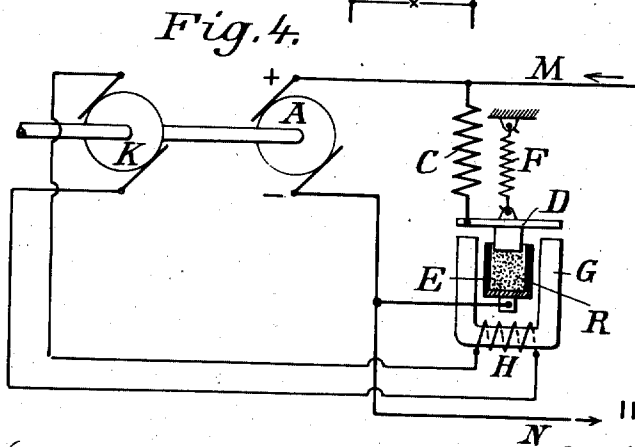
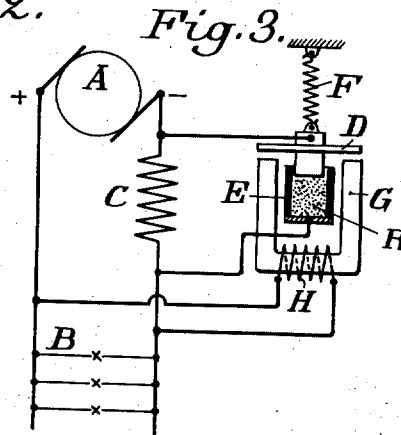
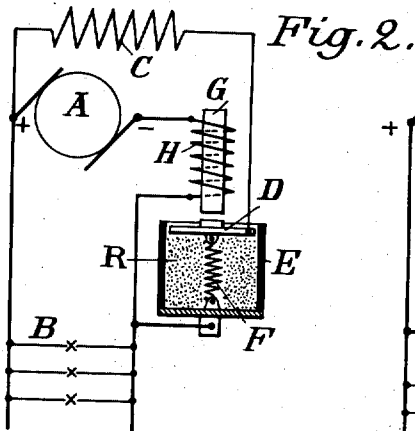
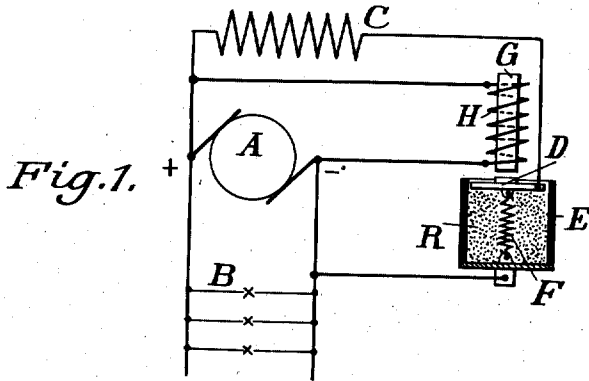


1,243,738.

Patented Oct. 23, 1917.
2 SHEETS—SHEET 1.



