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T. E. BARNUM ET AL

PRESSURE RESPONSIVE CIRCUIT CONTROLLER

Filed April 27, 1921

Fig. 1.

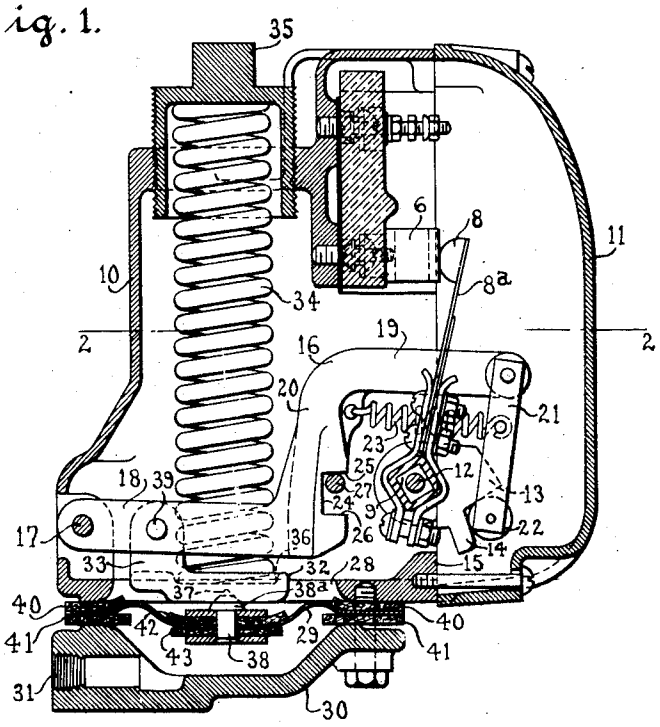
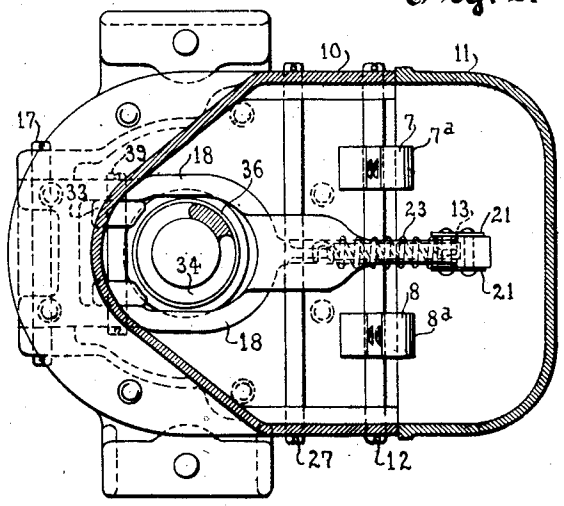


Fig. 2.



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UNITED STATES PATENT OFFICE.

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PRESSURE-RESPONSIVE CIRCUIT CONTROLLER.

Application filed April 27, 1921. Serial No. 465,065.

To all whom it may concern:

Be it known that we, THOMAS E. BARNUM and CLARENCE T. EVANS, citizens of the United States, residing, respectively, at Wauwatosa and Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Pressure-Responsive Circuit Controllers, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

This invention relates to pressure responsive circuit controllers and particularly to controllers of the diaphragm type.

Such controllers as heretofore constructed have been in many instances objectionable by reason of uncertainty of operation thereof and also by reason of disproportionate space requirements, together with inaccessibility of parts which inherently tend to require more or less frequent inspection, repair or replacement. Further, where metallic diaphragms are employed the same tend, in the absence of special provision, to deteriorate rapidly and to fail following a relatively brief period of service whereby again the reliability of the device is seriously curtailed.

The present invention has among its objects that of overcoming the aforementioned difficulties and disadvantages of such controllers as heretofore constructed.

Another object is that of providing an exceedingly simple, durable and reliable controller comprising a minimum number of simple and rugged parts compactly arranged and readily accessible.

