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FOR THE RADIO AND TELEVISION ENTHUSIAST

VOLUME 9 NUMBER 8 MARCH 1956

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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 oscil late 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, C2, is connected between the anode of the oscillator, V1, 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 V1 by means of the wire-wound potentiometer, R4. This potentio-

No. 64. A MINIATURE GRID-DIP METER

A M N Y 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 coil, 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.

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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 $C_3$. 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 $R_5$. 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, $R_8$. 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 range 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 squeezing 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 $C_4$ and $C_6$, should all be mounted close to $V_1$.

The length of the leads from the junction of $R_3$ and $C_2$ to $R_4$, and from the junction of $R_1$ and $C_2$ 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 join 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 Last Month's Issue We Discussed At Some Length the Basic Features of Multi-tester 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 multimeter to read widely differing 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.
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 test meter 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 switch 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 test meter 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 5%.

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 avoided in any conventional test meter 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 S1, 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 S1 were to introduce resistance, this would merely result in a larger voltage being dropped between the test meter terminals themselves. The basic meter would not be affected. Similarly, if S1 were to become open-circuited, all that would occur would be the cessation of current through the test meter. The basic meter, once more, would remain unaffected.

The basic meter is connected to the selected shunt by means of S2. Should any of the contacts of S2 become open circuit, all that would happen is that the meter would fail to read. If any contact of S2 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 S2 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 test meters, and suffers only from the disadvantage that it requires a two-pole switch. However, for currents up to 1 amp a conventional wire-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 test meter 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 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. 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 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

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

![Fig. 3](www.americanradiohistory.com)
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 former, around which the wire may be wound, with convenient wire-ends for anchor-

![Diagram](image)

**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

ing. 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.

**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**

Ohmmeter Ranges

All that remains in the home-constructed multi-tester 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 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.

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, 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 test-er 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 S1. The series resistor R3 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 R2 to R5 are selected via S1. S2 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 R10, R11, and S2, 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, S3 connects R11 directly to the negative terminal of the meter, thus allowing it to read f.s.d. S1 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, S1 and S2 perform the same functions as did S1 and S2 of Fig. 3. On position 12, S1 connects the meter across R8, 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 R10 and R11, 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 value 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

\[ R_s = \frac{I_m}{I} \times R_m \]

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 \( I \) is the current required to flow through the shunt. The shunt resistance, \( R_s \), is therefore:

\[ 1 \times 100 = 11.1 \text{ ohms} \]

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

THE RADIO CONSTRUCTOR

MARCH 1956
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 input incorporates quite a number of modern features to ensure maximum gain and stability, as well as providing adequate safeguards against Band I breakthrough.

Starting at the input circuit, it will be noted that the Band III aerial socket connects to a tap in the input coil L1. 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 V1. The "hot" end of L1 connects to the grid of V1 via L2, C1, 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.

V1 is employed as a cascode, the two separate triodes forming this stage being V1(a) and V1(b). The cathode of V1(a) is connected to chassis via R3 and R1. R2 is a 150 ohm fixed resistor whose purpose is to ensure that V1(a) always has sufficient cathode bias, whilst R1 is a variable component. R1 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 television to which the Converter is connected.

The anode of V1(a) is connected to the cathode of V1(b) via L3. L3 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, L3 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 V1(b) is normal, the resistor R3 serving as a grid-leak.

The Oscillator

The oscillator, V3, 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 Cag in the diagram, is connected across the whole of the coil. The remaining two capacities, Cae and Ccg (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 capacitor in the coil provided by \( C_{\text{fc}} \) and \( C_{\text{g}} \) 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.

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 \( C_{\text{fc}} \) or \( C_{\text{g}} \) 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 oscillator voltage appears across \( L_1 \). 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 \( L_3 \). This transformer is tuned to the Band I frequency employed by the television with which the Converter is to be employed, and 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 10\( \mu \)f resistor across the fixed contacts of \( S_3 \). Such a resistor is not shown in the circuit or in the wiring diagram, however.

**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 consequent increased safety factor. Rectification is provided by the full-wave metal rectifiers, their output being smoothed by \( C_{15} \) and \( C_{16} \), 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.

**THE RADIO CONSTRUCTOR**
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 Osmon 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 ½ in 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.

