June 7, 1949. L. K. DAVIS 2,472,369

RHEOSTAT

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FIG. 1

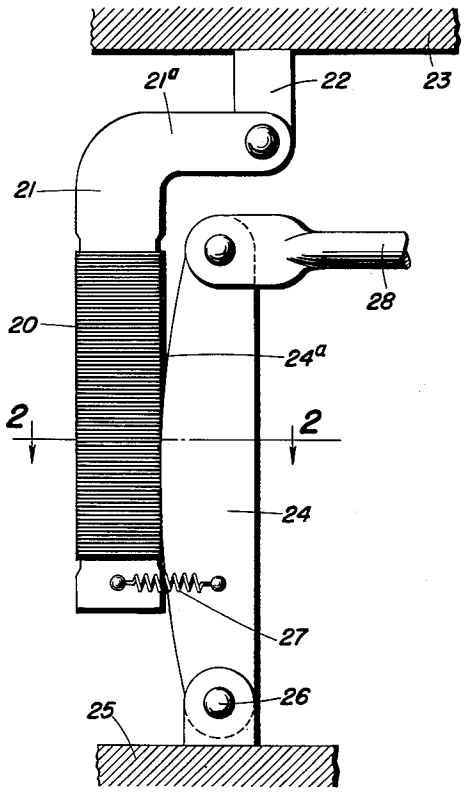


FIG. 2

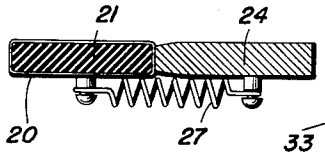


FIG. 3

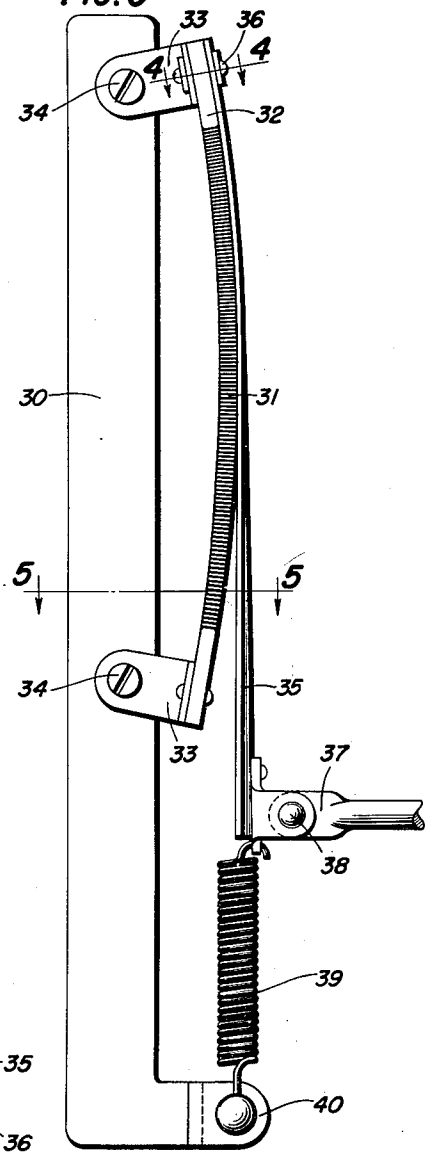


FIG. 4

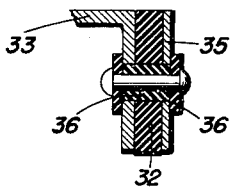
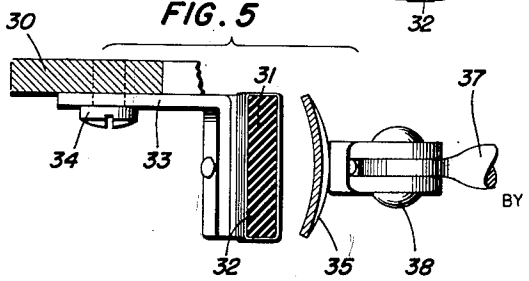


