March 21, 1950 W. B. M. CLARK 2,501,159

RHEOSTATIC CONTROL

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Fig. 1

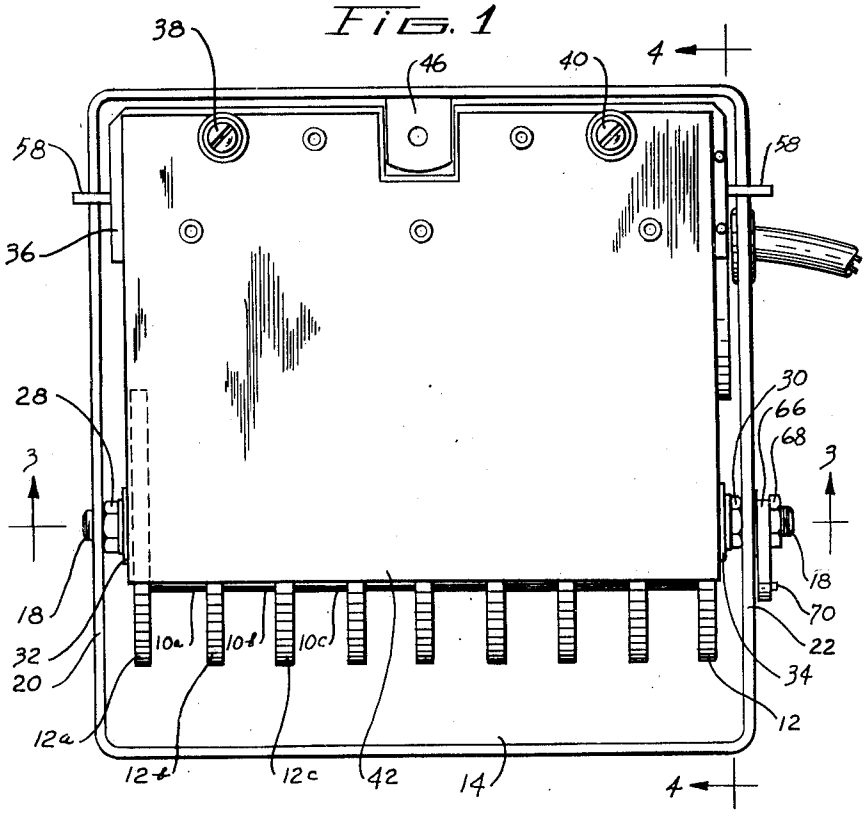
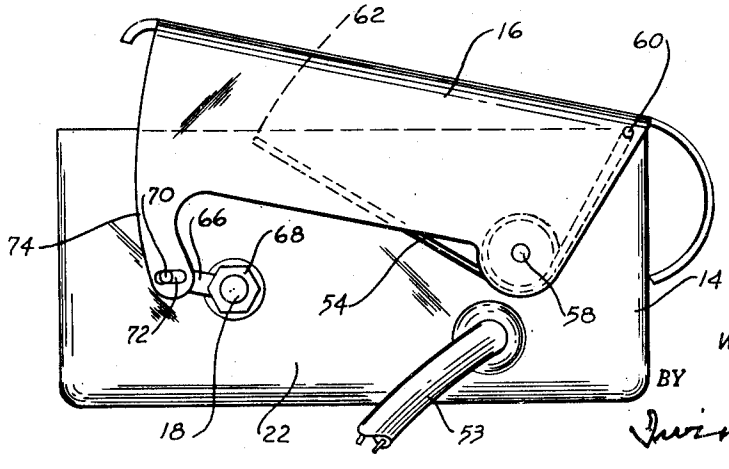



