrote in the first two lines of the new truth table, is when the hen, the fox and the corn are all together on one side and the man is over on the other side."

"True," agreed Smithy. "I'll make that situation the basis of the next two lines."

He entered the two lines in the table.

"Now, what's left?" said Dick musingly. "The only other dangerous state of affairs I can think of is when the hen and the corn are on one side and the man and the fox are on the other side."

Smithy wrote these last two lines in the truth table.

"And that," he commented, "should finally button things up. We've now got all the possible situations that can

MAN	HEN	FOX	CORN	SAFE/DANGER
S	N	N	S	DANGER
N	S	S	N	DANGER
S	N	N	N	DANGER
N	S	S	S	DANGER
S	N	S	N	DANGER
N	S	N	S	DANGER

Fig. 4. Truth table for the 'Danger' situations

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exist."

He indicated the two truth tables, which he had now laid out on the bench in front of him.

"I don't see," stated Dick, "how these tables are going to help us."

"Don't you? For a start, take a look at the first eight entries which give a 'Safe' outcome. Do you see any similarity between them?"

Dick looked more closely.

"Blimey," he said suddenly. "There is something there. All the first eight entries start with two letters 'N' or two letters 'S'. All the other entries, in both tables, have an 'N' followed by an 'S' or an 'S' followed by an 'N'."

"Exactly," said Smithy. "This means that if the man and the hen are both at 'North' or both at 'South' the situation is safe, and it doesn't matter where the fox and the corn are. So, in the circuit all the first eight entries for the safe condition can be dealt with simply by the 'Man' switch and the 'Hen' switch. The other two switches can just be ignored."

SIMPLIFICATION

"Gosh," said Dick, startled by this information. "That simplifies things no end."

"Doesn't it?" grinned Smithy. "Truth tables like the ones we've just drawn up can be jolly useful in pointing up methods of reducing complications. We can't do any further simplification by way of the first two letters in the truth tables, so let's see if we can find any common factors in the first three letters."

"I can see one," said Dick quickly. "The first four entries in the second table are 'S' 'N' 'N', or 'N' 'S' 'S'. These all give 'Danger' and it doesn't matter whether the fourth entry is 'S' or 'N'."

"Very good," said Smithy. "This means that the first four entries in the

'Danger' truth table can be catered for by the 'Man', 'Hen' and 'Fox' switches. There is no need to involve the 'Corn' switch for these entries."

"That leaves four final entries," stated Dick. "Two of which give 'Safe' and two of which give 'Danger'."

"These will involve all the four switches," said Smithy. "Two of the entries start with 'S' 'N' 'S', and if the fourth entry is 'S' then the outcome is 'Safe', whilst if the fourth entry is 'N' the result is 'Danger'. The other two entries are the same but with 'N' and 'S' transposed. This means that the 'Corn' switch will have to transfer the output from the 'Fox' switch to 'S' or 'D' accordingly."

"Let's try out some of these last entries with the actual circuit," said Dick. "Let's say the man is at 'North', the hen is at 'South' and both the fox and the corn are at 'North'."

"All right," replied Smithy. "Take a look at the circuit. You'll see that this set of circumstances gives a circuit from the positive side of the battery through S1(a) at 'North', S2(b) at 'South', S3(b) at 'North', and S4(b) at 'North', to the green lamp. If we change the 'Corn' switch from 'North' to 'South', which gives a 'Danger' situation, S4(b) completes the circuit to the red pilot lamp instead of to the green lamp."

Smithy picked up his mug and drank deeply.

"That's certainly a smashing circuit," remarked Dick appreciatively. "This would make a jolly good toy for kids to play with."

"For kids of all ages, I would suggest," grinned Smithy. "No executive desk should be without one!"

"It shouldn't be difficult to put together," commented Dick. "All you need is a box having a front panel for the switches and the pilot lamps, and which is large enough to take the battery. Any suggestions here,

Smithy?"

"Only some fairly obvious ones," replied Smithy. "The slide switches should be ordinary standard sized ones and not miniature types. Standard switches have a greater movement, which will give a more realistic subjective impression of crossing a river. Also, it's easier to see what position each switch is in than it would be with miniature slide switches. The battery and the lamps can be any voltage and it is desirable, of course, to use bulbs having a fairly low current consumption to ensure that the battery doesn't run down too quickly."

"What about wiring up?"

"No problem there," stated Smithy. "But it's easier to work from a wiring diagram than from the circuit diagram because, to make it easier to follow, the circuit is shown reversed, mirror-fashion, from left to right. As it happens, I've sketched out a wiring diagram, since I intend knocking up one of these gadgets myself."

Smithy took a further piece of paper from the rear of his bench and showed it to his assistant. (Fig. 5).

"That wiring diagram will be jolly helpful," said Dick eagerly. "Can I borrow it when you've finished with it?"