FIG. 5



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FIG. 6

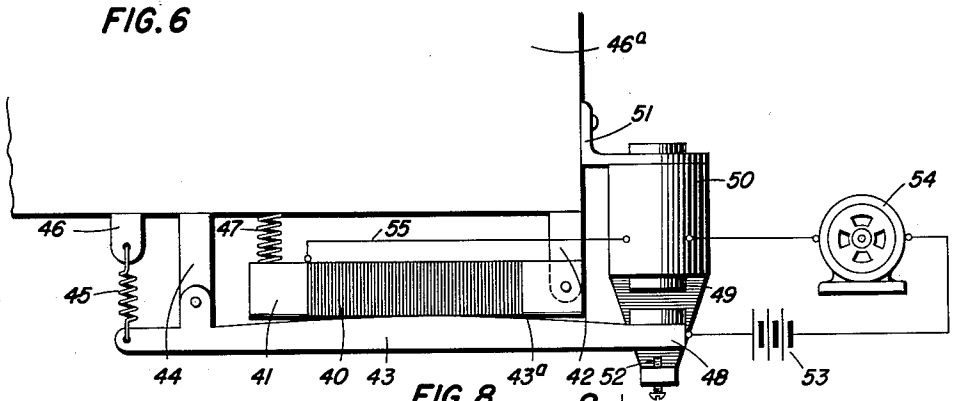


FIG. 8

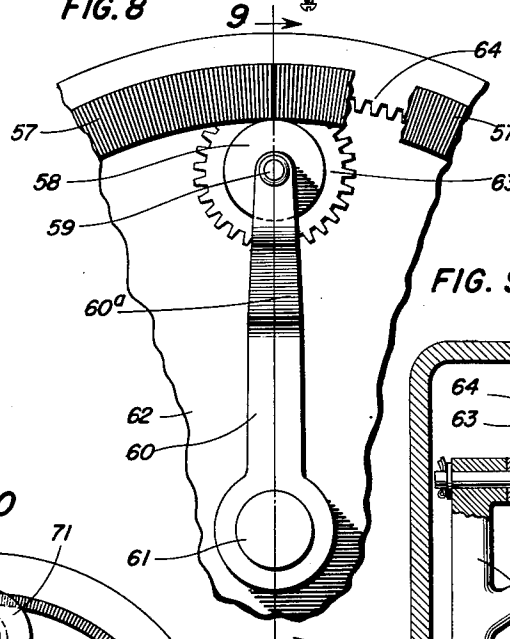


FIG. 9

FIG. 7

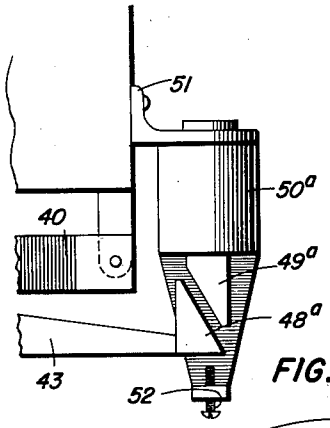
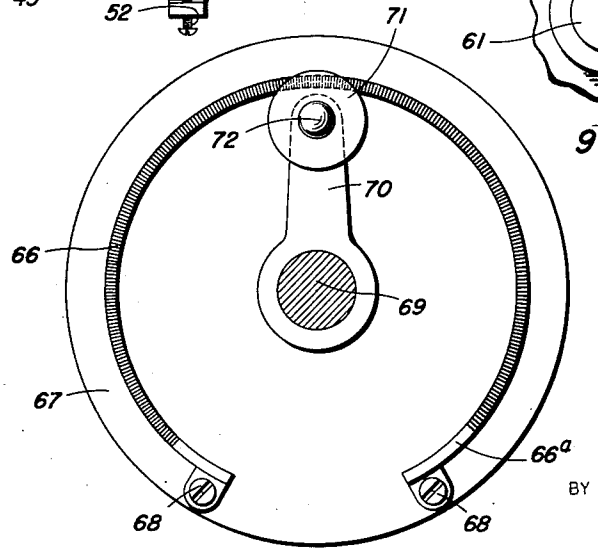
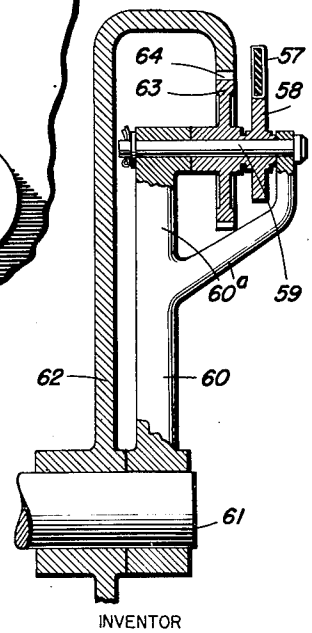


