

March 3, 1936.

L. W. THOMPSON
ELECTRICAL RESISTANCE DEVICE

2,033,015

Filed Aug. 30, 1934

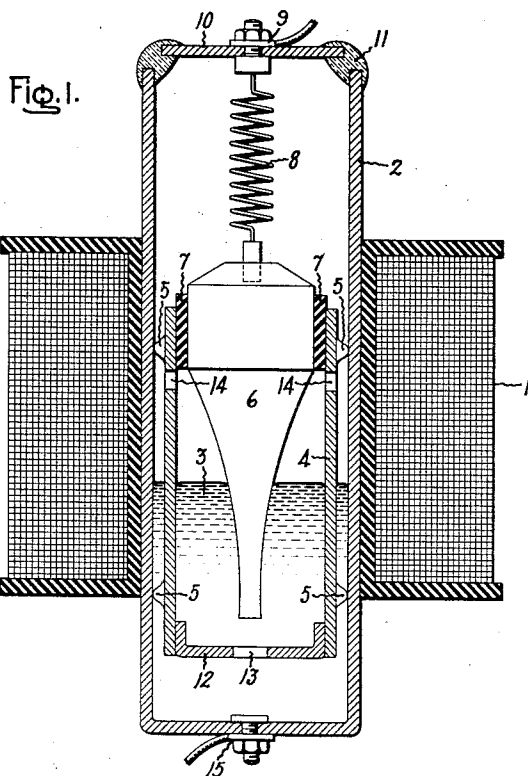
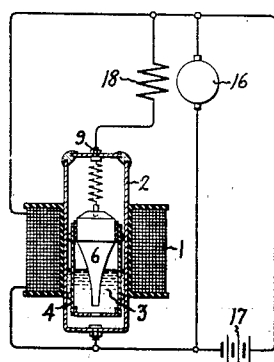


FIG. 2.



Inventor:
Louis W. Thompson.
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,033,015

ELECTRICAL RESISTANCE DEVICE

Louis W. Thompson, Schenectady, N. Y., assignor
to General Electric Company, a corporation of
New York

Application August 30, 1934, Serial No. 742,123

3 Claims. (Cl. 201—55)

My invention relates to electrical resistance devices and more particularly to improvements in magnetically operated liquid contact type electrical resistance regulators.

Heretofore regulators of the above mentioned type have been relatively large and expensive in that they have included a magnetic solenoid plunger member to which was appended a variable resistance element and to which in addition there was also sometimes added a motion damping means. This resulted in an elongated and wasteful structure. In accordance with my invention, I provide a novel, compact, rugged, and inexpensive construction by telescoping the plunger and resistance element and by causing the plunger to serve as a motion damping means.

An object of my invention is to provide a new and improved electrical resistance device.

A further object of my invention is to provide a compact, rugged and inexpensive magnetically operated liquid contact type electrical regulator.

My invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a cross sectional view of a practical embodiment of my invention, and Fig. 2 is a circuit diagram of an application of my invention as a voltage regulator for a direct current generator.

Referring now to the drawing, and particularly to Fig. 1 thereof, my device comprises a solenoid operating magnet 1, which is preferably normally mounted in the position shown, with its axis vertical. Surrounded by the solenoid 1 is a casing 2 of nonmagnetic material in which is placed a quantity of electrical conducting liquid 3, such as mercury. One suitable material for the casing 2 is nonmagnetic steel, as this is relatively unaffected by mercury. The casing 2 need not be of any particular shape, but it is convenient to construct it in the shape of a hollow cylinder whose axis corresponds with the axis of the winding 1. Mounted within the casing 2 is a hollow solenoid plunger 4 composed of suitable magnetic material, such as iron. The plunger 4 is maintained in proper position and relation with respect to the size of casing 2 by means of suitable guide buttons or projections 5 which may be integrally cast thereon, if desired.

