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L. J. HIBBARD

CONTROL APPARATUS

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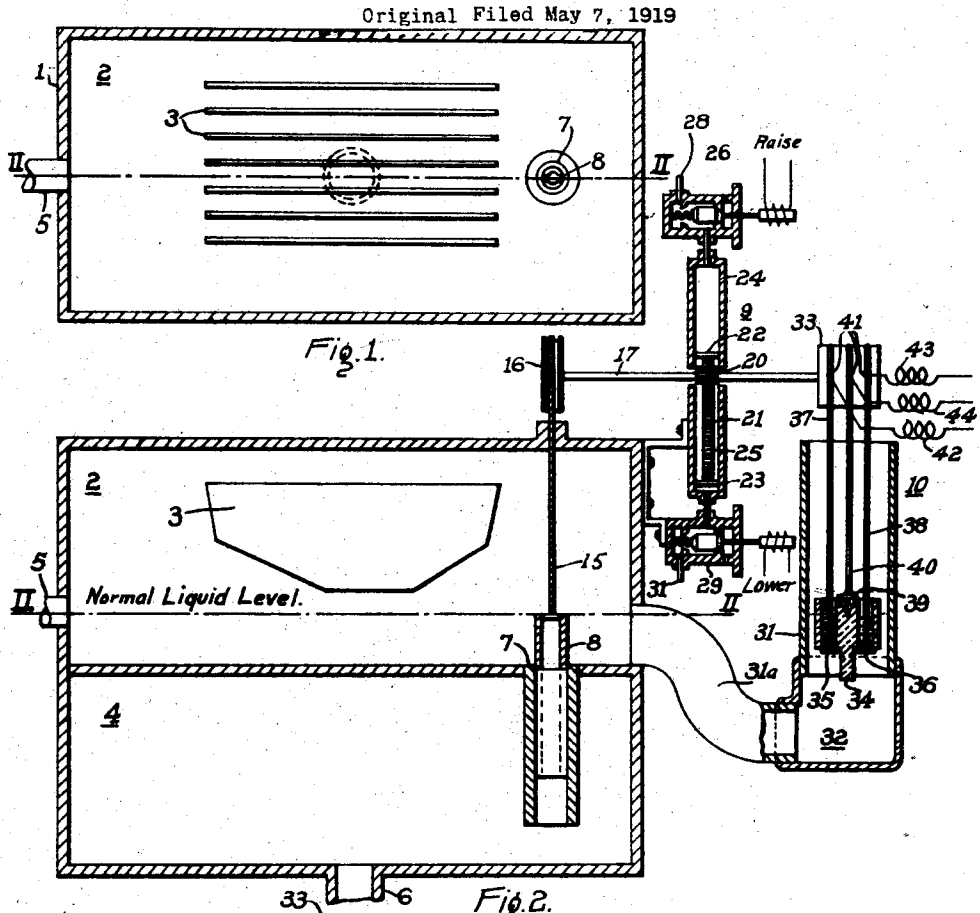


Fig. 1.

Fig. 2.

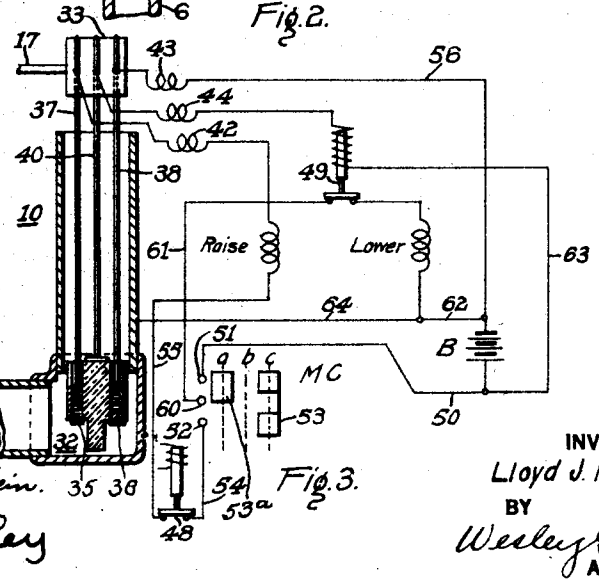


Fig. 3.