After 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

Component List

Resistors

(All ½ watt unless otherwise stated.)

| R1 | 10kΩ potentiometer |
| R2 | 150Ω |
| R3 | 100kΩ |
| R4 | 1kΩ |
| R5 | 470kΩ |
| R6 | 3.3kΩ |
| R7 | 220kΩ |
| R8 | 3.3kΩ |
| R9 | 100kΩ |
| R10 | 150kΩ 1 watt |

Condensers

| C1 | Parallel condenser (fitted in coil can) |
| C2 | 39pF, ceramic |
| C3 | 1.000pF, disc ceramic |
| C4 | 25pF, ceramic |
| C5 | 1.000pF, disc ceramic |
| C6 | 1.000pF, disc ceramic |
| C7 | 5pF, ceramic |
| C8 | 1.000pF, disc ceramic |
| C9 | 16 + 8pF, 350V, electrolytic (can diameter 1 inch) |

Valves, etc.

| V1 | B309 (Osram) |
| V2 | Z77 (Osram) |
| V3 | 6C4 (Brimar) |

Rectifiers DRM2 (Brimar)

Pilot lamp 6.3V M.E.S.

Inductors

(All Osmon, including mains transformer and smoothing choke)

| L1 | QTV3 |
| L2 | QTV4 |
| L3 | QTV5 |
| L4 | QTV6 |
| L5 | QTV7 |
| L6 | QTV8 |

Heater chokes (3 req.) QFMH

Cathode choke (1 req.) QFMH

Mains transformer. As shown in Fig. 1. Smoothing choke. As shown in Fig. 1.

Miscellaneous

| 1 set punching templates (Osmon) |
| 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-way tag-strap (see text) |
| 3-way tag-strap (see text) |
| 1 2-way tag-strap (see text) |
| 4 tin 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 L5, 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(sender 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. shortcircuits 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 for those who do not.

The first component to be lined up is the i.f. transformer, L5. To commence alignment, the Converter should be connected up to the television 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 R2) throughout the alignment procedure. If a signal generator is available its output should be connected between the control grid of V2 and chassis, and its frequency adjusted to the Band I vision carrier frequency of the television. The Converter should be switched to Band III. The signal generator output should then appear on the screen of the television 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 television. This is because L5 should be adjusted for maximum transfer of vision information. L5 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 L2 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. L5 should next be tuned for maximum signal strength (on vision, if possible). L5 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 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
again finalisation will still be necessary with
the signal itself.

Alignment for Band III consists of adjusting
L1, L3, L4 and L6. Of these four coils, L1 will
have the most flat characteristic. L3 should
be set initially such that its core is nearly flush
with the top of the can. The cores of L4 and
L7 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 L6 is then slowly
and carefully adjusted until the
Band III signal is seen, or heard. As soon as
this occurs L4 and L6 should be adjusted for
maximum signal strength, reducing receiver
gain (but not converter gain) as required.
L6 should then be readjusted through its
range to ensure that the optimum setting has
been found.

The core of L3 is next adjusted (towards
the centre of the coil) for maximum Band III
signal strength. It is possible that too high an
inductance in L1 may cause slight instability,
in which event the core should be unscrewed
again by several turns. Adjusting L1 may
possibly necessitate slight retiming of L1
and L4. L3 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 television 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 microwaves 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 equip-
ment 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 & Lea Ltd.
E. K. Cobb Ltd.
A. C. Cosson 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.

“FM TUNER UNITS
for FRINGE & LOCAL AREA RECEPTION”

This booklet, now in its Second Edition, includes a description of
a Suitable Tuning Indicator and of The Osram 912 High Fidelity
Amplifier. 32 pages with art board cover, price 2s. 2d., post paid.

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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, of course, essential if proper
control is to be obtained. This wheel must
be capable of generating the necessary com-
mand 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
gear driven 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
opens one or other microswitch, routing
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 gre the
analogy between control gear preceding the trans-
mitter and intergear following the receiver.
In this case the steering wheel is connected to
the centre shaft of a differential gear D, and
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 single-segment drums
(which are difficult to make) a single segment
contactor can be used, geared up from each
bevel wheel assembly.

Once these 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
delay circuits.

Other Systems
Pulses conveyed on multi-channel gear can,
of course, be used in other ways, but since the

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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 VHF/125 receiver and requires data on voltages, circuit, etc.

E.麦克肯齐, 2 Hill Crest Road, Birmingham 13, would like to buy or borrow complete circuit of the RI15A receiver.

D. F. HAYWARD, 3 St. Michael’s Avenue, Yeovil, Som., would appreciate any information on 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 Treslggan Road, St. Budeaux, Plymouth, requires data or circuit of the Phico Battery Receiver, 1.4 to 4 Mc/s, valve line-up believed to be ARTP2, ARPI2, AR8 and CV65.