"You may," conceded Smithy. "But I must warn you that I've counted all the slide switches we have in stock in the Workshop at the time being!"

BACK TO SERVICING

"The trouble with you, Smithy," complained Dick, "is that you have a suspicious mind."

"True," admitted the Serviceman.

"There are times," continued Dick, warming to his theme, "when I think you have no trust in anybody."

"You get that way," explained Smithy cheerfully, "when you've been servicing radios and TV's for as long as I have. It's an occupational hazard."

He looked at his watch.

"And, talking about servicing," he went on, "I think it's about time we started doing a bit of this ourselves."

"Let's just have another go at that switching gadget," pleaded Dick. "I want to try that second method of getting four switches over without the red lamp lighting up."

"Okey-doke," said Smithy agreeably. "But after that we really must get on with some work."

Several moments later, after Dick had successfully negotiated the man, the hen, the fox and the corn across the river, the pair returned to their respective benches. Whereupon Dick was to find that his run of simple faults had come abruptly to an end as he tackled his next job - a television receiver whose flywheel sync just failed to lock in.

EDITOR'S NOTE

Acknowledgement is due to T. J. L. Painter, who conceived the idea and the switching circuit described in this episode of 'In Your Workshop'.

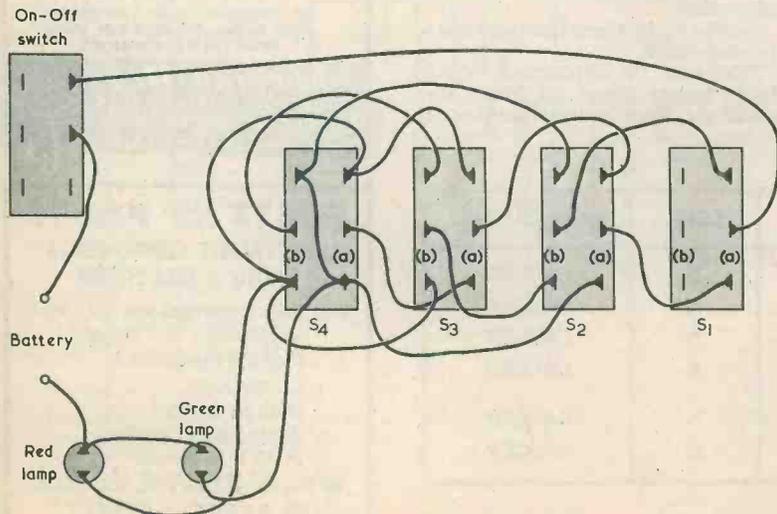


Fig. 5. Wiring diagram for the switch circuit

RADIO TOPIC

By Recorder

IT IS SOMEWHAT SOBERING TO REALISE that, in all engineering, there is no such thing in practice as an *exact* quantity.

I'm quite serious about this. In the engineering world, manufactured items are made to tolerances and never to a precise figure. If you went to a manufacturer of sheet metal parts and asked him to make you a large quantity of rectangular pieces in 18 s.w.g. mild steel sheet, each piece measuring 6 by 4 inches, he would turn to you and say: 'Certainly sir, and what are the tolerances on the 6 and 4 inch dimensions?'

TOLERANCES

The manufacturer has to ask this question in order that he can make the rectangular pieces in the most economic manner possible. If you wanted the pieces to be extremely close to the nominal values of 6 and 4 inches, you could specify a tolerance on both dimensions of, say, plus or minus 0.005 inches. This means that the length and width of each of the pieces made must be within five thousandths of an inch of the specified dimensions. For less exacting requirements the tolerance could be, perhaps, plus or minus 0.02 inch. In general, it would be cheaper to make a large quantity of pieces to the tolerance of plus or minus 0.02 inch because the press which stamped out the pieces need not be set up so accurately in the first place, and it would last longer before the stamped out pieces went out of tolerance due to wear.

Incidentally, this little example illustrates the necessity for tolerances on the length and width of the rectangular pieces. Does it also indicate a tolerance on the remaining dimension, which is the *thickness* of the pieces? Discerning readers will have noted that it does. Specifying 18 s.w.g. mild steel sheet means that the thickness of the metal must lie between the limits approved by the British Standards Institution for 18 Standard Wire Gauge wire, and these happen to be 0.0485 inch maximum and 0.0475 inch minimum. So there is a tolerance on the thickness of the metal as well.

The idea of a tolerance on dimensions may come as a surprise to some

readers of *Radio & Electronics Constructor*, since there are normally no dimensional tolerances at all in any of the constructional project diagrams that we publish. The main reason for the absence of tolerances here is that the projects are intended to be built individually in 1-off quantities, and the only requirement is that the dimensioned parts be made sufficiently accurately for the various bits and pieces in the project to fit together. If we were to go into mass production with any of our projects we would have to add the appropriate tolerances to all the dimensions.