FIG. 10





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FIG. 11

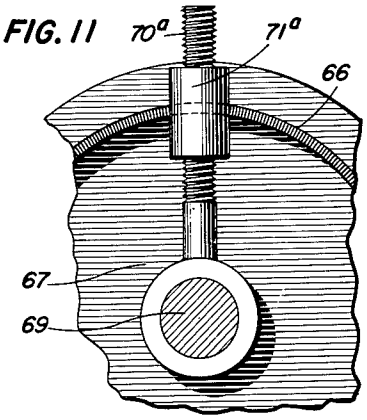


FIG. 12

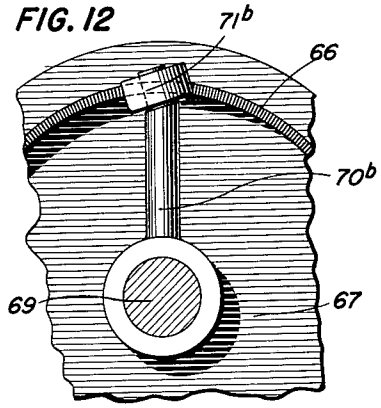


FIG. 13

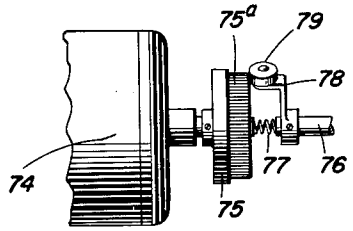


FIG. 14

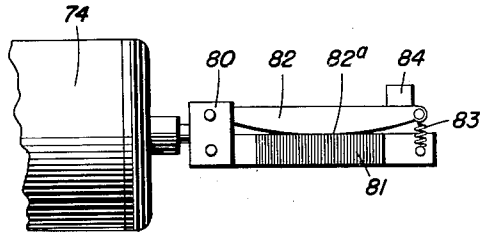
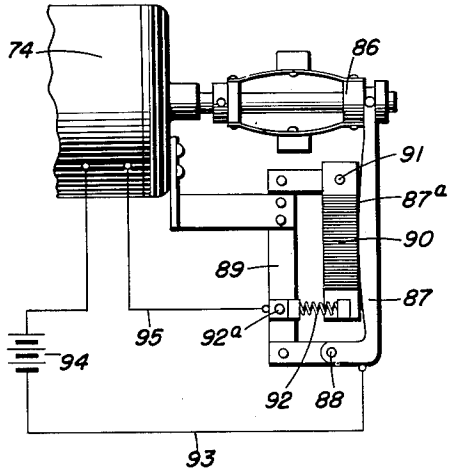


FIG. 15



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UNITED STATES PATENT OFFICE

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RHEOSTAT

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Application September 11, 1943, Serial No. 502,070

12 Claims. (Cl. 201—48)

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This invention relates to variable resistors or rheostats and more particularly to a novel device of this character in which variations in resistance are effected by a combination rolling and wiping action of two relatively movable contacting members. The new rheostat is of simple construction, affords a good contact between the relatively movable members, and is rugged and resistant to wear.

Rheostats of the usual rotary or slide types are not entirely satisfactory for the reason that the sliding movement of the contact over the resistance element causes considerable wear which may in time result in poor contact or breakage.