Fig. 2




INVENTOR.
WINSLOW B.M. CLARK

BY Irving F. Wood Dicus

ATTORNEY

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FIG. 3

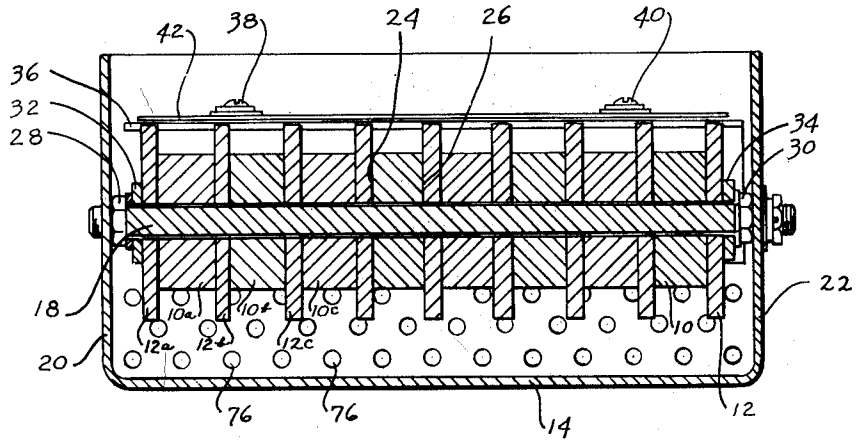



FIG. 4

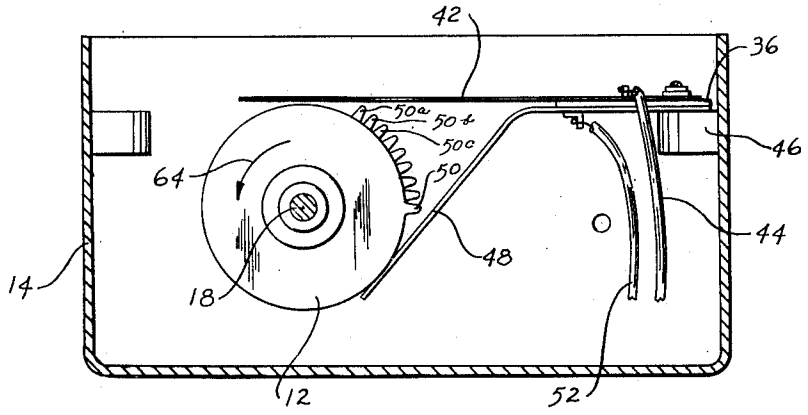



FIG. 6

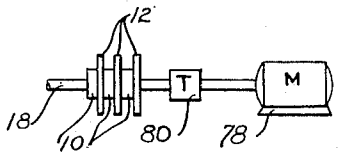
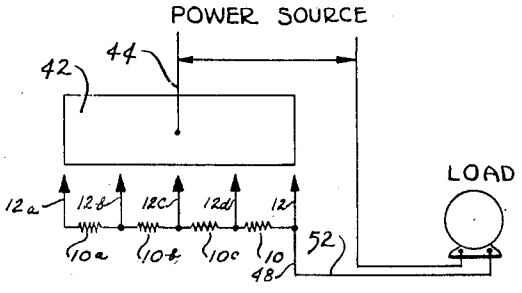



FIG. 5




INVENTOR.
WINSLOW B.M. CLARK

BY Irving F. Goodfriend

ATTORNEY

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# UNITED STATES PATENT OFFICE

2,501,159

## RHEOSTATIC CONTROL

Winslow B. M. Clark, Boulder, Colo., assignor to himself and Hans H. Furn, Orange, N. J., jointly

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7 Claims. (Cl. 201—55)

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The present invention relates to a rheostatic control for sensitively controlling the current requirements necessary to adjust the speed of motors, for example, those used with sewing machines, dental appliances or that demanded in different industrial processes, for example, chemical processes requiring specific current magnitudes to be applied for determined periods of time.

The present invention contemplates the provision of a rheostat which consists of a plurality of resistor elements, preferably formed from a granular-like resistance material held together by a binder to form a disc and which elements each have a fixed resistance of predetermined value, the opposite faces of which elements are preferably coated with a metal, the resistor elements being separated on a rotatable shaft by means of cams secured to the shaft, which is electrically insulated from both the cams and the resistor elements. Each resistor element is in electrical contact with the next element through the metallic cam between them and are therefore connected in series in the rheostat. The active resistance of the rheostat therefore is the sum of the resistances of the resistor elements which are electrically connected in the circuit to be controlled by means of the members of the rheostat.

