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J. F. SHANNON
CONTROL MECHANISM

2,541,299

Filed May 8, 1947

2 Sheets-Sheet 1

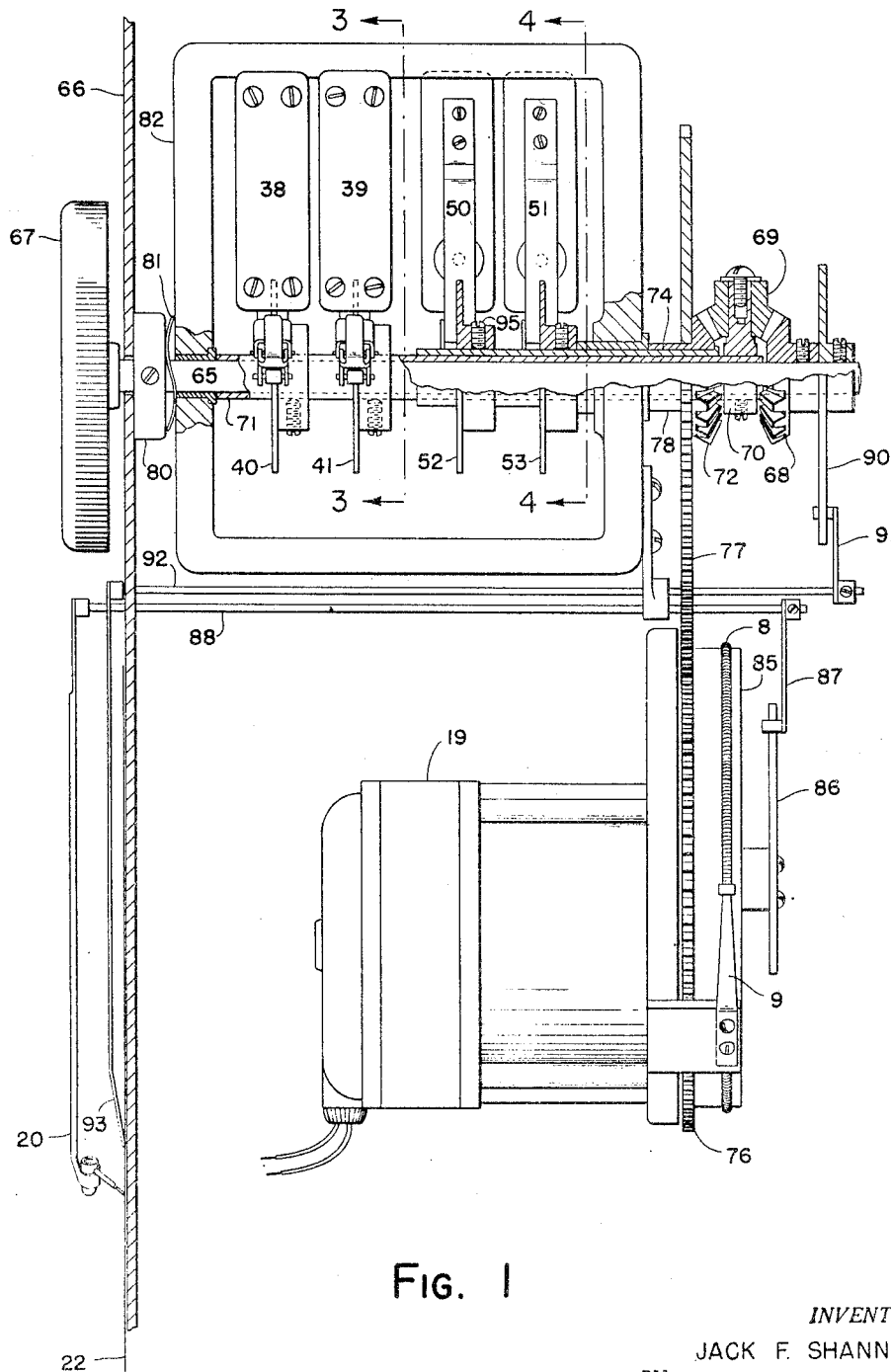


FIG. 1

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2 Sheets-Sheet 2

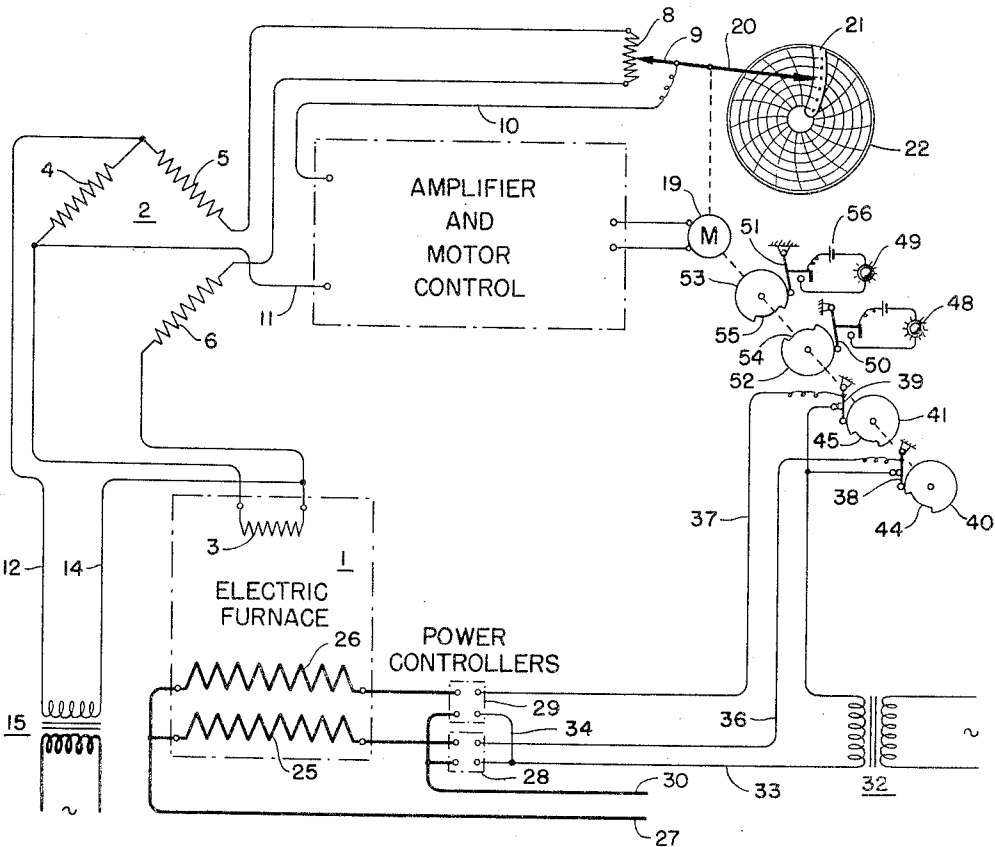


FIG. 2

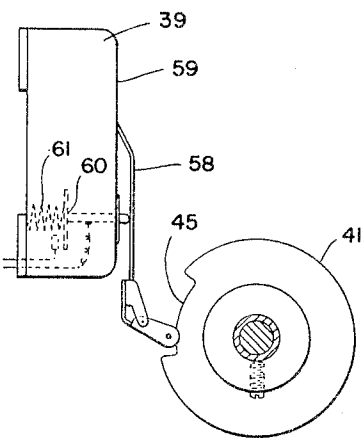


FIG. 3

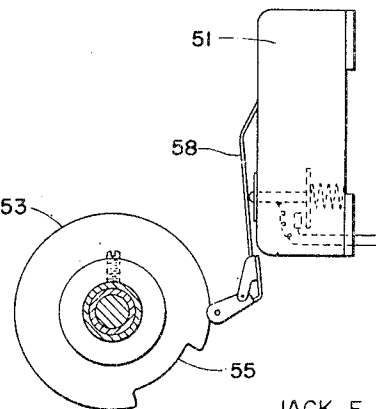


FIG. 4

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CONTROL MECHANISM

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5 Claims. (Cl. 200—18)

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This invention relates to control mechanisms adapted especially for use with indicating or recording meters which operate automatically in accordance with changes in a variable condition to be measured.

It is sometimes desirable that there be provided with meters measuring a variable condition, apparatus for giving an alarm when the condition goes above or below predetermined values. It is also frequently desirable that there be provided control means which tend to maintain the condition at some predetermined value or within a predetermined range of values. Even when such control means are employed there may be times when the value of the condition becomes too high or too low, and the giving of a warning is necessary. The control means may be used in some cases to regulate something other than the condition being measured, and the alarm may be caused to operate if the regulation should become ineffective. In any case the control means and/or the alarm apparatus should be readily adjustable to operate at any desired value.