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UNITED STATES PATENT OFFICE.

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CONTROL APPARATUS.

Continuation in part of application Serial No. 295,378, filed May 7, 1919. This application filed March 1, 1924. Serial No. 696,173.

My invention relates to control apparatus and it has special relation to the control of liquid rheostats of the type wherein the liquid level is varied to change the resistance of a circuit to be controlled.

The object of my invention is to provide an apparatus of the above-indicated character whereby a definite mechanical or positional relation is maintained between the level of the rising or falling liquid and the operating mechanism that causes such rise or fall.

More specifically stated, it is the object of my invention to provide an interlocking device or relay block that moves up and down with the actuating mechanism for the liquid rheostat and co-operates with the surface of the liquid medium to control the auxiliary electric circuits that effect movement of the actuating mechanism.

My invention may best be understood by reference to the accompanying drawing, wherein

Figure 1 is a simplified view, in transverse section, of a liquid-rheostat tank that may be employed in connection with my present invention.

Fig. 2 is a view, in longitudinal section, taken along the line II—II of Fig. 1, together with a corresponding sectional view of an operating mechanism for the rheostat and a view, partially in section and partially in elevation, of my improved interlocking apparatus, and

Fig. 3 is a diagrammatic view of the auxiliary control circuits that are governed by my relay block to control the operating mechanism that is illustrated in Fig. 2.

Referring to the drawing, the apparatus shown comprises a liquid rheostat 1 having an upper compartment 2 that contains a number of plates or electrodes 3 for the usual purpose of co-operating with the electrolyte or liquid medium in the rheostat for governing the secondary circuit of an induction motor, for example. The rheostat 1 also comprises a lower compartment or reservoir 4; an inlet pipe 5 that communicates with the upper compartment 2; and an outlet pipe 6 that communicates with the reservoir 4. The present rheostat employs a continuous flow of electrolyte from the inlet 5 to the outlet 6, such stream of liquid being circulated by means of a suitable pump, which need not be illustrated here because well known in the art.

A cylinder 7 is provided in the partition or wall between the upper and the lower rheostat compartments, and a movable valve member 8 co-operates with the cylinder 7 to normally allow the discharge of liquid from the upper compartment 2 to the reservoir 4, and also to regulate the height of the liquid in the electrode-containing compartment under operating conditions, as hereinafter more fully described.

An operating mechanism 9, preferably of a familiar electrically-controlled, pneumatically-actuated type, as set forth in detail later, is provided for actuating the valve member 8, while my improved interlocking device or relay block 10 is associated with both the valve member 8 and the operating mechanism 9, being actuated in accordance with the movements of the mechanism 9 to control such movement in conjunction with the level of the liquid in the rheostat, as will be more fully explained hereinafter.

The valve member 8 may be of any suitable form and is here shown as comprising a hollow cylinder slidably engaging the inner surface of cylinder 7. The valve member 8 normally occupies the position shown with respect to the cylinder 7, whereby liquid is discharged from the upper compartment 2 through the valve member 8 into the reservoir 4 without coming in contact with the electrodes or plates 3. The valve member 8 is adapted, under operating conditions, to force the liquid level to correspondingly rise in the upper compartment 2 to a plane that is determined by the upper surface of the valve. In this way, the position of the valve member 8 fixes the depth of immersion of the electrodes 3, or, in other words, the resistance of the circuit to be controlled, the excess liquid being discharged downwardly through the hollow valve into the reservoir 4.

