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CERTAIN FEATURES OF RHEOSTAT DESIGN.

ABSTRACT.

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Everyone who has used rheostats of the sliding-contact type has experienced inconvenience in obtaining the desired values of current and voltage. If the rheostat is connected in series with the load, small currents cannot be obtained. If the load is shunted across a portion of the rheostat on the potentiometer principle, part of the winding carries a double load and consequently only a fraction of the full current capacity is available. To secure the advantages of both methods of connection there must be a complete rewiring of the circuit. This requires time and attention and especially in the case of students affords an opportunity for injury to the rheostat and other apparatus. These difficulties have been eliminated in a new design[1] in which the line and load terminals are completely differentiated and properly labeled and the change from series to shunt connection is made by closing a simple knife switch.

Figure 20 shows the manner in which this result is accomplished. If one traces the circuits, he finds that when the switch is open the load is in series with that portion of the winding to the left of the slider. When the switch is closed the load is shunted across that part of the winding to the right of the slider and at the same time the entire winding of the rheostat is connected across the line. With the switch open, values of current up to the full capacity of the rheostat may be secured; with it closed small values of current and voltage, down to zero, are obtainable.

The importance of these features is at once apparent but ease of connection and manipulation mean but little if not had in connection with a resistance element so designed that the voltage and current ranges overlap for any load, no matter what its resistance. The inadequacy of the ordinary rheostat in this respect is a matter of common experience. For example

[1]A complete description of the new rheostat and of the various applications of the principles involved may be found in U. S. Patent No. 1,195,-660, Aug. 22, 1916.

let us assume that there is available a 110-volt source and one wishes to pass a current of 2.5 amperes through a load of 15 ohms resistance. A 12-ampere, 5.2-ohm rheostat of the ordinary type certainly has sufficient current capacity,[2] but if it is connected in series with the load, the smallest current which can be secured is 5 amperes. As it is impossible to shunt the rheostat across the 110-volt source without extreme overload, the desired amount of current cannot be secured.

Let us take a rheostat of the same size, wound with a wire of smaller gauge, so that it may be connected across the line. One with 18 ohms resistance, rated at 6.5 amperes, will serve. The lowest current which can be secured with this instrument in series is 3.3 amperes, which is not low enough; the highest current which can be secured with the shunt or potentiometer connection is 1.5 amperes[3] which is far too small. Although this particular instrument is able to furnish both large currents and small currents the ranges do not come anywhere near overlapping and there is a large range of current which it cannot supply.

Using one of still smaller current capacity, let us say a 3-ampere, 83-ohm rheostat, we find that it can give a current on series connection as low as 1.1 amperes. With shunt connection currents from 0 to 2.3 amperes can be obtained without overloading the rheostat. With an instrument so wound the desired value of current can be obtained, but the two ranges now overlap by a considerable amount and it is evident that a winding of wire somewhat larger than that which will carry 3 amperes could be used.

If we try a rheostat wound so as to have a resistance of 30 ohms and a current capacity of 5 amperes, it is found that when the rheostat is in series with the load, currents from 5 amperes down to 2.5 amperes may be obtained, and when it is in shunt relation currents from 0 up to 2.5 amperes can be obtained. Thus with this winding the greatest current capacity which is possible with overlapping ranges is secured.

[2]The rheostats which are compared are of the sliding-contact tube type. The tubes are all of exactly the same size and can dissipate energy at the same rate.

[3]When the slider is at a point distant 4.5 ohms from the full-resistance end of the winding the remaining 13.5 ohms is carrying its full load of 6.5 amperes. The 4.5 ohms which is shunted with the load carries 5 amperes, while the load receives but 1.5 amperes.