WITNESSES

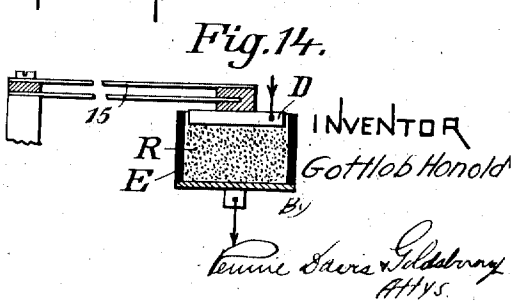
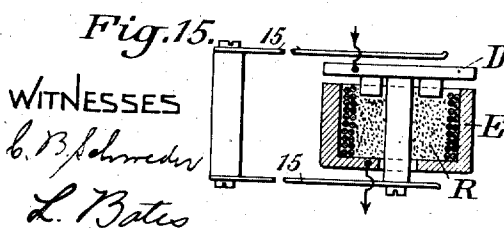
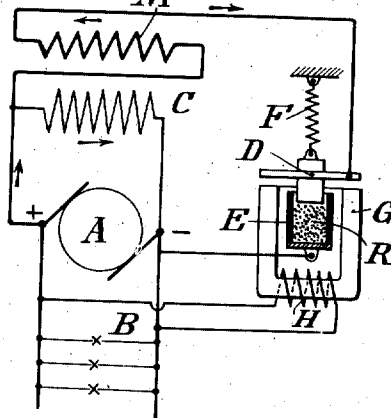
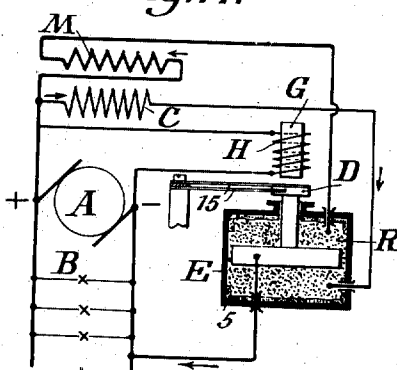
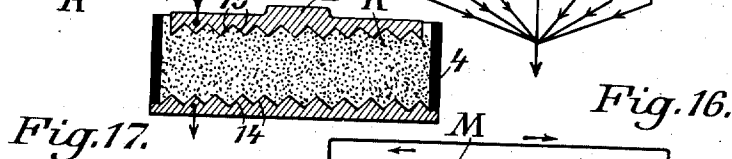
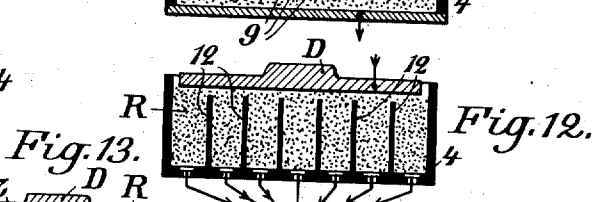
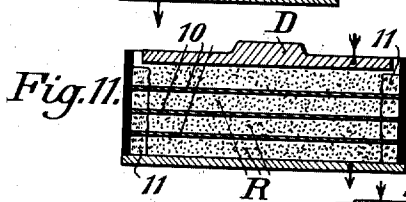
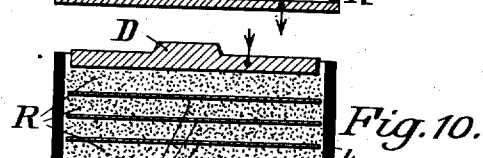
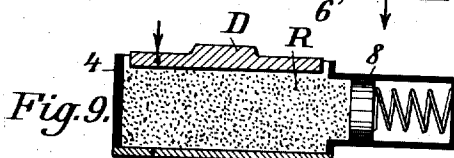
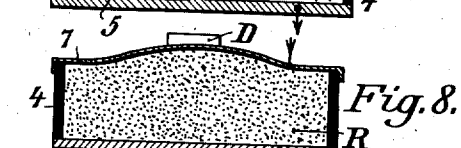
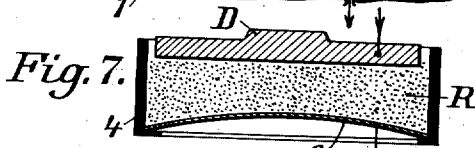
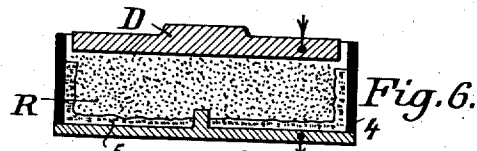
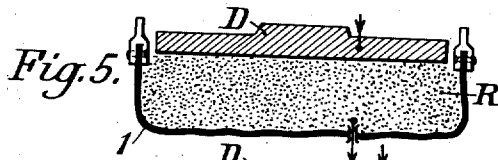
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1,243,738.

Patented Oct. 23, 1917.
2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

GOTTLOB HONOLD, OF STUTTGART, GERMANY, ASSIGNOR TO THE FIRM OF ROBERT BOSCH, OF STUTTGART, GERMANY.

ELECTRIC REGULATOR.

1,243,738.

Specification of Letters Patent.

Patented Oct. 23, 1917.

Application filed August 25, 1913. Serial No. 786,391.