Another object is that of providing a combination and assembly of parts such that a maximum mechanical effect is attained particularly as regards those functions wherein such efficiency is most desirable and without sacrificing other desirable features.

Another object is that of providing novel and improved means for minimizing deterioration of the diaphragm element to thereby increase the reliability and length of service of the device.

Other objects and advantages will hereinafter appear,

In the accompanying drawing wherein is illustrated an embodiment of the invention,

Fig. 1 is a vertical sectional view thereof; while,

Fig. 2 is a horizontal sectional view of the same, substantially on line 2—2 of Fig. 1.

Referring to the drawing the same illustrates a double pole switch mechanism comprising spaced and insulated fixed contacts 5 and 6 to be engaged selectively by corresponding movable contacts 7 and 8, resiliently carried by springs 7^a and 8^a respectively and the latter being positively secured in insulated relation to one another to an oscillatable shaft 9, pressure responsive operating means being provided for oscillation of said shaft to thereby actuate the aforedescribed switches simultaneously and similarly and all of the aforementioned parts being enclosed within a housing comprising separable sections 10 and 11.

In practice the fixed contacts, each provided with suitable circuit connections, are permanently and rigidly secured to the housing section 10, the shaft 9 being also pivotally supported within said housing section. Said shaft is preferably constructed hollow and of a length such as to permit ready insertion thereof within said housing section, a rod 12 being passed through suitable openings in said housing section and through the bore of said shaft for pivotal support of the latter, said rod being secured in place by cotter pins or otherwise.

An operating cam 13 is rigidly secured to said shaft preferably in a relation between the aforementioned contacts 7 and 8 as illustrated. Said cam is preferably provided with a dependent lug 14 adapted to coact with a flush portion 15 of the casing section 10 for limiting oscillation of said shaft in a direction corresponding with opening movement of the switch contacts.

An elongated lever 16 is pivotally mounted within and upon said housing section 10 at a point 17 located substantially opposite the position of said shaft 9, said lever being thus arranged to extend in a direction in general substantially perpendicular to the plane determined by said shaft and its attached contacts. Said lever is of

special construction and preferably comprises substantially parallel but laterally offset terminal portions 18 and 19 connected by an intermediate portion 20 which extends substantially at right angles thereto and substantially parallel to the direction of said movable contacts. The terminal portion 18 of said lever is furthermore divided as shown for a purpose to be hereinafter explained. The free end of said lever carries thereon a pivotally mounted dependent lever 21 normally occupying a position substantially parallel to that of the intermediate section 20 of said lever 16 and being of a length approximately equal thereto. A roller 22 is carried as illustrated adjacent the free lower terminal portion of said lever 21 in a relation suitable for direct co-operation with the cam 13.

The arrangement of the foregoing parts is such that the shaft 9 is located adjacent the central portion of a rectangle, three sides of which are formed by the dependent lever 21 and the terminal portion 19 and intermediate portion 20 of lever 16, the cam 13 extending toward said depending lever 21 and being located within the vertical projection of the terminal section 19 of said lever 16.

A tension spring 23 terminally connected to said levers as illustrated serves to bias the roller 22 against the cam 13.

Said intermediate portion 20 of lever 16 is furthermore provided with an elongated recess 24 having terminal shoulders 25 and 26 adapted to co-operate selectively with a lug 27 carried by said housing section 10 to thereby limit swinging of said lever in either direction. Said housing section 10 is provided at a point below the divided portion of the lever 16 with a relatively enlarged opening 28, said opening being in practice covered by a flexible diaphragm 29 preferably metallic in character, secured across said opening by means of a flared header 30 clamped to said housing section by means of suitable bolts or otherwise. Said header member is further provided with an exterior opening 31 for subjecting the space between the diaphragm and said header to fluid pressure.

A piston element 32 of a size materially less than that of the opening 28 is arranged within said opening above the diaphragm 29 in a relation to be lifted by said diaphragm, said piston being provided with an eccentrically located, upwardly projecting lug 33, the latter being pivoted to lever 16 at a point quite closely adjacent the point 17 of pivotal support of said lever.