The valve member 8 is actuated by means of a rope or chain 15 that passes over a pulley or sheave 16, which is secured to a rotatable shaft 17. The operating mechanism 9 comprises a pinion 20 that is also attached to the shaft 17 and is adapted to mesh with a transversely movable rack member 21, the

opposite ends of which constitute pistons 22 and 23 traveling within suitable operating cylinders 24 and 25, respectively. A valve member 26, having an actuating coil "Raise," normally occupies the illustrated open position to permit access of fluid pressure from any suitable source (not shown) through a pipe or passage 28 to the operating cylinder 24. A similar valve 29, having an actuating coil "Lower," also normally affects communication between a fluid-pressure inlet pipe or passage 31 and the other operating cylinder 25.

Consequently, balanced high-fluid-pressure conditions obtain in the two ends of the operating mechanism 9 to maintain the apparatus in any desired position. However, upon the energization of the coil "Raise", fluid-pressure is exhausted from the upper cylinder 24 through the valve 26 to the atmosphere, thereby permitting the high fluid-pressure in the cylinder 25 to actuate the piston members upwardly and also effect upward movement of the valve member 8 by means of the illustrated rope-and-sheave device. Upon de-energization of the coil "Raise", balanced high-pressure conditions again obtain in the operating mechanism to hold it in the desired position.

To effect the return or downward movement of the valve member 8, the other actuating coil "Lower" is energized to effect the release of fluid-pressure from the operating cylinder 25 through the valve 29 to the atmosphere, thereby causing the high fluid-pressure in the other operating cylinder 24 to force the piston members downwardly and thus also produce the desired downward movement of the liquid, rheostat valve member 8.

My interlocking device 10 is shown as employing a vertical tube 31, the lower end of which communicates with the upper compartment 2 of the liquid rheostat through a connecting tube 31^a, while the upper end is located above the maximum level of the liquid in the rheostat and is open to the atmosphere. It will be appreciated that, for the sake of clearness, the interlocking device and the tube have been illustrated on an enlarged scale, and that a relatively small and inexpensive structure is all that is actually necessary.

The relay block proper, designated as 32, moves up and down within the vertical portion of the tube 31 in accordance with the movement of a drum or cylinder 33 that is secured to the operating shaft 17.

The relay block 32 comprises a body portion 34 of suitable insulating material that is heavier than the liquid medium to be employed in the rheostat, thus preventing flotation of the relay block, and is provided, on its under surface, with a pair of contact members or studs 35 and 36 which are electrically secured to wires or conductors 37 and 38, respectively, of steel or other material having a relatively high tensile strength. A third contact terminal or screw 39 is located upon the upper surface of the relay block 34 and is also electrically connected to a suitable conductor or wire 40. The three conductors mentioned pass over the cylinder or drum 33, being secured to the drum at points 41 that will provide sufficient lengths of conductor to permit the desired up and down movement of the relay block. Suitable flexible conductors 42, 43 and 44 are connected to the supporting conductors 37, 38 and 40, respectively, for the purpose of effecting electrical connection with the auxiliary controlling circuits that are illustrated in Fig. 3.

It will be evident, from the illustrated construction and location of the interlocking device 10, that the relay block proper moves up and down in exact accordance with the movements of the rheostat valve member 8, while the contact members 35, 36 and 39 and the corresponding supporting conductors 37, 38 and 40 may be employed in conjunction with the surface of the liquid in the rheostat (the liquid surface in the tube 31 being on the same level as that in the rheostat proper) to control the electrical circuits that govern the actuation of the operating mechanism 9.

Referring to Fig. 3, the control system shown comprises, in addition to the circuits of the interlocking device 10 and the actuating coils "Raise" and "Lower" of the operating mechanism 9, a master controller MC for primarily governing the operation of the auxiliary circuits by directing energy from any suitable source, such as a battery B, through the desired circuits, including the surface of the liquid in the tube 31; and also a main-circuit current relay or limit switch 48 and an auxiliary-circuit relay 49 for governing certain of the illustrated circuits in a manner about to be set forth.