One object of the present invention, therefore, resides in the provision of a novel rheostat which is relatively free from wear by reason of its inclusion of a contact member adapted to roll over the resistance element with a wiping action to vary the effective resistance. I have found that by the use of a rolling contact which affords a slight wiping action, the friction incident to adjustment of the rheostat may be considerably reduced without sacrificing the desired firmness of contact.

Another object of the invention is to provide a rheostat of novel construction which may be manufactured at low cost, is sensitive to adjustment and affords a good electrical contact at all adjustments.

A further object of the invention is to provide a rheostat having means for pivotally mounting the resistance element and the contact member so that the region of contact remains out of alignment with the centers of movement of the two parts during pivotal movement thereof, whereby such movement results in a combination rolling and wiping action of the contact member on the resistance element.

Still another object of the invention resides in the provision of a rheostat wherein the contact member is in the form of a roller movable along the resistance element at a speed which varies from the linear speed of part of the roller surface contacting the resistance element, so that the rolling movement is accompanied by a wiping action of the roller relative to the resistance.

These and other objects of the invention may be better understood by reference to the accompanying drawings, in which

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Fig. 1 is a side view of one form of the new rheostat;

Fig. 2 is a sectional view on the line 2—2 in Fig. 1;

Fig. 3 is a side view of a modified form of the rheostat;

Figs. 4 and 5 are sectional views on the lines 4—4 and 5—5, respectively, in Fig. 3;

Fig. 6 is a side view of a rheostat similar to that illustrated in Fig. 1, showing schematically an automatic control device associated therewith;

Fig. 7 is a similar view of part of a modified form of the control device;

Fig. 8 is a side view of part of another form of the rheostat;

Fig. 9 is a sectional view on the line 9—9 in Fig. 8;

Figs. 10, 11 and 12 are side views of modified forms of the rheostat shown in Fig. 8;

Fig. 13 is a side view of the rheostat applied to an electric motor to control the motor in accordance with the torque, and

Figs. 14 and 15 are similar views showing different forms of the rheostat applied to a motor to control the speed.

Referring to the drawings, the rheostat shown in Fig. 1 comprises a resistance coil 20 wound on an insulating bar 21. At its upper end, the bar has a laterally extending arm 21a pivotally connected to a stud 22 secured to a suitable support 23. Adjacent the resistance coil is an elongated contact member having an arcuate face 24a normally engaging one face of the coil, the lower end of the contact member 24 being pivotally connected to a support 25, as shown at 26. The contact face 24a is urged against the adjacent face of resistance coil 20 by a tension spring 27 connected between the contact member 24 and the free end portion of bar 21.

The contact member 24 is movable on pivot 26 by means of an operating shaft 28 pivotally connected to the upper end of the contact member. When the member 24 is swung about pivot 26, its curved face 24a rolls along the adjacent face of resistance coil 20, and due to the spaced relation of the pivots for the contact member 24 and the resistance bar 21, respectively, the rolling is accompanied by a sliding action of the contact face 24a over the coil. As a result, a good contact is maintained between the curved face

24a and the coil, and the sliding action tends to remove any foreign matter which might otherwise accumulate between the contacting faces and thereby impair the conduction of current. It will be apparent that as the contact face 24a rolls along the resistance coil, the effective value of the resistance increases or decreases, depending upon the direction of movement of contact member 24 and the manner of connecting the resistance coil in circuit. The spring 27 maintains a firm engagement of the contacting surfaces at all times.

A significant feature of the new rheostat is that the region of contact between the curved face 24a and the resistance coil 20 is always maintained in offset relation to a line between the pivots or centers of movement of the contact member and the resistance, respectively, throughout the range of adjustment of the rheostat. Because of this positioning of the pivot points with respect to the contacting faces, rolling of the face 24a along the resistance coil incident to adjustment of the rheostat is always accompanied by a slight wiping or sliding action. It will be apparent that with the construction shown in Figs. 1 and 2 only a slight movement of the shaft 28 is necessary to operate the rheostat through its full range, since each of the levers 21 and 24 is pivotally mounted at the end remote from the pivoted end of the other lever.