To all whom it may concern:

Be it known that I, GOTTLOB HONOLD, engineer, a subject of the Emperor of Germany, residing at Stuttgart, Militärstrasse 4-8, Germany, have invented certain new and useful Improvements in Electric-Regulators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to automatic regulators for dynamo electric machines, and particularly to one comprising an electromagnet having a winding excited by current from a circuit connected to the dynamo and a movable-armature responsive to the magnetism produced thereby and effective on a variable resistance comprising a mass containing conducting particles in a container in the circuit to be regulated wherein either the container, or the mass, or both, are resilient so as to respond gradually and continually to the movement of the armature in either direction and thereby regulate the resistance of its circuit in fine increments throughout a wide range in substantial coincidence with the variations of the quantity to be regulated.

For automatically regulating generators to a predetermined voltage with a varying current or with varying speed, or for automatically regulating motors to a predetermined speed with varying load or with varying terminal voltage, it is usually preferable to operate on the exciting field circuit of the machine to be regulated, or on the machine supplying the excitation therefor, by altering the resistance and thereby changing the field current. However, the increments of change effected by the use of auxiliary motors or solenoids acting on pawls and ratchets for the purpose are not small enough, and also since there is a time lag due to the interposed mechanical masses, there is no gradual and continued change in the resistance in substantial coincidence with the variation of the quantity to be regulated. Furthermore, although a vibrator acting to continually cut a resistance into and out of the exciting circuit produces satisfactory regulation under certain conditions, yet it is not so well adapted in application to engine driven automobile lighting generators where the engine speed varies

over a range of about 4 to 1, and, besides, it is liable to overthrow one way or the other, and the vibrating contacts are likely to burn and corrode quickly.

In accordance with my invention, a durable automatic regulator, quick and sensitive in its action and yet well adapted for changes of small increments throughout a wide range without the production of sparks and without overthrow in either direction, is obtained by forming electrical conducting particles, such as grains of carbon, into a resilient mass which is compressed more or less by a spring-resisted movable-armature of an electromagnet having its exciting winding connected to the circuit to be regulated. The particles should form a resilient bolster of grains so that the slightest change of pressure exerted upon the mass will produce a corresponding change of resistance. Notwithstanding the certainty and responsiveness of the variation of the resistance produced thereby, the particles do not separate when the pressure is partially relieved, but they merely change the intimacy or completeness of their contact, and therefore the resistance is quickly responsive to variations and in small increments. Furthermore, no sparks occur within the mass, so that this cause of over regulation is eliminated while the destruction of the particles is prevented. Also, the friction in the mass of particles damps the movement of the armature of the electromagnet and thereby prevents overthrow and oscillation. There are other advantages of the arrangement resulting from its simplicity since all other regulating resistances are dispensed with, as are the condensers for suppressing the sparks and batteries for equalizing the voltage variations.

My invention may be embodied in various forms of construction. The electromagnet may have the form of a solenoid, or a magnet having a movable armature which is effective as a result of the current in the exciting winding to press on the variable resistance against the stress of a spring. The container for the mass of conducting particles may be resilient so as to be capable of elastic deformation by the electromagnet, as by making the container of india rubber, or lining it with felt, or the container may be rigid and the mass made resilient by forming it of carbon particles interposed

between mica or other disks, or mixed with flakes of mica or material of like nature.

In the accompanying diagrammatic drawings, I have illustrated various forms of regulators within my invention in diverse arrangement with several kinds of direct-current dynamo electric machines, and I have also shown various satisfactory forms of the variable resistance itself, and the movable armature for compressing the same.

Figure 1 illustrates the application of my regulator to a shunt-wound generator for maintaining a constant voltage at the terminals thereof;

Fig. 2 shows the regulator arranged to maintain a constant current from a shunt-wound generator;

Fig. 3 shows the application of the regulator to a series-wound generator;

Fig. 4 shows the regulator applied to a shunt-wound motor for maintaining constant speed;

Figs. 5 to 13 represent longitudinal sections of containers and the resistance mass therein;

Figs. 14 and 15 represent arrangements for guiding the armature of the electromagnet in movements of parallel translation;

Fig. 16 is a wiring diagram of an arrangement wherein one field winding of a shunt-wound generator is opposed by another field winding thereof containing the variable resistance to maintain a constant terminal voltage; and

Fig. 17 shows a combination of the arrangements of Figs. 1 and 16.

