Direct Current Eliminators

Unusual Problems Arise

THE outcry for all-electric receivers has reached those whose lighting power comes from direct current mains. Here a new problem is encountered. The "mains" set of to-day is made to operate from alternating current, whereas, in several districts in New Zealand, this type of power is not available. The current here is direct. Listeners in these localities, no doubt, wish to avail themselves of the new all-electric convenience, but are unable to use the usual set. The question then arises, "What can be done?"

On the surface, DC operation should be more simple than AC, for the AC current has to be rectified or turned into direct before it can be used in the set, thus it is brought back to where the DC mains start. "B" battery elimination with DC mains does not present a problem of any magnitude; with the elimination of the "A" battery, or supplying the filaments, a new problem arises.

Before delving into the particulars of eliminators, let us consider for a few moments the essential differences between alternating and direct current. Direct current implies a steady stream of electrons always in the same direction, and always at the same potential or voltage (except, of course, for incidental fluctuations). The origin of DC may be a dynamo with a commutator to bring the potential differences into one direction. Direct current is the foundation of all electric science, and it was not until Faraday's researches a hundred years ago revealed alternating current that electrical science made any great progress. Faraday discovered that when a conductor made one complete revolution in a magnetic field two half-cycles were induced. This induced charge rose to a certain potential, dropped to zero, reversed and then came back to normal. In other words, a complete cycle had been performed. This was alternating current. By so arranging the apparatus, the number of cycles per second could be varied. It has been found that 60 cycles per second is a good standard for alternating current for general use.

The use of AC current involves the use of transformers which may step the voltage up or down. When direct current is employed, transformers are impossible, for as first demonstrated by Faraday and later by Lenz and his predecessors, magnetic induction can take place only when the inducing current varies in its intensity. Only while a change is taking place in the magnetic field is work being done and current induced. With direct current another means of breaking down the voltage has to be found, and this only through resistances.

One familiarly hears of a resistance being spoken of as so many watts dissipation. This means that the resistance can break down voltage and is capable of passing a definite amount of current measured in amps. The product of these gives the number of watts dissipation. The difference between the final voltage or amperage and the voltage supplies by the line has to be passed off as heat, or is used in overcoming the resistance. In other words, it is wasted.

This is the first problem of DC operation. Take for example, a main supplying 230 volts DC. We wish to obtain 6 volts DC. A transformer is impossible; what then is the procedure? A resistance must be used. This resistance will have to break down the voltage from 230 to 6, and at the same time it will have to pass sufficient current to supply the valves. Say the total amperage required by the valves is 2, then the number of watts dissipation will be 448. This is obtained by multiplying the voltage drop, 224, by the number of amps passed, 2. The number of watts used by the filament is 6 x 2 = 12. Therefore, the waste current is 448 — 12 = 436 watts per hour. If a unit of electricity, 1000 watts, costs 3d., the waste per hour is about 1½d., which is by no means a small consideration. The resistances may quite conveniently be lamps.

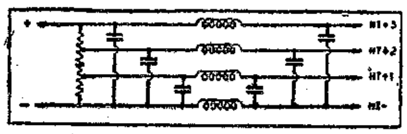
When, however, this is impracticable, there is a method whereby the AC mains may be availed of to charge the cells. We shall assume that we have 220-volt mains, and wish to charge a small 6-volt accumulator at the charging rate of 2 amps. It is well known that the resistance of of accumulator in good condition is practically negligible so that it may be disregarded. It is obvious that if the cell is connected directly to the mains there will be an enormous rush of current and this will damage it, as well as blow a fuse. A moment's working with Ohm's law shows that the value of the resistance to break down this voltage from 220 to 6 volts to supply 2 amps. should be 107 ohms. The equation is:—

$$I = E/R$$
$$\text{therefore } R = E/I = 214/2 = 107 \text{ ohms; say, } 100$$

It will then be necessary to secure a resistance of 100 ohms with a dissipation of 214 x 2 = 428 watts. This is an expensive item. It may be a lamp of this wattage; in any case the waste current will be 428 — (2 x 6) = 416 watts.

This is obviously not a paying proposition, unless, of course, it is impossible to get the batteries charged in an AC area.

Another problem with the "A" supply now arises. When a conductor becomes heated, its resistance rises, so that the potential applied to the filament will not be constant. For this reason "A" eliminators, if worked directly from DC mains, are not entirely satisfactory. There is the added difficulty of smoothing, which, although a problem of no great magnitude, might require quite a little expenditure, for smoothing chokes have to be capable of passing 2 amps., and must consequently be wound with 22-gauge wire. Although the inductance of the choke may be in the region of half a henry, such a choke will require a little skill in construction, and will not be particularly inexpensive. High capacity condensers of the electrolytic or mica type must be employed. Again, these are expensive. More smoothing is usually necessary than when a transformer is used to step down alternating currents.



A smoothing circuit for D.C. mains.

"B" Battery Elimination.

THE problem of "B" Battery elimination is not so acute. The full potential of 230 volts can be applied to certain power-valves without any breaking down. They will, however, require a little smoothing. Other than this, the resistances used for the audio taps may have the same value as in an AC eliminator. Large iron core chokes are recommended for each positive tapping lead. A potentiometer or lamp resistance of suitable value will give the voltage regulation desired, with a further choke in the negative lead and reservoir condensers between the extremities somewhat as indicated in diagram 1.

As to the inductance values these depend very largely upon the quality of the supply, but they should be rated at 50 henries for the maximum current demand. The condensers must be high-grade and tested to twice the working voltage. They vary in size from four to ten mfds. The frequency of the ripple, for DC current, is not entirely free from ripple, is not only governed by the factors situated at the individual source of the supply, but depends to a very great extent upon the type of power demands made in the locality. Thus a unit may be wholly free from hum at its output terminals when installed at one place, but produces a definite hum in another.

There is one important precaution which must not be lost sight of with all receivers connected across the mains for power supply and that is, the danger of a short. Invariably one side of the mains is earthed, and should this be the negative, little difference will arise, but if it is the positive, then the negative is 240 volts above or below earth potential. If H.T. be earthed direct at the receiver, a dead short will take place. This difficulty is overcome quite easily by including a 1 or 2 mfd.