A relatively heavy compression spring 34, arranged between the aforementioned divided portions of the lever 16, is compressed between the upper side of the piston element 32 and the upper portion of said housing section. In practice the upper end of said spring is preferably received and retained within an adjusting nut 35 screwed within said housing section, said nut thus providing for exterior adjustment of said spring. The upper side of said piston element is further provided with a suitable recess 36 arranged substantially centrally thereof for retention of the lower end of said spring.

The lower side of said piston element is preferably provided with a substantially conical recess 37 adapted to receive a rounded head portion 38^a of a stud 38 carried centrally of the diaphragm 29, thus affording an open universal pivotal bearing between said diaphragm and said piston element, the point 39 of pivotal attachment of said piston element to the lever 16 being materially offset laterally from said bearing as illustrated.

The cam element 13 is preferably of special construction and comprises a pair of substantially straight exterior surfaces meeting at an angle. The direction of such surfaces is moreover such that the bisector of the angle therebetween passes above the point 17 of pivotal support of the lever 16 as illustrated for a purpose to be described.

Flexible and preferably resilient gaskets 40—41 composed of rubber, leather, paper, or the like are arranged respectively upon the upper and lower sides of the diaphragm 29 as shown, being clamped between the housing section 10 and the header member 30 by the bolts aforedescribed, said gaskets being of sufficient radial extent to reach inwardly of the diaphragm a material distance beyond the point where the contiguous surfaces of said housing section and said header member diverge from one another. The employment of such gaskets has been found in practice to increase the period of reliable service of the diaphragm more than ten-fold, and without limitation to any definite theory to account for such effect, it is believed that the yielding or resilient nature of said gaskets permits the diaphragm when moved axially to assume the particular form determined by the stresses induced therein by the operating force without compelling the diaphragm to assume the form of the metallic parts contiguous thereto whereby the bending strains upon the diaphragm are greatly reduced.

Similar gaskets 42 and 43 are also preferably located in the central portion of the diaphragm and clamped in place by the stud 33 as illustrated and for similar purposes.

The second housing section 11 is adapted to be secured to the section 10 by means of screws or in any other desired or preferred manner, said housing sections being preferably articulated upon a common plane and said plane being so located with reference to the enclosed parts that upon simple removal of the section 11 the switch contacts

and connections as well as the aforedescribed cam, roller and spring 23 together with most of their associated parts are rendered readily accessible.

Further the aforedescribed method of mounting the shaft 9 provides for ready removal and replacement or interchange of said shaft together with the parts supported thereby. Also the aforedescribed manner of mounting the piston element 32 upon the diaphragm stud 33 permits ready removal of the lever 16 together with all of its associated parts upon simple disconnection thereof from its pivotal support 17 following withdrawal of the spring 34 by removal of the nut 35, removal of the diaphragm 29 and its associated parts not being required.

The operation of the device may be described as follows, the parts being in the position illustrated in full line in Fig. 1 and the pressure below the diaphragm being assumed insufficient to overcome the force of the spring 34 as adjusted. The stop 27 serves to prevent downward movement of lever 16 whereby the tension of the spring 23 causes roller 22 to exert upon the cam 13 a pressure having an upward component for maintaining the switch positively closed, and also effecting bending of the contact springs 7^a and 8^a with consequent storing of energy therein.

Upon attainment of a given pressure below the diaphragm 29, the latter is forced upward with consequent upward movement of the free end of lever 16, the spring 34 being compressed and also bent or bowed due to the eccentric location of lug 33. Also the roller 22 is caused to move upwardly and outwardly along the lower surface of cam 13, the spring 23 being placed under increased tension. The angle between said cam surface and the line joining the crest of the cam with the point 17 being relatively acute as aforedescribed, the opposition to upward movement of the lever, due to such co-operation of the cam and roller under tension of spring 23 is augmented.