In Fig. 1, the self-exciting direct-current generator A, having the shunt field winding C supplies the work circuit B containing lamps or other translating devices. The pressure plate D moves in the container E with substantially frictionless play, and forms the armature of the electromagnet comprising the core G excited by the winding H which receives current from the terminals of the generator. The container E is filled with a resilient mass R made up of grains of carbon to which flakes of mica are added. When no current flows in the exciting winding H of the electromagnet, the armature D is drawn down by the spring F to a position wherein the mass R is pressed together into such intimate and complete contact as to form a conductor of very small resistance, the spring F in this and other figures being arranged outside of the resistance mass, for instance, as indicated at 15 in Fig. 17. One terminal of the shunt field winding C is electrically connected to the armature D, and thence through the resistance mass R and the electrically conducting bottom of the container E to one terminal of the generator, while the other terminal of the field winding C is connected to the other terminal of the generator. The

operation of this arrangement is as follows: Upon increase of the terminal voltage of the generator A from the predetermined value, due to an increase of speed or any other cause, the current in the exciting winding H of the electromagnet will increase and the armature D will be attracted more strongly against the tension of spring F, whereupon the pressure upon the mass R will be reduced and the resistance in series with the field winding C increased. The terminal voltage of the generator A will therefore decrease due to the resulting decrease of current in the field winding C. Likewise when the terminal voltage of the generator A decreases the regulator acts in the reverse direction to bring it back to the predetermined value by increasing the pressure on the mass R. In consequence of the peculiar formation of the mass R, and because of the light weight and the small movement of the armature D, the regulating effect varies in small increments in substantial coincidence with the variation of the terminal voltage of the generator A, without any material time lag or overthrow in either direction.

The action of the regulating devices shown in Figs. 2, 3, 4, 16 and 17 will now be readily understood. In Fig. 2, the regulator is arranged to maintain a constant current from the self-excited shunt-wound generator A, the winding H of the electromagnet being connected in series with the work circuit, while the resistance mass R is connected in series with the field winding C around the winding H.

In Fig. 3, the regulator maintains a constant voltage at the terminals of the series-wound direct-current generator A, since the winding H of the electromagnet is connected across the terminals of the generator, the resistance mass R being shunted around the series field winding C. Hence, as the terminal voltage of the generator increases, the resistance of the path around the field winding C is reduced, so that the generator receives less field excitation; and, when the terminal voltage of the generator decreases, the strength of the field C is increased by the action of the regulator. If desired, the winding H of the electromagnet may be connected in series with the work circuit B, and the regulator will thus maintain a constant current output from the generator.

In Fig. 4, the speed of the motor A is maintained constant by connecting the terminals of the generator K, which is driven by the motor A, to the exciting winding H of the electromagnet, so that as the speed of the motor changes the voltage of the generator acts to bring about a regulating change of the resistance of mass R in series with the field winding C of the motor.

In Fig. 16, the automatic regulator is arranged to maintain a constant voltage at the

terminals of the generator A by increasing the current in the weaker field winding M, which is opposed to the field winding C, as the terminal voltage of the generator A increases. Similarly, when the terminal voltage decreases, the field excitation supplied by the field wind M decreases, and thereby the effective field excitation of the generator A increases and brings the terminal voltage back to its predetermined value.

Fig. 17 shows a combination of the arrangements illustrated in Figs. 1 and 16, whereby the movement of the armature D increases the pressure on one part of the mass R in the container E and simultaneously decreases the pressure upon the other part of the mass R. In this way, the regulating effect of the armature D is increased, or the movement required for a given amount of regulation is decreased. The mass R is made resilient in that case as in Figs. 1, 2, 3, 4 and 16, by mixing flakes of mica with the conducting particles of carbon, while the container E is lined with resilient material 5, as felt for example.