The rheostat shown in Fig. 3 comprises a frame 30 supporting a resistance coil 31 wound on a curved insulating bar 32. At its ends, the bar 32 is connected to the frame by brackets 33 held by screws 34. The resistance coil 31 coacts with a contactor 35 in the form of a thin metal ribbon which is normally curved transversely so that it is trough-shaped. At its upper end, the ribbon 35 is connected to the bracket 33 by means of a rivet 36 extending through the bracket, the insulating bar 32 and the ribbon, the later being suitably insulated from the rivet and the bracket, as shown at 36a. The lower end of the ribbon 35 is connected to one end of an operating lever 37 movable on a pivot 38. A tension spring 39 is connected between the outer end of lever 37 and an arm 40 on the frame, so that the ribbon 35 is normally held in tension against the curved face of resistance 31.

Under the tension of spring 39, the ribbon 35 is wrapped along the resistance coil 31, and the resulting imposition of a lengthwise curvature in the ribbon tends to reduce its transverse curvature and cause the ribbon to lie flat against the resistance. When the lever 37 is operated to draw the ribbon more tightly against the resistance, the resulting transverse flattening of the part of the ribbon moving into engagement with the resistance causes the edges of the ribbon to slide over or wipe the resistance transversely, whereby the desired combination of wiping and rolling actions is obtained. It will be understood that when the outer end of lever 37 is moved downwardly, the effective value of the resistance 31 is changed due to movement of the ribbon progressively out of contact with the intermediate portion of the resistance. Conversely, when the outer end of lever 37 is moved upwardly, the effective value of resistance 31 undergoes an opposite change for the reason that an additional part of the ribbon is drawn against the adjacent face of the resistance.

Referring to Fig. 6, I have shown a rheostat made in accordance with my invention and arranged to control a circuit including a variable load. The rheostat, as shown, is generally similar to that illustrated in Fig. 1 and comprises a resistance coil 40 wound on an insulating bar 41 pivoted at one end on arm 42. The coil 40 cooperates with a contacting member 43 having a curved face 43a normally engaging one face of the coil. The contacting member 43 is pivotally mounted on an arm 44 near the free end of resistance bar 41, and the member 43 projects beyond the arm 44 where it is connected to a tension spring 45 secured to an arm 46. A compression spring 47 is interposed between the resistance bar 41 and a frame 46a and normally urges the resistance coil 40 against the curved face of contact 43.

At its free end, the contact member 43 carries an armature 48 adjacent a pole piece 49 of an electromagnet 50. The electromagnet is supported on a bracket 51 secured to the frame 46a and has an adjustable stop 52 for limiting movement of the arm 43 away from pole 49. The armature 48 is connected to the positive side of a current source 53, the negative side of which is connected through the load, which may be a motor 54, to one side of the winding of electromagnet 50. The other side of the winding is connected through a wire 55 to the outer end of resistance coil 40.

In operation, assuming that there is an increase in the current load due to operation of motor 54, the electromagnet 50 draws armature 48 toward the pole 49. As a result, the curved contact face 43 rolls to the right along resistance coil 40 with a wiping action, as previously described, so that the effective resistance of coil 40 is increased to offset the increase in current through the circuit. Conversely, when the current in the circuit decreases due to operation of the motor 54, armature 48 moves away from pole 49 under the action of springs 45 and 47 and causes the curved contact face 43a to roll to the left along resistance 40, whereby the effective resistance of the coil 40 is decreased to offset the change in current.

The device shown in Fig. 7 is similar to that illustrated in Fig. 6, except that the pole of the electromagnet and the armature on the contact member 43 are of different form. As shown in Fig. 7, the electromagnet 50a has a pole 49a provided with a bevelled face lying adjacent to a parallel bevelled face of an armature 48a on the free end of contact member 43. By thus shaping the pole and the armature, the displacement of the latter may be caused to have the desired relation to the change of resistance. It will be apparent that the opposing faces of the armature and pole may have any other desired form, depending upon the desired relation of armature displacement to resistance variations.