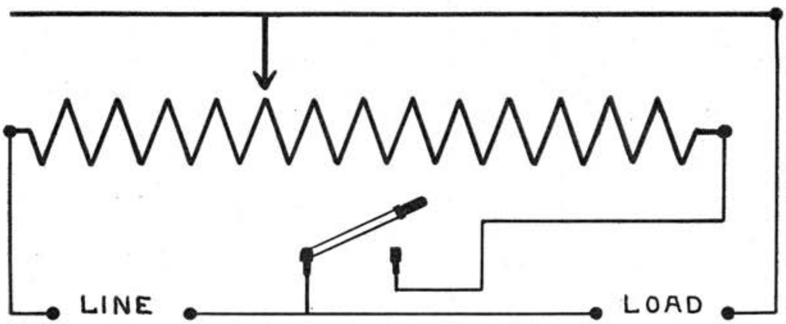

Fig. 20. Circuit diagram.

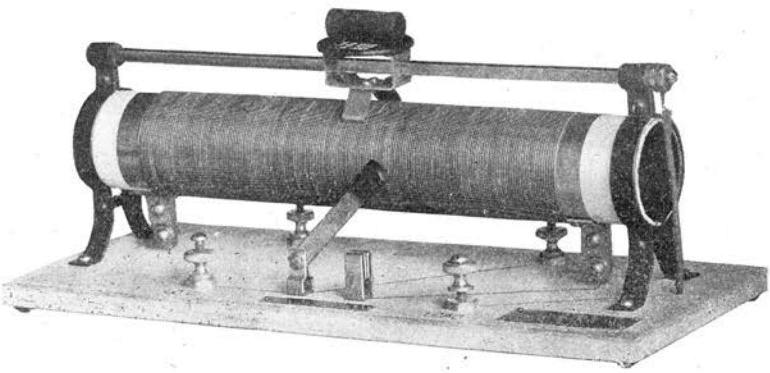

Fig. 21. "Jagabi" Dodge design rheostat.

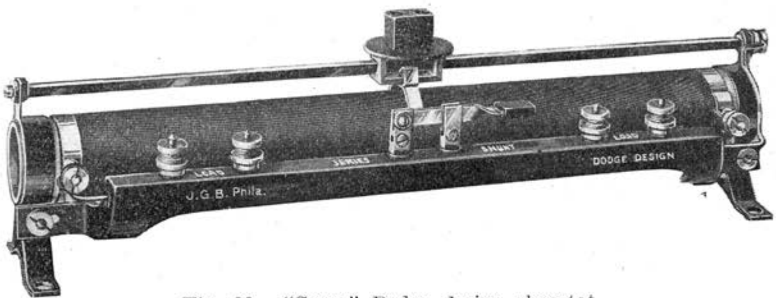

Fig. 22. "Cenco" Dodge design rheostat.

If similar computations are made for tubes of different sizes, loads of different resistances, and for various voltage and current ranges it is found that for a given voltage and size of tube (watt capacity) there is one and only one winding which will give the maximum current capacity and yet provide, in the case of any load, for overlapping of the series and shunt ranges.

With the ordinary rheostat, rated by current capacity and resistance, one has no means of knowing with what voltage it can be used. Nor can one know whether it is capable of giving overlapping ranges. That these important facts have been entirely overlooked in the design of laboratory rheostats is due largely to the fact that the prime importance of the voltage as a determining characteristic has been ignored. In fact the laboratory rheostat has been pretty generally looked upon as equivalent to a resistance box of large current capacity.

With the new design, voltage and current capacity are made the determining characteristics of a rheostat and the resistance is entirely incidental. If the windings are properly worked out the resulting current capacity is the greatest which can be secured with the given voltage and within these maximum limits all values of current and voltage down to zero may be secured, no matter what the load. Thus we find not only that this new type is easy to connect and to operate but also that it possesses the highest possible efficiency.

The method of mounting and the principles involved in the proper design of the windings may be applied to any form of resistance element but are particularly suitable to the sliding-contact tubular type. Figures 21 and 22 represent two different examples of the way in which manufacturers have applied the principles of the new design.

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