

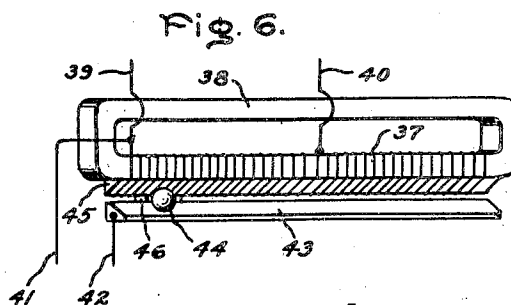
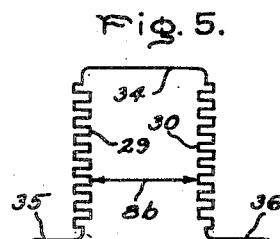
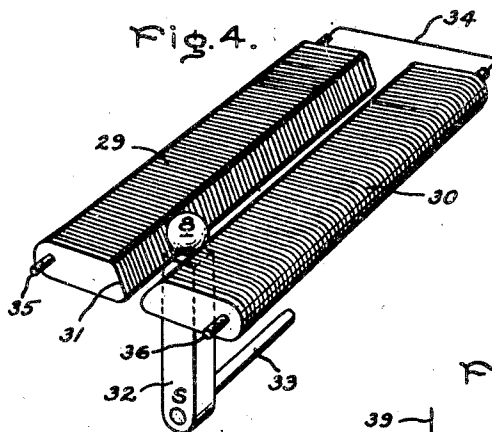
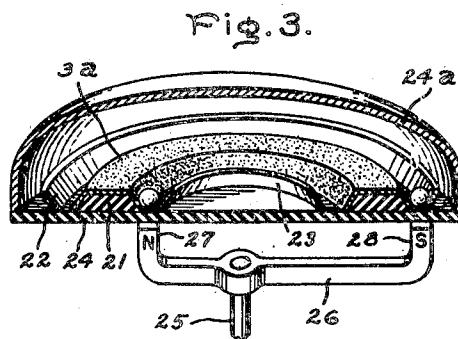
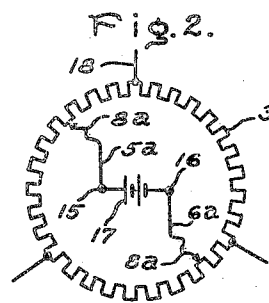
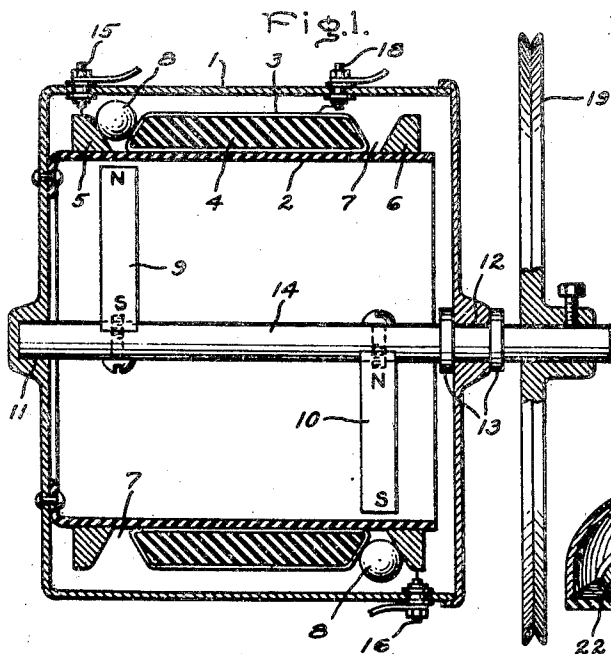
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ELECTRIC REGULATOR

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UNITED STATES PATENT OFFICE

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ELECTRIC REGULATOR

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2 Claims. (Cl. 201—56)

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My invention relates to electric regulators involving adjustable contact apparatus such as rheostats, and it is particularly useful as an enclosed telemetering transmitter of the variable resistance type, where the rheostat current is relatively low and excessive friction in the rheostat operation is to be avoided. In carrying my invention into effect, I employ as the adjustable contact or contacts a magnetic conductor ball or balls held in a commutating groove and propelled by a magnet.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention reference is made in the following description to the accompanying drawing in which Fig. 1 represents a telemetering transmitter for rotary motion embodying a variable resistance employing my invention. Fig. 2 may represent the electric circuit connections for Fig. 1. Fig. 3 represents another embodiment of my invention involving rotary motion. Fig. 4 represents a variable rheostat in which the resistance is varied by a linear motion. Fig. 5 may represent the electric circuit connections for Fig. 4, and Fig. 6 shows my invention applied to an adjustable auto-transformer.

