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FOR THE RADIO AND TELEVISION ENTHUSIAST

VOLUME 9 NUMBER 8 MARCH 1956

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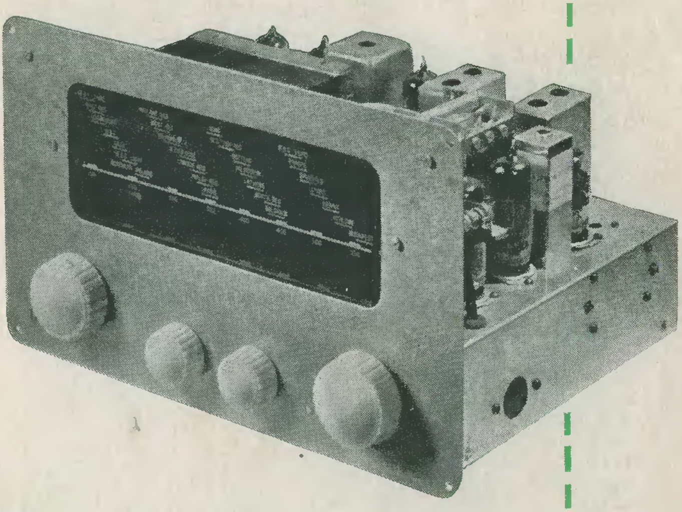

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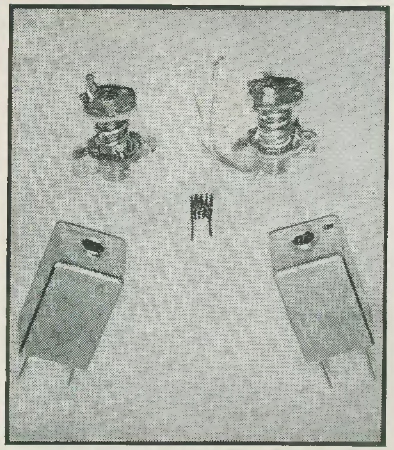

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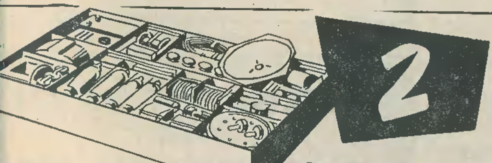

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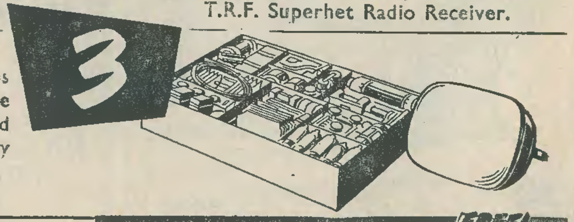

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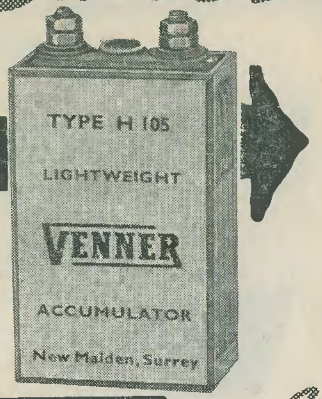

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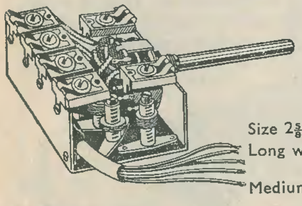

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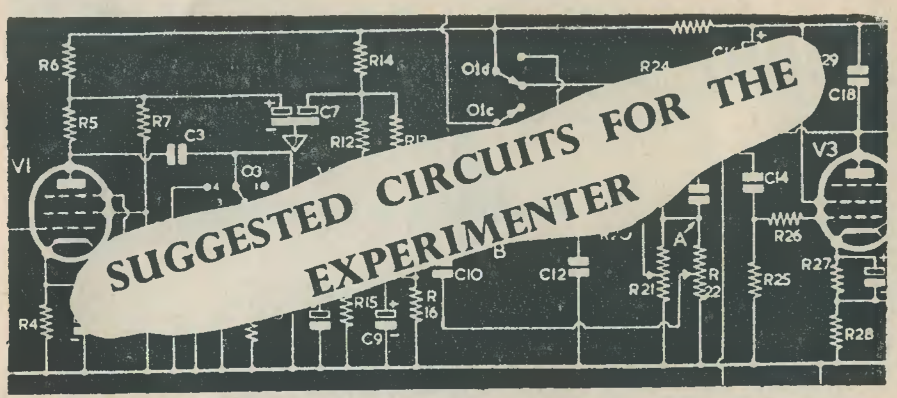


SUGGESTED CIRCUITS FOR THE EXPERIMENTER

The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 64. A MINIATURE GRID-DIP METER

As many readers will already be aware, one of the most useful measuring instruments for amateur use is the grid-dip meter. The basic purpose of this instrument is that of determining the resonant frequency of tuned circuits; but it may also be employed for measuring inductance or capacity when the component under test is shunted by a known inductor or condenser. The grid-dip meter has especially valuable properties so far as oscillator tuned circuits are concerned because, unlike some other devices normally employed for measuring frequency, it responds only to the fundamental and not to any harmonics. This point is particularly useful at v.h.f., where it is sometimes quite difficult to initially ascertain the fundamental frequencies of coils employing only the few turns required for operation at these frequencies.

Basic Functioning

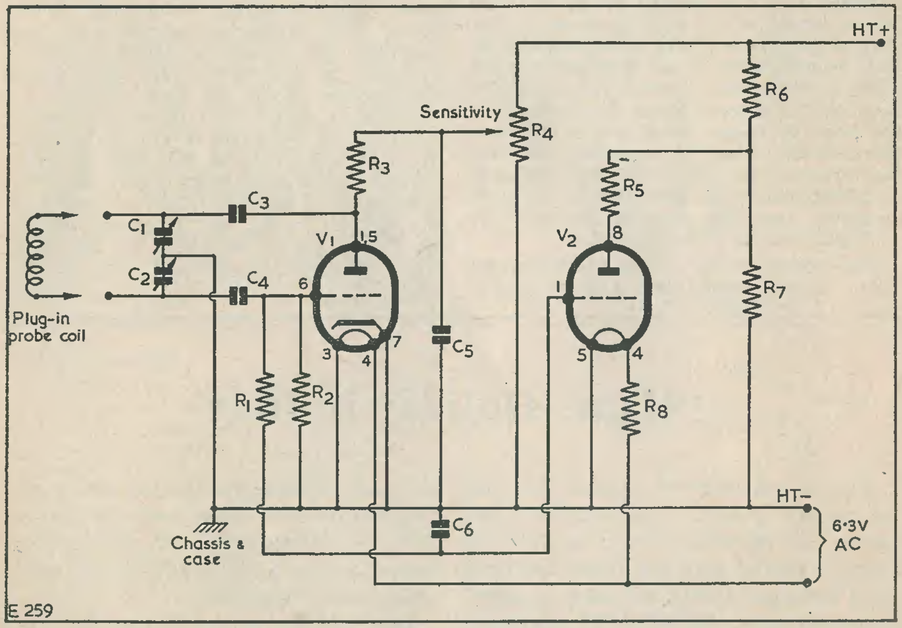
The conventional type of grid-dip meter consists essentially of an r.f. oscillator having a milliammeter or microammeter connected in series with its grid leak. This meter then undergoes a permanent deflection proportional to the negative grid current drawn by the oscillator during the time that the instrument is switched on. The coil of the oscillator tuned circuit is capable of being brought close to the coil of the tuned circuit whose resonant frequency it is desired to measure. The oscillator coil is then tuned by means of a variable condenser calibrated directly in frequency. When the frequency of the grid-dip meter tuned circuit approaches that of the circuit under test, the latter draws energy from it. In consequence, a "dip" in grid current occurs as the oscillator tunes through the resonant frequency of the test circuit, greatest dip being given when the two have the same frequency. The resonant frequency of the tuned circuit under test may then be read off from the calibrated tuning condenser of the grid-dip meter.

In practice, grid-dip meters can employ several different techniques for bringing the oscillator, or "probe," coil close to the one under test so that mutual inductive coupling may occur. However, the most common method consists, quite simply, of mounting the probe coil externally on a small case; the oscillator valve, grid current meter and tuning condenser being fitted inside. All other things being equal, the most useful grid-dip meter then becomes that which has the smallest and most conveniently-shaped case, since this enables the probe coil to be brought closest to the coil under test. This point is especially true when the test coil is fitted in a crowded and awkwardly positioned chassis. Unfortunately, the necessity of including the grid current meter and tuning condenser scale sets limits to the possible reduction in size of the grid-dip meter case.

This Month's Circuit

In the circuit to be described this month a somewhat novel solution is put forward in order to reduce the bulk of the unit housing the grid-dip oscillator circuit. This solution consists of dispensing with the grid-current meter altogether, employing in its place a miniature tuning indicator. As the readings given by the grid current meter are purely comparative the use of this type of indicator is quite permissible. There is the further advantage that the tuning indicator specified is cheaper than the normal cost of the meter it replaces.

The complete circuit may now be considered. As will be seen from the diagram, a Colpitts oscillator has been chosen, this being employed in conjunction with plug-in probe coils. Apart from the incidental advantage of requiring only two plug connections, the Colpitts circuit is especially well suited for v.h.f. work. As it stands, the circuit shown should oscillate comfortably between some 5 and 200 Mc/s, thus rendering it of use for amateur as well as for television and f.m. development. The tuning condenser C_1, C_2, should be a butterfly or miniature two-gang type having a maximum capacity in each section of 50 to 100pF. An h.t. blocking condenser, C_3, is connected between the anode of the oscillator, V_1, and the coil; this serving to prevent shock as the coil is handled. A variable amount of h.t. is applied to the anode of V_1 by means of the wire-wound potentiometer, R_4. This potentio-



Component Values

Valves

V_1	6C4 (see note below)
V_2	DM70

An alternative to the 6C4 is the triode section of any v.h.f. frequency-changer: viz. ECF80, etc.

Resistors

R_1	6.8MΩ, ⅛ or ¼ watt
R_2	47kΩ, ⅛ or ¼ watt
R_3	10kΩ, 1 watt
R_4	100kΩ, wire-wound
R_5	270kΩ, ⅛ or ¼ watt
R_6, R_7	68kΩ, ¼ watt
R_8	220Ω, 5%, 1 watt

Condensers

C_1, C_2	See text
C_3	1,000pF, ceramic
C_4	50pF, ceramic
C_5, C_6	1,000pF, ceramic

meter is needed in order to keep the oscillator grid current within the range of the tuning indicator at different frequencies.

In this circuit it would probably be more accurate to state that the tuning indicator reads grid voltage, rather than grid current. This grid voltage is negative with respect to chassis, and it is applied to the grid of the tuning indicator, V_2, via the resistor R_1, r.f. being bypassed by C_6. Owing to its relatively high value, R_1 does not interfere with the functioning of the oscillator circuit.

The tuning indicator is a Mullard DM70, this being a miniature valve which indicates varying negative voltage on its grid by means of a column of light, the length of this column reducing as the grid voltage goes more negative. In the arrangement employed here, grid "dip would be displayed as an increase in length of the column.

The DM70 tuning indicator has a 1.4 volt filament and is connected to the 6.3 volt heater supply of the grid-dip meter via the dropping resistor R_8. For correct functioning it is important to ensure that pin 5 is the filament pin which connects to chassis. A reduced h.t. voltage is fed to the anode of the indicator by means of a tap in the fixed potentiometer, R_6, R_7, together with the series resistor, R_5. This circuit arrangement should enable the indicator to have adequate sensitivity over the range of voltage to be anticipated at the oscillator grid.

The power supply is not shown in the circuit as it is intended that it be enclosed in a separate unit. If this is done, the grid-dip meter proper can then be operated at the end of a 3-core flexible lead carrying the h.t. and heater supplies. An h.t. voltage of 200–240 is desirable for adequate oscillator operation at the higher frequencies, maximum h.t. current approaching 15 mA under no-oscillation conditions, such as would be given during the changing of coils. Although within the rating of V_1, it would nevertheless be advisable in practice to reduce this h.t. current during coil changes by turning down the sensitivity control, R_4, in order to prevent undue heating of the valve. The heater current is 0.175 amps.

Practical Points

There are one or two practical points which require a little discussion before completing this month's contribution.

The first of these is that the probe coils employed by the grid-dip meter should have a reasonably high value of Q. High-Q coils result in high sensitivity in the meter. If it is found that squegging occurs with any particular coil, it may be cleared by slightly reducing the value of C_4. The tuned circuit connections should be kept as short as possible, as, also, should the wiring from the tuned circuit to the pins of V_1. The resistors R_1, R_2 and R_3, together with the condensers C_5 and C_6, should all be mounted close to V_1. The length of the leads from the junction of R_3 and C_5 to R_4, and from the junction of R_1 and C_6 to the grid of V_2, can be of any reasonable length since they do not carry r.f.

"Ham" Holiday in Italy

Readers are probably aware that the International Amateur Radio Union Conference will be held at Stresa in Italy in June. A holiday party for Hams and their wives and radio friends has been arranged to accompany the official R.S.G.B. delegation there, and to stay on afterwards for a lakeside holiday. All readers are invited.

The party will travel by train and will be housed in a pleasant hotel. They will be allowed to attend the conferences as observers, and to ioin in the excursions which have been arranged by A.R.I.. the Italian amateur radio organisation. These excursions are very well planned and should give pleasure to both Hams and their wives. After the conference the party will remain at Stresa to enjoy a fine holiday in this lovely town on Lake Maggiore.

The duration of the holiday is 14 days (departure date 10th June) and the cost from London is 37 gns. For groups of four or more booking together, reductions are available. Early application is advised and details are obtainable from G3GVZ, Francis Glynn Travel Service, 13 Station Road, East Grinstead. Telephone number is East Grinstead 3667.

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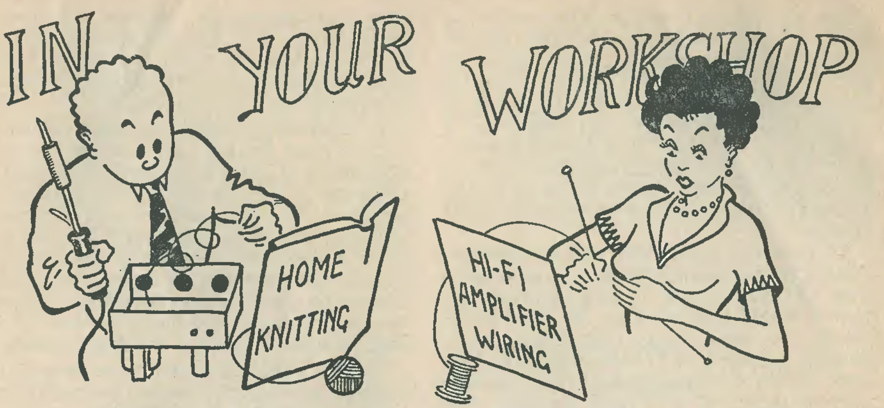


In which J. R. D. discusses Problems and Points of Interest based on Letters from Readers and his own experience

IN LAST MONTH'S ISSUE WE DISCUSSED AT some length the basic features of multi-testmeter design as seen from the point of view of the home constructor. Particular attention was then paid to suitable techniques for "manufacturing" the series resistor combinations required for the various voltage ranges. An empirical method was described that allowed the use of low-tolerance resistors which may normally be already to hand, or which can be obtained quite cheaply. We shall now pass on this month to similar techniques for the current and resistance ranges.

Switching Circuits

To enable the basic meter of a multi-testmeter to read widely differering values of currents, it is necessary to connect suitable resistors, called "shunts," across the coil of the meter. One shunt is required for each range. The most attractive method of selecting the individual shunts then consists of bringing them into circuit across the basic meter by means of a switch.

Unfortunately, it is quite possible, if an incorrect type of switch circuit is employed, to introduce errors into the readings given by the meter. It is even possible, also, for an unsuitable type of switch circuit to contribute towards accidental overload, with consequent damage, to the meter itself. The reason for these points will now be discussed.

It would appear, at first sight, that the most obvious switch circuit to employ in order to select one of a number of shunts is that shown in Fig. 1. As may be seen, the range switch shown in this diagram performs the very simple function of connecting different values of shunt across the basic meter in order to provide the various current ranges. What could be easier? Nevertheless, despite its evident simplicity, the circuit of Fig. 1 is *not* recommended to the home-constructor unless he is able to employ a switch which has considerably low contact resistance and which is completely reliable. Such switches are not normally obtainable very easily, and their value is problematic for the purposes required here.

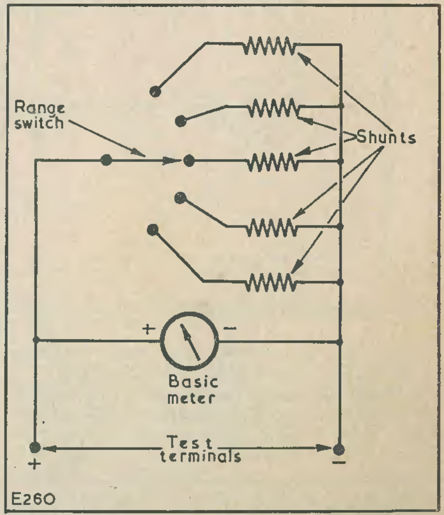


Fig. 1. A possible method of switching shunt resistors across a meter. For reasons which are explained in the text, this circuit is not recommended for the home-constructor

Let us assume that the range switch of Fig. 1 is set to a high current range (say 0–1 amps) and the basic meter employed has an f.s.d. of 1mA. The relevant circuitry may then be reduced to that illustrated in Fig. 2, which omits the ranges not selected. A current of 1 amp then flows through the testmeter circuit. Assuming negligible resistance in the switch contacts the majority of this current (999mA) will flow through the shunt resistor.

If, however, the switch contact suddenly developed a high resistance, a large proportion of the current passing through the circuit would flow through the basic meter itself. In consequence the latter would become damaged, and could quite easily burn out. When it is remembered that the high-current shunts of a normal testmeter may have values of a small fraction of an ohm, it will be appreciated that a switch contact resistance of only an ohm or so will be sufficient to allow the basic meter to be completely damaged. A typical instance of the low resistance values involved may be obtained from the example just described.

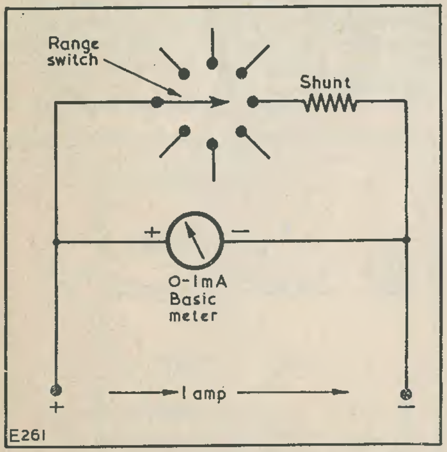


Fig. 2. Illustrating the most serious objection to the arrangement of Fig. 1. Should the range switch contacts become open-circuit or high-resistance, the meter may be burnt out

If the basic meter of Fig. 2 had a (quite conventional) coil resistance of 100 ohms, the 0–1 amp shunt would have a resistance (correct to three significant figures) of 0.1 ohms only.

Should the switch contacts shown in Fig. 2 present a very small amount of resistance they may not necessarily damage the meter. Nevertheless, they will still introduce errors. In the example just quoted, a contact resistance of 0.1 ohm would, for instance, introduce an error in readings of some 50%.

A far better current range switching circuit is illustrated in Fig. 3. This has several advantages, and the only danger presented to the meter is the possibility, which cannot be obviated in any conventional testmeter arrangement, of the shunt itself burning out, or of its becoming physically disconnected. The former point can, of course, be guarded against by using sufficiently heavy resistance wire in the shunt; and the latter by ensuring that its connections are soldered soundly.

In Fig. 3 the test current flows through the contacts of switch S_1, through the appropriate shunt connected in by that switch, and thence to the negative test terminal. ("Conventional" current flow from positive to negative is assumed.) If the contacts of S_1 were to introduce resistance, this would merely result in a larger voltage being dropped between the testmeter terminals themselves. The basic meter would not be affected. Similarly, if S_1 were to become open-circuited, all that would occur would be the cessation of current through the testmeter. The basic meter, once more, would remain unaffected.

The basic meter is connected to the selected shunt by means of S_2. Should any of the contacts of S_2 become open circuit, all that would happen is that the meter would fail to read. If any contact of S_2 presented a resistance, the accuracy of readings would be affected but by a much smaller amount than would occur for a similar contact resistance in the circuits of Figs. 1 and 2. The reason for this is that S_2 in Fig. 3 is in series with the coil of the meter, whereas the range switch in Figs. 1 and 2 is in series with the shunt. The coil of the meter will have a considerably higher resistance than is given by any of the shunts and the added series resistance of the switch contact would have proportionately the less effect.

The circuit of Fig. 3 is quite suitable for home-constructed testmeters, and suffers only from the disadvantage that it requires a two-pole switch. However, for currents up to 1 amp a conventional wave-change switch can be employed, in which case it becomes possible to obtain the contacts required for the extra pole quite easily. The switch employed by the constructor in this testmeter should be a reliable model of the "wafer" type; "miniature" 12-contact wave-change switches are not recommended here.

Making Shunts

The business of making shunts is liable to be a little tedious if a suitable design method is not employed. It is possible, however, to manufacture shunts using an empirical technique rather similar to that described last month for making the series voltage resistor combinations. This technique deserves a few words of explanation here.

Most shunts employed in the multi-testmeter will consist of resistance wire suitably mounted. The reason for this choice of material is that the shunts for the higher current ranges will have very low values of resistance, and such shunts can only be made with the aid of resistance wire. This type of wire is fairly easy to obtain by the amateur. Apart from normal retail sources it can be frequently salvaged from broken mains droppers and similar components. It is important to ensure that the resistance wire chosen for the shunts is capable of carrying the maximum current which will pass through it, and is such that it may be soldered readily. Also, the wire should not shift in resistance value as its temperature increases. The latter point will be automatically guaranteed by the use of "Eureka" or a similar type of wire. Wire salvaged from wire-wound resistors will also have a resistance which is sufficiently stable with temperature rise for our purposes here.

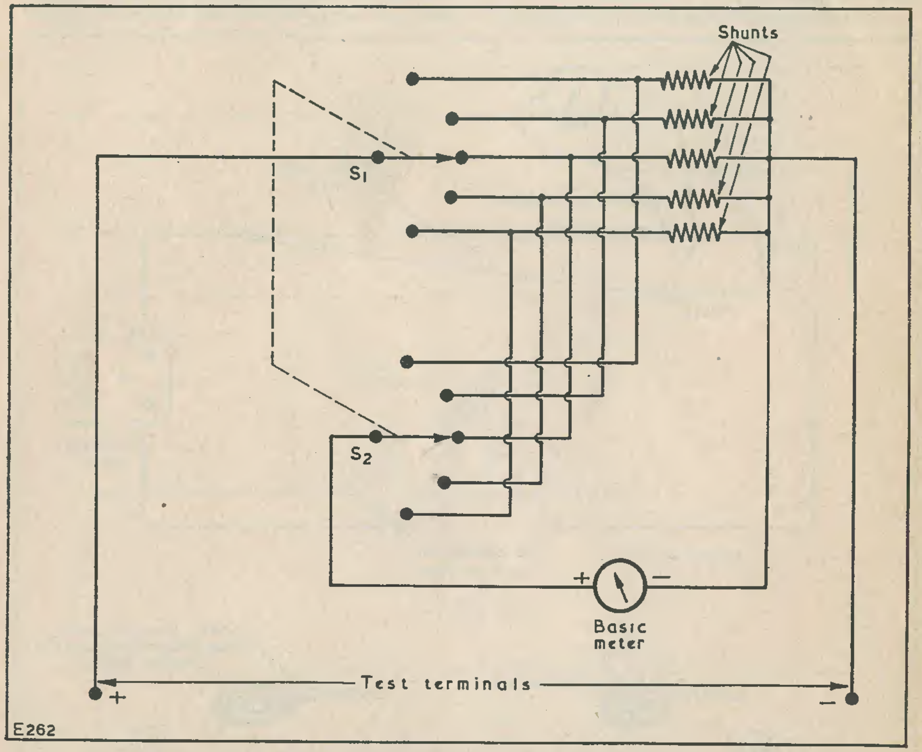


Fig. 3. A current range-switching circuit which gives good protection to the metre as well as ensuring a high degree of accuracy

Fig. 4 illustrates a very practicable technique for finding the length of wire needed for a particular shunt. A known current is passed through a length of the resistance wire, this being connected in series with a calibrating meter. The basic meter of the test instrument under construction has one terminal connected to one end of the resistance wire. The other terminal is then connected to a "jockey" which is slid along the wire in the direction indicated, starting at the left-hand end. As can be imagined, this process will cause a continually increasing deflection in the meter. When the deflection corresponds to the current reading given by the calibrating meter, the correct length of resistance wire will be that between the left-hand end and the jockey. This length may then be cut out (allowing sufficient extra for solder connections), fitted to a suitable mounting assembly and soldered into its appropriate place in the multi-testmeter.