The rheostat of the present invention contemplates the provision of means for shunting from the circuit in selected number one or more resistor elements to control the resistance of the circuit in which my invention is connected whereby the resistance of the circuit is reduced by the combined values of the resistor elements selectively shunted from the circuit.

Heretofore, rheostats in which were arranged resistor elements that were formed from composition resistance materials, conventionally referred to as carbon piles or disks, relied upon the change in contact area between the adjacent faces of abutting piles or disks, brought about by compression in a direction normal to the disk faces, to vary the resistance of that type of rheostat. That is, the resistance of such rheostats was reduced by increasing the pressure applied to the disk or pile. It was therefore difficult to maintain an initial calibration of such carbon pile or disk rheostats since the contact area (and thus the resistance) between the abutting disks depended not only on pressure but also on the relative flatness of the disk faces. Therefore, it will be recognized, that as the surface of the disk faces changed, for any reason

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such as wear, arcing and rotary shifting, the resistance associated with a particular pressure also changed.

The resistance of such prior art carbon pile or disk rheostats dropped off very rapidly on application of initial pressures. Further increments of pressure produced increasingly less change in resistance, until finally, as the contact area approached a maximum, little or no change in resistance was effected by additional increases in pressure. Since the greatest change in resistance of such prior art carbon pile rheostats occurred for a relatively small initial pressure increment, ease of sensitively selecting a desired resistance by conventional control levers was lacking.

Further, designs of prior art carbon pile rheostats required individual initial pressure adjustments in order to obtain a desired total initial resistance of the assembled pile.

On the other hand, a rheostat according to the present invention, while utilizing resistor elements formed from a like granular resistance material held together by a resinous binder and therefore having its advantages (as distinguished from a wire resistor) namely, long life, nonfatiguing and no instability due to breakage because thereof, low heat generation, relatively small space requirements because of high resistivity and comparatively low cost, nevertheless has none of the disadvantages of prior art composition disc or pile rheostats.

The present invention, as distinguished from heretofore known carbon disk or pile rheostats, does not in any way rely upon imposing pressures thereon to adjust its resistance.

Further, the rheostat of the present invention, as distinguished from prior art composition disk or pile rheostats, is comparatively rugged since no wear is imposed on the disks or piles from subjecting them to pressure which would result in their breakage; is not impossible of fine adjustment which obtains with the said prior art composition disk or pile rheostats occasioned by the difficulty in repeating the same resistance with the same pressure nor in my invention is there the necessity of physical abutment of the resistor elements since they need only be in some manner electrically connected.

Further, in the rheostat of the present invention, there will be no change of an achievable value of resistance with a given position of the control member. With carbon pile rheostats of the prior art, however, because of disk breakage, and influences of variations in temperature of the resistor elements, vibration and shocks, a

continuous change of the relative position of the disks and thus the amount of surface contacts took place with the result that a change in resistance occurred without a change of control pressure.

The present invention permits the provision of a rheostat which has all the positive advantages of wire resistors which will have any desired resistance characteristic required, because the resistance of each resistor element will remain fixed and each can be chosen in any relative arrangement. Since these resistor disks are mounted on a rotatable shaft and separated by cams on the shaft by means of which any selected resistor element or group of elements may be connected in the circuit during any sequence of shaft rotation, the present invention is particularly adapted to the automatic control of any industrial process.

The present invention still further contemplates the provision of such a rheostat in which there will be no arcing between the cams and disks, because these members will be maintained in firm and stable, metal to metal, contact whereas with carbon pile rheostats of the prior art, there existed a condition between the disks favorable to arcing, namely low contact pressure of high resistivity surfaces.

The present invention still further contemplates the provision of such a rheostat which is extremely versatile since rotating cams, the contact noses of which may be selectively varied or designed, determine the resistance of the unit at a selected period of rotation and in which the cams also serve as cooling fins to prevent overheating of the rheostat.

The present invention still further contemplates such a rheostat which is relatively indestructible, is not subject to wear and is completely independent of any critical pressure requirement for calibration.

Further, although the rheostat of the present invention has all the advantages of wire wound resistors with respect to their stable characteristics, it does not have their disadvantages arising from susceptibility to breakage, high working temperature, relatively large space requirements and high costs.