A preferred form of my invention may include relatively rotatable members operatively connected by a differential gearing mechanism in such a manner that rotation of either one of two members causes a third member to rotate with it, but has no effect on the rotation of the other. Means may be provided for rotating one of the two members manually, while the other member is connected for rotation in accordance with variations in a condition. Connected to the last mentioned member and to the third member are actuating means for an alarm and for control devices. With such an arrangement, the actuating means carried by the third member may be readily adjusted manually so that it becomes effective at any desired point, and then be actuated on changes in the condition to perform its function according to the adjustment made. If desired, both the alarm and the control devices may be connected to the third member so that they are adjusted simultaneously on rotation of the manually operated member.

An object of my invention is to provide alarm and control means arranged in an improved manner for manual adjustment and for actuation in accordance with variations in a condition. Another object is to provide control devices connected to a manually operable means and to means operating in accordance with a condition for selective adjustment by each. Still another object is to provide control devices

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connected through differential gearing to a manually operable member and to a mechanism operating in accordance with changes in a condition, the connections being such that the devices may be actuated by either the member or the mechanism. Yet another object is to provide improved means for indicating the setting of control devices which may be adjusted manually and which may be actuated from any adjustment in correspondence with variations in a condition. Other objects will appear in the course of the following description.

In the accompanying drawings in which there is shown for purposes of illustration, one form which my invention may assume in practice:

Fig. 1 is a view partially in section and partially in elevation, showing alarm and control devices arranged in accordance with my invention for manual adjustment and for actuation by a power mechanism.

Fig. 2 is a schematic diagram of a system in which my invention is adapted for use.

Fig. 3 is a view taken on the plane of the line 3—3 of Fig. 1.

Fig. 4 is a view taken on the plane of the line 4—4 of Fig. 1.

Referring to the drawings, and more particularly to Fig. 2, it will be noted that there is shown a system for measuring and controlling the temperature in a furnace 1. This system comprises a bridge 2 having an element 3 forming one of its legs and varying in resistance in accordance with the temperature in the furnace. A fixed resistance 4 forms another leg of the bridge, and resistors 5 and 6 combined with variable portions of a potentiometer 8, form the other pair of legs. A movable contact 9 for the potentiometer and a diagonally opposite point of the bridge are connected by conductors 10 and 11 to an amplifier and motor control which may be like that disclosed in the Ryder Patent 2,333,393 granted November 2, 1943. The other diagonal of the bridge is shown connected by conductors 12 and 14 to the secondary of a transformer 15, whose primary winding is connected to a source of alternating current. A motor 19 is energized by the amplifier and motor control when the bridge is unbalanced and operates to position the contact 9 until a balance is again obtained. An indicator or pen arm 20 may also be connected to the motor for indicating upon a scale 21 or recording on a chart 22 the value of the temperature.

The furnace is shown herein as an electric furnace heated by resistor elements 25 and 26

which are connected at one end to a power conductor 27 and are adapted to be connected at their opposite ends through power controllers or relays 28 and 29 to a power conductor 30. When both of the heating elements 25 and 26 are energized, the temperature within the furnace increases. If only one of the elements is energized, the temperature within the furnace may continue to increase slowly or may drop gradually to a lower value. The temperature may be maintained approximately at a predetermined value by energizing both of the heating elements when the temperature is too low, deenergizing one of the elements at or slightly below the desired temperature, and deenergizing the other element if the temperature increases a given amount over the desired value. By energizing the elements again as soon as the temperature drops below the values at which they are deenergized, it will be seen that a close regulation of the furnace temperature may be obtained.

The power controllers or relays 28, 29 are adapted to operate when energized to connect the elements 25, 26 to the power line 30. For energizing the relays, there is provided a transformer 32 having its primary winding connected to a source of alternating current, and its secondary winding connected at one end through conductors 33 and 34 to one terminal on each of the relays. The other end of the secondary winding is connected to the other relay terminals through circuits 36 and 37 containing switches 38 and 39. Cams 40 and 41 are operatively connected to the motor 19 and act to hold the switches closed as long as the temperature remains below the values at which it is desired that the heating elements be deenergized. Formed in the cams are notches 44 and 45 into which the ends of switch contact arms may move for effecting an opening of the circuits 36 and 37.