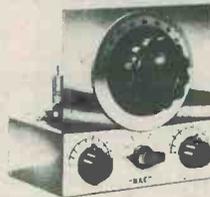
ELECTRONIC WORK

In electronic work, tolerances are not only present on dimensions but also appear in all the other quantities we use, be they units of capacitance, resistance, voltage or whatever. The concept of tolerances on capacitance and resistance is not at all unfamiliar, and whenever possible we use capacitors and resistors with tolerances of 10%, or so instead of the more costly versions which have tolerances of 1%, or 2%. The idea of a tolerance on voltage may on the other hand seem surprising, but in practice it is there. We can, for example, set up a potentiometer such that a certain related voltage in a circuit is, say, 'exactly' 10 volts. But how do we know that the voltage we obtain is truly 10 volts? The only means of determining the voltage is with the aid of a voltmeter, and the accuracy of a typical practical voltmeter is normally of the order of plus or minus 2% of full-scale deflection!

So, whether we like it or not, the quantities we encounter in electronics are all slightly imprecise. Fortunately, this doesn't matter in most instances, and if we require something which is exceptionally close to an exact value we introduce variables. These consist of capacitive trimmers which can be set up to give a specific circuit effect, iron-dust cored coils which can be similarly adjusted and, of course, potentiometers.

And what do we do when our pet electronic schemes do not produce the results we fondly imagined we would get? Why, we have to exhibit a certain degree of tolerance ourselves!

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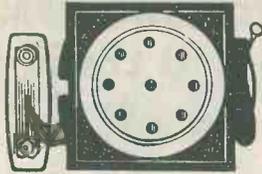
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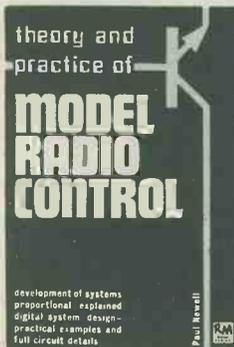
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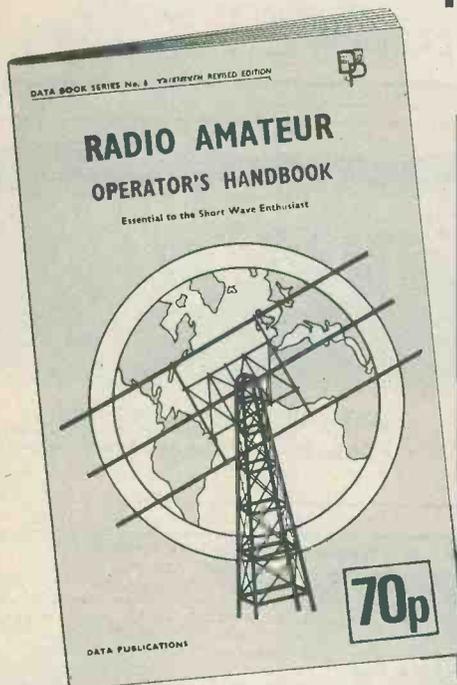
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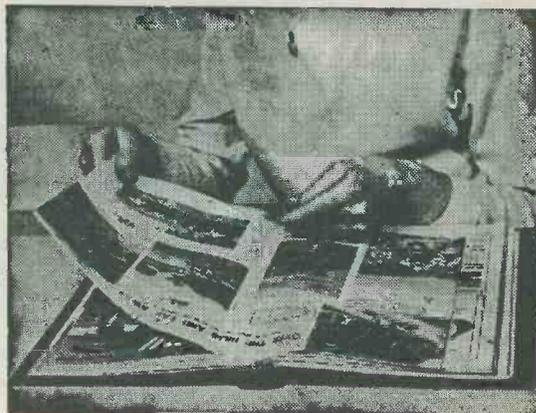
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25	64	32	13	6.4	3.2	1.3	0.64	0.32
10	160	80	32	16	8.0	3.2	1.6	0.80
5	320	160	64	32	16	6.4	3.2	1.6
2.5	640	320	130	64	32	13	6.4	3.2
1	1,600	800	320	160	80	32	16	8.0
0.5	3,200	1,600	640	320	160	64	32	16
0.2	8,000	4,000	1,600	800	400	160	80	40
0.1	16,000	8,000	3,200	1,600	800	320	160	80
0.05	32,000	16,000	6,400	3,200	1,600	640	320	160
0.02	80,000	40,000	16,000	8,000	4,000	1,600	800	400
0.01	160,000	80,000	32,000	16,000	8,000	3,200	1,600	800

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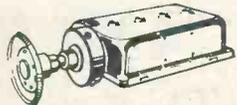
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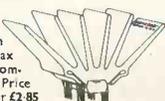
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