

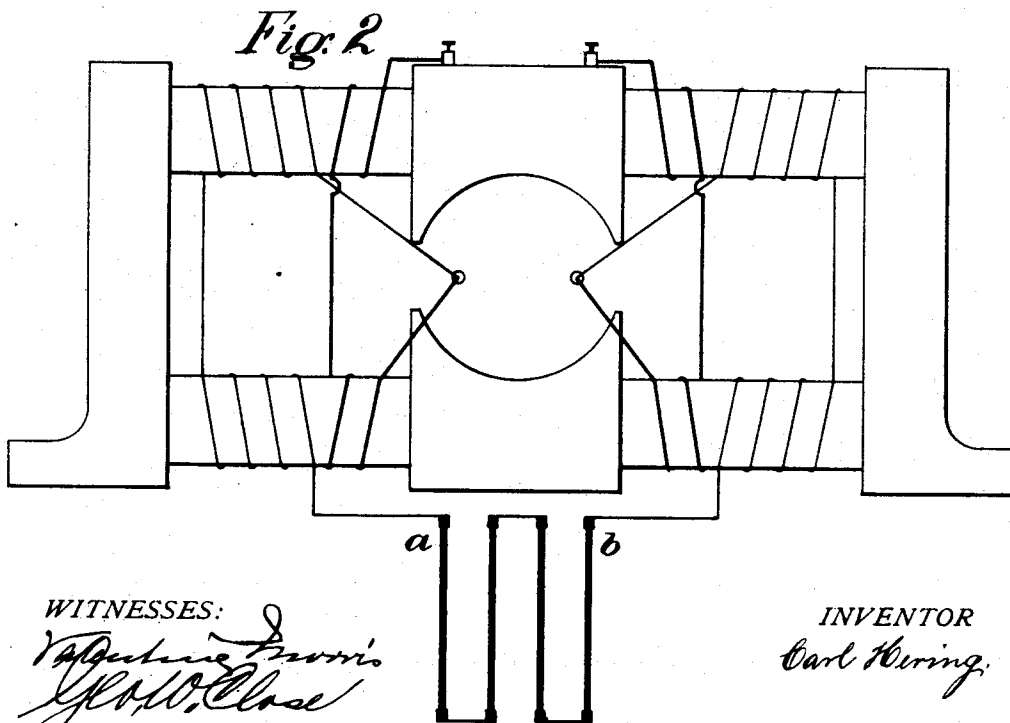
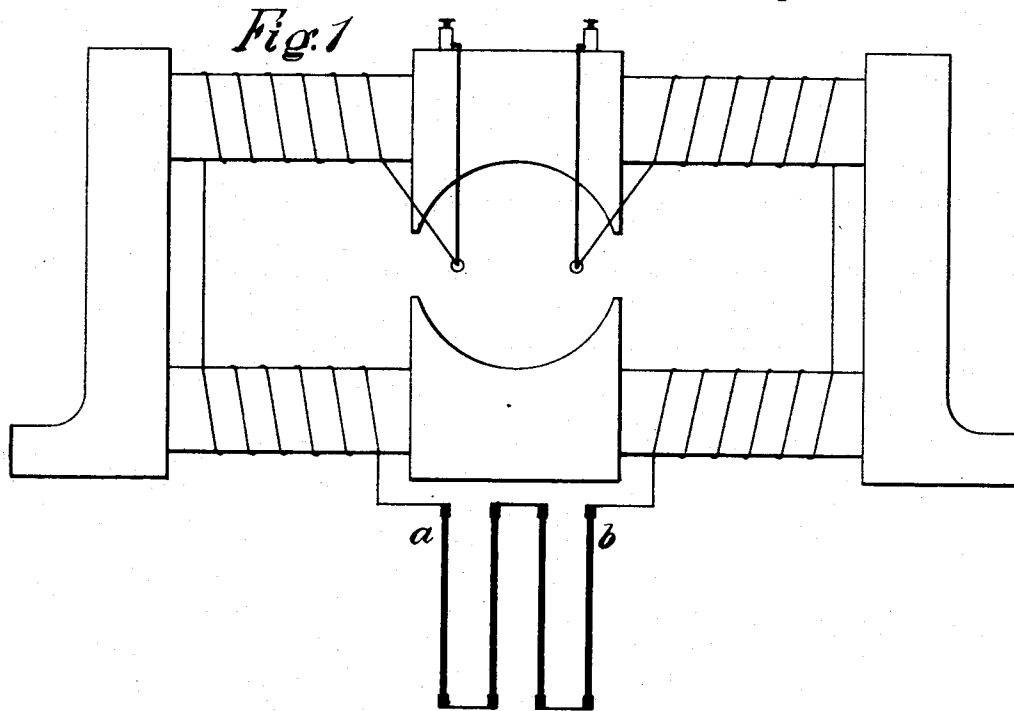
(No Model.)