When the temperature of the furnace is low, the cams 40, 41 may be in the positions shown in Fig. 2 for holding the switches 38, 39 closed and effecting an operation of the relays 28, 29 to energize the elements 25, 26. As the temperature increases, the resistance of the element 3 changes and unbalances the bridge 2, causing an operation of the motor 19 to rotate the cams in a clockwise direction and to position the contact 9 for rebalancing the bridge. When the notch 44 moves under the end of the switch arm of the switch 38, the latter opens and effects a deenergization of the heating element 25. If the furnace temperature should continue to increase until the notch 45 moved under the end of the switch arm of switch 39, the latter would then open to effect a deenergization of the heating element 26. With both of the heating elements deenergized, the temperature would then drop until switch 39 was again closed. If the temperature should continue to drop, switch 38 would soon be closed. Both of the heating elements would then be energized and the furnace temperature would increase.

A failure in the power line, or a failure in the switches 38, 39 or the relays 28, 29 may result in a drop or an increase in the furnace temperature beyond safe values. In order that the attendant may be warned when such conditions exist, there are provided alarms 48, 49, such as lights or bells, connected in circuits including switches 50 and 51. Cams 52 and 53 driven by the motor 19 hold the switches normally in open position, and are provided with notches 54 and 55 into which the ends of switch arms may move for closing the

switches and effecting the energizing of the alarms, as by batteries 56. If the relays 28, 29 fail to disconnect the heating elements from the power line when the switches 38, 39 open, or if the switches 38, 39 fail to open at the proper times, the furnace temperature continues to increase and effect operation of the motor 19 to rotate the cams in a clockwise direction. When notch 54 moves under the arm of switch 50, the latter closes and energizes the bell or signal light 48. A failure in the power line results in an operation of the motor to rotate the cams in a counterclockwise direction. At a predetermined low temperature, notch 55 moves under the arm of switch 51, causing the latter to close and complete the circuit through the light or bell 49.

The switches for controlling the alarm circuits and the control circuits may be provided, as shown in Figs. 3 and 4, with an arm 58 connected to a casing 59 and engageable with one of the cams at its free end. A contact member 60 is yieldably urged by a spring 61 against the arm for holding the latter against the cam. The contact members for the switches 38, 39, as shown in Fig. 3, are in open positions only when notches in the cams move into positions for receiving the ends of the arms. The contacts of switches 50, 51 are in open positions, as shown in Fig. 4, when the arms 58 ride on the outer periphery of the cams.

The improved supporting and actuating means for the cams 40, 41, 52 and 53 is shown in Fig. 1. In this case, a shaft 65 extends through an opening in a plate 66 arranged in a meter casing, not shown. Fixed to one end of the shaft is a knob 67 which may be grasped and rotated manually in either direction. Connected to the shaft 65 adjacent its other end is a bevel gear 68 meshing with a pinion gear 69 journaled on a member 70 which is fixed to a sleeve shaped member 71 rotatably mounted on the shaft. Another bevel gear 72 meshes with the gear 69 and is fixed to a sleeve shaped member 74 rotatably supported by the member 71. The cams 40, 41 are fixed to the member 71, and the cams 52, 53 are fixed to the sleeve member 74. The motor 19 drives a gear 76 meshing with a gear 77 fixed to a hub 78 of the bevel gear 72. The gears 68, 69 and 72 form a differential gearing connecting the sleeve member 71 for actuation by either the knob 67 or the motor 19.

When the shaft 65 is rotated manually, the gear 68 turns with it and causes the gear 69 to rotate and travel around the gear 72 which is held against rotation by reason of its connection through the gears 76, 77 to the motor 19. As the gear 69 travels around the gear 72, it rotates the sleeve member 71 and positions the cams 40, 41 relative to the switches 38, 39. Carried by the shaft 65 is a collar 80, and a bowed spring plate 81 is arranged between the collar and a stationary frame 82 supporting the shaft and the control switches. The plate 81 acts between the collar and the frame for resisting rotation of the shaft. When the bevel gear 72 is rotated by the motor through the gears 76, 77, the gear 69 rotates with it and travels around the gear 68, which is held stationary by reason of the plate 81 resisting rotation of the shaft 65. The sleeve member 74 turns with the gear 72 to position the alarm cams 52, 53, and the traveling of the gear 69 around the gear 68 causes the sleeve member 71 to rotate and position the control

cams 40, 41.

The slide-wire of the potentiometer 8 is shown in Fig. 1 as being mounted on a member 85, which is rotated by the motor 19 for positioning the slide-wire relative to the contact 9 which is held stationary. Connected to the power shaft of the motor is a cam 86 which positions a follower 87 fixed to a shaft 88 carrying the indicator or pen arm 20.

