July 5, 1927. 1,635,060

L. W. THOMPSON

INDUCTION VOLTAGE REGULATOR

Filed March 1, 1927

Fig. 1.

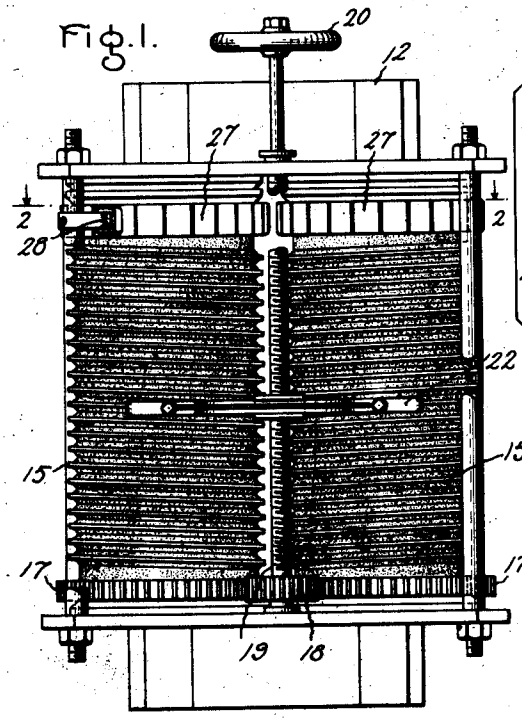
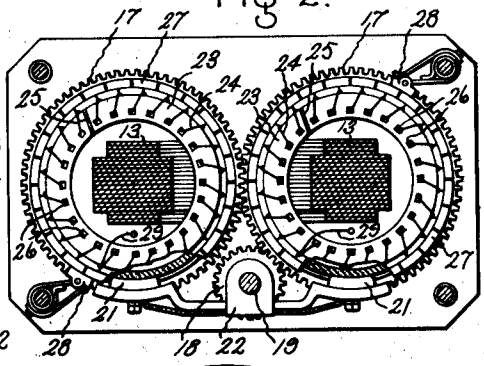


Fig. 2.



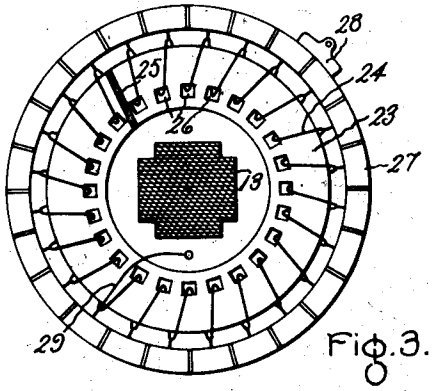
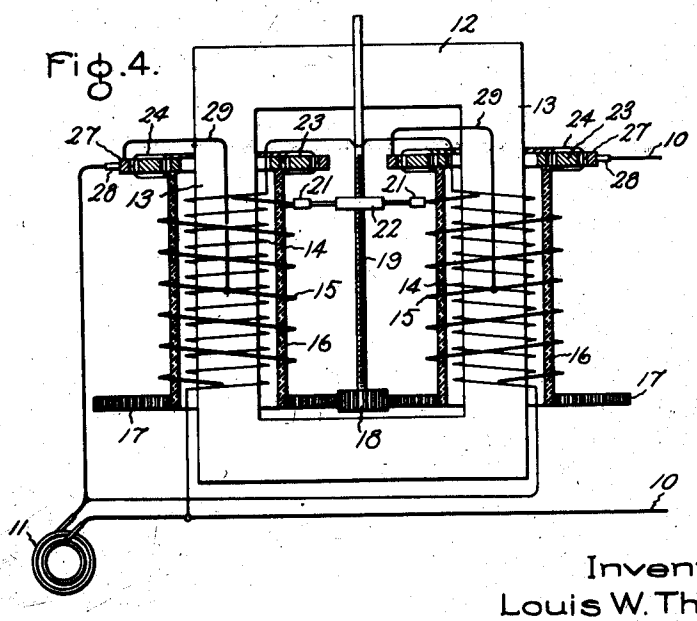


Fig. 3.

Fig. 4.



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UNITED STATES PATENT OFFICE.

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INDUCTION VOLTAGE REGULATOR.

Application filed March 1, 1927. Serial No. 171,864.