Thus the pressure below the diaphragm 29 is required to overcome not only the opposition of the spring 34 including that due to bending or bowing thereof, but also the opposing action of spring 23 as augmented in the manner just described.

Hence at the instant just prior to arrival of said roller at the crest of the cam the fluid pressure required to effect further movement of the lever 16 is considerably augmented due to the special construction and arrangement aforedescribed. At the instant wherein the roller passes the crest such augmented pressure is suddenly released for throwing the roller suddenly across the crest, the tension of the springs 7^a and 8^a being simultaneously released for effecting movement of the cam itself in the opposite direction, all of the foregoing effects combining to practically insure against positioning or hanging of the roller upon the crest of the cam in a relation such as to defeat the resultant snap opening movement of the switch contacts.

During reclosure of the switches due to a given reduction in pressure below the diaphragm 29 the various parts are adapted in general to perform functions similar to those aforedescribed but in the opposite sense. However, the developed forces which oppose downward movement of lever 16 are considerably reduced in order to avoid undue extension of the range of fluid pressure variations required to effect operation of the device in reverse senses.

Thus prior to closing movement of the switches the contact springs 7^a and 8^a are not bent and hence are not adapted to the release of stored energy tending to effect movement of the cam itself. The spring 23 is tensioned to the same extent as for opening but its force is less effectively applied in resisting downward movement of lever 16, the angle between the upper cam surface and the line between the crest of the cam and the point 17 being less acute than the angle between the lower cam surface and such line.

Movement of said lever in either direction is limited by the stop 27 following actuation of the switches whereas in either extreme position of the switch contacts the spring 23 is maintained under tension for positively maintaining said contacts in such position.

Here it should be observed that in the preferred construction and arrangement the bisector of the angle between the cam surfaces also passes above the axis of the shaft 12. That is to say the angle between the upper cam surface and the line between the crest of the cam and the center of said shaft 12 is less acute than the angle between the lower cam surface and said line. Thus, for reasons which will be apparent from the foregoing, the energy of spring 23 is applied more effectively for maintaining the switches in closed position than in open position, whereby a firm and adequate contact engagement is assured without unduly increasing the range of fluid pressure variation required to effect operation of the switches in reverse senses.

Also the foregoing special features in addition to the effects aforedescribed further serve to provide a strong and positive snap action of the switches particularly upon opening thereof.

It is further to be noted that both the spring 34 and the lever 16 are adapted to act directly upon the piston member 32 whereby the vertical dimension of the structure is practically determined by the required length

of said spring, in addition to the thickness of piston, diaphragm and header member. Also owing to the special construction of parts particularly of the lever 16, the horizontal dimensions of the device are brought substantially within the vertical projection of the diaphragm member, thus indicating that the space requirements of the device have been reduced substantially to a minimum.

What we claim as new and desire to secure by Letters Patent is:

1. In snap operating means for switches and the like, in combination, an oscillatory cam having angularly related faces meeting in an abrupt crest, a roller to coact with said cam and supporting means for said roller comprising a pivoted lever, a support pivoted to the free end thereof and carrying said roller at its free end, a spring associated with said lever and said support to bias said roller against said cam, means to exert upon said lever opposing forces tending to move the same against the force of said spring, the faces of said cam being so disposed with reference to the center of oscillation of said lever as to effect greater opposition to movement of the lever in one direction than in the other direction.

2. In a circuit controller, the combination with relatively movable contacts, of operating means therefor comprising a pivoted cam positively secured to certain of said contacts, a pivoted lever, a support pivoted to the free end of said lever, a roller carried by said support for coaction with said cam, a spring biasing said roller toward said lever and against said cam, a spring opposing movement of said lever in one direction and pressure responsive means to actuate said lever against the force of said spring for causing said roller to actuate said cam for snap operation of the switch, said cam being designed and arranged with reference to said lever and its associated parts to augment the force required to cause movement of said lever in one direction.