In Figs. 8 and 9, I have shown another form of the rheostat which comprises an arcuate resistance element 57 having a curved face normally engaged by a contact roller 58. The roller is mounted on a shaft 59 journalled on an arm 60 having a bifurcated end portion 60a for receiving the ends of the shaft. The arm 60 is mounted on an operating shaft 61 rotatably mounted in a frame 62. A gear 63 rotatable on the shaft 59 is integral with the roller 58 and meshes with a rack 64 on the frame, the radius of the gear 63 being somewhat greater than the radius of the roller 58.

In operation, when arm 60 is rotated on shaft 61, the gear 63 is rotated by its engagement with rack 64 and drives the roller 58. Due to the dif-

ference in the radii of the gear and the roller, the face of the roller contacting resistance 57 moves along the resistance at a speed somewhat less than the linear velocity of shaft 59, and, therefore, the roller moves along the resistance with the desired rolling and wiping action. By changing the ratio of the radii of the gear and roller, the degree of wiping action may be varied as desired.

A modified form of the rheostat is illustrated in Fig. 10. As there shown, the rheostat comprises a generally circular resistance strip 66 mounted on a stator 67 made of insulating material. The resistance 66 is wound on an insulating bar 66a secured at its ends to the stator by screws 68. A shaft 69 is rotatable in the stator and carries a radial arm 70, and a roller 71 is mounted on a pin 72 on the free end of the arm. The roller projects partly beyond the resistance strip 66 and has one flat side face engaging the strip. Accordingly, when the arm 70 is rotated on shaft 69, the roller 71 rolls along the resistance strip with a sliding or wiping action thereon.

The rheostats shown in Figs. 11 and 12 are somewhat similar to that illustrated in Fig. 10. However, in the rheostat shown in Fig. 11, the sliding or wiping action is obtained by mounting the roller 71a on a threaded arm 70a, the roller having internal threads engaging the external threads on the arm. Thus, when the arm 70a is rotated on shaft 69, the roller moves along resistance strip 66 and also moves radially relative to the strip, the radial movement providing the desired sliding or wiping action. The range of radial movement of the roller along the arm 70a is limited so that the roller always makes contact with the resistance strip within the range of adjustment of the rheostat. In the rheostat shown in Fig. 12, the radial arm 70b carries at its free end a roller 71b, the axis of which is inclined relative to the arm. By reason of the skew mounting of the roller on the arm, movement of the latter results in a combination rolling and wiping action of the roller on resistance 66.

Referring to Fig. 13, I have shown one form of the new rheostat arranged to control a motor 74. The rheostat comprises a stator 75 mounted on and rotatable with the motor shaft and supporting a generally circular resistance element 75a. A load shaft 76 is mounted in alignment with the drive shaft of the motor but is not connected directly therewith, the connection being made through a coil spring 77. The rheostat includes a roller arm 78 projecting radially from the load shaft 76 and carrying a skew-mounted roller 79 similar to the roller 71b, the periphery of the roller engaging one face of resistance 75a. The resistance 75a is connected in circuit with the armature winding of the motor by suitable wiring (not shown) extending through the motor shaft.

In operation, an increase in the load on shaft 76 causes roller 79 to move in one direction along resistance 75a with a combination rolling and wiping action, with the result that the effective resistance in the armature circuit is changed to compensate for the increased load. Conversely, when the load on shaft 76 is decreased, the roller 79 moves in the opposite direction along resistance 75a so that a compensating change is effected in the resistance of the armature circuit. It will be apparent that the drive spring 77 permits relative rotational movement between the motor shaft and the load shaft in accordance with variations in the load.