My invention relates to induction voltage regulators. The general object of the invention is to provide an improved voltage regulator of the type in which a contact may be moved along a helical winding, the winding being rotated about the core to maintain constant connection with the movable contact. A further object of the invention is to provide an improved arrangement for connecting the rotatable winding to the terminals of the regulator.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which Fig. 1 is a view in elevation of an induction voltage regulator constructed in accordance with the invention; Fig. 2 is a sectional view on the line 2—2 of Fig. 1; Fig. 3 is an enlarged detail view of part of Fig. 2; and Fig. 4 is a diagrammatic view showing the electrical connections.

Like reference characters indicate similar parts in the different figures of the drawing.

The invention will be explained in connection with the accompanying drawing which shows a regulator connected to regulate the voltage of a circuit 10 supplied with current from a generator 11. The regulator comprises a magnetic core 12 having two winding legs 13, each winding leg being surrounded by an exciting winding 14 and a voltage regulating winding 15. The two exciting windings 14 are connected in series between the two sides of the circuit 10 and together form the primary winding of the regulator. Each of the voltage regulating windings 15 is mounted on an insulating cylinder 16 which is arranged in any suitable manner to rotate about the corresponding exciting winding 14 and winding leg 13 of the core. The two cylinders 16 are geared together by the gears 17 which are driven by a pinion 18 on a threaded shaft 19 having a hand wheel 20. The two voltage regulating windings 15 may thus be rotated simultaneously by turning the hand wheel 20. Two brushes 21 which are electrically connected together make contact with the two voltage regulating windings 15, respectively. These brushes are mounted on a carrier 22 which engages the threads on the shaft 19. The pitch of the turns in the helical windings 15, the pitch of the threads on the shaft 19 and the gear ratios of the gears 17 and the pinion 18 are all so related that as the brushes 21 are moved or adjusted parallel to the axes of the windings 15, these brushes will always maintain contact with the windings.

Each insulating cylinder 16 carries a ring 23 of magnetic material surrounding the corresponding winding leg 13 of the core and provided with a winding 24. Each ring 23 has an insulating gap 25 to avoid a short-circuited turn on the core and is also formed with a series of spaced openings 26. The turns of the windings 24 pass through the spaced openings 26 and around the outer edges of the rings 23 so that they surround the annular outer portions of the rings between the series of openings 26 and the outer edges of the rings.

Connections are made from suitably spaced points along each winding 24 to the insulated segments or contacts of a contact ring 27 against which a brush 28 is pressed and one point of each winding 24 is connected by a conductor 29 to a point, preferably at or near the center, of the corresponding voltage regulating winding 15. This completes a voltage regulating circuit between the brushes 28 which is connected in series with one side of the circuit 10. The voltage regulating circuit includes those portions of the voltage regulating windings 15 which are between the brushes 21 and the points on these windings to which the conductors 29 are connected, and the voltage impressed on the circuit 10 will be raised or lowered by the regulator by an amount equal to the voltages induced by the primary winding 14 in these active portions of the windings 15. The voltage of the circuit 10 will be raised if the brushes 21 are at one side of the connections 29 and lowered if the brushes 21 are at the other side of those connections.

The brushes 28 are preferably so arranged and positioned that when one of these brushes is on that segment of its contact ring 27 to which the corresponding regulating winding 15 is connected, the other brush 28 is on that segment of its contact ring 27 which is diametrically opposite the connection to the other regulating winding 15. This arrangement of the brushes 28 is shown in Figs. 2 and 4. When a brush 28 is on the

contact of the ring 27 which is directly connected to its regulating winding 15, none of the current which flows between this brush and its regulating winding will flow through any part of its winding 24. When the brush 28 is on some other contact, however, so that the brush and its regulating winding 15 are connected to different points of the winding 24, then the current will divide and flow in two parallel paths and in opposite directions in the winding 24 between these two points. These currents in the two parallel connected sections of the winding 24 tend to induce magnetic fluxes in opposite directions in the magnetic ring 23 so that the two fluxes oppose each other and the total flux in the ring is small. The non-magnetic gap 25 increases the reluctance of the ring 23 and further reduces the total flux.