3. In snap operating means for switches and the like, in combination, an oscillatory cam having angularly related surface portions meeting in an abrupt crest and operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surface of said cam and means associated with said spring for moving said element across the crest of said cam in opposite directions for snap operation of the cam, and to arrest such movements of said element in relations such that said spring is maintained under tension for holding the cam, said cam surface portions being disposed with reference to the center of oscillation thereof to provide different values of the force so utilized for holding said cam following arrest of movement of said element in opposite directions respectively.

4. In snap operating means for switches and the like, in combination, an oscillatory cam having angularly related surface portions meeting in an abrupt crest and operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surface of said cam and means for moving said element across the crest of said cam in opposite directions for snap operation of the cam and to arrest such movements of said element in relations wherein said spring is maintained under tension for holding the cam, said cam surface portions being arranged to subtend unequal angles with reference to a line determined by the crest of the cam and the axis of oscillation thereof to thereby provide different values of the force utilized for so holding the cam following movement of said element in opposite directions respectively.

5. In a circuit controller, the combination with relatively movable contact members, of an oscillatory cam positively secured to certain of said contact members, said cam having angularly related surface portions meeting in an abrupt crest, and operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surface of said cam, means for moving said element across the crest of said cam in opposite directions for selective snap engagement and disengagement of said contact members and means to arrest such movements of said element in relations such as to maintain said spring under tension for positive holding of the switch in closed and in open position selectively, said cam surface portions being disposed with reference to the center of oscillation of the cam in a manner to augment the force for maintaining the switch closed over that for maintaining the same open.

6. In a circuit controller, the combination with relatively movable contacts, of an oscillatory cam secured to certain of said contacts, said cam having angularly related surface portions meeting in an abrupt crest, and operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surface of said cam, a pivoted support for said reciprocatory element, means to exert upon said support opposing forces each tending to cause the latter to move said element in one direction across the crest of said cam with a resultant release of stored energy for snap opening and closing of the switch selectively, said cam surface portions being arranged to subtend unequal angles with reference to a line determined by the crest of the cam and the pivotal axis of

said support such as to augment the value of the energy released upon movement of said element across the crest of the cam in the direction corresponding with opening of the switch.

7. In a circuit controller, the combination with relatively movable contacts and an oscillatory cam having a resilient operative connection with certain of said contacts and having angularly disposed surface portions meeting in an abrupt crest, of operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surfaces of said cam, a pivoted lever carrying said reciprocatory element, means to exert upon said lever opposing forces each tending to cause the latter to move said element in one direction across the crest of said cam for snap opening and closing of the switch selectively, means to arrest such movements of said element in relations wherein said spring is maintained under tension for positive holding of the switch contacts in closed and in open position selectively and for tensioning said resilient connection upon closure of the switch, said cam surface portions being disposed with reference to the pivot point of said lever in a manner to augment the value of the energy released upon movement of said element across the crest of the cam in a direction for opening of the switch, the tension of said resilient connection tending to effect movement of the cam during such transit of said element in switch opening direction.

8. In a circuit controller, the combination with relatively movable contacts and an oscillatory cam having a resilient operative connection with certain of said contacts and having angularly disposed surface portions meeting in an abrupt crest, of operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surfaces of said cam, a pivoted lever carrying said oscillatory lever, means to exert upon said lever opposing forces each tending to cause the latter to move said element in one direction across the crest of said cam for snap opening and closing of the switch selectively, means to arrest such movements of said element in relations wherein said spring is maintained under tension for positive holding of the switch contacts in closed and in open position selectively and for storing energy in said resilient connection upon closure of the switch, said cam surface portions being disposed with reference to the center of oscillation of said cam in a manner to augment the force for maintaining the switch closed over that for maintaining the same open to thereby augment the value of the energy stored in said resilient connection, such stored energy tending to effect reverse movement of the cam during such transit of said reciprocatory element in switch opening direction.