C. HERING.

COMPENSATING RESISTANCE FOR DYNAMO ELECTRIC MACHINES.

No. 339,773.

Patented Apr. 13, 1886.



WITNESSES:

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COMPENSATING RESISTANCE FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 339,773, dated April 13, 1886.

Application filed January 9, 1886. Serial No. 188,067. (No model.)

To all whom it may concern:

Be it known that I, CARL HERING, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Compensating Resistance for Dynamo-Electric Machines, of which the following is such a specification as will enable those skilled in the art pertaining thereto to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon.

In systems of incandescent electric lighting, when a number of lamps are fed from a shunt or a compound-wound dynamo-electric machine, it is well known to those skilled in the art that the candle-power of the lights is subject to considerable decrease after the machine has been running for some time. This is due to the fact that the increase in the resistance of the shunt-magnet circuit, consequent on the heating of the coils, has varied the current that flows through said coils, and consequently the magnetizing effect thereof on the field.

The object, therefore, of my invention is to insure greater constancy in the operation of dynamo-electric machines or motors when subjected to differences of temperature. To obtain these results I have invented certain new and useful improvements consisting in the combination, with a dynamo-electric machine or motor, either shunt or compound wound, of a compensating resistance introduced into the shunt-circuit of the machine-magnets, whereby an increase in the resistance of one part of the shunt-circuit, consequent upon an increase in temperature due to the current therein, is automatically accompanied by a corresponding decrease in the resistance of the remaining part of this circuit, thus avoiding the irregularity of the current supplied by the machine and the deleterious effects thereof, as heretofore pointed out. The manner in which I accomplish this maintenance of the constancy of the current will vary somewhat quantitatively, in accordance with the character of the machine with which the compensating resistance is used, as I will hereinafter point out.

Figure 1 shows the method of introducing the compensating resistance $a b$ into the shunt-circuit of a shunt-wound dynamo-electric ma-

chine. Fig. 2 shows the method of introducing the compensating resistance $a b$ into the shunt-circuit of a compound-wound dynamo-electric machine or motor.

To avoid changes in the potential of the machine, consequent on variations in the strength of the magnetic field following an increase in the resistance of the field-magnet circuit on an increase in the temperature therein due to the current flowing through them, I preserve constant, as nearly as possible, the total resistance of such field-magnet circuits by forming the same of such substances, as copper and carbon, for example, whose changes of resistance on change of temperature vary in the opposite sense.

I have shown in Fig. 1 this interposed resistance $a b$, which I call the "compensating resistance," as being composed of carbon rods or pencils connected in series and placed in a suitable break in the shunt-circuit. Since the electrical resistance of carbon decreases with an increase of temperature and the electrical resistance of copper increases with such increase of temperature, it is evident that by suitably proportioning the relative resistances of these two components or parts of the shunt-circuit their total resistance may thereby be maintained approximately constant.