In order to indicate the adjustment of the control cams 40, 41, there is provided a cam 90 fixed to the shaft 65 and actuating a follower 91 attached to a shaft 92 carrying an indicating arm 93. The arms 20 and 93 cooperate with the chart 22 at the face of the plate 66 for indicating the values of the condition measured and the value at which the condition will be when the control cams become effective.

While the control cams are shown mounted on the manually adjustable sleeve 71 and the alarm cams are mounted on the sleeve 74, it will be understood that the mounting of these cams may be reversed, if desired. It is usually desirable that the alarm circuits operate to give warning when the condition reaches certain values regardless of what the values might be when the control circuits operate. The points at which the control circuits operate are more frequently changed, and so the operating cams for such circuits are made readily adjustable. When it is desired to change the operating points for the alarm circuits in the arrangement shown, set screws 95 holding the cams 52, 53 on the sleeve member 74 may be loosened so that the cams may be rotated to new positions on the member.

While there is shown in this application one form which my invention may assume in practice, it will be understood that it may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

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

1. A multiple circuit switch operating mechanism comprising, in combination, three concentrically arranged members supported for rotation relative to each other, means operatively connecting said members so that rotation of either one of two of said members will effect rotation of a third member, manually operable means for rotating one of said two members, means for operatively connecting the other of said two members to an electro-responsive device for rotation thereby, cams connected to said third member for rotation therewith, and a switch operating device arranged for engagement with each cam.

2. A switch operating mechanism adapted for use with an electro-responsive device and comprising, in combination, a shaft, means supporting said shaft for rotation, a pair of sleeve-shaped members concentrically arranged on said shaft and adapted to be rotated relative to each other, differential gearing operatively connecting said shaft and said sleeve-shaped members, manually operable means for rotating said shaft, means connected with one of said sleeve-shaped members for rotation by the electro-responsive device, cams connected to said sleeve-shaped members for respective rotation therewith, and switches arranged for actuation by said cams at predetermined points in the rotation of the latter.

3. A multiple circuit switch operating mechanism adapted for use with an electro-responsive device comprising, in combination, a shaft, means supporting said shaft for rotation, a pair of sleeve-shaped members concentrically arranged

on said shaft and adapted to be rotated relative to each other, a member connected to one of said sleeve-shaped members and supporting a bevel gear for rotation on an axis normal to the axis of said sleeve-shaped member, bevel gears fixed to said shaft and to the other of said sleeve-shaped members and meshing with said first mentioned bevel gear, manually operable means for rotating said shaft, means connected with said other sleeve-shaped member for rotation by the electro-responsive device, a plurality of cams connected to each of said sleeve-shaped members for rotation therewith, and switch operating devices arranged to be actuated by said cams at predetermined points in their rotation.

4. A multiple circuit switch operating mechanism comprising, in combination, a shaft, means supporting said shaft for rotation, a pair of sleeve-shaped members concentrically arranged on said shaft and adapted to be rotated relative to each other, means connected to one of said sleeve-shaped members and supporting a bevel gear for rotation on an axis normal to the axis of said sleeve-shaped member, bevel gears fixed to said shaft and to the other of said sleeve-shaped members and meshing with said first mentioned bevel gear, manually operable means for rotating said shaft, means for connecting said other sleeve-shaped member to a driving motor, a cam fixed to said one of said sleeve-shaped members for rotation therewith, means including a switch adapted to be actuated by said cam at a predetermined point in its rotation for controlling one circuit, a cam fixed to said other sleeve-shaped member for rotation therewith, and means including a switch adapted to be actuated by said last mentioned cam for controlling another circuit.

5. A multiple circuit switch operating mechanism comprising, in combination, a shaft, means supporting said shaft for rotation, a pair of sleeve-shaped members concentrically arranged on said shaft and adapted to be rotated relative to each other, means connected to one of said sleeve-shaped members and supporting a bevel gear for rotation on an axis normal to the axis of said sleeve-shaped member, bevel gears fixed to said shaft and to the other of said sleeve-shaped members and meshing with said first mentioned bevel gear, manually operable means for rotating said shaft, friction means operating between the shaft supporting means and said manually operable means for resisting rotation of said shaft, means for connecting said other sleeve-shaped member to a driving motor, a pair of cams adjustably fixed to said one of said sleeve-shaped members for rotation therewith, a pair of switches adapted to be respectively actuated by said pair of cams at predetermined points in their rotation, a pair of cams adjustably fixed to said other sleeve-shaped member for rotation therewith, and a pair of switches adapted to be respectively actuated by said last mentioned pair of cams.

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