The method just described should give excellent results for normal purposes. If it is found, however, that the length of resistance wire needed for a particular shunt is rather low—say, less than three inches—this technique may not provide sufficient accuracy in determining the final length of resistance wire required.

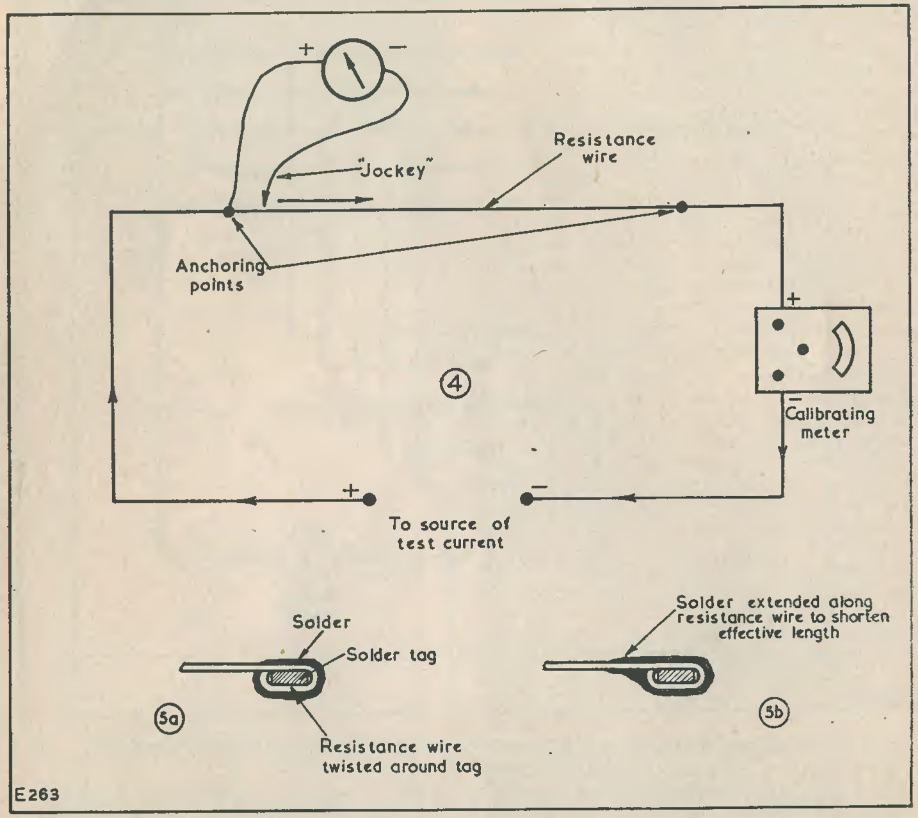


Fig. 4. An empirical method of determining the length of resistance wire required for a particular shunt. Fig. 5. The electrical length of resistance wire in a shunt may be "trimmed" over small limits by the technique shown here

In such an instance it is advisable to make the length of resistance wire employed in the shunt approximately ½-inch too long and "trim" it after it has been fitted into the circuit. A suitable "trimming" operation is shown in Fig. 5. Fig. 5 (*a*) shows, in cross-section, one end of the resistance wire soldered to its appropriate tag. The slight extra length of resistance wire is then "trimmed" out by soldering along its surface for a short distance. Fig. 5 (*b*) shows a cross section of the wire after this operation. When carried out with care, the process illustrated in Fig. 5 will give very good results.

The question of mounting the resistance wire used for the current shunts should not raise much difficulty. What are required for this purpose are short tubular insulated formers, around which the wire may be wound, with convenient wire-ends for anchoring. Formers of this type are frequently encountered in "surplus" equipment, where they are employed for r.f. chokes and similar inductors. A rather suitable former can be provided by a conventional resistor. The value of the resistor will normally be sufficiently high to have negligible effect on the shunt itself.

Ohmmeter Ranges

All that remains in the home-constructed multi-testmeter are the ohmmeter ranges. Normally, these will employ a simple "series" circuit; but it is possible to extend the usefulness of a home-built meter very considerably by the use of a "shunt" circuit as well. Such a circuit is capable of reading very low values of resistance.

A typical "series" circuit is illustrated in Fig. 6. In this diagram a battery (or single cell) is connected to the meter via a fixed resistor, a variable resistor and the test terminals. The variable resistor is intended to be adjusted such that, when the test terminals are short-circuited together, the meter reads full-scale deflection. Connecting the test terminals to various values of resistance will then cause corresponding meter deflections.

The purpose of the variable resistor in Fig. 6 is to allow for the fact that the output of the energising battery will fall with age. The circuit functions under the assumption that, as the battery ages, its voltage remains constant and its internal resistance increases. Unfortunately, this assumption does not provide a truthful picture of what occurs in practice, but it is sufficiently accurate for small variations of resistance in the variable resistor. The purpose of the fixed resistor is that of limiting the current from the battery to a safe amount. If it were not fitted in the circuit it might be possible, by careless adjustment of the variable resistor, to connect the battery directly to the coil of the meter; whereupon the latter could be burnt out.

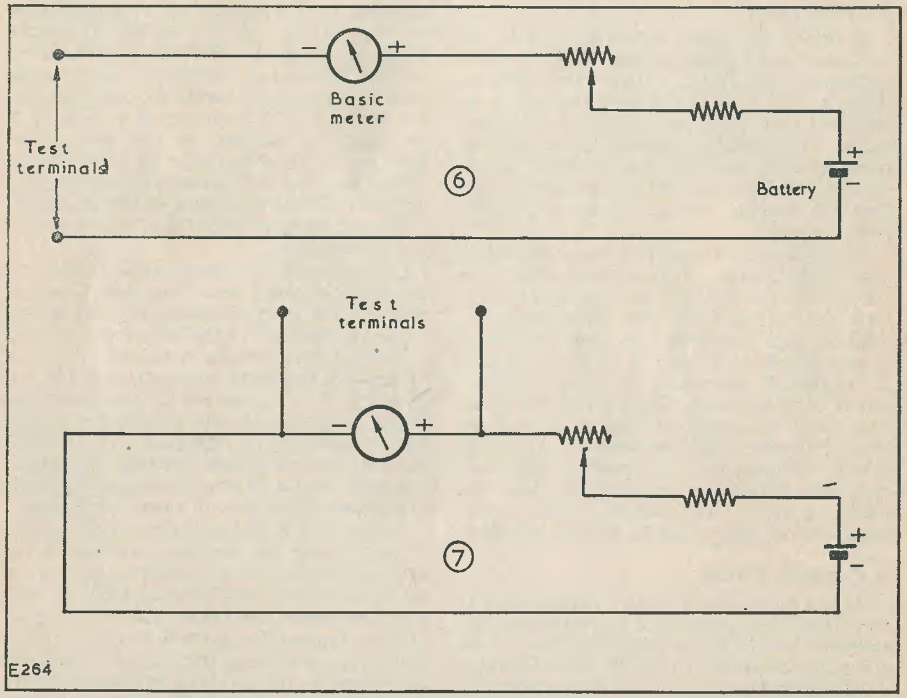


Fig. 6. A basic ohmmeter circuit suitable for "series" resistance measurements

Fig. 7. A slight rearrangement of Fig. 6 enables low-value "shunt" resistance measurements to be obtained

For practical purposes it should be adequate enough to give the fixed resistor a value sufficient to pass approximately 20% more current through the meter, when a brand new battery is fitted, than is given by its f.s.d. The variable resistor should then have a value which is sufficient to bring the meter back to f.s.d. under these conditions. A simple example should show all that is required. Let us assume that a single energising cell is employed, and that the meter has an f.s.d. of 1mA and a coil resistance of 100 ohms. The single cell can be assumed to have negligible internal resistance when new, and a voltage of 1.5. The resistance values needed to pass currents of 1.2mA and 1mA for a potential of 1.5 volts are 1,250 and 1,500 ohms respectively. These resistance figures will, of course, have to include the 100 ohm resistance of the meter coil. Therefore if we give our fixed resistor of Fig. 6 a value of 1,150 ohms and the variable resistor one of 250 ohms we shall have covered the requirements detailed above. In practice, a 1,200 ohm 5% resistor will be sufficiently near to the calculated 1,150 ohm value to meet our needs.

It should be noted, incidentally, that the variable resistor value just calculated is small compared with that of the fixed resistor. Such a course is intentional because it is intended that it should only have a limited range. This then prevents its being used to provide f.s.d. readings with batteries which are sufficiently exhausted to fall outside the constant battery voltage assumption mentioned above.

Fig. 7 shows a circuit suitable for "shunt" resistance readings. This employs exactly the same battery, fixed and variable resistors as were used in Fig. 6; the only difference being that the test terminals are now connected across the meter instead of in series with it. It is possible to obtain accurate measurements of resistance down to a fraction of an ohm, with the circuit of Fig. 7. As will be seen, the meter reads "backwards" when this circuit arrangement is used. "Infinity" resistance across the test terminals allows the meter to read f.s.d.; whilst "zero ohms" causes its needle to drop to the zero position.

A Complete Circuit

At the end of last month's contribution it was stated that a circuit of a complete multi-testmeter would be given in this issue. This circuit is now shown in Fig. 8. The testmeter illustrated in this diagram is a fairly ambitious job, but should not prove to be outside the range of the amateur.

A 12-position range switch is shown. This number of positions will be comfortably given by a normal wave-change switch with conventional 30 degree indexing, and such a switch will function satisfactorily in the circuit. A wave-change switch cannot, however, be recommended for switching very high voltages or currents, with the result that the 2,000 volt and 10 amp positive test circuits are not switched completely, but are brought out to separate test terminals. For all other ranges the "Common Positive" and "Common Negative" terminals are employed, the switching inside the test-meter presenting the appropriate internal circuit to these terminals.

A few words concerning the operation of the switching circuits may not be out of place at this point, On position 1 of the range selector switch, the 2,000 volt range is selected via S_1. The series resistor R_1 consists of four or more resistors, having approximately equal values, in series, as it is inadvisable to apply voltages in excess of 500 or so across the terminals of an individual resistor (unless it is manufactured especially for such voltages). On positions 2 to 5 inclusive, the series resistors R_2 to R_5 are selected via S_1. S_2 connects the upper end of the resistor chain to the "Common Positive" terminal. On position 6, the "Series Ohm" position, the energising battery is connected, via R_{10}, R_{11}, and S_2, to the "Common Positive" terminal. The circuit to the meter is then completed externally via whatever resistor is connected across the test terminals. On position 7, S_3 connects R_{11} directly to the negative terminal of the meter, thus allowing it to read f.s.d. S_1 connects the "Common Positive" terminal to the positive terminal of the meter, thus enabling "shunt" resistance readings to be taken across the two test terminals.

On position 8, the meter remains connected across the two test terminals, thereby allowing the multi-testmeter to read 0–1mA f.s.d. (i.e. the f.s.d. of the basic meter without a shunt). On positions 9, 10 and 11, S_1 and S_2 perform the same functions as did S_1 and S_2 of Fig. 3. On position 12, S_1 connects the meter across R_6, thereby allowing a 10 amp f.s.d. reading to be obtained. The external current does not pass through the switch contacts on the 10 amp range, owing to the limitations of the type of switch employed.

Although it is anticipated that constructors would employ the methods outlined in this and last month's issue for making the various series and shunt resistors required for their multi-testmeter, the values of these are given in the diagram for general interest. Apart from R_{10} and R_{11}, the values shown are calculated correct to three significant figures. They apply, of course, to a basic meter having, as shown in the circuit, an f.s.d. of 1mA and a coil resistance of 100 ohms. (Such meters are available through surplus channels, as was mentioned last month.)

The methods of calculating the series voltage resistors, as well as the fixed and variable resistors for the ohmmeter circuits, have already been described. That needed for the current range shunts is equally simple. Current shunt values may be calculated with the aid of the formula

$$R_s = \frac{I_m}{I_s} \times R_m$$

where R_s is the resistance of the shunt, R_m is the resistance of the meter, I_m is the current required to flow through the meter, and I_s the current required to flow through the shunt.

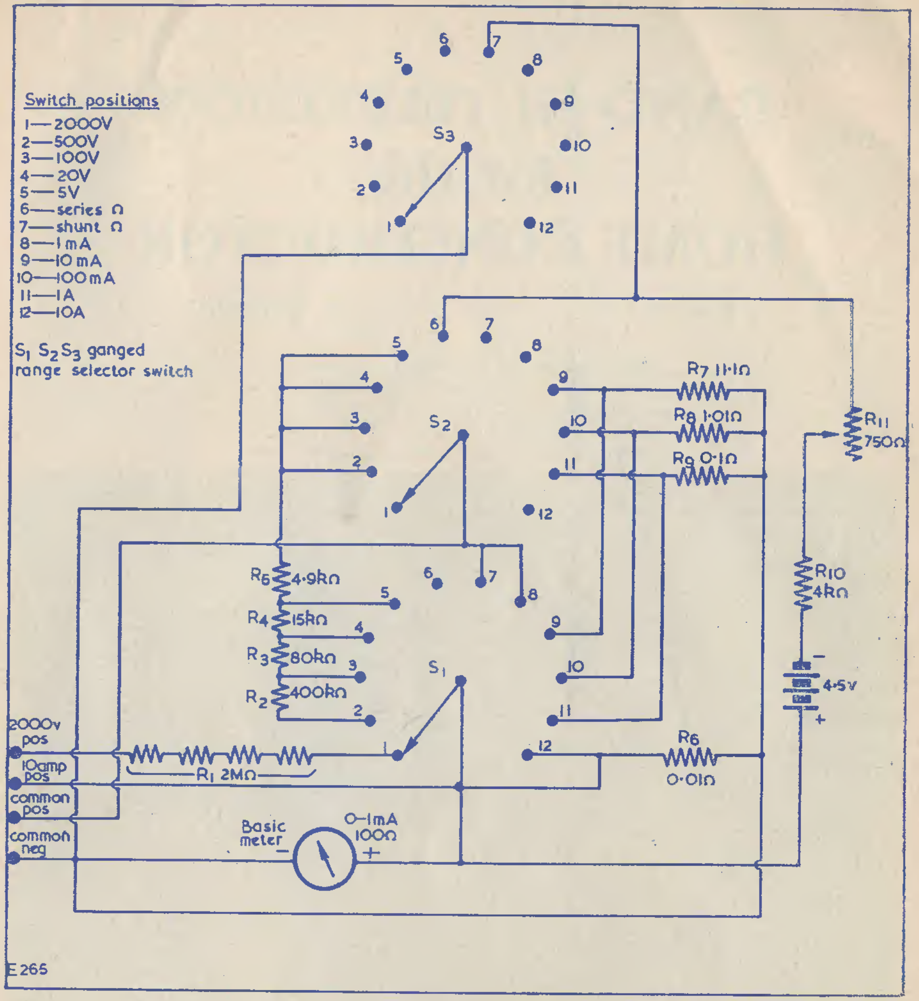


Fig. 8. The circuit of a complete and practicable multi-testmeter

Thus, on range 9 in Fig. 8, the multi-testmeter is intended to have an f.s.d. of 10mA. This infers that, at full-scale deflection, 1mA of current should pass through the meter and 9mA through the shunt. The shunt resistance, R_7, is therefore: $\frac{1}{9} \times 100 = 11.1$ ohms.

By the use of similar calculations, the circuit of Fig. 8 can be employed with any other meter of comparable sensitivity.

Next month . . . *Full details and point-to-point wiring diagram of the Mullard 3-valve 3-watt Hi-Fi Amplifier*

BAND III TELEVISION for the HOME CONSTRUCTOR

PART 9.

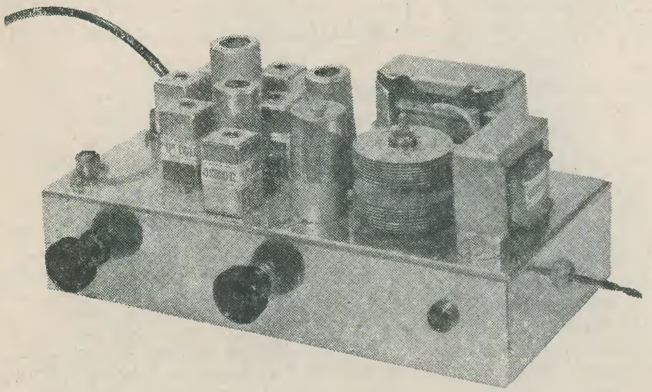
by S. WELBURN

This month S. Welburn continues his popular television series by discussing a new and sensitive Band III converter. This is the Osmor Television Converter, and complete details are given, both for construction and for alignment.

IN HIS CONTRIBUTION IN THE LAST ISSUE of *The Radio Constructor*, the writer concluded by stating that he would be giving a full description of the Osmor Television Converter in the next article. In accordance with this announcement, he has pleasure now in giving complete details of this modern and very efficient Band III converter.

The Circuit

The circuit of the Osmor Converter is illustrated in Fig. 1. As may be seen, the unit incorporates quite a number of modern features to ensure maximum gain and stability, as well as providing adequate safeguards against Band I breakthrough.



The Osmor Band III Converter

Starting at the input circuit, it will be noted that the Band III aerial socket connects to a tap in the input coil L_1. This tap is positioned such that the 75 ohm aerial input impedance matches accurately into the impedance presented to the complete coil by the grid and cathode of V_1. The "hot" end of L_1 connects to the grid of V_1 via L_2, C_1, the latter two components providing a rejector circuit at Band I frequencies. The function of this rejector circuit is to ensure that as little Band I breakthrough as possible is passed through the Converter circuits when the unit is switched to Band III.

V_1 is employed as a cascode, the two separate triodes forming this stage being $V_{1(a)}$ and $V_{1(b)}$. The cathode of $V_{1(a)}$ is connected to chassis via R_2 and R_1. R_2 is a 150 ohm fixed resistor whose purpose is to ensure that $V_{1(a)}$ always has sufficient cathode bias, whilst R_1 is a variable component. R_1 operates as a sensitivity control and should be adjusted such that switching from one band to another does not necessitate adjustments to the sensitivity or contrast controls of the televisor to which the Converter is connected.

The anode of $V_{1(a)}$ is connected to the cathode of $V_{1(b)}$ via L_3. L_3 is the peaking choke normally encountered in Band III cascodes; and it has the additional feature in this converter of being provided with an adjustable core, this being done to enable an accurate setting of its inductance to be obtained. It is possible that, when carefully set up, L_3 should enable a higher degree of gain at Band III to be obtained than is given by the use of a more conventional fixed-inductance choke. The grid-cathode circuit of $V_{1(b)}$ is normal, the resistor R_3 serving as a grid-leak.

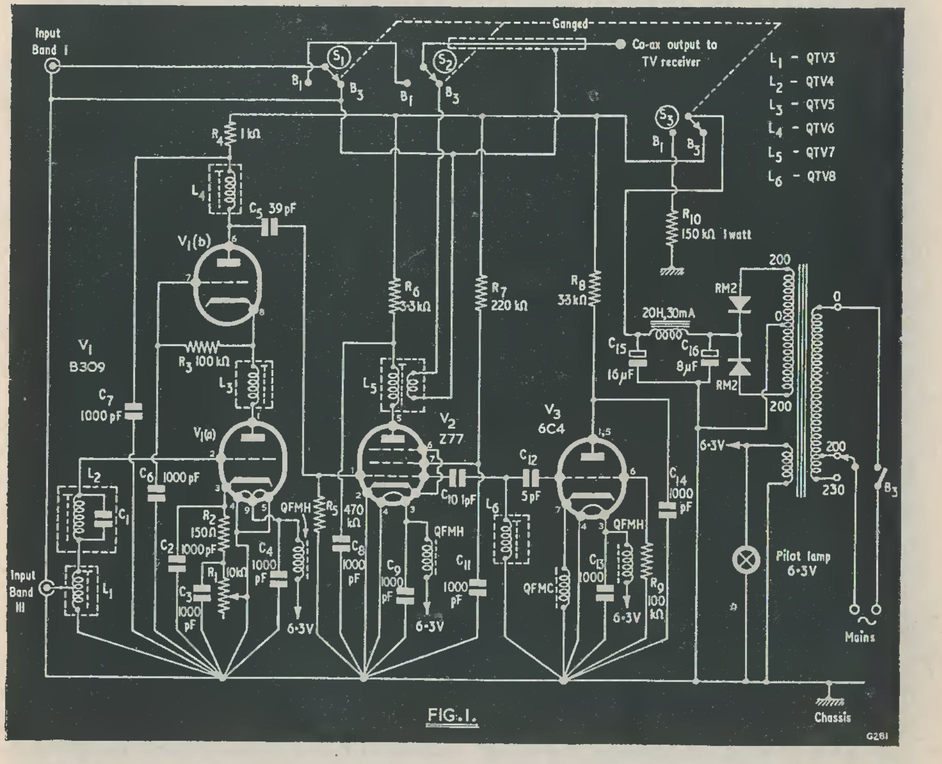


Fig. 1. The circuit of the Osmor Television Converter

The anode of $V_{1(b)}$ is connected to the coil L_4. This coil, paralleled by the stray capacities to chassis in the wiring plus the internal capacities in $V_{1(b)}$, functions as a parallel tuned circuit resonant at the desired Band III frequency. The r.f. voltage at the anode of $V_{1(b)}$ is then passed to the control grid of the mixer V_2.

The Oscillator

The oscillator, V_3, employs a version of the Colpitts oscillator which may be unfamiliar to some readers. In consequence, a few words of explanation concerning the circuit chosen would not be out of place at this point.

Fig. 2 (*a*) shows the normally encountered Colpitts oscillator, as employed in Band III converters and tuners. As will be seen from this diagram, the coil is tuned by three capacities. The first of these is the capacity existing between anode and grid of the valve, and this, shown as C_{ag} in the diagram, is connected across the whole of the coil. The remaining two capacities, C_{ac} and C_{gc} (those between anode and cathode, and between grid and cathode) then provide the capacitive tap into the coil necessary for the Colpitts mode of operation.

In Fig. 2 (*b*) the same circuit is shown after a slight rearrangement has taken place. In this instance the coil is still connected effectively between anode and grid, and the capacitive tap into the coil provided by C_{ac} and C_{gc} is still in existence. However, in Fig. 2 (*b*), the anode of the valve is at chassis potential so far as r.f. is concerned, this being achieved by its connection to the 1,000pF decoupling condenser C_{14}. The cathode, which in Fig. 2 (*a*) was connected to chassis, is now isolated via the r.f. choke. Despite these differences the requirements for oscillation still exist: the cathode connects into a tap along the tuned circuit, and the grid and anode are at points 180 degrees out of phase with each other; i.e. at opposite ends of the tuned circuit. All that has really changed is that, whereas in Fig. 2 (*a*) the cathode of the oscillator was connected to chassis, in Fig. 2 (*b*) it is the anode which is at chassis potential.