These, other and further objects and advantages of the present invention will be clear from the description which follows and from the drawings appended thereto, in which

Fig. 1 is a top plan view of a rheostat according to my invention, the pivoted cover being removed to disclose the apparatus underneath;

Fig. 2 is a side view of my rheostat;

Fig. 3 is a section on the line 3—3 of Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is a schematic wiring diagram of my rheostat;

Fig. 6 is a schematic view of a modification of my rheostat.

Referring now to the drawings, the resistor units 10 and the contact cams 12 are housed in the casing 14 on which the cover 16, which serves as a control member, here in the form of a foot treadle, is pivotally mounted.

Each resistor unit 10 is mounted on the electrically insulated shaft 18, which is journaled in the sides 20 and 22 of the casing 14 and is separated from an adjoining unit by a cam 12. Each resistor unit is in contact on each side with a cam.

The resistor units are preferably formed from a suitable composition material, an example of which is the conventional granular resistance carbon disk as used in a pile, held together by a suitable resin binder, though other such composition materials will occur to those skilled in the art. Each unit 10 is preferably metalized, that is coated on each parallel side surface 24 and 26 thereof with a copper spray to insure a good surface contact between the unit and the abutting surfaces of the metallic cams 12, which latter are preferably formed of copper.

Each unit 10 therefore has a fixed pre-selected resistance which is independent of any pressure that may be placed upon it, will not vary in service and has a long life by reason of its composition. It will of course be further understood that any type of material may be used to form the resistor units, which also may be made from a metal alloy of high resistivity. While I have shown the resistor units 10 to be made in the form of disks or cylinders, it will be understood that any other selected form or shape may be used.

The resistor units 10 and the separating metal cams 12 are drawn together on the shaft 18 between the nuts 28 and 30 which hold them on the shaft between the insulating washers 32 and 34.

The nut 30 is pulled tightly enough to prevent moving of any element on the shaft relatively to each other and assure that the entire assembly will move as a unit.

Since the resistance of each unit is independent of any pressure placed upon it, care need not be taken to hold the units and cams together by a force having a particular value. The unit therefore may be assembled by relatively unskilled labor.

Secured to the insulating shelf 36 at the rear of the casing 14 by any suitable means, such as the screws 38 and 40, I provide the resilient conducting wiper plate 42, which is tensioned downward against the noses 50 of the cams 12 to make contact with them for the purposes which I shall hereinafter point out.

This wiper plate 42 is connected by means of the wire 44 to one side of the power source (see Fig. 5) and therefore connects it to the cams and the resistor units 10 when the rheostatic control is operated. Beneath this wiper plate and also secured to the shelf 36, which is formed of an insulating material and itself is secured to the lug 46 on the rear wall of the casing 14, I secure the contact finger 48, the end portion of which is bent down and tensioned against the first cam 12 of the series of cams.

The finger 48 is connected by means of a wire 52 to the load (see Fig. 5), which load is connected to the other side of the power source.

The wires 44 and 52 are carried in the cable 53, which extends from a wall 22 of the housing 14 so that the rheostat may be plugged into the circuit for the motor or process to be controlled.

The nose 50*a* of the end cam 12*a* is arranged to be brought into wiping contact with the contact plate 42 when the shaft 18 is operatively rotated by the member 16, as I shall describe. The shaft 18 is normally held in starting position, as illustrated in Fig. 4, by the torsion spring 54, as I shall explain in further detail so that no cam nose is in contact with the plate 42 which, of course, keeps open the circuit through the rheostat, thereby constituting a switch.

The member 16 is mounted on the lugs 58 extending from the sides 20 and 22 and is held in normal position by the wire torsion spring 54, one end 60 of which is connected to the member 16 and the other end 62 of which is connected to

the casing wall 22, the nose 50a as stated, normally out of contact with the plate 42.

In order to rotate the cams and resistors on the shaft 18 in the direction of the arrow 64 (Fig. 4), I connect the member 16 thereto by means of the link 66, which is keyed to the shaft 18 and held thereon by the nut 68.