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

G. Dalgarne, 420 Duchill Road, Buckburn, 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. Transceiver 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, Western Terrace, Norhampton, urgently requires base connections, characteristics, etc., of the German Telefunken RL12-P53 valves.

G. Talworth, 137 Dudley Road, Grantham, Lincs, wants information on the RDF1, PVC-3312 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, built. (The original articles are available, together with the Oram 912 Amplifier circuit and other useful data, under the title F.M. Tuner Units for Fringe and Local Area Reception, price 25s.—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.

Although 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 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 the components not then required are marked in the Components List with an asterisk. The anode and grid of the triode grid 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 2719 valves are not used on M.W., and the switching reduces the circuit to a conventional superhet receiver. V3 (X79) is the medium wave frequency changer, V4 (W727) is the M.W. i.f. amplifier, and V6 (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 7Z19’s. V1 is the f.m. r.f. amplifier, V2 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. L5 to V3, which was the M.W. frequency changer but now acts as the first f.m. i.f. amplifier. The i.f. transformer, L4, in the anode of V3 and grid of V4 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.

V4 (W727) acts as the second f.m. i.f. amplifier. The primary of the i.f. transformer, L4, in the anode of V4 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 V5 (Z719) which in turn feeds the ratio detector coil, L6. 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. diodes.

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 reach stations such as Luxembourg, 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 V3 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.
Components List

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C09</td>
<td>25uF 25V</td>
</tr>
<tr>
<td>C10</td>
<td>0.01µF 500VW</td>
</tr>
<tr>
<td>C12</td>
<td>0.01µF 350VW</td>
</tr>
<tr>
<td>C13*</td>
<td>0.01µF 320VW</td>
</tr>
<tr>
<td>C14*</td>
<td>0.01µF 350VW</td>
</tr>
<tr>
<td>C15</td>
<td>0.05µF 350VW</td>
</tr>
<tr>
<td>C16</td>
<td>5,000pF ceramic</td>
</tr>
<tr>
<td>C17</td>
<td>5,000pF ceramic</td>
</tr>
<tr>
<td>C18</td>
<td>5,000pF ceramic</td>
</tr>
<tr>
<td>C19</td>
<td>5,000pF ceramic</td>
</tr>
<tr>
<td>C20</td>
<td>200pF ceramic</td>
</tr>
<tr>
<td>C21</td>
<td>200pF ceramic</td>
</tr>
<tr>
<td>C22</td>
<td>47pF silvered mica</td>
</tr>
<tr>
<td>C23</td>
<td>5,000pF ceramic</td>
</tr>
<tr>
<td>C24</td>
<td>200pF ceramic</td>
</tr>
<tr>
<td>C25</td>
<td>500pF ceramic</td>
</tr>
<tr>
<td>C26</td>
<td>200pF ceramic</td>
</tr>
<tr>
<td>C27</td>
<td>8uF 150VW</td>
</tr>
<tr>
<td>C28</td>
<td>32µF + 32uF 350VW</td>
</tr>
</tbody>
</table>

Capacitors

- C1: 1,000pF ceramic
- C2: 1,000pF ceramic
- C3: 1,000pF ceramic
- C4: 1,000pF ceramic
- C5: 33pF silvered mica
- C6: 33pF silvered mica
- C7: 5,000pF ceramic
- C8: 47pF silvered mica
- C9: 5,000pF ceramic
- C10: 0.02µF paper 350VW
- C11: 47pF silvered mica
- C12: 0.02µF paper 350VW
- C13: 500pF 2%, silvered mica
- C14: 5,000pF ceramic
- C15: 5,000pF ceramic
- C16: 0.02µF paper 350VW
- C17: 5,000pF ceramic
- C18: 5,000pF ceramic
- C19: 5,000pF ceramic
- C20: 200pF ceramic
- C21: 200pF ceramic
- C22: 47pF silvered mica
- C23: 5,000pF ceramic
- C24: 200pF ceramic
- C25: 500pF ceramic
- C26: 200pF ceramic
- C27: 8uF 150VW
- C28: 32µF + 32uF 350VW

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.
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.

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 V2. If this lead joins to the chassis at the same point as the heater bypass condensers, instability nearly always results due to feedback back 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 feeding 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 valve holders and connect all chassis wiring. Next, the heater wiring should be added; note the method of connecting to give a long lead between V1 and V5. 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 R4 to 23kΩ and add the cathode components R29 and C70.