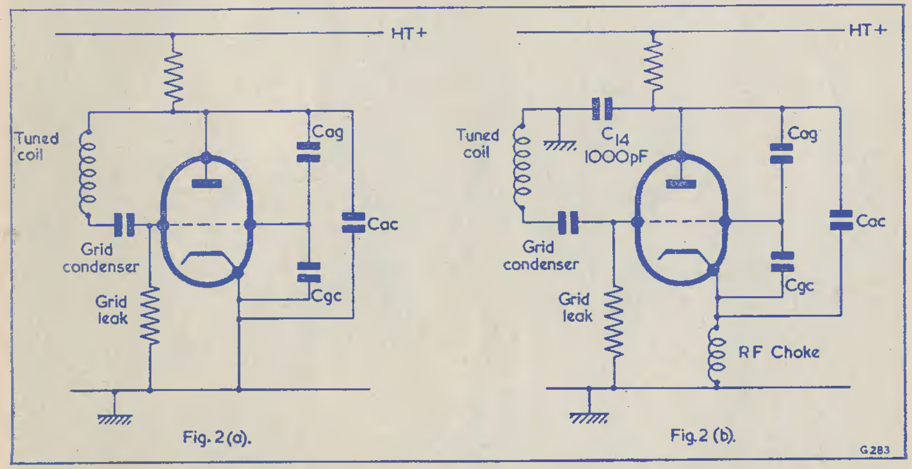


Fig. 2 (a). A conventional Colpitts oscillator, as used at Band III frequencies (b) A slight modification to the circuit of (a), in which the anode, and not the cathode, is at chassis potential.

The circuit of Fig. 2 (*b*) has been used commercially in the past for f.m. applications and would appear to have similar attractive features for Band III television purposes. Owing to the fact that one end of the coil is connected to chassis it possesses the advantage that the full oscillatory voltage appearing across this coil may be applied to the mixer, whilst in Fig. 2 (*a*) only that appearing across C_{ac} or C_{gc} would be so applied. Apart from the fact that the available oscillatory voltage is, therefore, greater with the circuit of Fig. 2 (*b*), there is the additional factor that the load (normally capacitive) presented to the oscillator by the mixer is now applied across the whole coil and not across a tapping into the tuned circuit. In consequence the oscillator feedback ratio is not altered by variations in the mixer and its tuned circuits.

It will be appreciated that, apart from a repositioning of the components, the oscillator of Fig. 2 (*b*) is identical to that shown in Fig. 1.

To return to Fig. 1 again, we may state that an oscillatory voltage appears across L_6. This voltage is applied to the control grid of V_2 via the 1pF condenser, C_{10}. V_2 is already receiving signal voltage via C_5, with the result that it now functions as an additive mixer.

The i.f. voltage appearing at the anode of V_2 is applied to the i.f. transformer L_5. This transformer is tuned to the Band I frequency employed by the televisor with which the Converter is to be employed, and its coupling winding enables a Band I output to be obtained at 75 ohm impedance.

The Switching Circuits

The 75 ohm output from L_1 is not applied directly to the associated televisor; it has first to be selected by the switching circuits. These, also, are shown in Fig. 1, and may now be considered in detail.

When the converter switch is set to the Band I position, the Band I aerial input is connected, via S_1 and S_2, to the coaxial output of the Converter. It will be noted that a link is provided between S_1 and S_2. This link helps to reduce any possible re-radiation which may occur when the Converter is switched to Band III. In the Band I position a further switching operation is provided by S_3, this switch breaking the h.t. feed to the valves in the Converter and connecting R_{10} across the h.t. supply. Due to this the Converter becomes inoperative when switched to Band I, whilst the formation of excessive voltage in the power unit output is prevented by the presence of the bleed resistor, R_{10}. If it is desired to feed a very low h.t. current to the converter valves when the unit is switched to Band I in order to prevent cathode poisoning, this may be done by connecting a 5 or 10MΩ resistor across the fixed contacts of S_3. Such a resistor is not shown in the circuit or in the wiring diagram, however.

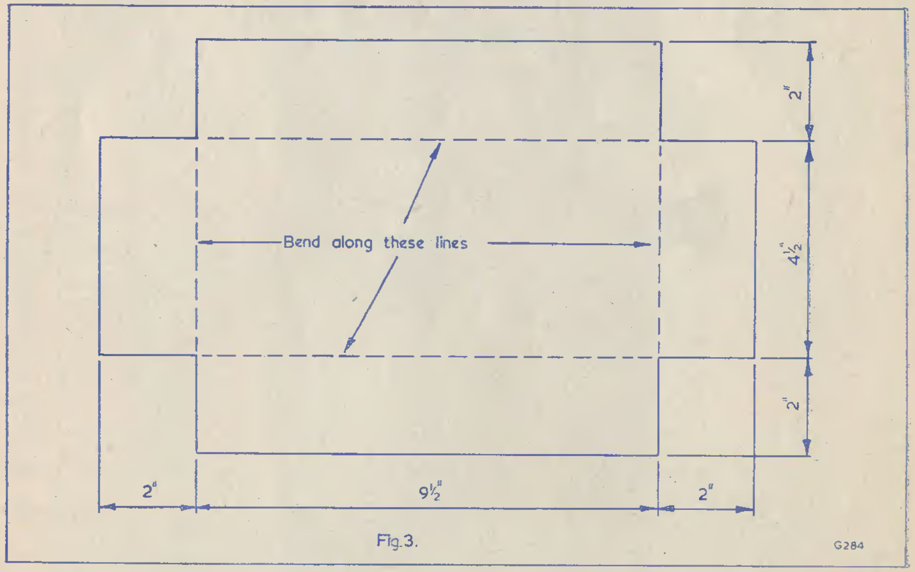


Fig. 3. The chassis of the Converter, before bending and drilling

When the switch is set to the Band III position, the Band I aerial input is short-circuited. This prevents Band I break-through, and also helps to alleviate any re-radiation via the Band I aerial. S_2 connects the secondary of the i.f. transformer, L_5, to the coaxial output cable connected to the receiver. At the same time, S_3 applies h.t. to the Converter, which then becomes fully operative.

Power Supplies

The power supply is an integral part of the Converter, and it employs a mains transformer with a separate h.t. winding. The use of such a component enables full isolation from the mains to be obtained, with a consequently increased safety factor. Rectification is provided by the full-wave metal rectifiers, their output being smoothed by C_{15}, C_{16}, and the smoothing choke. The choice of a smoothing choke instead of a resistor represents a good design feature, since it enables a high degree of h.t. regulation to be obtained. Without such regulation, adjustments to the sensitivity control could cause changes in h.t. voltage, with consequent shifts in oscillator frequency.

As will have been seen, considerable care has been taken to decouple the various stages in the Converter. This applies especially to the heater circuits, wherein each valve has its own heater decoupling condenser and choke. The chokes (Osmor type QFMH) are small components and do not add any physical complexity to the wiring. They are wound on small ferrite cores having wire ends, and are similar in appearance to small resistors. The cathode choke for V_3 (Osmor type QFMC) is similar in size to the heater chokes but has a different number of turns.

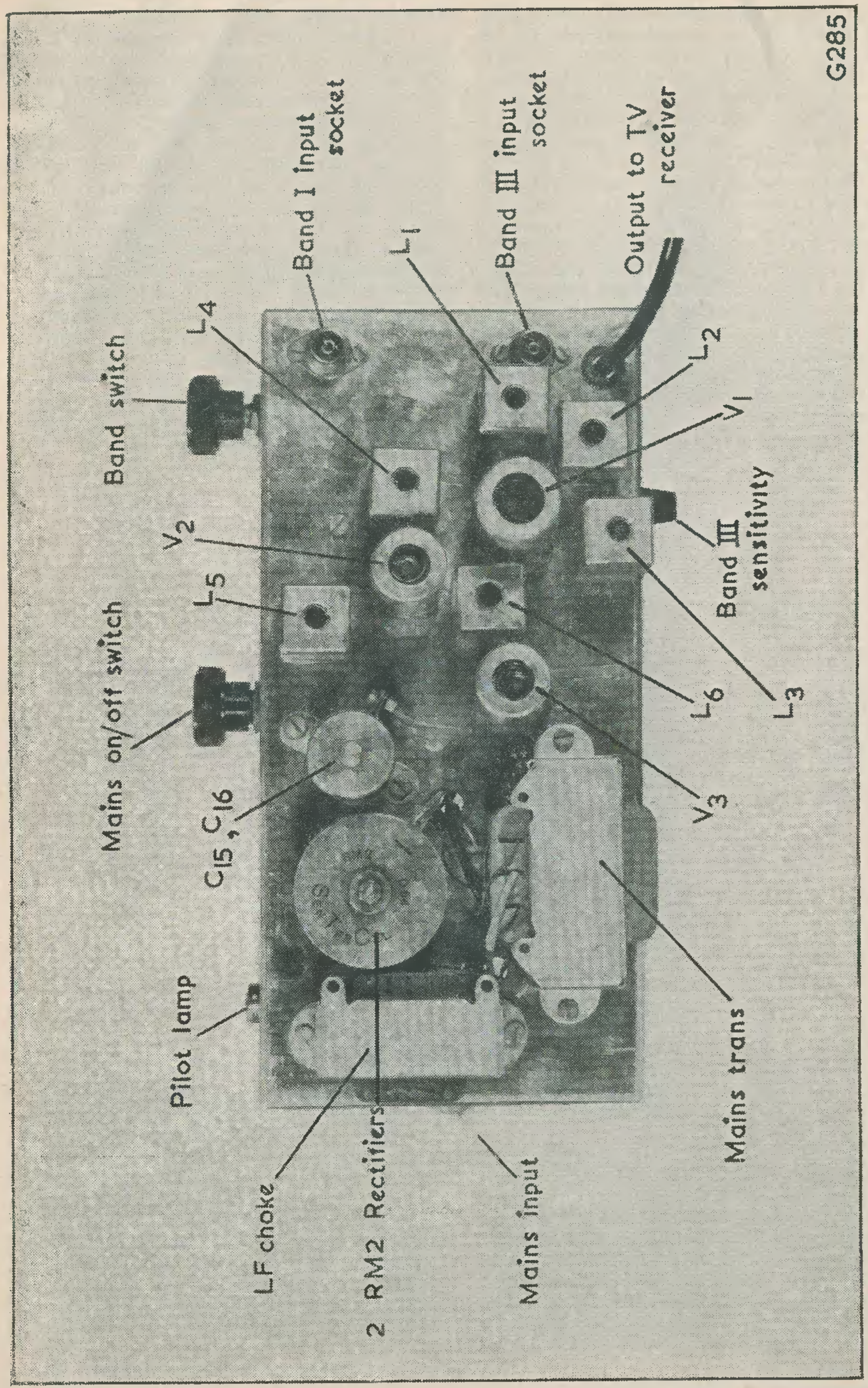


Fig. 4. *A top view, showing the layout of the principal components*

Constructional Details

We may now pass on to consider the constructional details of this Converter. In this particular article a complete chassis diagram showing drilling dimensions will be omitted, since punching templates are available from the manufacturers of the coils. These templates are in the form of sheets of paper giving the exact positions of the various hole centres. The sheets of paper may be laid on the chassis, after bending, whereupon the hole centres can be punched through the paper itself.

The size of the chassis, when complete, is 9½ by 4½ by 2in deep. The outside dimensions required, before bending, are illustrated in Fig. 3. The material used may be aluminium of any suitable gauge. The four chassis aprons shown in Fig. 3 are all bent down through 90 degrees. If desired, the completed chassis may be strengthened by fitting small angle brackets at each corner between adjacent aprons, but, if a sufficiently thick gauge of aluminium is employed, such brackets should not prove to be necessary.

After bending, the various holes in the chassis may be drilled out, using the Osmor templates. These give drilling dimensions for the top, together with the front and back aprons. It is also necessary to allow a means of entry for the mains lead, this being provided in the centre of the short apron at the mains transformer end of the chassis. The mains lead should be taken through a grommet, its position being shown in the wiring diagram, Fig. 5.

Three further grommets are required at the top of the chassis, and three ⅜in holes for these are marked out on the appropriate punching template. When the major components are fitted, the leads from the smoothing choke, mains transformer and rectifiers pass through two of these grommets. To facilitate this, the choke and transformer should be positioned such that their lead-out wires are on the inside, and the rectifier should be mounted so that its tags lie above the grommet adjacent to the electrolytic condenser.

All the major components may now be fitted to the chassis. Their positions, looking down on the top of the chassis, are illustrated in Fig. 4. The orientation of the mains transformer, choke, and rectifiers has already been dealt with. It is important to ensure that the valveholders are also fitted the correct way round. Their positions may be ascertained by checking Fig. 5. It should be noted that two 6-BA solder tags are fitted at each valveholder, these being secured under

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Component List

Resistors

(All ¼ watt unless otherwise stated.)

R_1	10kΩ potentiometer
R_2	150Ω
R_3	100kΩ
R_4	1kΩ
R_5	470kΩ
R_6	3.3kΩ
R_7	220kΩ
R_8	3.3kΩ
R_9	100kΩ
R_{10}	150kΩ 1 watt

Condensers

C_1	Parallel condenser (fitted in coil can)
$C_{2, 3, 4}$	1,000pF, disc ceramic
C_5	39pF, ceramic
$C_{6, 7, 8, 9}$	1,000pF, disc ceramic
C_{10}	1pF, ceramic
C_{11}	1,000pF, disc ceramic
C_{12}	5pF, ceramic
$C_{13, 14}$	1,000pF, disc ceramic
$C_{15, 16}$	16 + 8μF, 350W.V. electrolytic (can diameter 1 inch)

Valves, etc.

V_1	B309 (Osram)
V_2	Z77 (Osram)
V_3	6C4 (Brimar)
Rectifiers	DRM2 (Brimar)

Pilot lamp 6.3V M.E.S.

Inductors

(All Osmor, including mains transformer and smoothing choke)

L_1	QTV3
L_2	QTV4
L_3	QTV5
L_4	QTV6
L_5	QTV7
L_6	QTV8

Heater chokes (3 req.) QFMH
Cathode choke (1 req.) QFMC
Mains transformer. As shown in Fig. 1
Smoothing choke. As shown in Fig. 1.

Miscellaneous

1 set punching templates (Osmor)
2 B7G valveholders, with screening cans
1 B9A valveholder, with screening can
1 M.E.S. bulb holder, with panel bracket and bezel
1 range switch 3-pole 2-way (miniature)
1 on-off switch
3 coaxial sockets (Belling-Lee)
1 4-way tag-strip (see text)
3 3-way tag-strips (see text)
1 2-way tag-strip (see text)
4 ⅜in grommets
Coaxial cable, wire, etc.

the mounting nuts. The coils must also be fitted the correct way round, of course, but in this case the main possible cause of ambiguity is given by L_5, this being the only coil with four pins. Once again, Fig. 5 may be examined for correct positioning of this coil. The pin numbers of each coil can be checked, incidentally, by observing the identifying numbers moulded into the coil former material, these numbers corresponding with those shown in Fig. 5.

In addition to the solder tags at the valveholders, tag strips are secured under some of the component mounting screws as well. Thus, a two-way tag-strip (one tag earth) is fastened, below the chassis, under the rear mounting nut of the electrolytic condenser. A three-way tag-strip is similarly mounted under the front securing nuts of the smoothing choke and a four-way tag-strip under that mounting nut of the mains transformer which is adjacent to the smoothing choke. (It is assumed that the "front" of the chassis is that where the on-off switch and pilot lamp are mounted.) The remaining two three-way tag-strips are mounted separately by 4-BA nuts and screws in holes provided for them by the drilling template. It is important to note that all tag-strips have the mounting tag at one end of the strip, and not in the centre. Fig. 5 will assist in illustrating the positions of the various tag-strips below the chassis.

There is little else which requires further explanation so far as the main components are concerned. It might be pointed out, however, that the on-off mains switch can be either a toggle type, as shown in the wiring diagram, or a rotary type, as illustrated in the particular unit photographed for this issue.

Wiring up can now be carried out. The positioning of the various components is shown in Fig. 5. This diagram should be followed carefully, and it should prove to be of considerable assistance to the constructor in ensuring that all connections are made correctly. It is important to see that all wiring is kept as short as possible. For the sake of clarity some of the resistors and condensers illustrated in Fig. 5 have been shown slightly removed from their most favourable positions. In practice, these components should be mounted as close to their appropriate tags as possible. This point applies especially to the 1,000pF decoupling condensers.

It should be noted that it is possible to connect the mains input supply either to the 200 or 230 volt tapping of the mains transformer. These two taps are taken to the four-way tag-strip below the chassis, and the constructor should connect up to the tapping which corresponds to the mains voltage available.

Checking and Alignment

After completion, the Converter can be checked and aligned. Checking may consist of the normal routine of testing for h.t. short-circuits together with visual checks for correct connections, etc. The h.t. voltage available should be between 200 and 250 volts when the unit is switched for Band III operation.

The next process consists of alignment. It is possible that some constructors may have a signal generator available, and instructions will be given both for those who possess such an instrument and those who do not.

The first component to be lined up is the i.f. transformer, L_5. To commence alignment, the Converter should be connected up to the televisor with which it is to be used and both should be switched on and allowed to warm up. The Converter should be set to maximum sensitivity (i.e. minimum resistance in R_1) throughout the alignment procedure. If a signal generator is available its output should be connected between the control grid of V_2 and chassis, and its frequency adjusted to the Band I vision carrier frequency of the televisor. The Converter should be switched to Band III. The signal generator output should then appear on the screen of the televisor either as a series of horizontal bars (when modulated by a.f.) or as a brightening of the screen, if unmodulated. Should the signal generator frequency calibration be sufficiently accurate, it may be set to a frequency some 1 to 2 Mc/s below the vision carrier of the Band I channel employed by the televisor. This is because L_5 should be adjusted for maximum transfer of *vision* information. L_5 is now tuned up, backing off the signal generator attenuators as required.

The signal generator is then connected to the Band I aerial input socket, and L_2 adjusted for *minimum* Band I signal.

Should a signal generator not be available, it will be necessary to use the signal from the Band I aerial in its stead. This should be connected to the Band III input socket of the Converter, and the receiver sensitivity and contrast controls turned up until the Band I sound or vision becomes perceptible. L_5 should next be tuned for maximum signal strength (on vision if possible). L_2 should then be adjusted for minimum Band I signal.

The Band III circuits next need alignment. If a signal generator which covers Band III on *fundamentals* is available, this will prove of assistance here, although it will still probably be necessary to finalise the trimming of the Band III coils, with the aid of the signal itself. Signal generators which cover Band III on harmonics (especially high-order harmonics) are liable to cause errors, and may result in several false settings being given before the final correct adjustment is obtained. Once

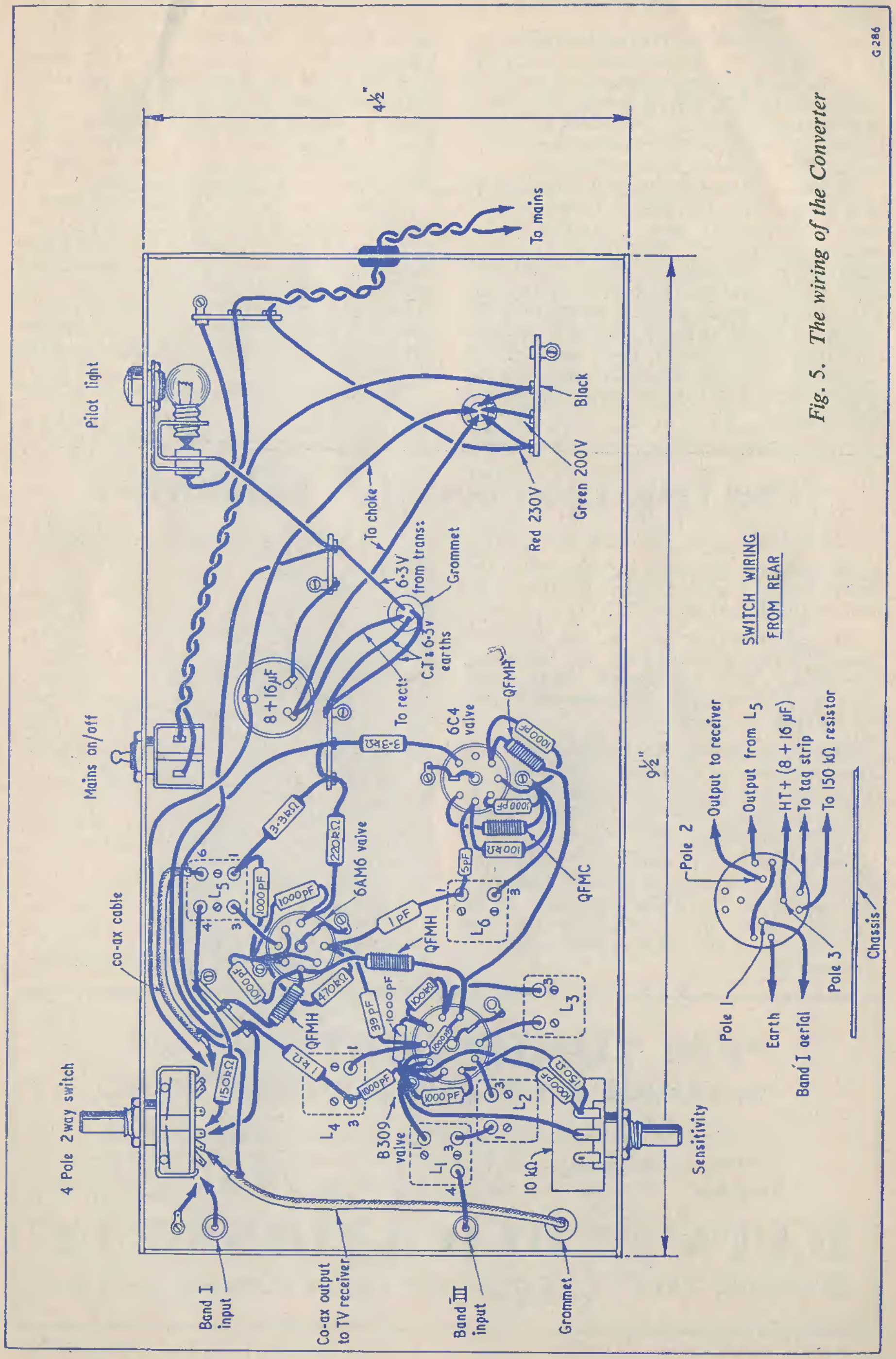


Fig. 5. *The wiring of the Converter*

again finalisation will still be necessary with the signal itself.

Alignment for Band III consists of adjusting L_1, L_3, L_4 and L_6. Of these four coils, L_1 will have the most flat characteristic. L_3 should be set initially such that its core is nearly flush with the top of the can, The cores of L_1 and L_4 should be left in the position they are in when the coils leave the manufacturer.

The Band III aerial (or signal generator) is next connected to the Band III input socket, and both receiver and Converter set to maximum sensitivity. The core of L_6 is then slowly and carefully adjusted until the Band III signal is seen, or heard. As soon as this occurs L_1 and L_4 should be adjusted for maximum signal strength, reducing receiver gain (but not converter gain) as required. L_6 should then be readjusted through its range to ensure that the optimum setting has been found.

The core of L_3 is next adjusted (towards the centre of the coil) for maximum Band III signal strength. It is possible that too high an inductance in L_3 may cause slight instability, in which event the core should be unscrewed again by several turns. Adjusting L_1 may possibly necessitate slight retrimming of L_1 and L_4. L_5 should then be finally adjusted for maximum transfer of vision energy, whereupon the alignment is complete.

All that remains is to connect the Band I aerial to the Band I input socket of the Converter. The unit is switched to Band I and the televisor reset to its normal contrast and sensitivity settings for this Band. The Converter is next switched to Band III, and its sensitivity control adjusted to provide the same contrast level in the receiver as was given on Band I.