A pin 70 is arranged on the end of the link 66 and rides in the slot 72 in the finger 74 extending down from the member 16. Thus, when the member 16 is forced downwardly, the shaft 18 is rotated to bring the nose 50a into contact with the plate 42.

Thus, the circuit through the rheostat is closed. The circuit is made from one side of the power source through the wire 44, the plate 42, the cam 12a, the resistor unit 10a, the cam 12b, resistor 10b and the remaining cams and resistor units to the cam 12 which is always in contact with the finger 48, through the wire 52 to the load and back to the other side of the power source.

The cams 12 are arranged relatively to one another on the shaft 18 so that the cam noses 50 are angularly positioned relative to one another around the periphery of rotation of the resistor unit formed by the shaft, cams and resistors. In one of the rheostats, which I have made, I have found that good results have been obtained by making the angle between the radii from the center of the axis 18 to the center of the cam nose 50 equal to seven degrees. This angular position can be varied and is conditioned by the desired characteristic of the process or time-current relation to be controlled.

To put it another way, the nose of a cam in the direction of rotation leads the nose that follows by a seven degree angle, which of course may be varied, as desired, to meet any condition in practice.

Upon continued rotation of the shaft 18, the nose 50b of the next cam 12b is brought into engagement with the plate 42 and the nose 50a of the cam 12a is withdrawn from engagement with the plate 42. The circuit is now made from cam 12b through the remaining resistor units through cam 12, thus shunting the resistor 10a from the circuit and so reducing the resistance in the circuit.

Continued rotation of the shaft 18 will progressively shunt resistors from the circuit until the nose 50 of the cam 12 is brought into contact with the plate 42, when all the resistor units are shunted from the circuit.

Thus, the resistance of the rheostat may be controlled by bringing any number of resistor units from zero to the total number thereof into the circuit by corresponding movement of the control member 16. It will be also apparent that any number of resistor units 10 may be selected so that the resistance may be varied in relatively small increments of equal magnitudes or of any other desired values, making it possible to obtain and reproduce any desired characteristic.

There is therefore made available a rheostat which is formed from composition resistor units which has all its advantages without any of the disadvantages of units that heretofore used such composition piles or disks and which rheostat also has all the advantages of wire wound rheostats without any of their disadvantages.

Although the heat generated by the resistor units is comparatively low, I provide in the front and rear walls of the casing 14, the vent openings 76. It will be noted that the cams 12 will also serve as cooling fins for the resistor units.

The cam shaft 18 may be driven by a motor 78 (see Fig. 6) through, if desired, a train of gears 80 that will control the speed of rotation of the shaft and thus hold a selected nose 50 in contact with the plate 42 so that a selected resistance will be thrown in the circuit for a selected time. In such event, it will be recognized that the profile of the cam nose will be designed or shaped to maintain the corresponding cam in engagement with the plate 42 for the desired length of time instead of forming the noses for point engagement as illustrated in Fig. 4.

It will be recognized that the composition material from which the resistance units are formed is one that is adapted to be accurately manufactured so that the resulting unit is thereby given a specific predetermined and substantially unchanging resistance value.

It will still further be recognized that both the disks and fins may be formed from a granular resistance material that is held together by a suitable binder in which event the surfaces of the disks and fins which are in mutual contact are metalized as will be the nose 50, 50a etc. of each fin and the entire peripheral surface of the fin 12 at the end of the plurality of fins that is engaged by the finger 48.

It will be further recognized that each cam may be provided, in such case, with one or more spaced cam noses and that the cam noses on each cam will be so relatively positioned that a resistance having the selected value will be thrown in the circuit for the time desired.

While I have shown in detail embodiments of my invention, I do not intend to be limited thereto but wish to claim my invention as broadly as the scope of the prior art and the appended claims permit.