The kind of resistance material employed and the construction of the container, are of essential importance to the invention. In Fig. 5, the container 1 for the mass R containing conducting particles is made entirely of elastic material, as india rubber, so that its walls yield with the slightest increase of pressure exerted by the armature D upon the mass, while upon diminution of pressure the walls resume their former position. In this way the walls quickly and gradually follow every movement of the armature and thereby bring about a change of pressure in fine increments upon the mass R, so as to bring the conducting particles more or less into intimate or complete contact with each other. Fig. 6 shows a rigid container 4 lined with a resilient material 5, as felt, whereby the same resilient effect as in Fig. 5 is produced. In Fig. 7, the bottom 6 of the container is a resilient member adapted to yield to the pressure of the armature D, while in Fig. 8, the resilient member 7 is made a part of the armature D of the electromagnet, while the bottom of the container is rigid. So also, the container may be made resilient in effect by making one or more of the walls into a spring pressed piston 8 adapted to yield resiliently to the pressure of the armature D, as in Fig. 9.

Under certain conditions it is desirable to subdivide the mass R containing the conducting particles. For instance, when the resistance of the regulator is to be very small for the maximum exciting field of the generator, the mass should have considerable cross section. With such an arrangement it may happen that the consistency of the mass is not uniform throughout and the pressure may likewise not be uniform, so

that the resistance and the quickness of action may become influenced. These defects may be overcome in several ways; for instance, as shown in Fig. 10, the mass may be subdivided into layers by the interposition of conducting plates 9 of metal, carbon, or the like. In this way, a number of smaller masses of particles is obtained. A still better effect is obtained, if, as shown in Fig. 11, the individual layers are separated from each other by plates 10 held apart by the resilient material 11 of rubber, felt, or other material of like nature. Fig. 12 shows an arrangement wherein the mass R is subdivided vertically, the walls 12 being of insulating material. The effect of separating the mass into parallel conducting columns can, however, be substantially attained by providing that side of the armature D which is in contact with the mass R with tooth-like projections 13 located opposite corresponding tooth-like projections 14 on the bottom of the container 4, as shown in Fig. 13.

Instead of making the container resilient, the mass R may be made resilient by mixing flakes of mica or other material of like nature with the grains of carbon, or if desired the container as well as the mass may be resilient, as pointed out hereinbefore.

Inasmuch as the armature D of the electromagnet should at all times press uniformly upon the mass R, it is preferable that the armature should have a movement of parallel translation, and also this movement should be brought about without any considerable friction. This may be obtained by connecting the armature D to a system of springs 15 forming a guiding structure as shown in Figs. 14 and 15, and as embodied in the regulator of Fig. 17.

It will be apparent that the automatic regulator of this invention may be used for alternating current machines as well as for direct current machines, and that the regulator may be so arranged as to be responsive to two quantities, for instance, voltage and current, as well as to one or the other.

The regulator shown is particularly well adapted for the regulation of engine driven automobile lighting generators, because as a result of the inherent damping characteristic of the mass R, the regulator is not affected by vibration or jar of the vehicle.

Having thus described my invention, what I claim is:—

1. In an automatic regulator for dynamo electric machines, the combination with an electromagnet having an exciting winding and a movable armature responsive to the magnetism thereof, of a variable resistance comprising a mass containing conducting particles, said armature having a portion buried in the mass and dividing the mass into two parts so that upon movement of the

armature in either direction one part of the mass is subjected to increased pressure while the other part is subjected to decreased pressure, and a single container for both parts of the mass; substantially as described.

2. In an automatic regulator for dynamo electric machines, the combination with an electromagnet having an exciting winding, a movable-armature responsive to the magnetism thereof, and a deformable guiding structure for guiding the movable armature in a movement of parallel translation, of a variable resistance comprising a resilient mass containing conducting particles, and a container for the mass, said armature hav-

ing a portion buried in the mass in such manner that upon movement of the armature in either direction one part of the mass is subjected to increased pressure of substantially uniform amount throughout while the other part is subjected to decreased pressure of substantially uniform amount throughout; substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

GOTTLOB HONOLD.

Witnesses:

PAUL WOLFART,
HERMANN SCHNEIDER.