The Converter is then set up and ready for use.

The Television Society's Exhibition

A complete microwave link, as used in Eurovision, will be shown in operation at the Television Society's Annual Exhibition to be held at the Royal Hotel, W.C.1, in March.

The exhibition is confined to items of research and development in television, educational and production items, and apparatus developed by firms who are patron members of the Society.

Among the exhibits will be the new C.P.S. Emitron Camera chain, a "folded-beam" projection receiver, new aerials for Band III, and a complete range of measuring equipment for transmitters and receivers.

The exhibition will open on Tuesday, 6th March at 10 a.m. and will close on Thursday, 8th March at 6 p.m. Admission is by invitation ticket to be obtained from the Secretary, Television Society, 164 Shaftesbury Avenue, W.C.2.

The following firms will be exhibiting:—

Belling & Lee Ltd.
E. K. Cole Ltd.
A. C. Cossor Ltd.
The Edison Swan Electric Co. Ltd.
Ferguson Radio Ltd.
Livingston Laboratories Ltd.
Murphy Radio Ltd.
Electric & Musical Industries Ltd.
Ferranti Ltd.
British Insulated & Callenders Cables Ltd.
Standard Telephones & Cables Ltd.
Wolsey Television Ltd.
Direct TV Replacements Ltd.
Hallam, Sleigh & Cheston Ltd.
20th Century Electronics Ltd.
Cinema-Television Ltd.
J. S. Fielden Ltd.
The General Electric Co. Ltd.
Leland Instruments Ltd.
Telegraph Construction & Maintenance Ltd.

RADIO—AND CONTROL

PART 5.

by RAYMOND F. STOCK

IT IS ASSUMED THAT A STEERING WHEEL would be employed to control the model, the wheel acting in a normal or natural sense, which is, of course, essential if proper control is to be obtained. This wheel must be capable of generating the necessary command pulses, the number being proportional to angular movement and the appropriate channel being determined by the direction of rotation. Two obvious methods are available.

Fig. 20 shows the first one. The wheel is geared up to a contact drum, having one insulating and one conducting segment. Against this drum are arranged two bushes; each time the drum rotates the conducting segment completes the transmitter keying circuits; this solves the problem of producing the pulses. The gear ratio can be adjusted to taste, according to what "lock" is required.

In order to select the correct channel, one extra device is needed. Instead of being attached rigidly to the driving gear, the steering wheel is fixed by its shaft to a lever. This lever transmits torque to the first gear via one of two contact pairs—or preferably microswitches—bolted to the gear. Thus, on turning the wheel, the first small movement closes one or other microswitch, routeing subsequent pulses via the appropriate channels (CP or CS in the diagram). Generally, these will be true independent radio channels, but they could be Mark and Space in a vibrator type circuit such as Fig. 3.

A second control gear is shown in Fig. 21, and this is interesting in pointing the analogy between control gear preceding the transmitter and intergear following the receiver. In this case the steering wheel is connected to the centre shaft of a differential gear D, and thus drives the pinions. The two bevel wheels are each locked in the opposite direction by ratchet wheels and detents, so that whichever way the wheel is turned one bevel must rotate. Fixed to each bevel is a contact drum having a suitable number of conducting segments on its periphery: and one brush (keying one channel) goes to each drum. Instead of the multi-segment drums (which are difficult to make) a single segment contactor can be used, geared up from each bevel wheel assembly.

Once again suitable components can be obtained from surplus sources, and the former device, particularly, is simple to make.

Similar pulsing drums to these are often needed in radio control, and, though simple devices, they can be troublesome. When used to break power-carrying circuits such as h.t. lines in single channel gear the only trouble, not usually serious, is slight sparking; but when employed to pulse modulated channels they are often used in the grid circuit of a valve where negligible power is handled. It is then necessary to use high-quality contact materials on the brush and drum, or, better still, to make the contactor operate a keying relay in the transmitter chassis.

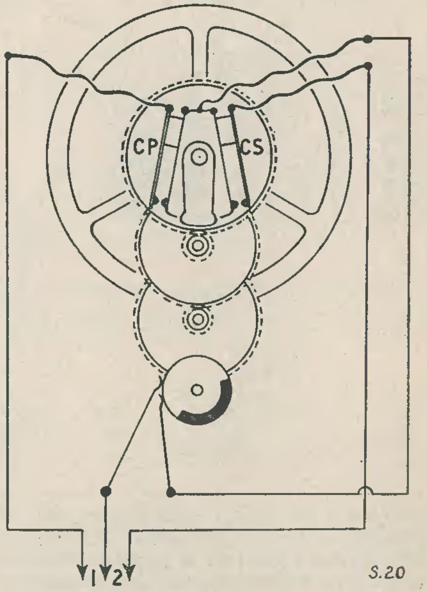


Fig. 20. 1 *and* 2 *are the two channel keying circuits*

Other Systems

Pulses conveyed on multi-channel gear can, of course, be used in other ways, but since the described method is most direct these other systems will not be dealt with at length.

The ratchet motor need not, of course, use electricity as its power source, and can be driven by hydraulic or pneumatic means, electromagnetically operated valves controlling the fluid.

If three channels can be allocated to one control (very luxurious!) an almost perfect system results; no doubt many readers will have seen or used repeater motors—again a surplus item—in remote indicating systems. These are usually connected to their "transmitter" (to use the Services' term) by three wires. If the wires are replaced by a three-channel radio link such a repeater motor can operate a rudder with a very high degree of resolution, since repeaters are capable of following movement in either direction, at high speed and in small steps.

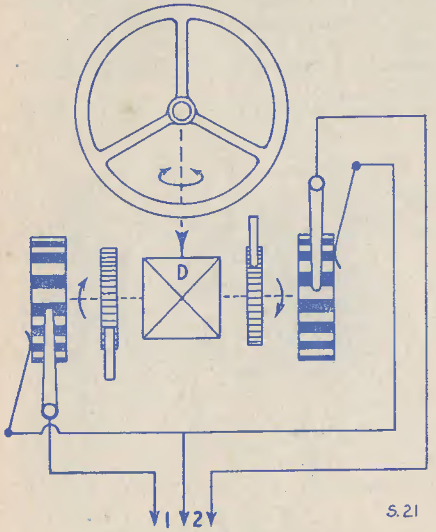


Fig. 21.

For the real expert (and millionaire) it is possible to devise a system in which a regularly repeated sequence of pulses is generated by purely electronic means at the transmitter, each train accompanied by a synchronising pulse. At the receiver, an elaborate gating circuit routes pulses arriving on various channels according to their spacing, in time, from the datum, or synchronising pulse. Since the equipment is all-electronic, very high pulsing rates are possible and a large number of pulses, representing channels, can be used. This, of course, gives great flexibility in design, though the scale of the equipment places it beyond the average amateur.

Radio Requirements

We have now come a long way from basic single-channel radio, and if any reader is still undeterred it may be a good idea to get back to earth and see what reasonable control means, in terms of radio equipment.

Granted that two proportional controls are needed, as explained at the beginning of this series of articles, any continuous system will thus need two independent radio channels, one for steering and one for speed control. Pulse systems will require just twice this potential, though remembering Fig. 19 we can see that two such controls will also permit two further facilities to be used. In general, then, allowing for the operation of one or two secondary controls in addition to steering and speed, we need either three or four quite independent channels, and of course more in special cases.

The only types of radio gear giving multi-channel facilities at all easily use amplitude modulation of the carrier at various audio frequencies. One system uses tuned reeds to separate the audio signals in the receiver, the other uses tuned circuits; both are exactly analogous but very different in practice and performance.

The reed-type receiver was first used long before the war, but has only become common during the last five years. The modulated signal is received on a (generally) super-regenerative circuit of the simple, squegging, single-valve type. The rectified audio signal is resistance-capacity (or, better, choke-capacity) coupled to a voltage amplifier, usually a pentode, and passed on by R-C coupling to a power amplifier (output pentode).

In the anode circuit, forming the load, is the reed unit. This consists of a high resistance coil wound on a laminated core, which includes a permanent magnet to avoid frequency doubling. Completing the magnetic circuit are a bank of reeds, cut from shim steel to different lengths, so that they are mechanically resonant to the various audio frequencies in use. When an audio signal appears in the output the appropriate reed vibrates, and in so doing makes intermittent contact with a closely adjusted fixed contact. In series with each contact is a relay with a smoothing condenser across it, and the relay will close whenever the reed vibrates. Thus each audio frequency sent represents a channel, terminating in its own relay.

The electronic-filter receiver is basically similar. Signals are detected and amplified in the same way (though more amplification is necessary, as explained later) and passed on to a bank of filter circuits. Each of these consists of a filter valve having a resonant circuit (LC) in its grid, so that it amplifies selectively its own frequency. This filtered signal is passed on to a relay valve normally biased beyond cut-off. Arrival of the filtered signal results in swinging the grid either side of this point so that the positive half-cycles cause anode current to flow. A relay in the anode circuit then closes, and once again represents the termination of a channel.

As normally built, the two types of system show the following characteristics:—

The reed receiver is small, light, needs little power and usually has from three to six reeds; though the author knows of one 14-channel set in use. Unfortunately only one channel can be used at a time, though this is not an inherent defect; but to overcome it would require additional gear that would negate the principle advantage of reed receivers, i.e. simplicity. A second snag is that speed of operation is low, perhaps 4 or 5 pulses per second.

The electronic-filter circuit exhibits no such disadvantages; it can operate at high speeds (e.g. 30–40 pulses per second), and any combination of channels can be used simultaneously (once again; this is not an inherent quality, but in practice is always applicable). But, this type of set uses two valves per channel, following amplification, and must have efficient LC circuits and numerous other small components. Extra valves mean, of course, extra batteries to supply them, thus adding to the weight.

A transmitter for a reed circuit is generally simple and requires only one valve in addition to the r.f. arrangements.

A transmitter for an electronic-filter circuit may use 8 or 10 additional valves for 4 channels.

The reason for these complementary advantages and disadvantages lies in the behaviour of resonant circuits, whether electrical or mechanical, and in the theory of modulation.

(*To be continued*)

Can Anyone Help?

Requests for information are inserted in this section free of charge; subject to space being available

P. L. Grieveson, of 46 Clarence Crescent, Sidcup, Kent, has a VHF1125 receiver and requires data on voltages, circuit, etc.

* * *

E. Mickenzie, 2 Hill Crest Road, Birmingham 13, would like to buy or borrow complete circuit of the R1155A receiver.

* * *

D. F. Hayward, 3 St. Michael's Avenue, Yeovil, Som., would appreciate any information or circuit of RDF1 unit and will gladly purchase if required.

* * *

W. Dupuis, 93 Edridge Road, Croydon, Surrey, requires an instruction manual of the "Electronic Fault Tester" SN.B171.B, manufactured by Labgear Ltd., either to buy or on loan.

* * *

R. Prowse, 5 Tresluggan Road, St. Budeaux, Plymouth, requires data or circuit of the Philco Battery Receiver, 1.4 to 4 Mc/s, valve line-up believed to be ARTP2, ARP12, AR8 and CV65.

* *

A. Jarvis, 44 Chalvington Road, Chandlers Ford, Hants, wishes to buy or borrow an instruction book for the Weston Battery Oscillator E692, type 2.

G. Dalgarne, 420 Duchmill Road, Bucksburn, Aberdeen, requires on loan the circuit or data concerning Transmitter Unit TR1196, type 49.

* * *

B. Wilkins, 271 Upper Rainham Road, Hornchurch, Essex, requires circuit values for the Ultra S.W. Transreceiver UF2 manufactured by Jefferson Travis, New York.

* * *

R. T. Trull, 1 Approach Road, Broadstairs, Kent, wishes to obtain data on the Rees Mace type N receiver.

* * *

D. W. Kennedy, c/o Stewart, 244 Blackness Road, Dundee, Angus, requires details of a mains power supply unit for the Cossor All-Wave 338 Battery receiver.

* * *

B. Hayes, G3JBU, 7 Western Terrace, Northampton, urgently requires base connections, characteristics, etc., of the German Telefunken RL12-P35 valves.

* * *

G. Tulworth, 137 Dudley Road, Grantham, Lincs, wants information on the RDF.1, ZC13312 circuit, and colour code of mains transformer and if for 80 or 230V.

(*continued on page 503*)

The ARGONAUT

A.M.-F.M. M.W.-V.H.F.

TUNER—RECEIVER

PART 1.

by G. BLUNDELL

THE *Jason F.M. Tuner Units* DESCRIBED in this magazine in the latter half of 1954 proved very popular, and many thousands have been, and still are being, built. (The original articles are available, together with the *Osram* 912 *Amplifier* circuit and other useful data, under the title *F.M. Tuner Units for Fringe and Local Area Reception*, price 2s.—Ed.) Perfect results may be expected up to a distance of some 60 miles from the transmitter, while there have been many reports of good reception from points 150 miles away.

The original tuner appeared with an uncalibrated scale, but there is now available a calibrated glass scale with bronze front panel. This makes the tuner more acceptable to other members of the family. With this in mind, the *Argonaut* is provided with an attractively designed dial assembly which will look most presentable when mounted in a cabinet. The front panel hides the edge of the woodwork, and there is therefore no need for a professional finish to the cut-out.

Though the advent of frequency modulated broadcasts on v.h.f. has resulted in perfect reception of the three British programmes, there is still a need to be able to tune in to the popular continental stations such as Luxembourg, especially if the *Argonaut* is to be the family receiver. In the writer's opinion, too, it can be a dangerous situation when one can only obtain news from local sources, when it is becoming very necessary to forget National frontiers. It can be easily seen that in France, during the last war, the Underground Movement could not have been nearly so effective without radio contact with this country, and that such contact would have been an extremely chancy business if the local receivers had been restricted to the v.h.f. bands.

There is, therefore, still a considerable need for a tuner or receiver which will cover both the M.W. and V.H.F. broadcast bands. Short wavebands have not been added to the *Argonaut*, since then the switching would have become very complex. It is believed that this design is the first to change from a.m. to f.m. by a simple 3-pole switch mounted in one corner of the chassis. Some designs use long slider-type switches mounted as close as possible to the circuit being switched, and this is, of course, very necessary when switching live grids and anodes. If short waves had been included in the *Argonaut*, then switching would have been required at the M.W. frequency changer grid. This has been avoided by mounting the M.W. trimmer close to the f.m. i.f. transformer so that the trimmer acts as an effective r.f. bypass to chassis as far as the 10.7 Mc/s i.f. is concerned.

Short waves, if required, may easily be added by means of a converter which would use the M.W. band as the first i.f., thus giving double conversion and very good performance on short waves. If sufficient interest is shown in this, an article describing a suitable converter will appear in due course.

Alternative Output

It is anticipated that many constructors will not require an output stage, since they will already possess suitable amplifiers. Without the output stage, choke smoothing becomes unnecessary, and resistance smoothing may be substituted; indeed, it becomes essential in order to reduce the h.t. voltage to 240 at the lower current consumption. As a tuner, the output is taken from C_{33}; the components not then required are marked in the Components List with an asterisk. The anode and grid of the triple-diode triode DH719 should be connected to chassis.

With the output stage, the total current taken by the receiver is 80mA on f.m. and 60mA on M.W. As a tuner only, the current consumption falls to 35mA on f.m. and 25mA on M.W.

Circuit Description

A description will now be given of the functions of the various stages. The three Z719 valves are not used on M.W., and the switching reduces the circuit to a conventional superhet receiver. V_3 (X79) is the medium wave frequency changer, V_4 (W727) is the M.W. i.f. amplifier, and V_6 (DH719) is the M.W. second detector and audio amplifier.

When changing to f.m., the M.W. oscillator h.t. is switched off (triode section of the X79) and h.t. is switched on to the Z719's. V_1 is the f.m. r.f. amplifier, V_2 is a self-oscillating frequency changer which produces a 10.7 Mc/s signal when tuned to a v.h.f. station. This i.f. signal is fed through the f.m. i.f.t. L_5 to V_3, which was the M.W. frequency changer but now acts as the first f.m. i.f. amplifier. The i.f. transformer, L_8, in the anode of V_3 and grid of V_4 is tuned to both 10.7 Mc/s and 472 kc/s, and the appropriate part of the transformer functions according to the signal being fed in.

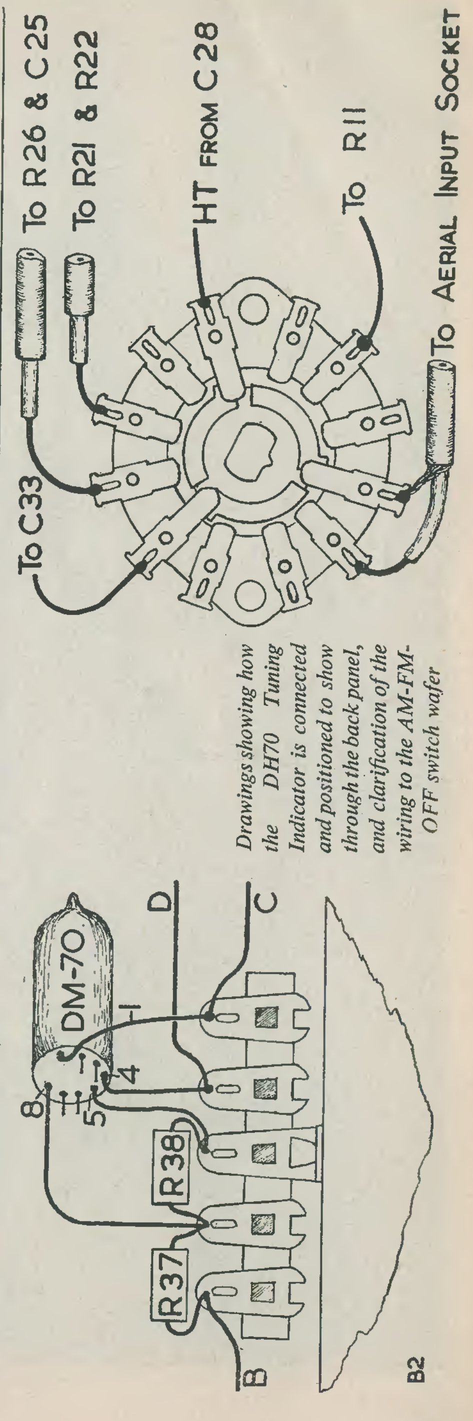
V_4 (W727) acts as the second f.m. i.f. amplifier. The primary of the i.f. transformer, L_9, in the anode of V_4 also tunes to both frequencies, but the secondaries are quite separate. The secondary of the 472 kc/s i.f. connects directly to the detector, whilst the f.m. i.f. secondary connects to the limiter V_5 (Z719) which in turn feeds the ratio detector coil, L_6. Detection is by means of the special diodes of the DH719. The wiring of these diodes must be followed exactly as shown in the diagrams, as the f.m. diodes have a very low resistance compared to that of the M.W. diode.

A.M./F.M. Switching

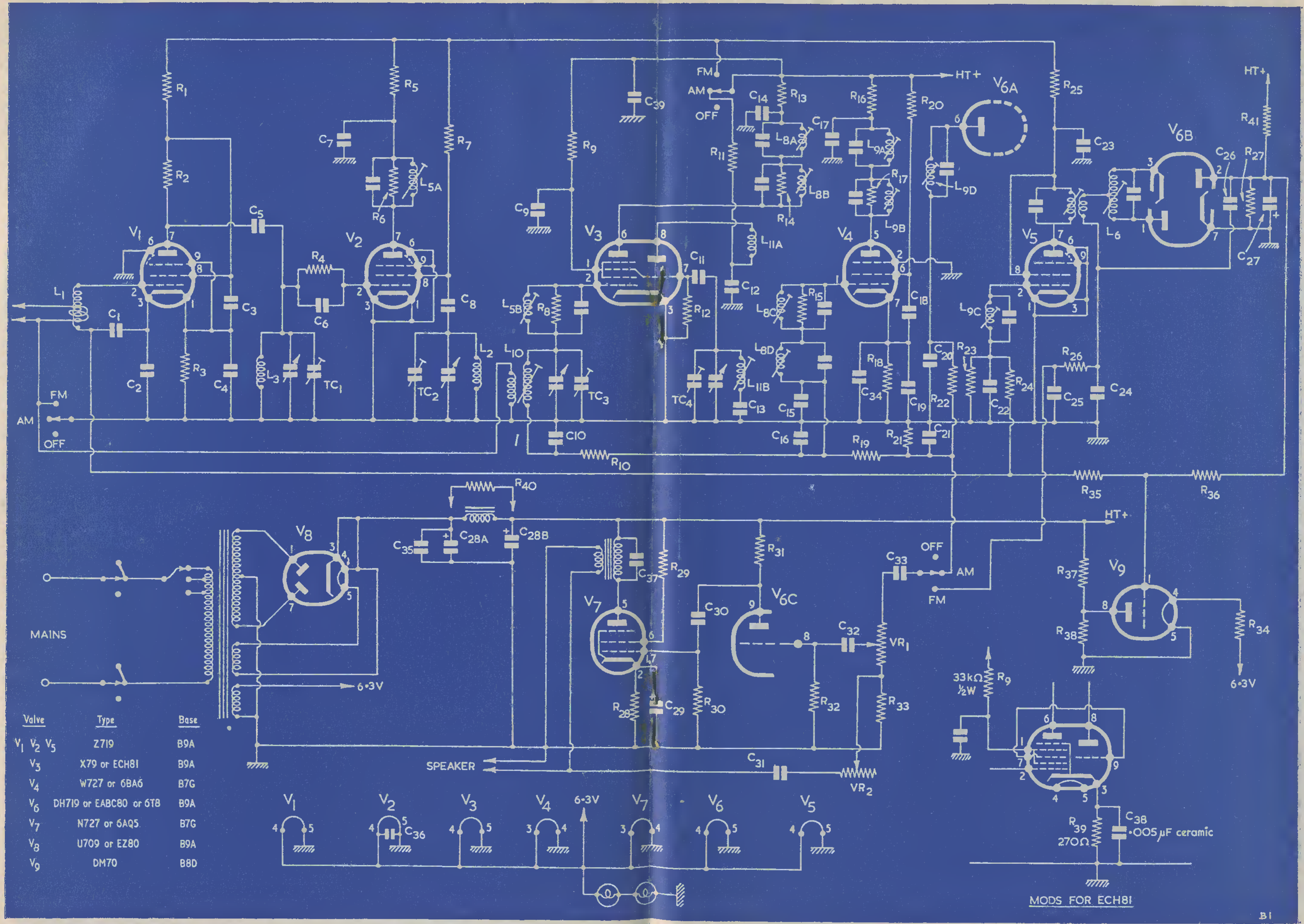
Change-over from f.m. to a.m. is effected by switching the appropriate h.t. and audio leads; it was also found necessary to switch the aerial input. Some designs of receiver have two separate aerial connections, but here the f.m. dipole is used as the M.W. aerial by disconnecting the one side of the dipole from chassis. In the first experimental model a filter was used to enable the dipole to perform both functions, but it was found difficult to obtain a sufficiently low impedance to the chassis at v.h.f. and also at the 10.7 Mc/s i.f. without affecting the performance on medium waves. Also, it was found that heavy interference could be transferred directly into V_3 and spoil the f.m. performance. The circuit used short-circuits the medium wave aerial coil to prevent this. Ordinary connecting wire could have been used, but co-axial cable is actually employed in order to achieve a low impedance connection between dipole and chassis when switched to f.m.