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 R5 and R6. 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 R12. 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." Detailed 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 C28 to the choke. If the choke is not used, the smoothing resistor employed instead may be wired directly across the condenser terminals; if C28 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., B.Sc., L.R.I.B.A., F.I.E.E., F.R.S., etc., etc.

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.
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 $\frac{1}{2}$ to $\frac{3}{8}$ 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 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 bored into 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 gained 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 3/8 of each screw should project above its nut. If long screws are used, these can be cut after mounting. Shakerwood 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 3/16 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 very 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)


A. S. Eastaugh, G3AJV, The Modern School, Ripon, Yorks, is anxious to obtain information on the DST.100 communications receivers, particularly with regard to re-alignment, 5-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 oscillograph of Indicator unit SLC No. 5, ZC348.

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, Grangtown, Sunderland, Co. Durham, wishes to buy or borrow any of 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.
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 wobulators will be able to check this quite quickly by displaying the response curve of the i.f.

amplifier on an oscilloscope. A wobulator 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.

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 shorting 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.

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 electrostatically 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
BOOK REVIEWS


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

The greatest 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 equalizing networks for the different types of gramophone pickup 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 is recommended for those who require sound designs together with expert guidance on constructing simple apparatus.

RADIO RECEIVER CIRCUITS HANDBOOK. By E. M. Squire. 150 pages, 125 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 have 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. For this method has proved to be the best way to deal with the subject. This handbook (which contains a lot of sound factual information), real down-to-earth stuff with no frills.


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 as a surprise to read that a primitive form of wire recording was used in 1787.

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 service, and some special applications of the art. A useful bibliography indicates sources from which material has been drawn, and references for further study. Anybody dealing with copyright law and performing rights, recording and reproducing characteristics, and standards for commercial machines will find this book a useful addition to their library.

This book has obviously been prepared with some care and considerable research; it is well produced, and makes interesting and informative reading.

W. E. THOMPSON

THE RADIO CONSTRUCTOR

MARCH 1956

506

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.

Thus 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:

\[ I = \frac{V}{R} \]

where \( I \) is the current, \( V \) the voltage and \( R \) the resistance.

Example: If the current is 0.5 amp, the voltage is 20 volts, what is the resistance?

\[ R = \frac{V}{I} = \frac{20}{0.5} = 40 \, \text{ohms} \]

If the current is 0.2 amp, what must the voltage be to get the same resistance?

\[ V = IR = 0.2 \times 40 = 8 \, \text{volts} \]

If the current is 0.1 amp, what must the voltage be to get the same resistance?

\[ V = IR = 0.1 \times 40 = 4 \, \text{volts} \]

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

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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:

\[ P = V \times I, \]

where \( V \) and \( I \) are voltage and current respectively.

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:

\[ P = \frac{V^2}{R} \]  

\[ P = \frac{V^2}{R} \]  

(5)

(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.

\[ V = \frac{E}{\frac{R_1}{R_1} + \frac{R_2}{R_2} + \frac{R_3}{R_3}} \]

\[ \frac{R_1}{R_1} + \frac{R_2}{R_2} + \frac{R_3}{R_3} \]

\[ \frac{R_2}{R_2} + \frac{R_3}{R_3} \]

\[ \frac{R_3}{R_3} \]

\[ \text{etc.} \]

\[ \text{where } R_T \text{ is the total resistance.} \]

If 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:

\[ \frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \]

\[ \text{etc.} \]

\[ \text{where } \frac{1}{R_T} \text{ is the total resistance.} \]

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

\[ R_T = \frac{R_1 \cdot R_2}{R_1 + R_2} \]

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 \( \Omega \) were connected across it, 4 amps would flow. We would expect, therefore, that 400 watts would flow if a resistance of 1 ohm were connected.

\( \Omega \)

\( \text{Unless the battery were very large, we would be disappointed. We would probably find only 40 watts were flowing. What has happened, then? Has Ohm’s law gone wrong?} \)

\( \text{No. We have assumed a perfect battery. In practice, a battery (or any other source) will have some internal resistance.} \)

\( \text{In a simple circuit as Fig. 4 shows, the current looks when the resistance is included. The battery terminals and the power of the (dotted) box, giving some hint of the resistance. Mind you, the resistance has not been deliberately included by the manufacturer. It actually exists right within the battery cell; it is an unavoidable feature of any battery or generator.} \)

\[ \text{Now if nothing is connected to the terminals 1 and 2, a genuine 4 volts exists there. If a resistor is connected, however, some current flows. This means that there will be a voltage drop across } R_1, \text{ and the voltage between terminals 1 and 2 will be } \frac{4V. \text{ less this drop.}} \]

\[ \text{For example, let us suppose } R_1 = \text{0.1 treatment of the last few paragraphs has.} \]

\[ \text{The wiring may also be calculated from:} \]

\[ \text{2I = 1.9 amps. The voltage drop across } \]

\[ \text{If we decrease the value of } R_1 \text{ to 1, the voltage across terminals 1 and 2 will drop to 3.6V.} \]

**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 referred to 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 d.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 "forms" and so exactly the same shape as this.