Referring now to Fig. 1, 1 represents a cylindrical-shaped enclosing casing in cross section. Secured therein and concentric with the casing is a thin-walled hollow cylinder 2 which may be made of insulating material such, for example, as plastic. At least the outer surface of the cylinder 2 is of insulating material and if the cylinder is partially made of metal, it will be nonmagnetic. About the outer surface of cylinder 2 and over its central portion is a circuit element such as a resistance element 3. This resistance element is in the general form of a hollow cylinder and may be formed by winding a resistance wire 3 about a form 4, the form 4 being in the shape of a hollow cylinder concentrically surrounding cylinder 2 and the resistance wire 3 wound thereon in the nature of a Gramme ring winding. The form 4 will be made of a suitable insulating material and the wire 3 as wound thereon insulated so as to avoid short circuit between adjacent turns. The form wound resistance element may be secured to the periphery of drum 2 by an insulating cement. Adjacent each end of the re-

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sistance element is a pair of circuit elements comprising conductor rings 5 and 6. The adjacent surfaces of rings and resistance element are beveled as shown, so as to form V-shaped grooves or tracks 7 about the cylinder. The surfaces of the insulated wire facing in such V-shaped grooves are bared and flattened as necessary to make a fairly smooth commutating surface formed by alternate sections of insulation and resistance wire, which commutating surfaces extend completely around the cylinder at either end of the resistance unit and form the inner walls of the V-shaped grooves or tracks 7. Into each of these grooves is placed a ball 8 of magnetic conductor material, such as steel or nickel or a suitable magnetic conductor alloy. Such balls thus form connections between the copper rings 5 and 6 and the points on the resistance wire 3 with which the balls make contact in the grooves where the insulation has been removed from such wire to form the commutating surfaces, and in rolling along the groove, can make contact with two adjacent commutating segments simultaneously so as not completely to interrupt the circuit there-through.

Secured on a central rotary shaft 14 is a pair of radially disposed permanent bar magnets 9 and 10. The shaft 14 may rotate in bearings at 11 and 12 and be prevented from endwise displacement by collars or shoulders 13. The magnets 9 and 10 are secured to shaft 14 opposite the grooves 7 and extend radially close to the inner wall of cylinder 2, adjacent the throat of the grooves such that substantial magnetic attraction exists between the outer pole pieces of such magnets and the magnetic balls 8 in grooves 7, such that they are securely held in the grooves and are caused to rotate in the grooves when shaft 14 rotates by reason of the magnetic attraction between the balls and adjacent pole pieces of the magnets, the balls following the magnets closely with a smooth rolling action. When first assembled, the balls may not be opposite their corresponding magnets but a single complete rotation of shaft 14 will bring each magnet adjacent its corresponding ball, and thereafter the magnetic linkage indicated in Fig. 1 will be and will remain established. The magnetic force between the magnets and balls is sufficient to maintain the balls opposite the ends of their corre-

sponding magnets against the action of gravity in all operating positions of shaft 14 and in all oriented positions of the assembly. Hollow balls may be used to lighten them but this will seldom be necessary.

It is seen now that the balls form contacts between their corresponding conductor rings 5 and 6 and the points on the resistance wire 3 which are in contact with the balls in the grooves 7, and that the positions of such contacts are varied by the rotation of shaft 14. The electrical connections for the device of Fig. 1 may be as represented in Fig. 2 where 3 represents the resistance wire of that number in Fig. 1, and arrows 8a of Fig. 2 represent the ball contacts to such resistance. The rings 5 and 6 may be represented in Fig. 2 by connections 5a and 6a. These rings may be connected to a source of supply 17 through terminals 15 and 16, which terminals may be supported on the housing 1 as indicated in Fig. 1. The fixed terminal connections to the resistance wire 3 may likewise be supported on housing 1. One such terminal 18 is represented in the drawing. The casing 1 may be made gas-tight and filled with an inert gas to prevent oxidation and corrosion of the commutating parts.

The device of Fig. 1 employing the connections of Fig. 2 will thus constitute a transmitter for rotary motion of shaft 14 employing the telemetering principle of Fig. 2 of United States Patent No. 2,298,893, October 13, 1942. If, for example, the device is used to transmit liquid level, the shaft 14 may be provided with a pulley 19 so as to be connected to a float with a cord such as will cause the shaft 14 to be rotated with change in liquid level.