Constructional Notes

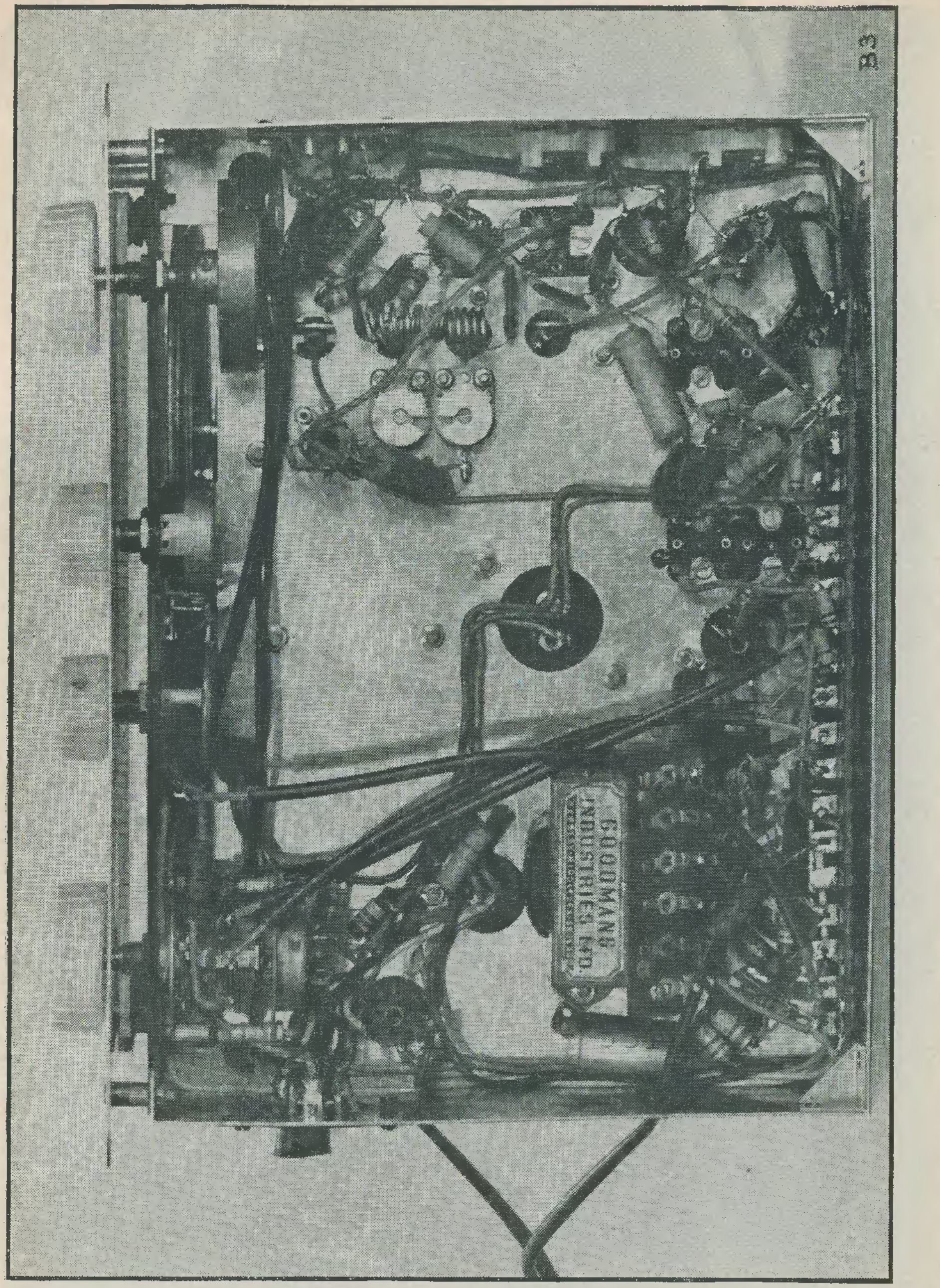
It is advisable to follow the point-to-point wiring diagram very closely, especially as far as earth wiring on valveholders is concerned. The positioning of components is important,



Drawings showing how the DH70 Tuning Indicator is connected and positioned to show through the back panel, and clarification of the wiring to the AM-FM-OFF switch wafer



Valve	Type	Base
V_1 V_2 V_5	Z719	B9A
V_3	X79 or ECH81	B9A
V_4	W727 or 6BA6	B7G
V_6	DH719 or EABC80 or 6T8	B9A
V_7	N727 or 6AQ5	B7G
V_8	U709 or EZ80	B9A
V_9	DM70	B8D



Under-chassis view of the prototype. Since the photograph was taken, one or two minor alterations have been made. Therefore, where there is any discrepancy between this view and the point-to-point wiring diagrams, the latter should be adhered to

COMPONENTS LIST

Resistors (¼W unless otherwise stated)

R_1	4.7kΩ ½W	R_{23}	47kΩ
R_2	6.8kΩ ½W	R_{24}	100kΩ
R_3	270Ω	R_{25}	47kΩ ½W
R_4	100kΩ	R_{26}	100kΩ
R_5	4.7kΩ	R_{27}	15kΩ
R_6	47kΩ	R_{28}*	270Ω 1W
R_7	47kΩ ½W	R_{29}*	270Ω
R_8	47kΩ	R_{30}*	270kΩ
R_9	100kΩ	R_{31}*	270kΩ
R_{10}	100kΩ	R_{32}*	10MΩ
R_{11}	47kΩ ½W	R_{33}*	270Ω
R_{12}	47kΩ	R_{34}	220Ω ½W
R_{13}	4.7kΩ	R_{35}	500kΩ
R_{14}	47kΩ	R_{36}	270kΩ
R_{15}	47kΩ	R_{37}	1MΩ
R_{16}	4.7kΩ	R_{38}	1MΩ
R_{17}	47kΩ	R_{39}	270Ω ECH81 only
R_{18}	68Ω		
R_{19}	1MΩ	R_{40}	3.3kΩ 6W
R_{20}	47kΩ ½W	R_{41}	500kΩ
R_{21}	47kΩ	VR_1	500kΩ
R_{22}	100kΩ	VR_2	20kΩ or 25kΩ

Capacitors

C_1	1,000pF ceramic
C_2	1,000pF ceramic
C_3	1,000pF ceramic
C_4	1,000pF ceramic
C_5	33pF silvered mica
C_6	33pF silvered mica
C_7	5,000pF ceramic
C_8	47pF silvered mica
C_9	5,000pF ceramic
C_{10}	0.05µF paper 350VW
C_{11}	47pF silvered mica
C_{12}	0.05µF paper 350VW
C_{13}	500pF 2% silvered mica
C_{14}	5,000pF ceramic
C_{15}	5,000pF ceramic
C_{16}	0.05µF paper 350VW
C_{17}	5,000pF ceramic
C_{18}	5,000pF ceramic
C_{19}	5,000pF ceramic
C_{20}	200pF ceramic
C_{21}	200pF ceramic
C_{22}	47pF silvered mica
C_{23}	5,000pF ceramic
C_{24}	200pF ceramic
C_{25}	500pF ceramic
C_{26}	200pF ceramic
C_{27}	8µF 150VW
C_{28}	32µF + 32µF 350VW
C_{29}*	25µF 25VW
C_{30}*	0.01µF 500VW
C_{31}*	0.01µF 350VW
C_{32}*	0.01µF 350VW
C_{33}	0.01µF 350VW
C_{34}	0.05µF 350VW
C_{35}	5,000pF ceramic
C_{36}	1,000pF ceramic
C_{37}*	5,000pF ceramic
C_{38}	5,000pF ceramic
C_{39}	5,000pF ceramic
TC_1	20pF air-spaced trimmer
TC_2	20pF air-spaced trimmer
TC_3	50pF compression trimmer
TC_4	50pF compression trimmer

Coils

Where coil numbers agree with design of Jason F.M. Tuner, they are identical. All coils by Jason Motor & Electronic Co.

L_1	Aerial coil
L_2	F.M. oscillator coil
L_3	F.M./F.C. grid coil
L_5	10.7 Mc/s I.F.T.
L_6	Ratio detector coil
L_8	Twin I.F.T.
L_9	Twin I.F.T.
L_{10}	M.W. aerial coil
L_{11}	M.W. oscillator coil

Valves

V_1	Z719 Osram
V_2	Z719 Osram
V_3	X79 Osram
V_4	W727 Osram, 6BA6 Brimar
V_5	Z719 Osram
V_6	DH719 Osram, EABC80 Mullard
V_7*	N727 Osram, 6AQ5 Brimar
V_8	U709 Osram
V_9	DM70 Mullard
Pilot Lamps	4V, 0.3A

Transformers

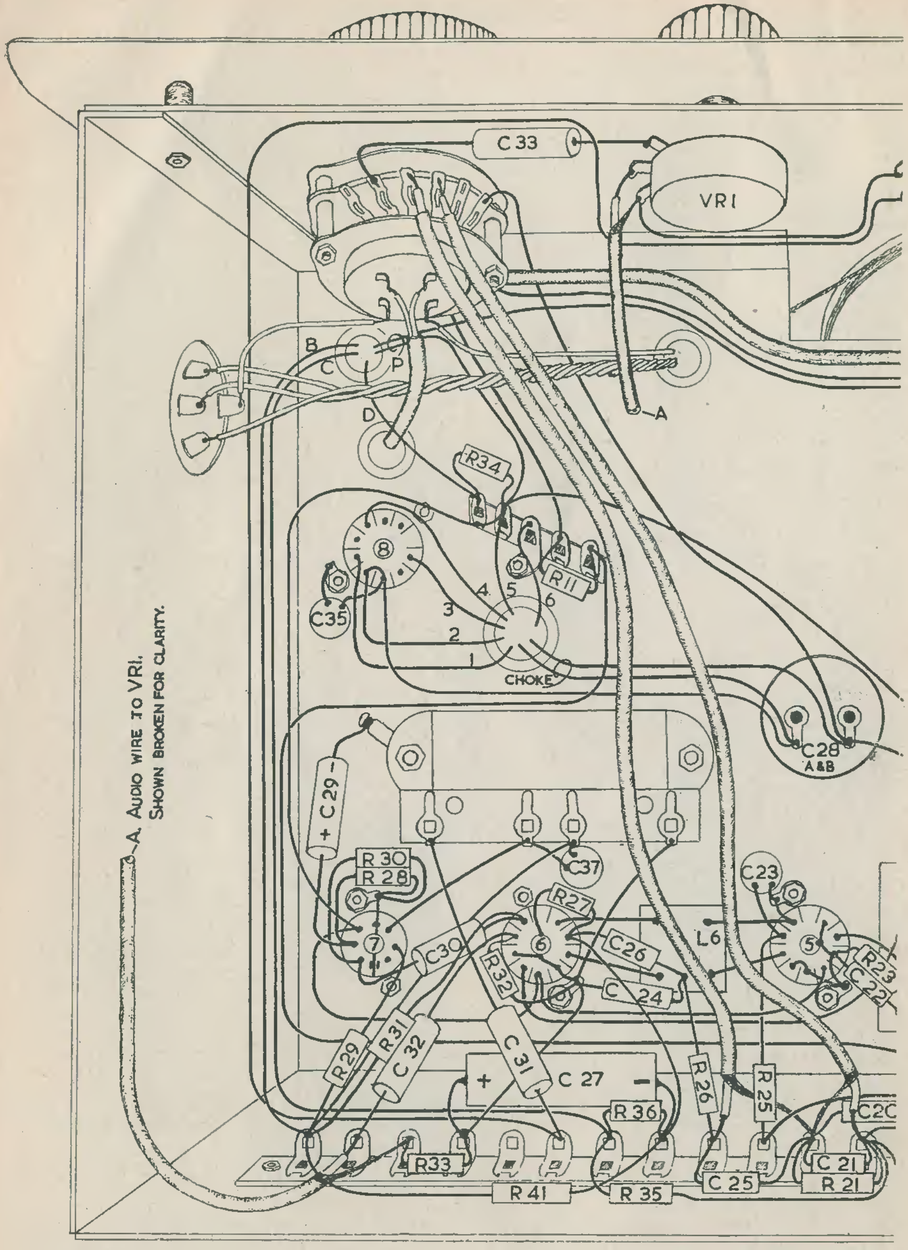
Output Transformer: matching 5,000Ω to speech coil

Mains Transformer: Primary 0–200–220–240V

Mains Transformer: Secondaries 250–0–250V at 80mA, h.t.; 6.3V at 3A, main heater; 6.3V at 1A, rectifier heater

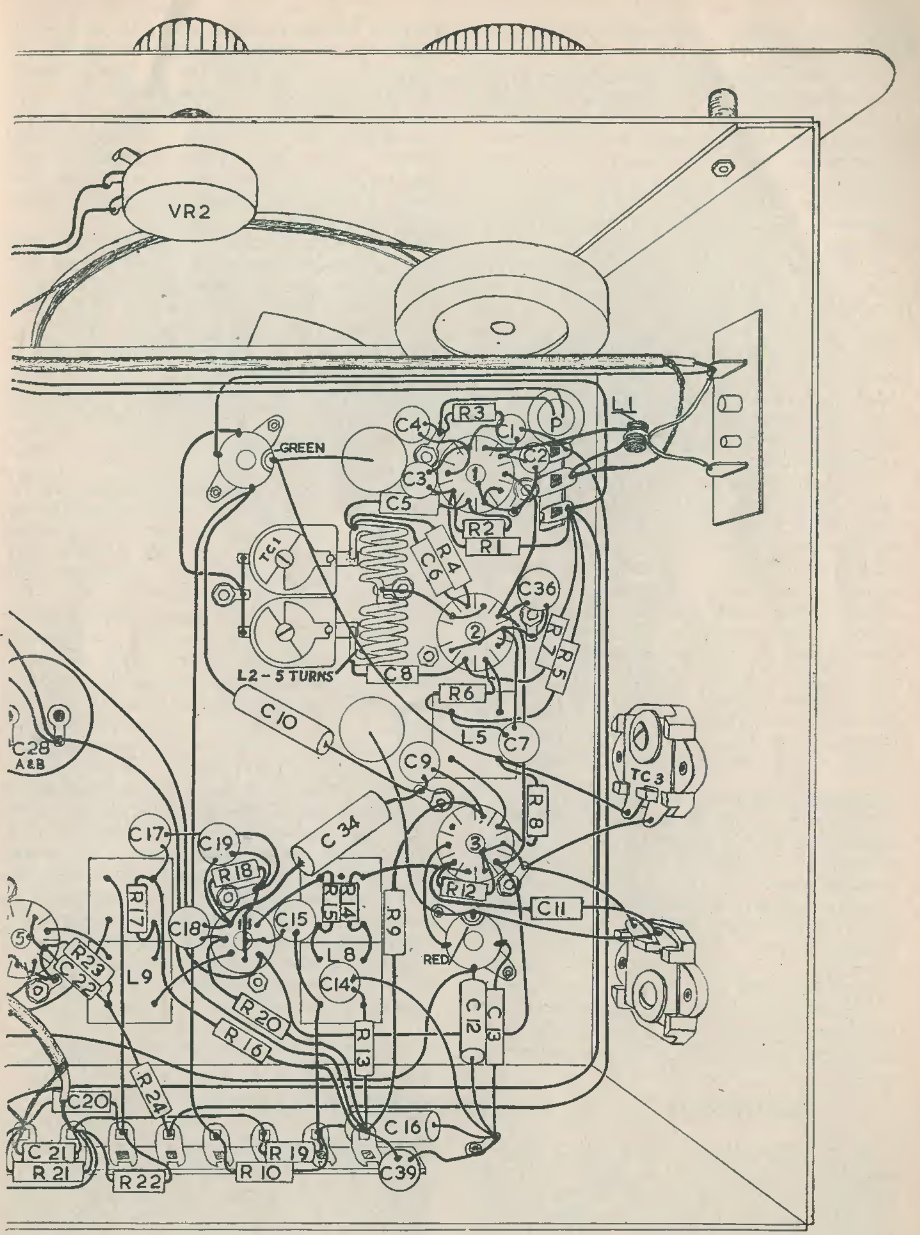
Smoothing Choke*: 10H at 100mA

Components marked * are not required if the output stage is omitted.



B4

Point-to-point wiring diagrams. This diagram, and the one on the opposite page, show the under-chassis layout, which should be strictly adhered to



B5

In order to avoid any confusion, this diagram and that on the opposite page have an overlap. The wiring to the change-over switch and tuning indicator are shown in the diagrams on page 491 too, and again the diagram should be adhered to.

With the *Jason Tuner Units* it was found that constructors with limited experience often obtained the best results; provided, of course, that soldered joints were well made. Constructors working from the circuit diagram only invariably fell into one pitfall or another. A typical example, which also applies to the *Argonaut*, is the positioning of the cathode lead of the f.m. frequency changer V_2. If this lead joins to the chassis at the same point as the heater bypass condensers, instability nearly always results due to feedback along the heater line into the common inductance formed by the earthing lead and solder tag. This is also a major cause of dead spots on the dial due to harmonics fed back along the heater line from the limiter stage. Repositioning the wiring always gives a complete cure.

The first operation, then, is to mount the valveholders and connect all chassis wiring. Next, the heater wiring should be added; note the method of connecting to give a long lead between V_1 and V_5. The long wires between tag strips should then be fitted, as this can be difficult after other components have been added. Any part of the wiring may then be commenced, leaving the screened cables to the switch and potentiometers as the last items. Care should be taken when mounting the air-spaced trimmer not to break the ceramic base by over-tightening the fixing screws. Spring washers should be used.

Alternative Frequency Changer

Details are given in an inset to the circuit diagram of the employment of the *Mullard* ECH81 as an alternative frequency changer to the *Osram* X79. The following modifications are required: Join pins 7 and 9, change R_9 to $33k\Omega$ and add the cathode components R_{39} and C_{37}.

Tuning Indicator

The DM70 was chosen as the magic eye because it is small and yet effective. Note that its heater is rated at 1.4V, and so a 220Ω series dropping resistor must be employed. The signals are fed to the magic eye through the resistors R_{35} and R_{36}. This method of combining the signals avoids the necessity of an extra pole on the a.m./f.m. switch. If the magic eye is not required, then the bracket may be reversed so that it lies flush against the back dial panel, thus blocking the hole.

Three wires connect to the magic eye and are shown entering the grommet near the change-over switch. Wire B is the h.t. lead and this connects to R_{37}. Wire C is the grid lead and is connected to pin 1. Wire D is the heater lead which is connected to pin 4. The other heater wire, pin 5, must be connected to chassis. The tuning indicator may be supported on the connecting wires as shown in the diagram.

Miscellaneous

The dial lamps are wired in series and 4V bulbs are used. This reduces the potential on each bulb to 3.15V and so gives a longer life. The actual wiring of the pilot lamps is not shown except in the point-to-point diagram where the leads are marked "P."

Detail wiring of the mains transformer is not shown since any type with a suitable voltage and current rating may be used. Working from the point-to-point diagram, the transformer should be wired as follows: Leads 1 and 2 connect to the 6.3V rectifier heater winding. Leads 3 and 4 go to the two 250V wires (h.t. secondary). Wire 5 is the main 6.3V heater lead. Lead 6 connects to the other side of the main 6.3V heater winding, and also to the centre tap of the 250–0–250V secondary winding. The other two wires through this grommet are the connections from the smoothing condenser C_{28} to the choke. If the choke is not used, the smoothing resistor employed instead may be wired directly across the condenser terminals; if C_{28} has wire ends, a tag panel must be used to support the resistor.

(*To be continued*)

Professor G. W. O. Howe Honoured by I. E. E.

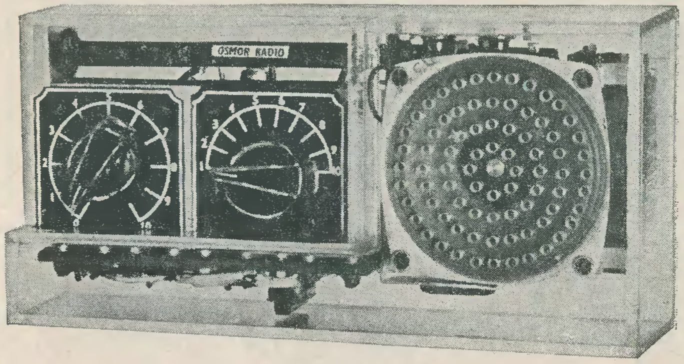
It is announced by the Institution of Electrical Engineers, London, that the recipient of the 34th award of the Faraday Medal is Professor G. W. O. Howe, D.SC., LL.D., M.I.E.E.

The Faraday Medal is awarded by the Council of the Institution for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science.

Professor Howe, who is Emeritus Professor of Electrical Engineering at the University of Glasgow and a director of the Mullard Radio Valve Company Limited, has received the award for "his pioneering work in the study and analysis of high frequency oscillations and on the theory of radio propagation; and for his outstanding contributions to engineering education."

The actual presentation to Professor Howe will take place on the occasion of the Kelvin Lecture on 26th April at the Institution's headquarters in London.

The "TRANSISTORETTE"



PART 2. by **G. A. FRENCH**

This article is the second in the series describing this modern miniature transistor receiver, and it discusses the chassis-work which is needed for its construction

LAST MONTH WE INTRODUCED THE TRANSISTORETTE, and we dealt with its circuit from the theoretical point of view. We also discussed the various precautions which should be observed during its construction and testing in order to prevent damage to the transistors. It is pointed out again here that these precautions must be kept in mind continually whilst the receiver is being made and checked. They will be further referred to at the appropriate places in the wiring instructions.

Metal-work

Several items of metal-work are required for the receiver, and these should not present any serious difficulties to the home constructor who has the simple metal-working tools found in the average amateur radio workshop. A steel rule, a small vice, a centre punch, and a hand brace are practically all that is required in addition to the essential screwdriver and pliers. Owing to the small dimensions of the completed receiver a slightly unconventional chassis layout is used, and the dimensions of the individual parts are fairly critical if the whole assembly is to fit together in a "professional' manner. A tolerance of $\pm\frac{1}{32}$in should prove to be more than adequate for all chassis dimensions, and such a tolerance may be obtained quite easily with the simple tools mentioned above. It should be pointed out that no harm will result if the chassis assembly is made up outside these tolerances (provided, of course, that adequate clearance is maintained between adjacent electrical connections), and the newcomer to metalwork need not feel, therefore, that anything that is at all ambitious is required of him.

The first metal part to make up is the main chassis holding the tuning condenser and volume control. The dimensions of this are given in Fig. 3 and Fig. 4. The chassis shown in these diagrams is made from aluminium of between 14 and 18 s.w.g.

Contrary to the normal practice of some amateurs, it may be found advisable in this instance to drill the holes in the main chassis *after* bending. The reason for this is that inaccuracies in bending could cause holes drilled beforehand to appear in slightly incorrect positions. It is also possible that, due to the softness of the metal, the $\frac{1}{2}$in dimension shown in Fig. 4 for the width of the side apron may not be maintained after bending. A touch with a file should normally clear any inaccuracies here.