A modified form of the motor control is illustrated in Fig. 14. As there shown, the drive shaft of the motor 74 carries a head 80 rotatable with the shaft. A resistance strip 81 is pivotally mounted at one end on the head 80 at one side of its axis, and a contact member 82 is pivotally mounted on the head at the oposite side of its axis. The contact member 82 has a curved face 82a which is normally held against one face of the resistance strip 81 by a tension spring 83 connected at its ends to the contact member and the resistance strip, respectively. A weight 84 is mounted on the free end portion of contact member 82 on one side of the axis of rotation of the head 80. In operation, an increase in the motor speed causes the free end of contact member 82 to move outwardly from the axis of rotation under the action of centrifugal force on the weight 84. As a result, the resistance strip 81 moves with the contact member because of its connection thereto through the tension spring 83, the resistance strip moving about its pivot on the head 80. The resulting relative movement of the resistance strip 81 and the contact member 82 causes the curved face 82a of the contact member to roll along resistance 81 with a wiping action. The resistance strip 81 and contact member 82 may be connected by suitable wiring (not shown) into the armature circuit of the motor so that changes in the effective resistance of the strip 81, due to variations in the speed of the motor and the centrifugal force on weight 84, effect a compensating action in the armature circuit of the motor.

I have shown in Fig. 15 a governor 86 mounted on the drive shaft of the electric motor 74 and operatively connected to the free end of a forked lever 87. The lever 87 is pivotally mounted on a pin 88 in a frame 89, which is made of insulating material, and has a curved face 87a normally engaging one face of a resistance strip 90. One end of the resistance strip 90 is supported on a pivot 91 in the frame, and the free end of the strip is engaged by one end of a compression spring 92 seated on a conducting member 92a on the frame, whereby the resistance strip is urged against the curved face of lever 87. The lever 87 is connected through a wire 93 to one side of a current source 94, the other side of the current source being connected to one side of the field winding (not shown) of motor 74. The other side of the field winding is connected through a wire 95, the conducting member 92a and spring 92 to the lower end of the resistance strip.

When the speed of the motor 74 increases, the weights on governor 86 cause lever 87 to move to the left on pivot 88, this movement of the lever causing resistance strip 90 to move to the left on its pivot 91 against the action of spring 92. Accordingly, the curved face 87a of the lever rolls upwardly along resistance strip 90 with a sliding or wiping action so that the effective resistance of the strip is increased. Thus, the current through the field circuit, including resistance 90 and spring 92, is decreased to compensate for the increase in the motor speed. When the speed of the motor decreases, the lever 87 is moved in the opposite direction and causes the curved contact face 87a to roll downwardly along resistance 90 with a wiping action so as to decrease the resistance in the field circuit and compensate for the decrease in motor speed.

In the control devices shown in Figs. 14 and 15, suitable means (not shown) are preferably provided so that the rheostat does not begin to operate until the motor has nearly attained the de-

sired speed, whereupon a small change in speed produces a relatively large change in resistance. An auxiliary "overload" spring may be provided to cut in only when the motor speed reaches a predetermined maximum.

I claim:

1. In a rheostat, a resistance member, a contact member engaging said first member, the contact member and resistance member being movable relatively to vary the effective resistance of said first member, and constraining means for moving said members relatively to cause one of the members to move along the other with a combination rolling and sliding action, the constraining means including pivots about which said members are movable and disposed so that a line between the pivots is offset from the point of contact of the members throughout the range of movement thereof.

2. In a rheostat, a curved resistance strip, a thin metal ribbon adjacent the strip, the ribbon being generally trough-shaped with its concave side facing said strip, and means for wrapping the ribbon progressively along the strip, whereby the ribbon straightens transversely in the region of contact with the strip to cause the edges of the ribbon to wipe the strip.

3. In a rheostat, a resistance strip, a contact arm having a free end portion movable along said strip, a roller turnably mounted on the contact arm and peripherally engaging the resistance strip, and means operatively connected with the roller whereby the peripheral face of the roller contacting the strip moves along the strip at less than the linear velocity of its axis thus to perform a wiping action as it is rolled along the strip by movement of the arm.

4. In a rheostat, a generally circular resistance strip, a contact arm adjacent the strip and pivotally mounted on the axis of curvature thereof, and a roller mounted on the free end portion of the arm and rotatable thereon about an axis parallel to the axis of curvature of the resistance strip, one flat side surface of the roller engaging said strip.