It is evident to one skilled in the art that in order to maintain constant the resistance of the shunt-magnet circuit, which in the case in question would be composed of the joint resistance of two substances whose specific resistances varied in an opposite sense, if one of these substances were increased in its resistance by an increase in temperature to an amount equal to, say, x ohms, the other would require to be decreased by the same increase of temperature to an extent equal to x ohms. To express this mathematically, let m equal the coefficient of increase of resistance for temperature for copper and m' equal the coefficient of decrease of resistance for temperature for carbon. To determine, now, what resistance r' should be given to the carbon, in order to permit it when introduced into the circuit of copper field-magnet coils whose resistance equals r , to maintain, by its change of resistance on change of temperature the constancy of the sum $r+r'$, it is evident, as

above stated, that the increase $r m t$ must equal the decrease $r' m' t$, in which t is the increase in temperature in degrees. This is evidently equal to the following equation: $\frac{r}{r'} = \frac{m'}{m}$, from which one sees that the value which must be given to r' is $r' = \frac{r m}{m'}$; or, in other words, the compensating carbon resistance must have a resistance equal to the resistance of the copper in the field-magnet circuit multiplied by the ratio $\frac{m}{m'}$, provided the temperature is the same in both. If the temperature is different for the two resistances, this ratio will evidently be $\frac{m t}{m' t'}$.

If it is desirable to compensate for the increase in resistance of the leads to the lamps, consequent upon their increase in temperature, it is evident that it is only necessary to make the value of the compensating resistance such as will permit it to properly lower the total resistance of the shunt-circuit, in order to increase the magnetic effect of the shunt field-magnets sufficiently to overcome the increased resistance of the leads. The proper amount to be given to this resistance can be readily calculated by the preceding formula.

Although I have given rules by which the exact value of the compensating resistance may be calculated, yet I find it convenient in practice to so arrange the compensating resistance that I can readily increase or decrease its value by any suitable means until the proper effect is obtained.

Since the fall in resistance of carbon for increase in temperature is comparatively small, its resistance would have to be made comparatively great. In order to avoid this, it is evidently only necessary to allow the temperature of the carbon to rise much higher than that of the copper by suitably controlling its cooling or otherwise properly affecting its temperature.

In applying my compensating resistance to compound-wound dynamo-electric machines or motors, I also introduce it into the circuit of the shunt-magnet coils. In this case, in order to obtain automatic compensation, it is evident that since in machines of this type the resistance of the series-coils also increases with an increase of temperature, an allowance must be made for this circumstance in calculating the resistance necessary to be given to the compensating resistance, in order that it may compensate for both shunt and series coils, and also for the leads, if desired. The value necessary to be given in this case may be deduced from the following formula:

$$r' = \frac{R - R' + R t m}{t' m' + t m}$$

in which R is the total resistance of shunt-coils

and compensating resistance when both are cold, and R' is the same when both are warm, the other letters being the same as in the formula hereinbefore given.

I have shown in Figs. 1 and 2 the compensating resistance $a b$ as being inserted in the circuit between the two pairs of magnet-coils. It is evident, however, that any other convenient position in the circuit may be assigned to it. In order to preserve its temperature the same as that of the coils, it may be placed on, about, or in the magnet-coils.

I claim as my invention—

1. In a dynamo-electric machine or motor, the combination, with its shunt field-magnet coils, of a resistance composed of carbon or other suitable material whose resistance on increase in temperature decreases to an amount equal to the increase in the resistance of the coils of copper or other material forming the shunt-magnet circuit, substantially as described and specified.

2. In a dynamo-electric machine or motor, a compensating-resistance whose resistance on variation in temperature varies to an equal extent but in the opposite direction to the resistance of that part of the circuit which it is designed to compensate.

3. In a compound-wound dynamo-electric machine or motor, the combination, with the shunt-coils thereof, of a compensating resistance, substantially as and for the purpose described.

4. In a compound dynamo-electric machine or motor with constant potential, the combination, with the shunt-coils, of a compensating resistance whose variations in resistance consequent on variations of temperature, being in the opposite sense to that of the copper coils, automatically compensate for the effects of temperature in the coils.

5. In a dynamo-electric machine or motor, the combination, with the circuit of the magnet-coils, of a compensating resistance, of carbon or other suitable material, whose variations in resistance consequent on variations of temperature, being in the opposite sense to that of the copper coils, automatically compensate for the effects of temperature in the magnet-coils.

6. In the circuit of a dynamo-electric machine or motor, the combination, with the circuit of the magnet-coils, of a compensating resistance, of carbon or other suitable material, whose variations in resistance consequent on variations of temperature, being in the opposite sense to that of the copper coils and leads to the lamps, automatically compensate for the effects of temperature in the magnet-coils and in the leads to the lamps.

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Witnesses:

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