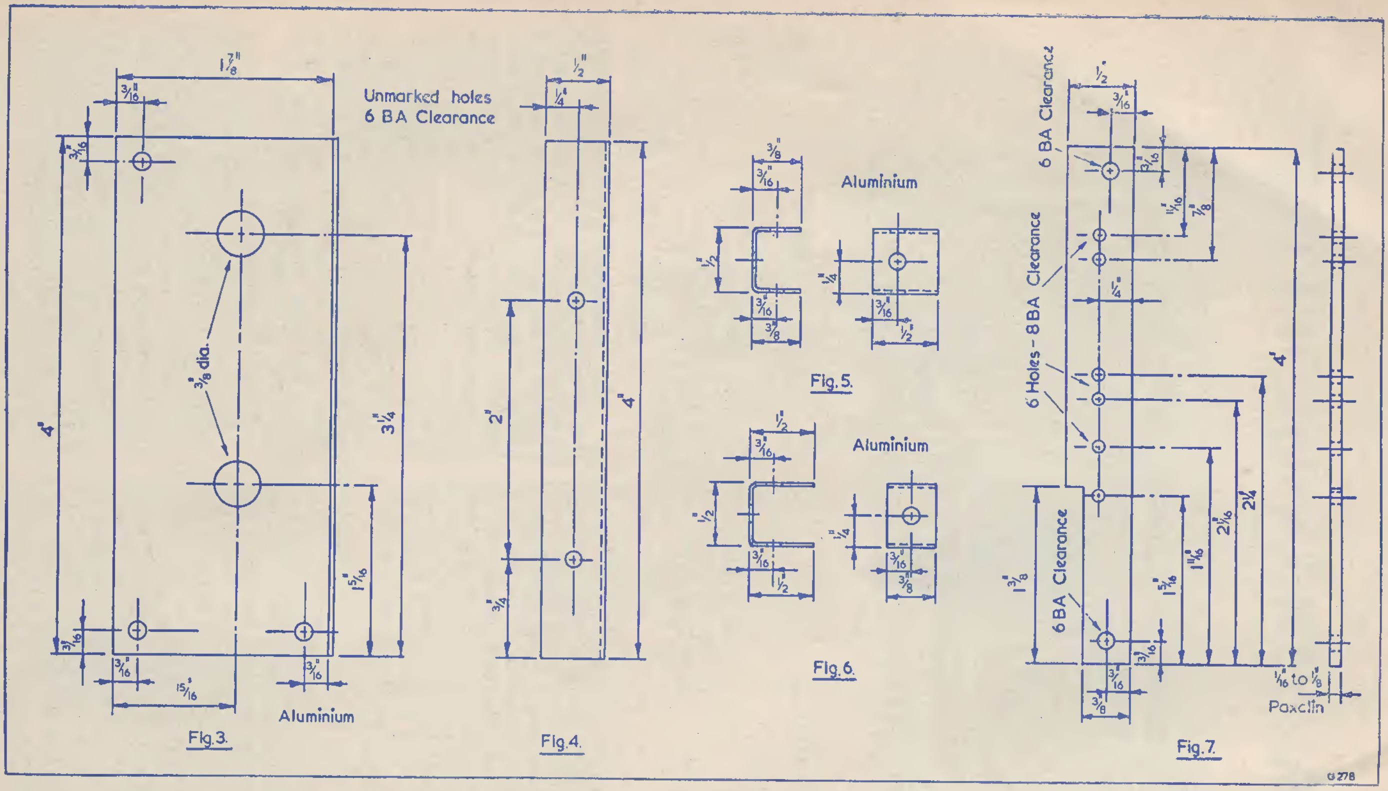


Fig. 3. Front view of the main chassis of the Transistorette. The material is 14 to 18 s.w.g. aluminium sheet, and all holes are 6-BA clearance (No. 32 drill) unless otherwise stated. Fig. 4. Side view of the main chassis. The two holes are 6-BA clearance. Fig. 5. The "inner" bracket. The material is 14 to 18 s.w.g. aluminium and all three holes are 6-BA clearance. Fig. 6. The "outer" bracket. This uses the same material and has the same diameter holes as the bracket of Fig. 5. Fig. 7. The dimensions of the the condenser-support strip. The 8-BA clearance holes shown may be made with a No. 41 or 42 drill

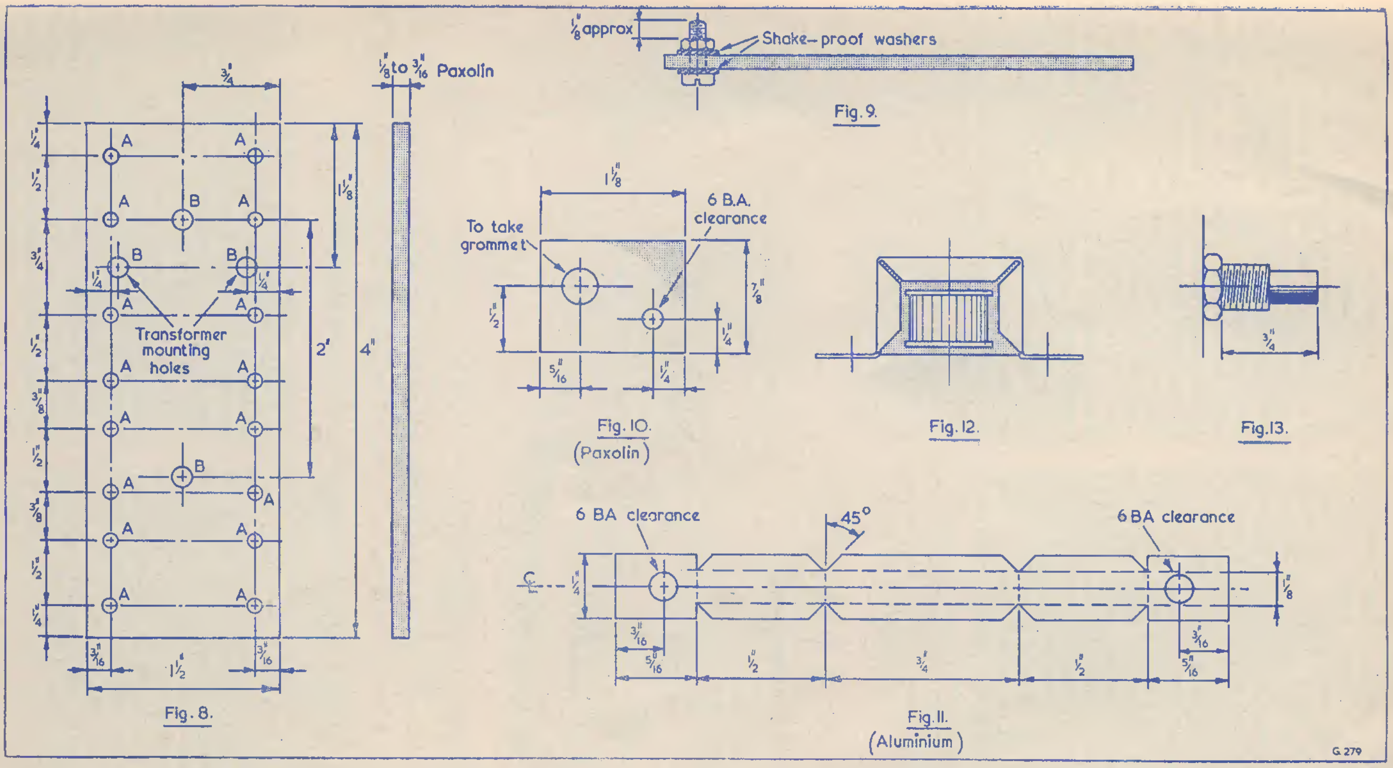


Fig. 8. The transistor tag-board. This is made from s.r.b.p. of thickness ⅛ to 3/16 inch. Holes marked A are 8-BA clearance; and those marked B are 6-BA clearance. Fig. 9. This diagram illustrates the method of mounting the individual 8-BA nuts and screws to the transistor tag-board. Fig. 10. Dimensions of the brackets used for mounting the ferrite core of the aerial coil. Two of these brackets are required. The material is thin s.r.b.p. Fig. 11. The clamp required for the Multitone hearing-aid transformer. Fig. 12. Showing how the clamp of Fig. 11 is folded to fit around the laminations of the transformer. Fig. 13. The dimension to which the tuning condenser and volume control spindles should be cut before assembly

The next parts to make are the two brackets shown in Figs. 5 and 6. These are called, respectively, the "inner" and "outer" brackets, and they are made of the same material as the main chassis. Although rather small in size, they should not prove too difficult or fiddling to make. Owing, once more, to the softness of the material used, it might be advisable to cut out these brackets a little oversize before bending, after which operation they may then be quickly cleaned up with a file. As was just mentioned, and in common with all the other parts used in the construction of this receiver, a high degree of accuracy is not essential provided that the essential electrical clearances are maintained. Nevertheless, a little care in the construction of the metal work at this stage pays good dividends, since it can result in a very neat looking job when the whole receiver is completed.

The condenser support strip comes next, and its dimensions are given in Fig. 7. This strip is a piece of s.r.b.p. which supports some of the electrolytic condensers used in the a.f. amplifier. The term s.r.b.p. stands for "synthetic resin-bonded paper" and is a generic term for most of the well-known range of insulating materials described under trade-names such as "Paxolin," etc. The s.r.b.p. used for the condenser support strip should have a thickness of between $\frac{1}{16}$ and $\frac{1}{8}$ of an inch.

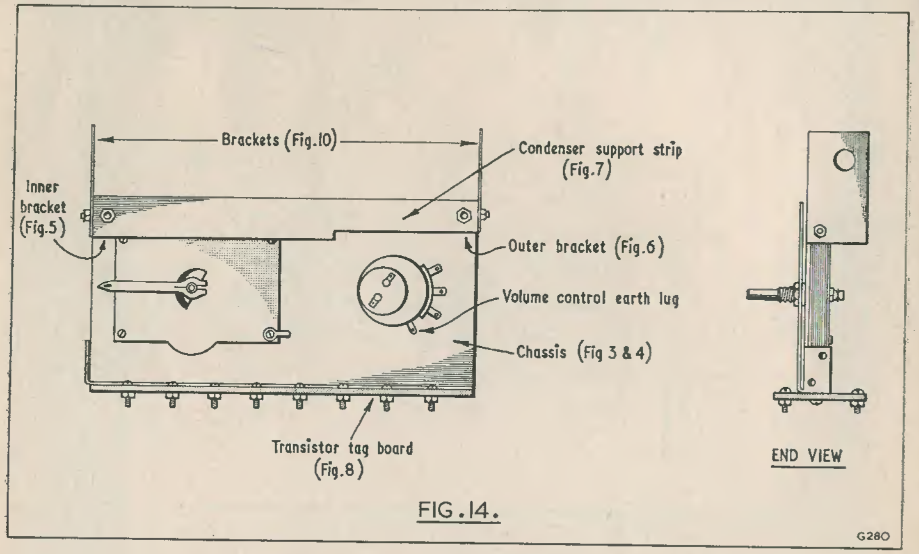


FIG. 14.

Fig. 14. How the main parts of the chassis are assembled

The Transistor Tag-board

The transistor tag-board follows, its dimensions being illustrated in Fig. 8. This is a most important part of the assembly because it mounts the various tag-spills together with the three transistors and the miniature deaf-aid a.f. transformer. The tag-board should be marked out with reasonable care before drilling, this precaution obviating any troubles at a later date due to difficulties of component spacing, etc. The tag-board is made from s.r.b.p. also.

As will be seen from Fig. 8 there are two rows of 8-BA clearance holes along either side of the transistor tag-board. These holes are intended to accommodate 8-BA brass nuts and screws; these acting as the actual tag-spills to which the various soldered connections are made. 8-BA screws are employed for this purpose because it would almost certainly be difficult for the constructor to obtain the small solder tags which would otherwise be required, and which might also need to be eyeletted instead of bolted to the tag-board. If the constructor has access to small two-way solder tags capable of being held under 8-BA nuts, these could be used as soldering spills instead of the screws suggested here. In practice, however, very little advantage would be given by such tags as the screws themselves form quite efficient and practical spills. 8-BA screws are used instead of 6-BA screws because the latter, being larger, retain the heat of the soldering iron for too long a period.

After completion of the tag-board, the 8-BA brass nuts and screws may be fitted. Before this is done, however, the individual nuts and screws should be de-greased in order to facilitate soldering. De-greasing can be carried out by standing the nuts and screws for a time in a small container of petrol, carbon tetrachloride, or similar solvent. (Carbon tetrachloride is available from any chemist in the form of an inexpensive proprietary household cleaning fluid.)

The individual 8-BA nuts and screws are mounted as shown in Fig. 9. It will be seen from this diagram that approximately $\frac{1}{8}$in of each screw should project above its nut. If long screws are used, these can be cut after mounting. Shake-proof washers under both nut and screw-head are desirable, as these will help to prevent the screws working loose after soldering. It will be remembered, of course, that once the soldering iron has been applied to a screw its nut will become soldered to its threads, thereby preventing any subsequent adjustment of tightness.

The next job is the construction of two small brackets of the type shown in Fig. 10. These brackets are made from thin s.r.b.p. of approximately $\frac{1}{32}$in thickness, and they hold the grommets which, in turn, hold the ferrite core of the aerial coil. These brackets have to be made of insulating material instead of metal in order to prevent losses in the ferrite core material. Metal brackets could constitute a single "shorted turn" around the ferrite rod. The grommets, incidentally, are supplied by the manufacturers with the coil.

The Transformer Clamp

All that now remains at this stage is a clamp for the deaf-aid step-down transformer. The dimensions for this clamp, in its flat state, are given in Fig. 11, and the clamp should be made from very thin tinplate, copper strip, or similar material. One of the easiest ways of constructing this clamp consists of cutting it out initially and then bending it carefully around the laminations of the transformer itself. The greatest care should be taken during this operation in order to prevent damage to the transformer, this being somewhat fragile and capable of being damaged by a slip of a tool. The transformer, fitted with its clamp, should have the appearance shown in Fig. 12.

This completes practically all the metalwork with the exception of the mountings for the h.t. battery. This mounting is dealt with in the later article which describes the construction of the cabinet.

Assembly

The assembly of the various chassis parts may now commence, together with the fitting of the volume control and tuning condenser. Before these two components are mounted, however, their spindles should be cut to the dimension illustrated in Fig. 13. The appearance of the complete assembly is illustrated in Fig. 14.

Next Month

In next month's article we shall carry on to the wiring and testing of this little receiver.

Can Anyone Help?

(*continued from page 489*)

J. L. Sheppard, "Moleview," 3 Hertford House Estate, Farquhar Street, Hertford, Herts, requires past examination papers for the City and Guilds and R.T.E.B. Radio Servicing final exam. 1954 papers not required as already available.

* * *

A. S. Eastaugh, G3AJV, The Modern School, Ripon, Yorks, is anxious to obtain information on the DST.100 communications receiver, particularly with regard to re-alignment, S-meter fitting, power pack, etc. Willing to pay for manual or borrow.

* * *

G. F. Green, Cedar Cottage, Earlswood Mount, Pendleton Road, Redhill, Surrey, will willingly purchase or reimburse anyone able to supply or lend the circuit and/or conversion data for oscilloscope of Indicator unit SLC No. 5, ZC3488.

J. Allnutt, G4QW, 38 Chatsworth Avenue, Merton Park, London, S.W.20, requires information on the Motorola model 924.

* * *

J. E. Heaver, 67 Percy Street, Portland, Victoria, Australia, requires information on constructing a pH meter for soil testing.

* * *

R. H. Shepperd, 5 Askern Avenue, Grangetown, Sunderland, Co. Durham, wishes to buy or borrow the circuits of the Murphy AC/DC U102 superhet and the Sobell Tablegram 052473.

* * *

A. E. Joyce, 40 Elm Drive, St. Albans, Herts, would like to buy or borrow booklet or information on the Denco CT3 Coil Turret.

Technical Forum

Tuning Hiss

A reader recently made up a superhet radio receiver based on one of the designs published in our magazine. Whilst the results were generally satisfactory, he reported a rather severe hiss which was heard as the set was tuned over a station. This type of fault is often difficult to track down, as it is not always apparent when the set is tuned on a station, but usually shows up with a small amount of detuning. The hiss may be quite loud and is particularly annoying on a weak signal. The effect exactly as described is usually traced to instability in the i.f. amplifier. Those constructors who have made wobbulators will be able to check this quite quickly by displaying the response curve of the i.f. amplifier on an oscilloscope. A wobbulator frequency deviation of at least 30 kc/s should be employed, with the instruments connected up in the usual manner. Should there be no instability in the i.f. stage, the response curve will appear approximately as shown in Fig. 1(*a*), but if instability is present, it will show up as in Fig. 1(*b*). This is not a severe case of oscillation, as it does in fact cease as the a.v.c. voltage rises and reduces the gain of the stage. In bad cases the oscillation may persist over the whole of the response curve, but in these circumstances the audible effect will not be a hiss but a heterodyne whistle.

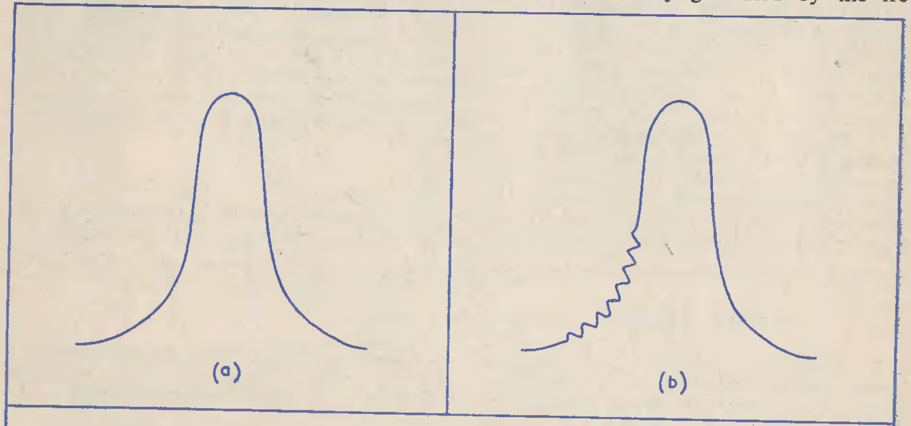


FIG. 1. Response curves of (a) a stable receiver and (b) one showing slight IF instability

The first components to suspect when seeking the cause of the trouble are the decoupling capacitors, the most likely culprit being the one between the screen grid of the i.f. valve and earth. These capacitors are easily checked in situ merely by shunting each in turn with a known good component. Next turn to the a.v.c. decoupling capacitor and treat them in similar fashion. If the fault still persists, check that the screening on or around the i.f. valve is intact and well earthed.

Before leaving this point, it is worth remembering that general receiver noise or hiss is most likely generated by the frequency changer valve and may indicate either a faulty valve or incorrect local oscillator operation. If the noise is, however, of this origin it will persist whenever a signal is heard, but it will not show up on the response curve as in the case of i.f. instability.

Electrostatic Focusing

There is an old saying that there is nothing new under the sun, and whilst it is not the purpose of this article to consider whether or not this is correct, it must certainly appear to the casual observer that there are occasions when engineers go round in circles. It will be remembered that the first cathode ray tube employed "gas" focusing, but it was in 1923 that the electrostatic method of focusing the electron beam was first used. This was achieved by the use of an additional anode situated between the grid and the high potential anode and maintained at a considerably lower potential. The results achieved using a two-anode tube were not altogether satisfactory, and difficulty was experienced in obtaining good focus over the complete range of brilliance, it being found that the voltage on the grid had a marked effect upon the focusing. This effect was due to the fact that the electrostatic field produced by the electrode system influenced the electron stream in a very similar manner to that in which a system of lenses influence a beam of light. An electron lens has its own focal length depending upon the relative potentials on the electrodes. Thus any alteration in the grid potential altered the focal distance of the first lens formed by the grid and first anode. This disadvantage was eliminated by the three-anode focusing system which has been used in the majority of oscilloscope tubes up to the present time.

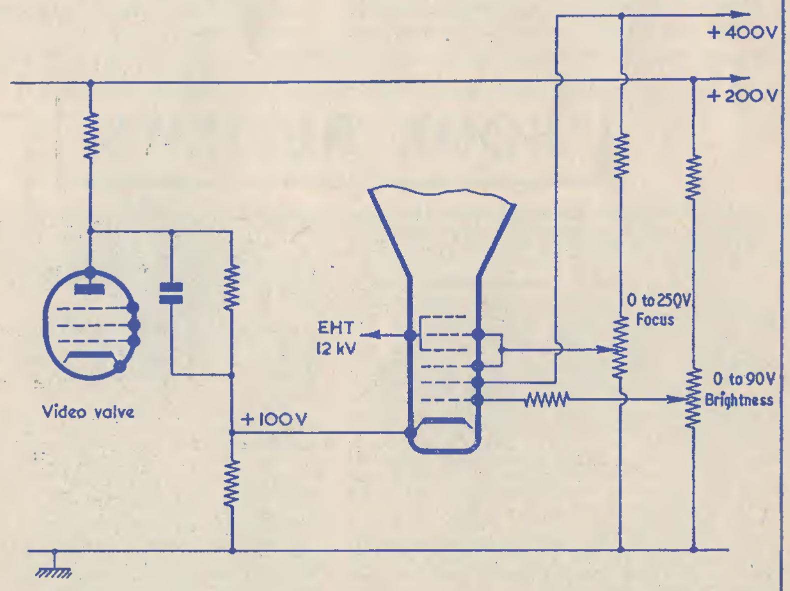


FIG. 2. SHOWING TYPICAL VOLTAGES ASSOCIATED WITH AN ELECTROSTATICALLY FOCUSED TV TUBE

This electrode system has not been used extensively in television tubes, largely because the close spacing of the electrodes renders it unsuitable for the high potentials which are required in the large picture tubes of the post-war years. However, more recently a modified form of the electrostatical focused gun has been introduced. This new assembly has five anodes apart from the normal grid and cathode. Careful design has made possible the use of the high anode potentials hitherto associated only with tubes having magnetic focusing. Also, very accurate control of the spacing between the anodes has resulted in a very good uniformity of focus between tubes. To the user this consistency between production tubes means that the range of adjustment of the focus electrode voltage can be reduced to a minimum.

Electrostatically focused picture tubes are now being used by several of the leading receiver manufacturers in this country. Their advantage lies in the fact that the cost of the focusing magnetic system is saved without in any way degrading the picture. The tubes are of the five-anode type in which the first anode functions much in the same way as the screen grid of a pentode valve. This anode is normally fed with a fixed potential of some 200V. The second and fourth anodes are strapped together within the tube and are supplied from an adjustable voltage source for focusing purposes. The voltage range required for focus is from −100V to about +150V. The third and fifth anodes are connected together within the tube and are joined to the side connector. These anodes are fed at high potential, usually in the region of 12kV. It should be specially noted that the voltages referred to are measured with respect to the cathode of the tube, which in the majority of television receivers is positive by about 100V. Thus if the focusing anodes are connected directly to chassis, the voltage on them will be −100V.

The circuit in which the electrostatically focused tube is employed differs from normal only by virtue of the additional adjustable supply to the focusing electrode. Adjustment of this voltage is provided either by means of a number of fixed tapping points on a potential divider or by a potentiometer. A circuit using this latter method is shown in Fig. 2. The higher focusing voltage is generally obtained from the boosted H.T. line in the line timebase.

With the absence of the focusing unit some method has to be provided with electrostatic tubes to centre the picture on the screen. This is usually achieved by a small adjustable magnet located immediately behind the deflection coils. Rotating the complete centring magnet assembly about the neck of the tube will shift the picture in one direction, whilst rotating the magnet relative to its pole pieces provides shift in the other direction. Tubes of the type under discussion are fitted with ion trap guns and require the use of a standard ion trap magnet. This magnet is adjusted in the normal manner.

BOOK REVIEWS

K.M. AMPLIFIERS AND FEEDERS. 32 pages, 20 diagrams. Published by Kendall and Mousley Ltd., 18 Melville Road, Edgbaston, Birmingham 16. Price 2s. 6d.

This is a paper covered handbook mimeographed in typescript. Five chapters describe a direct-coupled amplifier recently developed by Messrs. Kendall and Mousley, and suitable feeder units to work with it.

The keynote is simplicity, both in circuit design and construction. Nevertheless, the aim has been to produce equipment capable of good quality reproduction. The two-stage amplifier circuit is unique in that it employs direct coupling, thereby reducing phase-shifts to a minimum and at the same time demanding fewer components to make it. Negative feedback is incorporated, and it should give a good account of itself when used with the simple but effective tone control circuit and the four equalising networks for the different types of gramophone pick-up catered for.

The feeder units include the simplest of crystal receivers, and more advanced designs using thermionic valves and transistors give a wide choice for the constructor. Particular attention has been given to fully describing how to build all the units described.

A chapter on the use of electrostatic speakers also presents some useful information.

This booklet can be recommended for those who required sound designs together with expert guidance on constructing simple apparatus.

RADIO RECEIVER CIRCUITS HANDBOOK, by E. M. Squire. 156 pages, 122 diagrams. Published by Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 15s. 0d.

The fourth edition of this popular book should still appeal to those who want a ready reference to the basic circuits used in radio apparatus. This latest edition has been enlarged to include a new chapter on f.m. receiver circuits.