5. In a rheostat, a generally circular resistance strip, a contact arm adjacent the strip and pivotally mounted on the axis of curvature thereof, and a roller threaded on the free end portion of the arm with the peripheral portion of the roller engaging the strip and with the axis of the roller disposed generally transversely of the strip, whereby the roller is screwed generally transversely of the strip as it rolls along the strip on the arm.

6. In a rheostat, a generally circular resistance strip, a radial arm pivoted at the axis of curvature of the strip, a roller engaging the strip, and means for rotatably mounting the roller on the free end portion of the arm with the axis of the roller disposed at an acute angle to the longitudinal axis of the arm, whereby the roller is movable on the arm along the strip with a combination rolling and sliding action.

7. In a rheostat, a curved resistance strip, a curved rack adjacent the strip, an arm pivotally mounted on the axis of curvature of the strip, a roller mounted for rotation on the free end portion of the arm with the periphery of the roller engaging said strip, a gear mounted for rotation on the free end portion of the arm and meshing with the rack, the radii of the gear and the roller being of different lengths, and an operative connection between the gear and the roller whereby movement of the arm causes the roller to roll along said strip with a sliding action due to operation of the gear.

8. In a circuit having a variable load, an electromagnet, a resistance element pivotally mounted at one end and a current source connected in series with the load, a contact arm pivotally mounted at one end portion and having a curved face engaging the resistance element, said pivots being disposed so that a line between the pivots is offset from the point of contact of the members throughout the range of movement thereof and the arm being movable to cause said face to roll along the resistance element with a sliding action to vary the effective resistance thereof, and an armature on the free end portion of the arm and disposed adjacent one pole of the electromagnet for moving the arm in accordance with variations in the current through the electromagnet due to changes in the load.

9. In a circuit having a variable load, an electromagnet, a resistance element and a current source connected in series with the load, a contact arm pivotally mounted at one end portion and having a curved face engaging the resistance element, the arm being movable to cause said face to roll along the resistance element with a sliding action to vary the effective resistance thereof, and an armature on the free end portion of the arm and disposed adjacent one pole of the electromagnet for moving the arm in accordance with variations in the current through the electromagnet due to changes in the load, said pole and armature having their opposing faces bevelled.

10. In combination with an electric motor having a drive shaft and a load shaft operable by the drive shaft, a rheostat assembly for controlling the motor in accordance with variations in the load and comprising a resilient connection through which the load shaft is driven by the drive shaft, whereby the shafts are rotatable relatively upon variations in the load on said load shaft, a generally circular resistance element mounted on one of the shafts and rotatable therewith, a radial contact arm mounted on the other shaft and rotatable therewith, and a roller on the free end portion of the arm engaging the resistance element and movable thereon with a combination rolling and sliding action in response to relative rotational movement of the shafts.

11. In combination with an electric motor having a drive shaft, a rheostat assembly for controlling the motor in accordance with variations in its speed and comprising a head on the shaft rotatable therewith, a resistance element pivotally mounted at one end on the head on one side of the axis of the shaft, a contact arm pivotally mounted at one end on the head on the opposite side of said axis, the arm having a curved face engaging the resistance, a spring normally urging the resistance element and the arm together, and a weight on the arm operable by centrifugal force to move the free end portion of the arm outwardly against the centrifugal force on the resistance element, thereby causing said curved face to roll along the resistance element with a sliding action and vary the effective resistance of said element.

12. In combination with an electric motor having a drive shaft, a rheostat assembly for controlling the motor in accordance with variations in its speed and comprising a governor on the shaft, a pivoted arm operatively connected to the governor and having a curved face, a resistance

element pivoted adjacent the arm and normally engaging the curved face thereof, and means for connecting said element in circuit with the motor including a wire leading from said arm and a spring normally urging the resistance element against the arm, said arm being movable by the governor to cause the curved face to roll along the resistance element with a sliding action and thereby vary the effective resistance of said element.

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