When either of the contact rings 27 is in such position that its brush 28 touches two of its contacts as shown in Figs. 2 and 3, the section of its winding 24 between these two contacts is short-circuited by the brush. When this condition exists, the flux in the magnetic ring 23 cannot pass through the short-circuited section of the winding 24 and is forced to the inner or opposite side or edge of the magnetic ring. This avoids sparking at the brush because there is substantially no magnetic flux in the short-circuited section of the winding 24 when the short-circuit is removed by the rotation of either of the contacts away from the brush. The cross sectional area of the inner annular portion of the magnetic ring 23 is made only as large as is necessary to carry magnetic flux past a short-circuited section of the winding 24 in the manner which has been described. This inner annular portion of the magnetic ring 23 completes a magnetic path around each of the openings 26 through which the sections of the winding pass. This tends to increase the reactance of the winding 23 but not to an objectionable amount if the cross sectional area of the inner annular portion of the ring 23 is so small that it becomes saturated by a small amount of magnetic flux.

As already described, the two windings 24 are connected in series with one side of the circuit 10. The reactance of either of the windings 24 varies with its position with respect to its brush 28, but it will be apparent that any variation in the reactance of one of these windings is accompanied by an opposite variation in the reactance of the other winding because when one of the connections 29 is moving away from one of the brushes 28 the other connection is moving toward the other brush 28. The reactance in the circuit 10 due to the two windings 24 is, therefore, approximately constant.

The invention has been explained in connection with a particular embodiment thereof, but it will be apparent that various changes may be made within the scope of the invention as defined in the appended claims.

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

1. An induction voltage regulator comprising a magnetic core, an exciting winding for said core, a rotatable voltage regulating winding surrounding a part of said core, a magnetic ring, a winding on said ring, a contact ring having its contacts connected to points distributed along said magnetic ring winding, said magnetic ring winding being electrically connected to said voltage regulating winding, said magnetic ring with its winding and contact ring being arranged to rotate about a part of said core with said voltage regulating winding, and a brush for said contact ring.

2. An induction voltage regulator comprising a magnetic core, an exciting winding for said core, a rotatable voltage regulating winding surrounding a part of said core, a magnetic ring having a series of openings, a winding on said ring and passing through said openings, a contact ring having its contacts connected to points distributed along said magnetic ring winding, said magnetic ring winding being electrically connected to said voltage regulating winding, said magnetic ring with its winding and contact ring being arranged to rotate about a part of said core with said voltage regulating winding, and a brush for said contact ring.

3. An induction voltage regulator comprising a magnetic core having two winding legs, an exciting winding for said core, a rotatable voltage regulating winding of helical form surrounding each of said winding legs, means for connecting a point of each of the voltage regulating windings to an outside circuit, two electrically connected brushes in contact respectively with the two voltage regulating windings, means for rotating said voltage regulating windings, and means for moving said brushes to maintain contact between each brush and its winding as the winding is rotated.

4. An induction voltage regulator comprising a magnetic core having two winding legs, an exciting winding for said core, a rotatable voltage regulating winding of helical form surrounding each of said winding legs, an electrical connection between said voltage regulating windings, a magnetic ring surrounding each winding leg, a winding on each magnetic ring, a contact ring for each magnetic ring winding, the contacts of each each contact ring being connected to points distributed along the associated magnetic ring winding, each magnetic ring winding being electrically connected to a voltage regulating winding, each magnetic ring with its winding and contact ring being arranged to rotate with its voltage regu-

lating winding, and a brush for each contact ring.

5. An induction voltage regulator comprising a magnetic core having two winding legs, an exciting winding for said core, a rotatable voltage regulating winding of helical form surrounding each of said winding legs, an electrical connection between said voltage regulating windings, a magnetic ring surrounding each winding leg, a winding on each magnetic ring, a contact ring for each magnetic ring winding, the contacts of each contact ring being connected to points distributed along the associated magnetic ring winding, each magnetic ring winding being electrically connected to a voltage regulating winding, each magnetic ring with its winding and contact ring being arranged to rotate with its voltage regulating winding, and a brush for each contact ring, the positions of the brushes being such that when one brush is near that point of its magnetic ring winding which is connected to a voltage regulating winding the other brush is near a point of the other magnetic ring winding which is opposite its connection to the other voltage regulating winding.

In witness whereof, I have hereunto set my hand this 28th day of February, 1927.

LOUIS W. THOMPSON.