The author maintains his previous policy of presenting circuits in their simplest form, describing them in some detail in the text, wherein typical component values are indicated. This method has stood the test of time, and for this type of book it is clearly the best way to deal with the subject. Though not a large book, it contains a lot of sound factual information; real down-to-earth stuff with no frills.

MAGNETIC RECORDING HANDBOOK. by R. E. B. Hickman, M.B.K.S., M.T.S. 176 pages, 109 illustrations. Published by George Newnes Ltd., Tower House, Southampton Street, Strand, London. W.C.2. Price 21s. 0d.

At first glance this appears to be a description of the various types of recording equipment that are available commercially, but closer study soon reveals that there is a fair amount of technical information within the pages of this book. The development of tape and wire recording is traced from their beginnings, and it comes as a surprise to read that a primitive form of wire recording was used nearly 90 years ago!

Following a survey of development up to the present day, there are chapters on the theory of magnetic recording and typical apparatus. The treatment is non-mathematical, but the description is explicit enough to enable the technicalities to be understood. Clear diagrams and photographs play a large part in conveying to the reader much that would otherwise require a great deal of less easily assimilated matter.

Commercial equipment is described in some detail, both as regards mechanical features and the electrical circuits. The treatment here extends even to recording on film. Other chapters deal with maintenance and servicing, and some special applications of the art. A useful bibliography indicates sources from which material has been drawn, and references for further study. Appendices deal with copyright law and performing rights, recording and reproducing characteristics, and standards for spools and machine fittings.

This book has obviously been prepared with some care and not a little research; it is well produced, and makes interesting and informative reading.

W. E. THOMPSON

RIGHT—*From the Start*

PART 3. SIMPLE ELECTRICITY

by **A. P. BLACKBURN**

OUR FIRST TWO ARTICLES IN THIS SERIES have been concerned with the essential business of interpreting circuit diagrams and recognising some of the more common components. Experience of these simple arts will enable you to satisfactorily build and operate published designs.

However, although such successes are encouraging, it is not long before the beginner becomes curious about the working of the circuits. Perhaps this may be due to a disappointment with an unsatisfactory result, or possibly to some creative instinct to design in one's own right; whatever the reason, the effect is that the beginner wants to learn something of the theory of radio.

It is with the transition from one stage to another that this series is designed to help. The article this month will deal with simple electricity. Obviously, since the whole basis of radio is electricity, no one can hope to fully understand the problems they are likely to meet without first understanding a little of the basic electrical principles involved. For a start, then, we shall take a look at the most fundamental electrical quantities.

Ohm's Law

This is probably the most important law in electricity, and most people have heard of it, even if they don't know what it is. Now let us look at the circuit shown in Fig. 1.

The battery B has a voltage V. This represents a pressure causing the current I to flow around the circuit, rather as a pump would cause water to flow in a pipe. Now the resistor R, as its name implies, resists the flow of current, just as a section of pipe, smaller in diameter than the rest, would resist the flow of water.

The current flowing will therefore depend upon the voltage (pressure) of the battery and the resistance in the circuit. Ohm's law states this quite simply as:

$$\text{Current } I = \frac{\text{Voltage } V}{\text{Resistance } R} \qquad \ldots\ldots(1)$$

The unit of current is the *ampere*, the unit of pressure the *volt*, and the unit of resistance the *ohm*.

Now we can take a practical example. A 2 volt battery is connected to a lighting bulb of resistance 1 ohm. What is the current? From the formula:

$$I = \frac{2}{1} = 2 \text{ amps.}$$

This formula can be rearranged thus:

$$R = \frac{V}{I} \qquad \ldots\ldots(2)$$

$$V = IR \qquad \ldots\ldots(3)$$

As an example of (2), if a 6 volt battery is connected to a heating element and a current of 2 amps flows, what is the value of the resistance?

$$R = \frac{6}{2} = 3\ \Omega \text{ (}\Omega\text{ is the symbol used for ohms)}$$

If the current and resistance are known, the voltage may be calculated from 3.

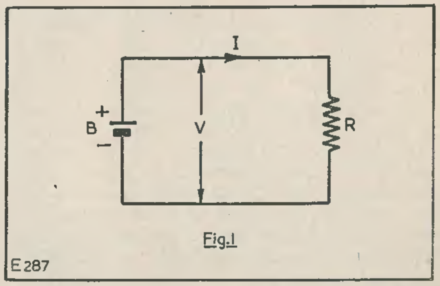


Fig.1

Power

The fact that the resistor only impedes the flow of current, and does not stop it altogether, implies that the current must work to pass through the resistance. This is true, and, in fact, the current heats the resistance. This is what is happening in an electric fire, or a lighting bulb. The wire in each case is of sufficient resistance to cause the current to heat it. The unit of electrical power is the watt. Of course, some power is dissipated in a resistor by the passage of current, and this may be calculated from the expression:

Power $P = V \times I$, where V and I are voltage and current as before ......(4)

The power dissipated in the resistor in Fig. 1 if the battery were 2 volts and the current 2 amps would be 4 watts.

The power may also be calculated from

$$P = I^2R \qquad \text{......(5)}$$

$$P = \frac{V^2}{R} \qquad \text{......(6)}$$

These last formulae, 4, 5 and 6, are of considerable importance. In the second article of this series it was mentioned that resistors are specified not only by their resistance value but by the wattage (power) they can safely dissipate. It is often necessary, therefore, to calculate the wattage of a resistor in a circuit to ensure that one of adequate rating is used.

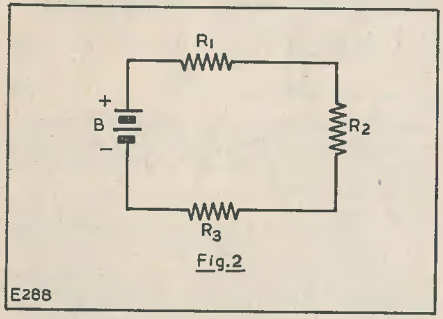


Fig.2

One thing that has not been mentioned about Fig. 1 is polarity. The + and − signs at the ends of the battery represent the "polarity" of the battery terminals. The + marks the positive end (this terminal is often marked in red on an actual battery) and the − sign negative. It is common practice to relate potentials to earth, i.e. the earth's surface. As we have shown it here, no earth is indicated, but if the negative end of the battery were connected to earth, the battery would be said to provide a positive supply.

Series and Parallel

The circuit shown in Fig. 1 is, of course, very simple. A slightly more complex circuit is shown in Fig. 2. The three resistors R_1, R_2 and R_3 are said to be connected "in series." The total resistance in the circuit is merely the sum of these resistors: Total resistance$=R_1+R_2+R_3$. If B were 6V. $R_1=1\Omega$, $R_2=1.6\Omega$, $R_3=0.4\Omega$, then the total resistance would be 3Ω and the current in the circuit

$$I = \frac{V}{R} = \frac{6}{3} = 2 \text{ amps}$$

Any number of series resistors may be added up in the same way.

Fig. 3 shows another type of circuit. The two resistors R_1 and R_2 are said to be connected "in parallel." The total resistance of any number of resistors in parallel is given by:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

....etc., where R_T is the total resistance.

If R_1 were 2Ω and R_2 4Ω, then

$$\frac{1}{R_T} = \frac{1}{2} + \frac{1}{4} = \frac{3}{4}\,\Omega, \text{ and therefore}$$

$$R_T = \frac{4}{3}\,\Omega.$$

A simpler formula, if only two resistors are in parallel, is

$$R_T = \frac{R_1.R_2}{R_1+R_2}$$

Any combination of components may be placed in series or parallel; batteries, resistors, etc.

Internal Resistance

An extremely important fact which is always cropping up is that every source of electricity, whether it be dry battery, accumulator, generator or dynamo, all have some internal resistance.

Let's have another look at Fig. 1. If B were a 4 volt battery and 1Ω were connected across it, 4 amps would flow. We would expect, therefore, that 400 amps would flow if a resistance of $\frac{1}{100}\Omega$ were connected. Unless the battery were very large, we would be disappointed. We would probably find only 40 amps were flowing. What has happened, then? Has Ohm's law gone wrong?

No. We have assumed a perfect battery. In practice, a battery (or any other source) will have some internal resistance. Fig. 4 shows how the circuit looks when this unseen resistance is included. The battery terminals 1 and 2 poke out of the (dotted) box, giving no hint of R_B within. Mind you, R_B has not been deliberately included by the manufacturers. It actually exists right within the battery cell; it is an unavoidable feature of any battery or generator.

Now if nothing is connected to the terminals 1 and 2, a genuine 4 volts exists there. If a resistor is connected, however, some current flows. This means that there will be a voltage drop across R_B, and the voltage between terminals 1 and 2 will be 4V. *less* this drop.

For example, let us suppose $R_B=0.1\Omega$ and $R=2\Omega$.

There are two resistors, R and R_B, in series so we add their values. The total resistance is 2.1. The current is, therefore,

$\frac{4}{2.1} = 1.9$ amps. The voltage drop across R_B is

$$E = IR_B = 1.9 \times 0.1 = .19 \text{ volts.}$$

The voltage appearing between terminals 1 and 2 is, therefore, 4−0.19=3.81 *volts.*

If we decrease the value of R to 1Ω, the voltage across terminals 1 and 2 will drop to 3.64V.

Alternating Current

So far we have considered only batteries, as our source of current. Because the current and voltage produced by a battery is steady, it is said to produce "direct current." In a few parts of the country the mains are direct current, or d.c. as it is abbreviated.

More common nowadays for the mains, is a.c., or alternating current. Such supplies are so called because the voltage and current are continually fluctuating at a steady rate. In Britain the rate is 50 cycles per second for mains supplies.

So with a.c. we have three things to consider: voltage, current and frequency. It is helpful here to draw a graph of a few cycles of an alternating voltage.

Fig. 5 shows two cycles. The voltage varies smoothly from zero volts up to a maximum positive value, then decreases through zero to a negative value. The current "waveform" is of exactly the same shape as this.

Resistors behave with a.c. exactly as they do with d.c. Capacitors and inductors also act rather like resistors when a.c. is applied to them. There is an important difference, however. The apparent resistance (called reactance) of capacitors and inductors depends upon the frequency of the applied voltage.

A capacitor in its simplest form is two plates insulated from one another. When a source of d.c. is applied to a capacitor, the capacitor is an open circuit and current does not flow round the circuit. However, the capacitor charges and will hold the charge after the battery has been disconnected. What has happened then, is that current flowed into the capacitor and charged it to the voltage of the battery. If the battery is disconnected and the capacitor terminals are shorted together, a current will flow around the circuit and the capacitor will discharge. The discharging current will heat up the connection between the capacitor terminals and the energy will be dissipated. Current only flows in a capacitor, then, upon application of a voltage. It does not continue to flow, as current does in a resistor.

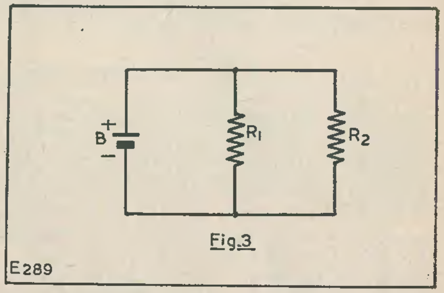


Fig.3

If we now apply an alternating voltage to a capacitor, each time the capacitor gets charged in one direction, the voltage begins to move off in the other direction, as in Fig. 5. Current will be chasing backwards and forwards into and out of the capacitor plates the whole time. It appears, then, that current is flowing the whole time, even if it is undecided about its direction. The "capacity" of the capacitor is a measure of its ability to store a charge, which in turn is related to its "resistance" to an applied alternating current. This "resistance" is called "reactance," and the reactance of a capacitor is calculated from:

$$\text{Reactance } X = \frac{1}{2\pi fC} \text{ ohms,}$$

where $\pi=3.142$
f=frequency of applied voltage in cycles/sec.
C=capacity in Farads.

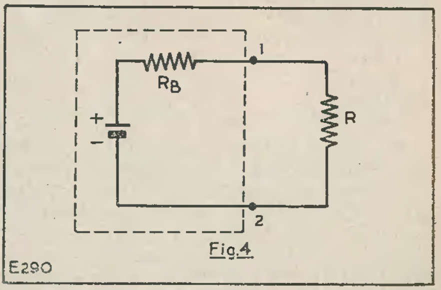


Fig.4

For example, a 1 microfarad capacitor has a voltage of 100V at a frequency of 50 c/s applied to it. What is the reactance of the capacitor and what is the current flowing through it?

One microfarad is one millionth of a Farad; then

$$X=\frac{1}{2\times\pi\times50\times\frac{1}{1,000,000}}$$

$$=3,300\,\Omega\text{ approx.}$$

From Ohm's law the current is:

$$I=\frac{V}{X}=\frac{100}{3300}=.03\text{ amps approx.}$$

Note that the reactance X is merely substituted for the resistance R in Ohms law. This shows that a capacitor impedes the current in an a.c. circuit in the same way as a resistor.

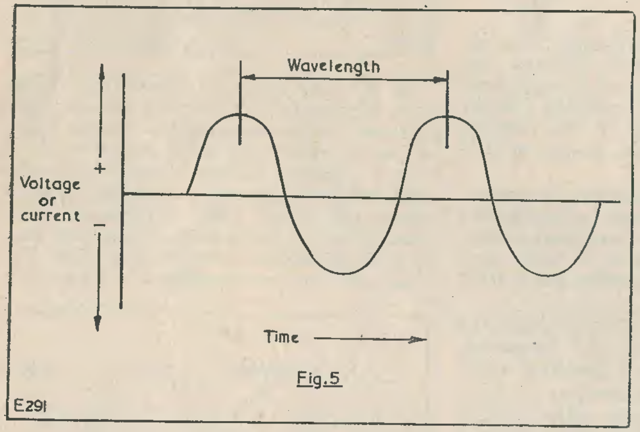


Fig.5

The important thing to notice is that the *higher* the frequency of the applied voltage, the *lower* the reactance. If the applied frequency had been 500 c/s the reactance would be 330Ω. This property of capacitors is of tremendous importance in radio, as we shall see when we come to consider amplifiers. A coil in an a.c. circuit also has a reactance. The difference between this component and a capacitor is that the reactance increases with frequency.

The expression for the reactance of an inductance is:—

$X_L=2\pi fL$ ohms, where L is the inductance in Henrys.

For example, a coil of inductance 1 Henry in a circuit where the applied voltage has a frequency of 50 c/s will have an inductance of

$$X_L=2\pi\times50\times1=314\,\Omega$$

Once again X_L can be substituted for R in the expression for Ohms law. We will see later that a combination of inductance and capacitance in a circuit can produce some very useful results.

Frequency Range

The frequency range met with in radio work is fantastically large. Audible sounds lie in the range of a few cycles per second to approximately 16,000 cycles per second. Radio waves may have frequencies from 100 kilocycles per second to thousands of megacycles/second. Kilocycle and megacycle mean a thousand cycles and a million cycles respectively.

The audible range is usually referred to as the "audio range." Frequencies above 100 kc/s (kilocycles/second) have various titles; radio frequencies (r.f.) and high frequencies (h.f.) are probably the most common.

Wavelength & Frequency

When speaking of radio signals, one hears two terms frequently used. A radio station is either said to be operating at a frequency of so many megacycles/second or on a wavelength of so many metres. For example, the B.B.C. Home Service operates at a frequency of 330 metres, or a frequency of 908kc/s. This is really two ways of saying the same thing.

Frequency and wavelength are related in the following way. Radio waves travel at the speed of light, which is 300 million metres/second. If we imagine a radio wave of frequency 1 million cycles/second, passing a particular point in space, each complete cycle of the wave would have to be 300 metres long. In other words,

$$\text{Wavelength }\lambda=\frac{\text{Velocity V}}{\text{Frequency }f}$$

and

$$\text{Frequency }f=\frac{\text{Velocity V}}{\text{Wavelength }\lambda}$$

As the velocity is always the same,

$$\lambda=\frac{300}{f}\text{ where }f\text{ is in megacycles}$$

and

$$f=\frac{300}{\lambda}\text{ where }\lambda\text{ is in metres}$$

(*continued on page 513*)

Radio Miscellany

CENTRE TAP *talks about*

THE I.T.A.
R.C. ANNUAL ?
AUDIO FAIR
READERS' CABINETS

SCANNING THE PAGES OF CERTAIN SECTIONS of the popular Press to see what is fresh by way of biased comment or spiteful reporting on the doings of I.T.A., is becoming one of my new sources of amusement. Obviously the I.T.A., despite the fact that its programmes for the most part are to me as unsatisfying as the B.B.C.'s, is highly successful with viewers. The bigger its audience, the greater the danger that advertisers will divert an increasing percentage of their newspaper advertising to this new and telling medium. Is it because I.T.A. is becoming too successful that these attacks are apparently growing more bitter?

For the thoughtful reader this sniping has its funny side. After all, what could be more amusing than to find a daily whose special appeal is sex, sensation and violence, rebuking the I.T.A. for "bad taste," and the paper which styles itself the champion of freedom clamouring in its Leaders for the I.T.A. to be handed over lock, stock and barrel to the B.B.C. for use as a "second programme."

Even the B.B.C. Director-General joins in the chorus. He is front-paged as asking if the I.T.A. is not becoming too independent—of the Act. Anyway, he has the last laugh. Even should the I.T.A. provide the programmes for huge audiences, his Corporation scoops up their licence fees.

I am all for classical plays, ballet and opera—in their right proportion. Even the programme planners must eventually recognise that people needing relaxation at the end of a hard working day would rather see a couple of good heavyweights than Hamlet! My own little research is probably no guide, but it includes only selective viewers—and they spend more time with I.T.A. For myself, I watch either if there is anything to appeal to me—when I have nothing better to do!

I still believe my own solution—to ration both I.T.A. and B.B.C. to 30 hours a week each on an agreed percentage of "types" of programmes—would enable both to have a chance of improving general standards in material as well as production.

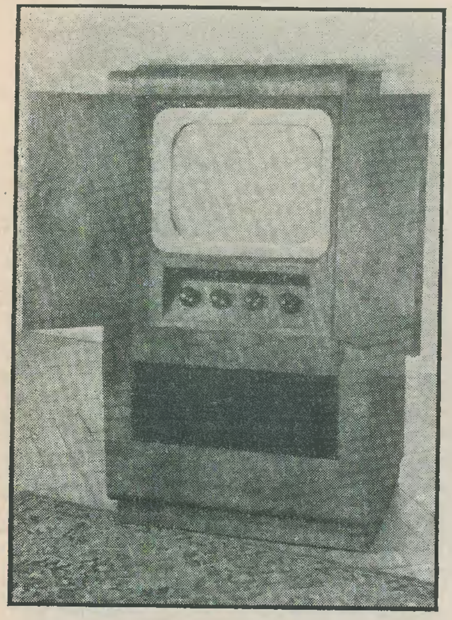
Anyway, column scanning for I.T.A. titbits led me into a trap. Lured on by a headline I dived in, only to find that it was all about quite a different I.T.A.—the Invalid Tricycle Association!

Extra Services

A number of readers have asked for further details of the multiple attachment for electrically driven drills which I mentioned a couple of months ago. My first reference to it was made from memory after a single reading of the advance details. It is now generally available in the shops. Called the "Selecta" it is capable, in addition to the normal operations of drilling, grinding and polishing, of sawing, mitreing, routing, grooving, undercutting, etc. The weight is 24 lbs, and the vertical and horizontal adjustments are 13½in and 12in respectively. The price is £12 10s., and while, so far, I have had no opportunity of trying one, it would certainly seem to be worth investigation by those who are contemplating the purchase of additional equipment for their power drills.

Annual

Once again this month I must apologise for not replying to all correspondents individually. I could once boast, like a good amateur, that I QSLd 100% sure, but in recent months I have fallen badly into arrears, although I keep struggling. From Mr. R. E. Hogben of Dover (a reader since No. 1) I have received an interesting suggestion. He puts forward an idea for an R.C. Year Book which, although incorporating the usual technical information, would be primarily aimed to reflect the progress and trend of amateur construction with full details of new (and unpublished) receivers and test equipment. Other features would include a review of all new items introduced during the previous year and modifications of older patterns, detailed specifications of all radio and T.V. components available to the amateur, a photo digest of amateur designed equipment, a review of new developments in electronic techniques and recent research work, a section for hints and ideas—and a completely new item. The latter, he proposes, would be a selection of personal experiences written by regular readers in varying stages of advancement briefly describing what they have built, the difficulties they encountered and their future plans.



A television receiver built by reader R. A. Gaston of Forest Hill. The cabinet is home-made, too—see text

As Mr. Hogben points out, there is nothing quite on these lines in this country, and there is certainly a need for such a work. Whether or not the demand is great enough to make it an economic proposition at a really low selling price is a matter to which careful consideration would have to be given.

The compilation of some of the items, such as equipment, photographs, hints and ideas, readers' experiences (triumphs and pitfalls) could well be run on competition lines with payment for all those used.

Well, that about sums up Mr. Hogben's suggestion. If you feel you have any comment to make on the idea, don't write to me, please, but to your Editor.

Proof of the Pudding

The Audio Fair, advance details of which were reported in our last issue, will for the first time give enthusiasts an opportunity to hear audio equipment in operation. A great contrast to merely seeing it on Exhibition stands. Timed to immediately follow the R.E.C.M.F. Exhibition, it will attract a large number of members of the trade as well as amateurs and hi-fi enthusiasts. Hence the whole-hearted support of virtually 100% of the firms in the sound recording and reproduction business.

The use of hotel double bedrooms as audio chambers is not only a novel idea but a good one, which assures prospective users of making direct comparisons as well as giving them their money's-worth purely as a show. The latter is an important point. The general public go to exhibitions to see what sort of choice they have next time they are buying, rather than of making an immediate purchase.

Those who have not heard reproduction at its best may be startled at its vividness under good conditions. I remember, with a couple of friends, having a private demonstration at the Philips' factory in Eindhoven, where a network of speakers are concealed in a special small concert hall. The sound comes at one from all directions, and one actually feels as though one were standing in the middle of the orchestra. To add to the occasion, the engineers recorded some of our conversation by way of an amusing diversion to give us a surprise later. Half-way through we realised what was happening. On the play-back, the early part sounded perfect, but once we knew our words were being recorded, much of the naturalness was lost. When trying out a home-recorder allowance must be made for a certain artificialness—one's voice seems to become much thinner and harder, as soon as one is conscious it is going on record.

The use of a microphone, to sound really natural, especially when it is necessary to actually speak into it, is an art only acquired by experience—as everyone experienced in recording and amateur transmitting can tell you.

Readers' Corner

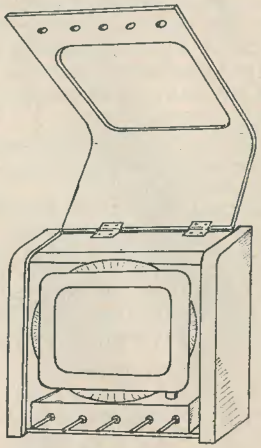
Quite a number of letters have been received regarding cabinet-work with neat, but strong jointing. A Salford reader, A.F. (signature uncertain) summarises the position nicely. He writes: "The idea is certainly a good one. Most home constructors follow commercial design slavishly, but factory-made cabinets are made to suit mass production methods and mass marketing. Not only is there no place for individual ideas, but the public are reluctant to accept original or unconventional design. Photographs of good amateur designs should certainly prove a popular feature, especially if supported by ideas for good jointing. The 5-ply top of my own T.V. cabinet is already warping inwards and one "seam" is beginning to open—no doubt due to internal heat. As the cabinet is a close fit, a batten across the top is out of the question. It would prevent the chassis, on which the C.R.T. is mounted, from being withdrawn."

Mr. P. A. Barber of Croydon writes in a similar vein. He considers the joinery in manufactured cabinets unsatisfactory, and hopes to send a photograph of his radiogram console when finished. It is to contain an 8-watt amplifier, F.M. unit, Collaro deck and dual speakers.