9. In a circuit controller, the combination with relatively movable contacts and an oscillatory cam having a resilient operative connection with certain of said contacts and having angularly disposed surface portions meeting in an abrupt crest, of operating means for said cam comprising a reciprocatory element to coact therewith, a spring biasing said element against the surface of said cam, a pivoted lever carrying said oscillatory member, means to exert upon said lever opposing forces each tending to cause the latter to move said element in one direction across the crest of said cam for snap opening and closing of the switch selectively, means to arrest such movements of said elements in relations wherein said spring is maintained under tension for positive holding of the switch contacts in closed and in open position selectively and for storing energy in said resilient connection during maintenance of the switch in closed position, said cam surface portions being disposed with reference to the pivot point of said lever and to the center of oscillation of said cam in a manner to augment the value of the energy released upon movement of said element across the crest of the cam for opening of the switch and also to augment the force for maintaining the same open, the stored energy of said resilient connection tending to effect reverse movement of the cam during movement of said reciprocatory element across the crest of the cam in switch opening direction.

10. In snap operating means for switches and the like, in combination, a pivoted lever, a pressure responsive diaphragm, a stud carried by said diaphragm, a plunger centrally and pivotally mounted upon said stud, said plunger having an eccentrically located lug pivotally connected with an intermediate portion of said lever, a spring arranged to be compressed between said plunger and a relatively fixed abutment for opposing movement of said lever in one direction by said diaphragm the eccentric relation of said lug with reference to said stud serving to effect bowing of said spring by said plunger to thereby augment the stored energy of said spring.

11. In operating means for switches and the like, the combination with a flexible diaphragm to be moved with reference to an associated rigid element in response to pressure variations, of flexible means clamped between said diaphragm and said element for reducing strains in said diaphragm due to such pressure variations.

12. In operating means for switches and the like, the combination with a diaphragm and a rigid element associated therewith to

provide for flexing of said diaphragm with reference to said element in response to pressure variations, of a flexible gasket associated with said diaphragm for reducing strains therein due to such pressure variations.

13. In operating means for switches and the like, the combination with a diaphragm and a rigid element associated therewith to provide for flexing of said diaphragm with reference to said element in response to pressure variations, of a flexible gasket clamped between said diaphragm and said element and extending beyond the proximate surfaces thereof to reduce the strains induced in the former incident to such flexing thereof.

14. In operating means for switches and the like, the combination with a flexible diaphragm and means, including a rigid element clamped thereto, to provide a pressure chamber, of a flexible gasket associated with said diaphragm and said element for reducing strains set up in said diaphragm incident to movement thereof.

15. In operating means for switches and the like, the combination with a flexible diaphragm and means, including a rigid element clamped thereto, to provide therewith a pressure chamber, of a flexible gasket clamped between said diaphragm and said member and extending inwardly materially beyond the zone of clamping pressure for reducing strains set up in said diaphragm incident to movement thereof.

16. In a pressure responsive device, the combination with a flexible diaphragm and a rigid element clamped thereto to provide a pressure chamber, of a flexible gasket clamped to said diaphragm and said element to render the shape of said diaphragm corresponding with different pressures within said chamber substantially independent of the contour of said element.

17. In a pressure responsive device, the combination with a flexible diaphragm, a rigid end member clamped thereto to provide a pressure chamber, of flexible means for reducing strains in said diaphragm due to bending thereof in proximity to said end member.

18. In a pressure responsive device, the combination with a flexible diaphragm, a rigid end member clamped thereto to provide therewith a pressure chamber and a rigid plate secured to and centrally of said diaphragm, of flexible gaskets to be clamped between said diaphragm and said rigid elements for reducing strains in said diaphragm due to bending thereof in proximity to said elements.

19. In a pressure responsive device, the combination with a pair of rigid elements, of a flexible diaphragm clamped therebetween to provide a pressure chamber and a rigid plate secured to said diaphragm centrally thereof, of resilient gaskets clamped between said diaphragm and said rigid members respectively and extending material distances beyond the zone of clamping pressure for reducing strains set up in said diaphragm incident to pressure variations within said chamber.

In witness whereof, we have hereunto subscribed our names.

THOMAS E. BARNUM.
CLARENCE T. EVANS.