**Resistors** behavior 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.

\[ \text{If we now apply an alternating voltage to a capacitor, each time the capacitor gets charged in one direction, the voltage begins to move off in the other direction, as in Fig. 5. Current will be changing backwards and forwards into and out of the capacitor plates the whole time. It appears, then, that current is flowing the whole time, even if it is undecided about its direction.} \]

The "capacity" of the capacitor is a measure of its ability to store a charge, which in turn is related to its "reactance" to an applied alternating current. This "reactance" is called "reactance," and the reactance of a capacitor is calculated from:

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

\[ \text{where } \pi = 3.142 \]

\[ f = \text{frequency of applied voltage} \]

\[ \text{in cycles/sec.} \]

\[ C = \text{capacity in Farads.} \]

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**THE RADIO CONSTRUCTOR**

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**E289**

If now 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 \( R_1 \), and the voltage between terminals 1 and 2 will be 4V. less this drop.

For example, let us suppose \( R_1 = 0.1 \text{ treatment of the last few paragraphs has.} \)

The wiring may also be calculated from:

\[ 2I = 1.9 \text{ amps. The voltage drop across } \]

\[ \text{If we decrease the value of } R_1 \text{ to 1, the voltage across terminals 1 and 2 will drop to 3.6V.} \]

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**E289**

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 changing 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 "reactance" to an applied alternating current. This "reactance" is called "reactance," and the reactance of a capacitor is calculated from:

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

\[ \text{where } \pi = 3.142 \]

\[ f = \text{frequency of applied voltage} \]

\[ \text{in cycles/sec.} \]

\[ C = \text{capacity in Farads.} \]
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

\[ X = \frac{1}{2\pi \times 50 \times 1} = \frac{1}{314} \]

\[ = 3,100 \text{\ ohms} \]

From Ohm's law the current is:

\[ I = \frac{V}{X} = \frac{100}{3100} = 0.03 \text{\ amps approx.} \]

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.

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,

- Wavelength \( \lambda = \frac{\text{Velocity} V}{\text{Frequency} f} \)
- Frequency \( f = \frac{\text{Velocity} V}{\text{Wavelength} \lambda} \)

As the velocity is always the same,

\[ \lambda = \frac{300}{f} \]

where \( f \) is in megacycles

and

\[ f = \frac{300}{\lambda} \]

where \( \lambda \) is in metres

(continued on page 513)

**Radio Miscellany**

Scan the pages of certain sections of the popular Press to see what is fresh by way of bizzar 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.

**CENTRE TAP**

**talks about**

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

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. tit-bits 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, mitring, routing, grooving, undercutting, etc. The weight is 24 lbs. and the vertical and horizontal adjustments are 13½ in and 12½ in 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 O.S.I.d 100% sure, but in recent months I have fallen badly into arrears, although I

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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.

As Mr. Hogben points out, there is nothing quite like 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 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 have to spend money 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出来了 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 conversations 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 hi-fi cabinet one is often surprised at how a certain artificiality—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 joints. A Salford reader, A.F. (unaccountably absent) hints 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 joining. 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 batter 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 3in 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 glazing 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 extra half-quarter mirror on a chair stood in front of it, and trying to peer 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 be one-piece and the cabinet light and bright. The handles and brightness 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 faced the tack for 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 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.”

**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:

\[ f = \frac{c}{\lambda} = \frac{300 \times 10^6}{1500} = 0.2 \text{ Mc/s or } 200 \text{ kc/s.} \]

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.ICE., GSTL

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 hereafter 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 L1 and L2 are small pule-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 7 turns of 38 gauge enamel wire for the 160 metre band and 9 turns 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 Hicko sub-miniature 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.