Mounted within the hollow plunger 4 is a length of resistance material, which is shown by way of example as a rod 6 extending substantially the length of the plunger 4. The rod 6 may

be composed of any suitable electrical resistance material, and one such material which I have found to be satisfactory is the synthetic silicon-carbide material known to the trade as "Globar". The rod 6 is insulated from the hollow plunger 4 by means of suitable insulation 7 and it is electrically connected by means of a conducting element, such as a resilient spring 8, to a connection terminal 9 mounted in a top closure 10 for the casing 2. Closure 10 is insulated from casing 2 by means of a glass or porcelain seal 11, as shown.

The resistance element 6 is shown tapered. This is in order to produce an accelerated resistance change with changes in position of the core 4 so that the range of travel of the core of the plunger is reduced, thereby reducing the size of the entire device. Thus as the plunger 4 is drawn upward, not only is the length of the portion of the rod 6 which is out of contact with the mercury, increased, but also the effective cross section decreases, so that both these factors, that is to say, length and cross section, operate together to produce the increase in resistance.

In order to provide proper damping of the motion of the plunger 4 the lower end thereof is closed by an element such as a washer 12 having a relatively small opening 13 therein. In addition relatively small openings 14 are provided near the top of the hollow plunger 4 so as to allow ingress and egress of air to the plunger.

The operation of the construction shown in Fig. 1 is as follows: If the energization of the main operating winding 1 is increased, the pull on solenoid plunger 4 is increased thereby tending to draw this plunger up into the magnet. However, this motion is retarded by the fact that too rapid raising of the plunger 4 tends to lift the mercury contained in it so that the speed of raising of the plunger 4 is controlled by the time required for the mercury to run out through the hole 13. As the plunger 4 rises, less and less of the resistor 6 is submerged, or in contact with the mercury 3, and consequently the resistance of an electrical path from the terminal 9 through the spring 8, the resistor 6 and the mercury 3 is increased. Similarly, if the energization of magnet 1 is decreased, the core 4 tends to descend into the mercury 3, but this action is retarded by the fact that the holes 14 are so proportioned that it takes an appreciable time for the air to escape therethrough so that it takes an appreciable time for the core or plunger 4 to lose sufficient buoyancy to allow it

to descend into the mercury. As the plunger 4 does descend into the mercury more and more of the resistor 6 is short circuited thereby in effect decreasing the electrical resistance of the device.

For convenience in making electrical connections to my device, a terminal 15 is fastened to the casing 2 and as this casing is in engagement with the mercury the circuit can be completed through the device by making connections to the terminals 9 and 15.

In Fig. 2 my device is arranged for regulating the voltage of a generator 16, such as may be used on automobiles for charging a storage battery 17 and for supplying energy to various other translating devices (not shown). Generator 16 is provided with a shunt field winding 18 in circuit with which is connected the resistance element of my regulator, that is to say, the field winding 18 is connected to the terminal 9 and the other terminal 15 of my device is connected to the other side of the generator. Also the winding 1 is connected across the generator 16.

In the operation of Fig. 2, if the voltage of generator 16 rises above a predetermined normal value the core 4 is moved upwardly, thereby causing my device to insert an increased electrical resistance in the shunt field winding circuit of the generator 16, thereby tending to reduce the current in the field winding 18 a sufficient amount to hold the voltage of the generator substantially constant. In a similar manner, if the voltage of the generator 16 falls below the specified normal value, the plunger 4 descends thereby submerging more and more of resistor 6 in the mercury 3, whereby the electrical resistance in cir-

cuit with the shunt field winding 18 is decreased, thereby increasing the current through this winding a sufficient amount to maintain the voltage substantially normal.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention, and I, therefore, aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a magnetically operated liquid contact electrical resistance device, a hollow solenoid plunger of magnetic material, and a length of electrical resistance material insulatingly mounted in said plunger and extending substantially the length of said plunger.

2. In a solenoid actuated liquid contact regulator, a hollow substantially cylindrical solenoid plunger of magnetic material, and a tapered resistance rod insulatingly supported within said plunger and extending substantially the length thereof.

3. In a liquid contact regulator, a combined resistor element, solenoid plunger and damping dashpot comprising a hollow member of magnetic material, relatively small openings near the bottom and top of said member, and a length of resistance material mounted inside said member and extending substantially the length of said member.

LOUIS W. THOMPSON.