The rheostat form may take a variety of forms and be used for a variety of purposes. Fig. 3 represents another form of construction which may serve the same purpose as Fig. 1. Here the resistance element has a general doughnut shape, only one-half of which is represented, and may consist of a thin outer coating 3a of resistance conductor metal sprayed or deposited on an insulating form 21. The coating may completely cover the form or cover only its upper and side surfaces. The inner and outer peripheries of the resistance unit are sloping, and the metal coating on these sloping surfaces provides a smooth conducting commutating surface which will have a point contact with a ball. Adjacent such commutating surfaces are conductor rings 22 and 23 shaped to form with the sloping commutating surfaces of the resistance unit a pair of circular V-shaped tracks in which magnetic conductor balls 8 are placed. The assembly is supported on an insulating plate 24, and beneath the plate is a rotary shaft 25 carrying a U-shaped permanent magnet 26. The axis of rotation of shaft 25 is concentric with the axis of the circular resistance element and its commutating tracks, but the permanent magnet is offset such that one pole 27 lies under the inner track and the other pole 28 lies under the outer track. The magnetic attraction between magnet poles and balls 8 holds the balls in the tracks and causes their rotation therein when the shaft 25 is rotated. The wiring connections may be like those represented in Fig. 2. The plate 24 and a cover part 24a may completely and hermetically seal the resistance element and its commutating arrangement, and the enclosure may be evacuated or contain an inert gas such as helium or nitrogen to prevent oxidation.

Fig. 4 represents a rheostat embodying my in-

vention having a linear motion instead of a rotary motion. Two resistance elements are used represented generally by reference characters 29 and 30, and each consisting of a resistance wire wound about a flat form. One edge of these elements is beveled as represented at 31, and the resistance wire surface bared on these beveled edges. The two resistance elements are assembled with the beveled edges adjacent to form a commutating groove in which the magnetic conductor ball 8 is placed, forming an adjustable contact connection between the two resistance elements. Beneath the groove a permanent magnet 32 is provided and arranged to be moved in a linear direction parallel to and beneath the groove as by a rod 33, thereby causing the ball to roll in the groove and follow the magnet. The connections may be as represented in Fig. 5 where the connection 35 represents the ball 8 of Fig. 4; and 34 an end connection between the two resistance elements 29 and 30; and 35 and 36 circuit terminals. It is, of course, obvious that one of the resistance sections of Fig. 4 may be replaced with a copper bar connector forming one side of the track. All parts of this device except the magnet 32 and operating part 33 may be hermetically sealed as explained in connection with Fig. 2.

Fig. 6 illustrates the invention as applied to an adjustable autotransformer. The transformer winding 37 is wound on a magnetic core 38. Thirty-nine (39) and 40 may indicate the primary supply leads, and 41 and 42 the secondary output leads. The output lead 42 is connected to an adjustable point on the winding 37 through the conductor strip 43 and the magnetic conductor ball 44 which ball may roll along a V-shaped groove formed by the strip 43 and a commutating surface along a bared surface of winding 37 wound over strip 45 of insulation placed against one side of the transformer core. A movable magnet 46 beneath and spaced from the V-shaped slot thus formed serves to retain the ball 44 in the groove and to move it along the groove to vary the joint of connection between the circuit elements used and hence the relation between primary and secondary voltage. The resistance of the winding 37 and the voltage between turns will be made such that short circuiting a turn by the ball 44 by reason of its making contact with two adjacent turns simultaneously will do no harm.

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

1. An electric regulator comprising a resistance element in the general shape of a hollow cylinder, conductor rings spaced from and extending adjacent each end of said cylindrical resistance element such as to form a circular groove between each end of said element and the adjacent conductor ring, a ball of magnetic conductor material in each of said grooves and forming an electrical connection across the groove between resistance element and adjacent ring, a rotary shaft extending axially at the center of said cylindrical resistance element and conductor rings, permanent magnet means carried by said shaft and having pole pieces on opposite sides of said shaft extending close to said circular grooves such that the balls in said grooves are held in and rotatively positioned in said grooves by reason of the magnetic attraction between said balls and pole pieces and the rotary position of said shaft, and means for rotating said shaft to vary the points of electrical connection to said resistance elements by said balls.

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2. An electric regulator comprising a resistance element generally in the shape of a hollow ring, conductor rings spaced from and positioned adjacent the inner and outer edges of said resistance element, the adjacent surfaces of resistance elements and conductor rings being shaped to form circular grooves, a ball of magnetic conductor material in each such groove forming an electrical connection between its ring and the adjacent surface of the resistance element, permanent magnet means for retaining said balls in their respective grooves by magnetic attraction, and means for rotating said permanent magnet means on the axis of rotation of said resistance and con-

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ductor rings simultaneously to vary the points of electrical connection between said conductor and resistance rings by said balls.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,402,696	Wallis	Jan. 3, 1922
2,256,833	McDonald	Sept. 23, 1941