Assuming that the apparatus occupies the positions illustrated, to effect a rise in the level of the liquid in the rheostat from the normal level in the compartment 2, as shown in Fig. 2, the master controller MC may be moved to its final operative position *c*, whereby a circuit is established from the positive terminal of the battery B through conductor 50, control fingers 51 and 52, which are bridged by contact segment 53 of the master controller, conductor 54, contact members of the main-circuit current relay 48 in its lower or circuit-closing position, conductor 58, actuating coil "Raise" of the operating mechanism 9, flexible conductor 42, supporting conductor 37, lower contact members 35 and 36 of the relay block 34, which are initially immersed by reason of their relatively low position in the tube

31, whence circuit is completed through supporting conductor 38, flexible conductor 43 and conductor 56 to the negative terminal of the battery B. Consequently, the operating mechanism 9 is actuated to move the valve member 8 upwardly, in accordance with previously described principles, whereby the electrodes or plates 3 are gradually immersed and whereby, also, the relay block 34 is gradually moved upwardly in synchronism with the movements of the valve member 8.

It will be understood, without detailed explanation, that the illustrated current relay 48, being governed by the main-circuit current, energizes and de-energizes the actuating coil "Raise" in accordance with the flow of current through the liquid rheostat and the electrodes 3, whereby this current is maintained substantially constant, in accordance with a familiar practice.

In previous types of rheostats, which have not been provided with my interlocking device 10, considerable difficulty has been experienced in regulating the rate of flow of the electrolyte to cause the upper surface thereof to rise and fall synchronously with the regulating valve 8. Consequently, the train operator has not been able to govern the acceleration or retardation of the vehicles under his control as smoothly and reliably as desirable. However, by the provision of my interlocking device 10, such difficulties are obviated, since an exact relation between the positions of the electrolyte surface and of the regulating valve 8 is maintained at all times.

This desirable result is effected through the agency of the illustrated contact members of the interlocking device acting in conjunction with the surface of the liquid in the tube 31. Under the assumed conditions, when the liquid level is being raised, the actuating coil "Raise" cannot be energized, irrespective of the position of the main-circuit current relay 48, unless the electrolyte in the tube 31 and, therefore, in the main rheostat proper, has reached a height sufficient to immerse the contact members 35 and 36, this height being exactly determined by the position of the regulating valve 8 by reason of the mechanical connection between the regulating valve and the relay block 34.

Assuming that it is desired to effect the reverse control of the liquid rheostat, that is, to lower the level of the electrolyte, the master controller MC is actuated to its position *a*, whereby a circuit is established from the positive terminal of the battery B through conductor 50, control fingers 51 and 60, which are bridged by contact segment 53ª, conductor 61, the contact disk of the auxiliary relay 49, provided that the relay occupies its lower or de-energized position, whence circuit is completed through the actuating coil "Lower" and conductor 62 to the negative battery terminal. The operating mechanism 9 is thus actuated to cause the regulating valve 8 and the interlocking device 10 to gradually recede to their initial lowermost positions.

However, such energization of the actuating coil "Lower" is permitted only when the relay device 49 occupies its lower position, which is dependent upon the location of the relay block 34. Whenever the surface of the liquid in the tube 31 is on a plane flush with or above the upper contact member 39 of the relay block, then a circuit is established from the positive terminal of the battery B through conductor 63, the actuating coil of the auxiliary relay 49, flexible conductor 44, supporting conductor 40, contact terminal 39 of the relay block, the electrolyte in the tube 31, and thence, through conductor 64, which is electrically attached to the tube 31, and conductor 62, to the negative battery terminal. In other words, the relay 49 prevents the lowering of the electrolyte level unless that level is already below the contemporaneous position of the contact member 39 of the relay block 34, which position is exactly determined by the corresponding position of the regulating valve 8.