I claim:

1. In a rheostatic controller for arrangement in a circuit, a housing, a shaft journaled for rotation therein, a plurality of resistors mounted on the shaft to form a resistance unit, a first cam on one side of the resistance unit on the outside thereof, a second cam on the other side of the resistance unit on the outside thereof, the first and second cams being in electrical contact with the resistance unit, each resistor formed from a granular resistance material held together by a binder to form a disk having a smooth surface, each resistor being of selected size and shape to form an exact predetermined resistance, intermediate cams separating the resistors, the resistors and the cams movable with the shaft, a plate spaced from the resistance unit and extending from one side thereof to the other side thereof, the said plate for connection to a source of power, each cam having a single nose extending radially from the periphery of the cam and being of the same shape and size, a finger for connection to a load, said finger in electrical contact with the periphery of the first cam, the noses positioned relatively to each other around a longitudinal axis through the unit to thereby bring into contact with the plate upon rotation of the shaft whereby the circuit is completed through the source of power, the rheostatic controller, the load and a resistance equal to that of the resistors between the first cam and the cam the nose of which is brought into contact with the plate.

2. The rheostatic controller of claim 1, the nose of each cam having a selected angular relation to the nose on any other cam whereby the resistance inserted in said circuit may be varied

in selected predetermined unvarying reproducable increments of resistance.

3. In a rheostatic controller, a rotatable shaft, a variable resistance and spaced cams comprising a first mentioned cam, a second mentioned cam and intermediate cams unit mounted on said shaft and rotatable therewith, said unit formed from a plurality of spaced resistors, each resistor formed from a granular resistance material held together by a binder and of selected size to form a disk having an unvarying predetermined resistance, the first mentioned cam one one side of the resistance unit on the outside thereof, the second mentioned cam on the other side of the resistance unit on the outside thereof, said resistors mounted on the shaft between said first mentioned and second mentioned cams with an intermediate cam separating a pair of adjacent resistors, each of said cams in contact with the resistor adjacent it, the cams formed from an electrically and thermally conducting material and being of the same shape and size, the diameters of the cams larger than the diameters of the resistors whereby the peripheries of said cams extend beyond the peripheries of the resistors, said cams constituting cooling fins for the resistance unit, a resilient means for connection to one side of a circuit, a second resilient means for connection to the other side of the circuit, said second resilient means in contact with the periphery of the first cam, and a cam nose on the periphery of each cam, the nose on each cam normally out of contact with said second mentioned means, and the cam noses positioned angularly relatively to each other around the rotatable shaft of the resistance unit on the periphery thereof to bring a selected cam nose into contact with the first mentioned resilient means upon rotation of the shaft to shunt selected resistors between the selected cam and the second mentioned cam from the circuit, the resistance of the resistance unit in the circuit being that of the total number of resistors between the first cam and the cam the nose of which is brought into contact with the first resilient means.

4. The rheostatic controller of claim 3 and including means for rotating the shaft.

5. In a rheostatic controller for arrangement in a circuit, a plurality of resistor disks formed from a granular resistance material held together by a binder, said resistor disks of selected



size and shape and thereby having an unchanging resistance of predetermined magnitude, a fin of greater diameter than the disks on each side of a disk and in contact therewith, said disks and fins rotatable as a unit about an axis passing through the center of the disks and together forming a variable resistance unit, a nose on the periphery of each fin, the noses on the fins arranged relatively to one another in spaced angular relation around the axis about which the fins are rotatable, means in contact with the periphery of the fin at one end of the resistance unit for coupling the rheostatic controller to one side of the circuit and second means for connecting the rheostatic controller to another side of the circuit, the noses on the fins normally out of contact with the second means and arranged relatively to each other so that only the nose on one of the fins at a selected position of rotation is brought into contact with the second means upon rotating the disks and fins as a unit about the said axis around which they are rotatable, the circuit completed through the first mentioned means and the fin contacted thereby and the second mentioned means and the nose of the fin contacted thereby, the resistance of the variable resistance unit being dependent upon the resistance thereof between the fin contacted by the first mentioned means and the nose of the fin contacted by the second mentioned means.

6. The rheostatic controller of claim 5, the surfaces of the sides of the disks being throughout in contact with the surfaces of the adjacent fins and being metalized.

7. The rheostatic controller of claim 5 and including control member for rotating the fins and disks as a unit to bring the nose on a selected fin into contact with the second means to thereby adjust the resistance inserted between the first and second means.

WINSLOW B. M. CLARK.


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