![Circuit Diagram](https://www.americanradiohistory.com/)

**List of Components for Miniature Phone and Signal Monitor**

1. 100µF variable Eddycon condenser.
2. 0.001µF TCC 150V wkg condenser.
3. 0.005µF TCC 150V wkg condenser.
8. Egin miniature 1MΩ pot.
10. Small chokes, or Aladdin formers for coils.
11. Germanium crystal.
12. Hicko sub-miniature valve type XFY 41.
13. Ever-Ready dry batteries, D14 (Hearing Aid). 1.5 volts.

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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 division networks for biasing circuits and bleed networks. It was pointed out that the chart 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 R1. In addition to this load, a further current will flow jointly through R1 and R2, and as a rule its value is not critical.

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

If we were to choose a value for Rs now, the parallel combination of Rs and the value we have just calculated for Rs would together be of value less than Rs alone; i.e. in this example less than 100kΩ. This value, which as yet we have not fixed, will be equivalent to R2 of last month's chart.

Before we can determine this parallel value we must calculate the fractional ratio R1/R2, which, if the ratio of the voltage drops, as explained last month. This will be 100/200 or 0.5 here.

Now comes the major step: R1 we have not fixed yet, and all we know about R2 is that it must be less than 100kΩ. So we can scan the vertical 'R1/R2' scale at 0.5 and select a starting value on the horizontal scale for R1 which intersects the 0.5 line at less than 100 on the diagonal R2 scale. Note that this R1 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 R2 we take, therefore, will be an interpolated one; that is, we literally read between the lines.

Performing this step for our example, 30kΩ for R1 would give an approximately 78kΩ for R2 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 R3 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 R1 scale, drawn through 78 on the Rp scale, will cut the 100 R1 value at the required value of R3, which is read on the scale marked R2. 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 using 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 vertical lines running upwards from left to right are the reactance values, covering 1000H to 0.2µH, while the other diagonal lines present the capacitive information in the range 1000µF to 2pF.

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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 300 µH and a capacitance of 100pF resonate when connected in parallel as a tuned circuit?

At resonance the reactance 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:

\[ X_C = \frac{1}{2\pi f C} \]

\[ X_L = 2\pi f L \]

\[ f = \frac{1}{2\pi \sqrt{L/C}} \]

where \( X_C \) is capacitive reactance in ohms, \( f \) is frequency in c/s, \( X_L \) is inductive reactance, \( L \) is inductance in Henrys, \( C \) is capacity in Farads.

Next month's article: Frequency to Wavelength conversion.

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**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 SPG1's. These require an I.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 i.t. outputs can be quite an expensive business. By example, a T.V. receiver and timebase was constructed some time ago and the power requirements were: 300V, 8.5A, 2.0V plus 6.3V at 8A. Some sixteen valves were used, ten of which were SPG1'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 T2 and associated components were omitted, the 300V line being used for the timebases. This, of course, gave only a very small scan on the VCR07 tube. When results warranted it T2 etc. was included and it was decided to arrange for the 300V supply to be separately switched; S2 was therefore included. It may be thought that with S1 closed and S2 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 S2. This is an advantage, as the timebase valves can get a good warming up before full h.t. is applied.

T1 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 100mA. The resistor R1 is used as a surge limiter and smoothing is effected by two small chokes, again an economy measure, C3 being removed from an ex-government unit. C1, C2, C3 are also ex-government blocks purchased for three shillings! C6 is a small tubular type.

Regarding T2—as the timebases only require some 20-30mA, this is a midset component and can be obtained quite cheaply. The original also has an I.T. winding but this is not used. The condensers C5 and C6 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 R2 is dependent upon the requirements of the subsequent circuit.
This can be found from the equation:

\[ R = \frac{\text{voltage required to be dropped} \times 1,000}{\text{current in millamps}} \]

As the vision strip in the original requires 80 mA,

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

The whole pack can be built on a chassis 9"x6"x2\(\frac{1}{2}\)" and a suitable layout is given in Fig. 2.

**Components**

- **T1** (see text).
- **V1** 5Z6G or 5V4G.
- **C1, C2, C3** 16+16+16uF 500V
- **C4** 8uF, 500V
- **C5, C6** 8+8uF, 350V.
- **Ch1** 5 Henry, 200 mA.
- **Ch2** (see text)
- **Metal rectifier 230V, 30 mA.**
- **T2** 200V, 30 mA sec.
- **R1** 68 ohm, 3 watt.
- **R2** (see text).
- **R3** 1,000 ohm, 1 watt.
- **S1, S2** 'On-Off' toggle switches.
- **F1, F2** 2A fuses.
- **F3, F4** 2.5V bulbs.
- **Chassis** (see text).