It will be seen that, by the use of my interlocking device 10, "hunting" of the rheostat, that is, non-synchronous movements of the regulating valve 8 and the level of the electrolyte in the rheostat are positively precluded, since the relay block 34 is, at all times, positioned in exact accordance with the location of the regulating valve, while the height of the liquid in the tube 31 is continuously the same as the height of the electrolyte in the rheostat proper. These two conditions are thus co-ordinated by the use of my interlocking device 10 to effect synchronous movement of the electrolyte level and of the regulating valve of the rheostat.

I do not wish to be restricted to the specific structural details, circuit connections or arrangement of parts herein set forth, as various modifications thereof may be made without departing from the spirit and scope of my invention. I desire, therefore, that only such limitations shall be imposed thereupon as are indicated in the appended claims.

I claim as my invention:

1. In a rheostat, in combination, a container for electrolyte, electrodes disposed in the container and means subject to the flow of current through the rheostat for controlling the level of the electrolyte in the container.

2. In a rheostat, in combination, a container for electrolyte, electrodes disposed in the container, means for varying the level

of the electrolyte in the container, and means dependent upon the flow of current through the rheostat for maintaining a predetermined relation between said level-varying means and the level of the electrolyte in the container.

3. In a rheostat, in combination, a container for electrolyte, electrodes disposed in the container, means for varying the level of the electrolyte in the container, means for actuating the level-varying means, and means controlled by the current flowing through the rheostat for interrupting the operation of said actuating means whereby said electrolyte level is controlled to maintain a substantially constant current.

4. In a liquid rheostat, the combination with a movable valve for controlling the liquid level, of means actuated in synchronism with said valve and acting in conjunction with the level of the liquid for maintaining substantially equal heights of the valve and the liquid level.

5. In a liquid rheostat, the combination with a movable valve for controlling the liquid level, of means mechanically actuated in synchronism with said valve and electrically employing the liquid for maintaining substantially equal heights of the valve and the liquid surface.

6. In a rheostat, in combination, a container for electrolyte, a plurality of electrodes disposed in the container, means for varying the level of the electrodes in the container to control the resistance of the rheostat, the operation of said means for varying the level of the electrolyte being dependent upon the current flowing through the rheostat.

7. In a rheostat, in combination, a container for electrolyte, a plurality of electrodes disposed in the container, a movable valve for controlling the level of the electrolyte in the container, actuating means for the valve, means movable with the valve for interrupting said valve-actuating means, and means adapted for operation when the valve moves to limit its movement to a predetermined distance independent of a corresponding movement of the level of the electrolyte.

8. In a liquid rheostat, the combination with a movable valve for controlling the liquid level, of an electrically-governed operating mechanism for said valve, and means actuated in synchronism with said valve and acting in conjunction with the liquid level for electrically governing said operating mechanism.

9. In a liquid rheostat, the combination with a movable valve for controlling the liquid level and means for actuating the valve, of an inter-locking member movable up and down with the valve, contact members carried by the interlocking members, the contact members being disposed for movement into and out of the liquid to control the movements of said valve-actuating means thereby to maintain a predetermined relation between the positions of the liquid level and the valve.

10. In a liquid rheostat, the combination with a movable valve for controlling the liquid level, of an electrically-governed operating mechanism for said valve, of an interlocking member movable up and down with the valve and embodying contact members adapted to form electrical circuits with the liquid for governing said operating mechanism.

11. In a liquid rheostat, the combination with a movable valve for controlling the liquid level, of an interlocking member having a plurality of suspending conductors and a plurality of contact members attached thereto, and means for paying out or retrieving said conductors in accordance with the movements of said valve.

12. In a liquid rheostat, the combination with a movable valve for controlling the liquid level, of an electrically-governed operating mechanism for said valve, of an interlocking member having a plurality of suspending conductors and a plurality of contact members attached thereto, and means for paying out or retrieving said conductors in accordance with the movements of said valve to form electrical circuits including the liquid and said contact members for governing said operating mechanism.

In testimony whereof, I have hereunto subscribed my name this 4th day of February 1924.

LLOYD J. HIBBARD.