The T.V. in the accompanying photograph was built by Mr. R. A. Gaston of Forest Hill, S.E.23. Fitted with a 15in tube, it follows conventional lines and is built from ⅜in ply covered with walnut veneer and french polished.. At first glance it is indistinguishable from a professional hand-made job. It is excellently proportioned and the graining of well-selected veneer gives it added beauty. One virtue which strongly appeals to me is that the front is removable, enabling easy adjustment or servicing.

It is a work of art to adjust my own drawing room T.V. receiver. Every time I see the tuning card I decide to have a go at further improving the 3 Mc/s lines. This entails balancing a mirror on a chair stood in front of it, and trying to peep over the top of the cabinet while touching up the trimmers. Just at the moment when I have brought everything under control, the test pattern is taken off! Hence my ideal form of table cabinet would be something on the lines I have sketched. The front and top should hinge back after removal of the volume and brightness tuning knobs. This, of course, means that the sides have to support themselves and not be merely held in position by the top and front, a job I haven't yet dared tackle for fear the thing will fall to bits the first time I open it up.

Mr. Gaston kept no record of the cost of his T.V. console but estimates it at not more than £4. A similar factory-made job would cost at least twelve pounds and a hand-made one about twenty. He plans to modify it to take a 17in rectangular tube when replacement is necessary. Another advantage of the home-built variety! He concludes: "I do not own an electric sander; the silky finish was obtained the hard way—by hand."



Designed by Centre Tap to give easy accessibility, but not yet built — see Readers' Corner

Mr. Chas. Dainty of Edinburgh 13, also sends along an interesting letter and photographs of his mahogany-faced plywood cabinet. He describes his methods as unorthodox and has achieved a professional looking job with the simplest of tools. His only workshop is the kitchenette, obviously only available for short periods. Even then he has to watch out—neither he nor his wife likes the taste of sawdust, even if it is of the best mahogany. You may, however, read more about his methods and type of construction later, as I understand he is preparing a short article for an early issue.

RIGHT—*From the Start*

(*continued from page 510*)

Take for example, the B.B.C. Light Programme; on the long wave band it has a wavelength of 1,500 metres. What is the frequency? From the above formulae:

$$f=\frac{300}{1500}=0.2 \text{ Mc/s or } 200 \text{ kc/s.}$$

Next month we will take a look at the very heart of radio—valves, and how they amplify.

A MINIATURE PHONE AND SIGNAL MONITOR FOR THE TRANSMITTER

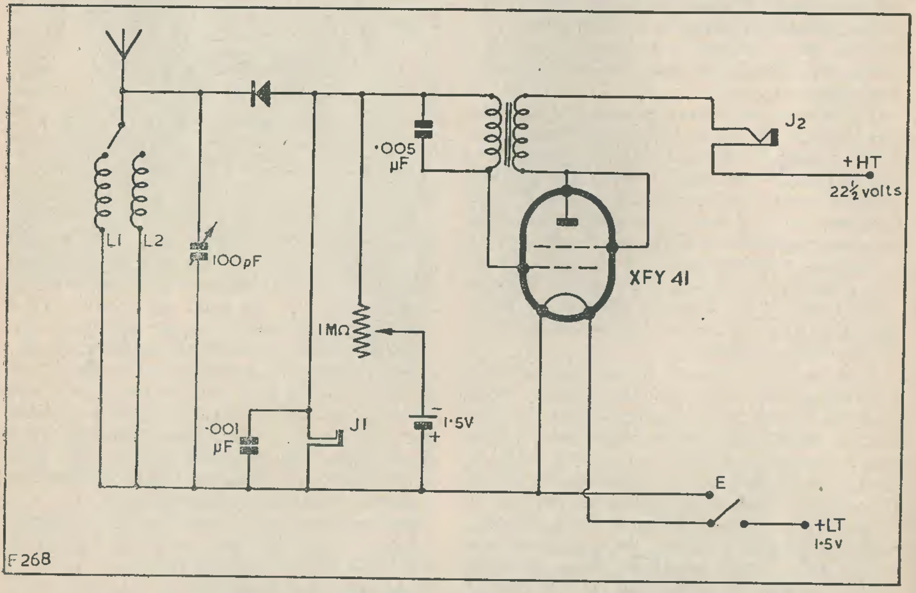
by **C. H. L. EDWARDS, A.M.I.E.E., G8TL**

It is very desirable when operating mobile to have some method of keeping a check on the outgoing signals, as there is always the chance when driving over a bumpy road of something shaking loose and causing the transmitter to go off the air. It is also useful to have such a check when operating a fixed station.

The small unit described herewith answers the purpose satisfactorily, is easy to build and is cheap to maintain.

It is designed to cover two bands, 160 and 80 metres, but can easily be coiled for other ones if desired. The two coils L_1 and L_2 are small pile-wound chokes with the turns removed until they fall into the amateur bands. Any small chokes will do, and it is an easy matter to put them on frequency with the help of a G.D.O. Small Aladdin formers can be used if desired, wound with approximately ⅞in of 38 gauge enamel wire for the 160 metre band and ⅝in of 38 s.w.g. enam. for the 80 metre band.

As can be seen from the circuit diagram, the phone section is simply a crystal receiver. An odd length of wire plugged into the aerial socket on the front panel provides sufficient pick-up. For monitoring c.w. a separate oscillator is added. The miniature transformer from the dinghy lifeboat transmitter is suitable for this circuit. The Hivac subminiature valve is biased off by the 1MΩ miniature Egin potentiometer. If this is not available, a 470kΩ resistor should suffice. All batteries are mounted under the small chassis and the drain is so small that they have practically shelf life.



List of Components for Miniature Phone and Signal Monitor

1	100pF variable Eddystone condenser.
1	0.001μF TCC 150V wkg condenser.
1	0.005μF TCC 150V wkg condenser.
1	Bulgin toggle change-over switch S.P.-S265.
1	Bulgin single-pole toggle switch S259.
1	Open circuit Bulgin jack J2.
1	Closed circuit Bulgin jack J6.
1	Egin miniature 1MΩ pot.
1	Lifeboat miniature transformer.
2	Small chokes, or Aladdin formers for coils.
1	Germanium crystal.
1	Hivac subminiature valve type XFY 41.
2	Ever-Ready dry batteries, D14 (Hearing Aid), 1.5 volts.
1	Ever-Ready battery B122, 22½ volts.

DESIGN CHARTS FOR CONSTRUCTORS

No. 4. REACTANCE-RESISTANCE CHART

by **HUGH GUY**

Before dealing with the chart shown in this issue, a method of extending the usefulness of charts Nos. 2 and 3 is given below.

Voltage and Current Dividers

Last month's article explained the use of a design chart produced to facilitate easier calculation of voltage dividing networks for biasing circuits and bleed networks. It was pointed out that the method was only applicable to resistive combinations from which no extra current was drawn, and the closing paragraph promised information on the extension of the chart's use to design current dividing networks also.

A typical example of one such current and voltage dividing network is that of supplying screen current to a pentode or tetrode from a voltage divider, and this is illustrated in Fig. 1. In this example the screen of a pentode must be supplied at a fixed potential, say 200V, and it draws 2mA. This 2mA will therefore flow through R_1. In addition to this load, a further current will flow jointly through R_1 and R_B, and as a rule its value is not critical.

The screen current can conveniently be considered as being absorbed by a resistor R_C, shown dotted, whose value will of course be 200/2 or 100kΩ.

If we were to choose a value for R_B now, the parallel combination of R_B and the value we have just calculated for R_C, would together be of value less than R_C alone; i.e. in this example less than 100kΩ. This value, which as yet we have not fixed, will be equivalent to R_2 of last month's chart.

Before we can determine this parallel value we must calculate the fractional ratio R_1/R_2, which is the ratio of the voltage drops, as explained last month. This will be 100/200 or 0.5 here.

Now comes the major step: R_1 we have not fixed yet, and all we know about R_2 is that it must be less than 100kΩ. So we scan the vertical 'R_1/R_2' scale at 0.5 and select a standard value on the horizontal scale for R_1 which intersects the 0.5 line at less than 100 on the diagonal R_2 scale. Note that this R_2 value need not necessarily be a standard value; this is because it is a parallel combination of two other resistors only one of which is actually a standard component value. The reading for R_2 we take, therefore, will be an interpolated one; that is, we literally read between the lines.

Performing this step for our example, 39kΩ for R_1 would give approximately 78kΩ for R_2 at the 0.5 intersection.

The final step involves the use of chart No. 2. We have two resistors (one of value 100kΩ), whose parallel resistance equals 78kΩ. To find the second resistor, which will be R_B in the circuit, and therefore must be one of the standard range of values, we select 78 on the Rp scale of chart No. 2. A line from 0 on the R_1 scale, drawn through 78 on the Rp scale, will cut the 100 R_1 value at the required value of R_B, which is read on the scale marked R_2. Our example produces a value of between 330kΩ and 390kΩ, these two being the nearest available values in the 10% range of components.

The choice of either value would not produce any serious discrepancy from the required voltage. The 390kΩ resistor would result in 202V, while the other would give 198.5V.

This is just one example of the combined use of these charts, which though appearing rather involved at first reading, is really quite straightforward.

Reactance-resistance Chart

This well-known chart provides complete information on the solution of a wide range of inductive and capacitive reactances.

It has three principal uses, which are:

1. To determine the reactance of a known value of capacitance at a given frequency.
2. To determine the reactance of a known value of inductance at a given frequency.
3. To determine the resonant frequency of a tuned circuit comprising known values of inductance and capacitance.

And of course the changes may be rung on any one of these functions.

The bottom scale gives the frequency calibration of the vertical lines on the chart, which, it will be noted, are presented on a logarithmic scale in common with the three other sets of information.

The horizontal lines are calibrated in values of resistance ranging from 10 ohms to 100kΩ. The diagonal lines running upwards from left to right are the inductance values, covering 1000H to 0.2μH, whilst the other diagonal lines present the capacitive information in the range 1000μF to 2pF.

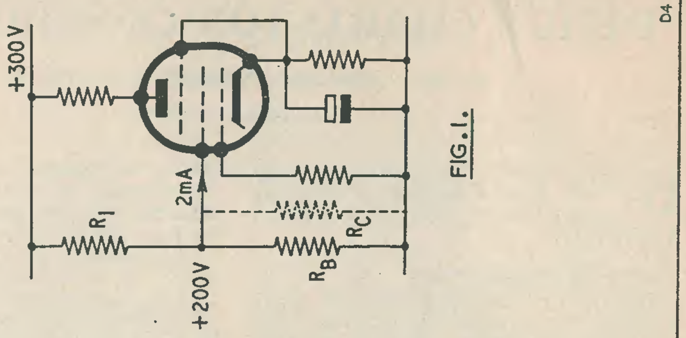
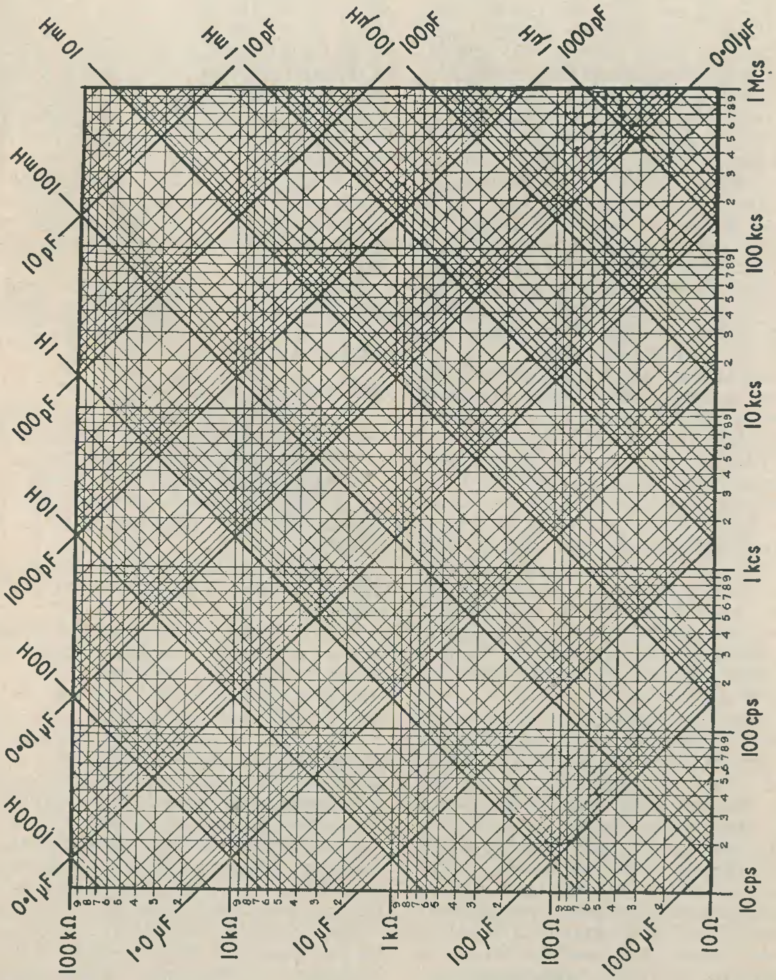


FIG. 1.



UNIVERSAL REACTANCE – RESISTANCE CHART

Examples best illustrate the method of using the chart, and three are given below.

Example 1: The stray capacities shunting the 10kΩ anode load of a pentode stage have a value of 30pF. At what frequency does their reactance equal the value of the anode load? (This is another way of asking what the frequency is for a 3db drop in output).

The 10kΩ horizontal line intersects the 30pF downward diagonal at a point midway between 500 and 600 kc/s. Since the scale is logarithmic, the frequency will be approximately 530 kc/s.

Example 2: An r.f. choke has a reactance of 50kΩ at 200 kc/s; what is its inductance?

The 50kΩ horizontal scale and the 200 kc/s vertical scale intersect at an upward diagonal of 40mH, which is therefore the required inductance value.

Example 3: At what frequency will an inductance of 300µH and a capacitance of 100pF resonate when connected in parallel as a tuned circuit?

At resonance the inductance and capacitance in any tuned circuit have equal reactances, which is an additional fact that the chart shows. The intersection of the two diagonals occurs at approximately 920 kc/s, which is thus the desired answer.

Summarising then, this chart may be used to provide the solution to any of the three following formulae, and their individual rearrangements:

$$X_c = \frac{1}{2\pi fC}$$

X_c is capacitive reactance in ohms.
f is frequency in c/s.
C is capacity in Farads.

$$X_L = 2\pi fL$$

X_L is inductive reactance.
L is inductance in Henrys.

$$f = \frac{1}{2\pi\sqrt{LC}}$$

f, L, and C as above.

The constant term 2π may be taken as 6.28 for those readers who may wish to verify the results obtained from the chart by a numerical check.

Next month's article: Frequency to Wavelength conversion.

INEXPENSIVE T.V. POWER UNIT

by **A. S. CARPENTER**

When converting ex-government units for T.V. purposes, one of the main problems is finding the necessary power supplies—especially if the valves consist, as they often do, of SP61's. These require an l.t. supply of 6.3V at 0.6A, and if many are used the heater consumption is quite heavy. To obtain a mains transformer with suitable h.t. and l.t. outputs can be quite an expensive business. For example, a T.V. receiver and timebase was constructed some time ago and the power requirements were:—500V, 300V, 200V plus 6.3V at 8A. Some sixteen valves were used, ten of which were SP61's. The power pack shown in Fig. 1 was constructed to meet these requirements, and with the aid of the junk box was built for less than £3 and has proved entirely satisfactory over a long period.

During initial T.V. experiments T_2 and associated components were omitted, the 300V line being used for the timebases. This, of course, gave only a very small scan on the VCR97 tube. When results warranted it T_2 etc. was included and it was decided to arrange for the 500V supply to be separately switched; S_2 was therefore included. It may be thought that with S_1 closed and S_2 open the timebases would not function, but such is not the case. A small scan is obtained which opens up to fill the screen on closing S_2. This is an advantage, as the timebase valves can get a good warming up before full h.t. is applied.

T_1 was obtained from Messrs. Galpins and is rated at 150-0-150V, 200 mA; 6.3V, 8A; 5V, 2A. It is a substantial job with a generous core. Used with half-wave rectification, practically 300V is obtainable at 100 mA. The resistor R_1 is used as a surge limiter and smoothing is effected by two small chokes, again an economy measure, Ch_2 being removed from an ex-government unit. C_1, C_2, C_3, are also an ex-government block, purchased for three shillings! C_6 is a small tubular type.

Regarding T_2—as the timebases only require some 20-30 mA, this is a midget component and can be obtained quite cheaply. The original also has an l.t. winding but this is not used. The condensers C_5 and C_6 should be of the cardboard cased variety, but if a metal can type is used this must be well insulated from the chassis as the "negatives" are in connection with the 300V line!

The value of R_2 is dependent upon the requirements of the subsequent circuit.

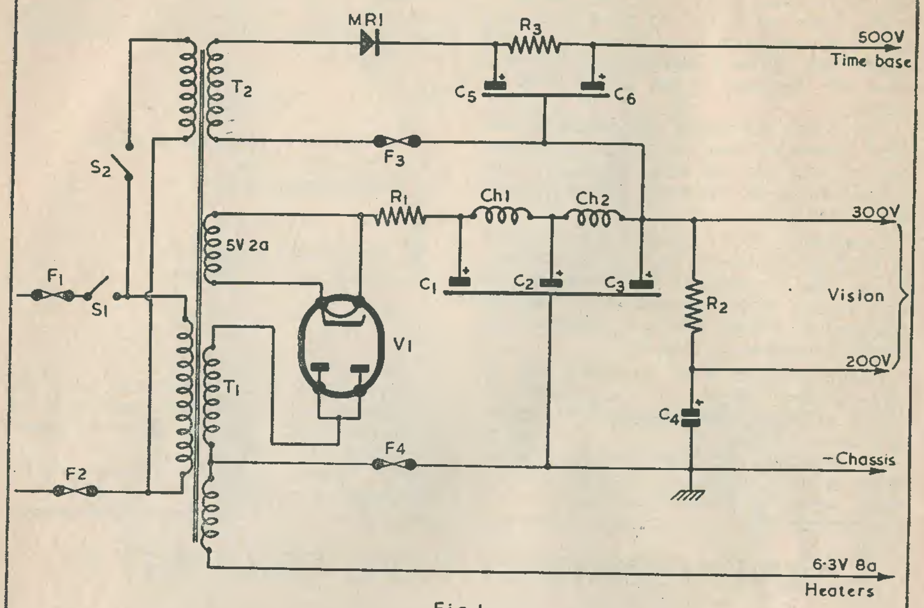


Fig.1

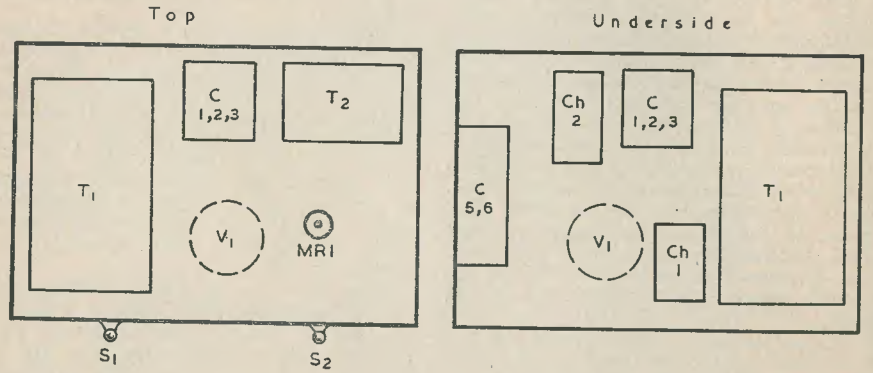


Fig.2

E269

This can be found from the equation:—

$$R = \frac{\text{voltage required to be dropped} \times 1{,}000}{\text{current in milliamps.}}$$

As the vision strip in the original requires 80 mA,

$$R = \frac{100 \times 1{,}000}{80} = 1{,}250 \text{ ohms, 8-10 watts.}$$

The whole pack can be built on a chassis 9″×6″×2½″, and a suitable layout is given in Fig. 2.

Components

T_1	(see text).
V_1	5Z4G or 5V4G.
C_1, C_2, C_3	16+16+16μF 500V
C_4	8μF, 500V
C_5, C_6	8+8μF, 350V.
Ch_1	5 Henry, 200 mA.
Ch_2	(see text)
Metal rectifier 230V, 30 mA.	
T_2	200V, 30 mA sec.
R_1	68 ohm, 3 watt.
R_2	(see text).
R_3	1,000 ohm, 1 watt.
S_1, S_2	'On-Off' toggle switches.
F_1, F_2	2A fuses.
F_3, F_4	2.5V bulbs.
Chassis	(see text).

RADIO CONTROL
FOR MODEL SHIPS, BOATS AND AIRCRAFT
by F. C. JUDD, G2BCX

To operate a model ship or aircraft is a most interesting hobby. But how much more fascinating it would be if one could emulate the skipper or pilot and remain in control after the model has been set off on its course. This, thanks to radio control, can now be done, and enthusiasm for it is steadily mounting. **Radio Control for Model Ships, Boats and Aircraft** has become a recognised handbook in this field.

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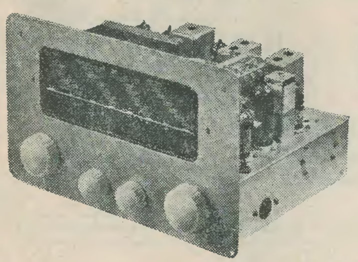

BUILD THE
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A.M.-F.M. TUNER-RECEIVER

Following the success of our F.M. Tuner Kit, we now introduce this super-sensitive M.W.–F.M. Tuner–Receiver. The switching and wiring are simple, but performance has not been sacrificed. There is space on the chassis for power pack and output stage. The building instructions are appearing in the March and April issues of this magazine, and will be available as a reprint.

Dial assembly, with chassis, flywheel tuning, Jackson Bros. 4-gang condenser, 500pF+500pF, and 15pF+15pF, glass scale calibrated in station names on both bands, and hammer finish front panel, **price £3 . 18 . 0**

All coils, including ratio detector, M.W. coils and 2 twin-i.f.t's (472 kc/s and 10.7 Mc/s), **price £2 . 17 . 9**
Approximate total cost to build, as a receiver and with power supply, **£16 . 0 . 0**

Send S.A.E. for complete component price list

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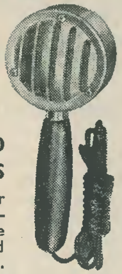

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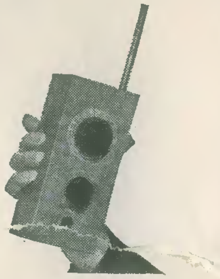

Send 2/– for layout, wiring diagram and components price list.

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32/6

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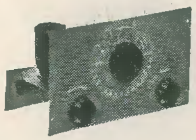

Ideal for the beginner or for those requiring a simple standby receiver. This 1 valve S.W. receiver can be built for **30**/– from our list of components, which can be purchased separately. It includes valve and 1 coil covering 20-40 metres. Provision is made to increase to 2 or 3 valves if required, and all components are colour-coded so that the beginner can build this set quite easily. *Send 2/– for specification, wiring diagram, layout and price list.*

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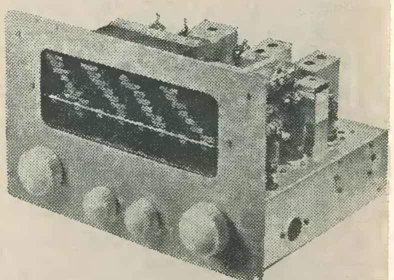
Valve Set complete, comprising three EF80, ECH81, 6BA6, EABC80, 6AQ5, EZ80 and DM70 at special inclusive price of **82/6**, or set of valves less 6AQ5 price **75/–**

N.B.—This chassis is for FM and medium waves only



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