Aug. 8, 1939. J. L. DEFANDORF ET AL 2,169,039

CIRCUIT COMMUTATING DEVICE

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Fig. 1

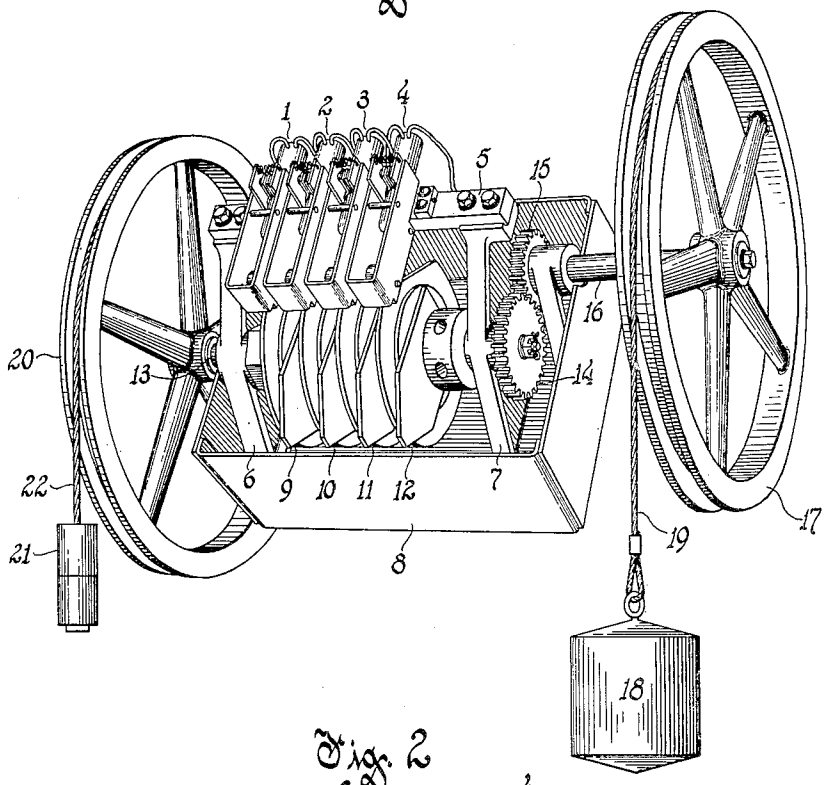
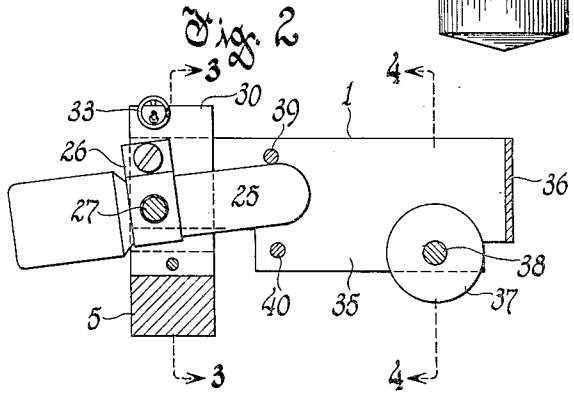


Fig. 2



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Fig. 3

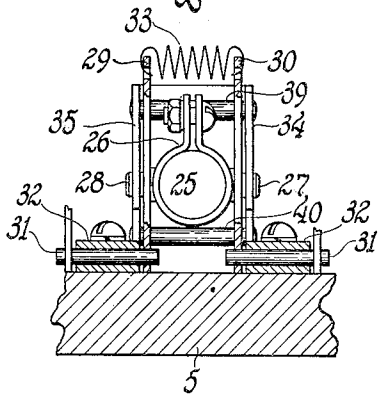


Fig. 4

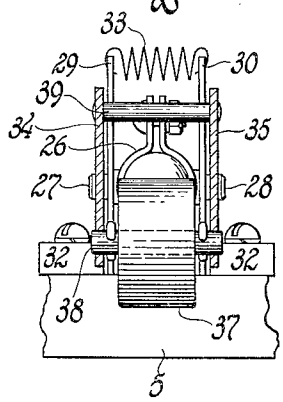


Fig. 5

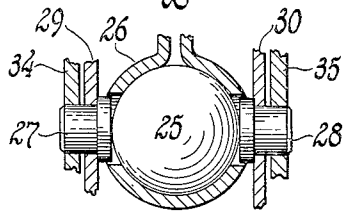


Fig. 6

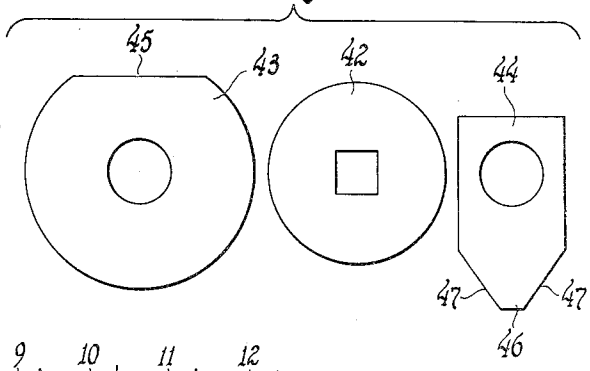
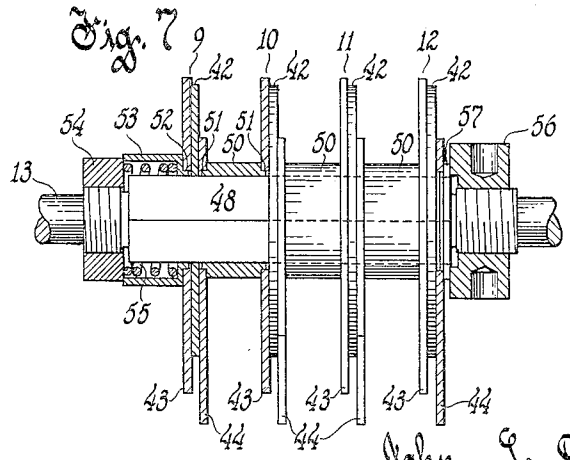


Fig. 7



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2,169,039

CIRCUIT COMMUTATING DEVICE

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Application October 23, 1936, Serial No. 107,154

11 Claims. (Cl. 200—18)

This invention relates to circuit commutating devices and is especially applicable to float operated devices employing mercury switches.

Such float operated devices are commonly required to control a plurality of circuits, a separate mercury switch being employed for each circuit. Muti-circuit devices of such character are commonly employed for controlling motor driven pumps for supplying or withdrawing fluid, and in practice the switch control required for different applications varies widely. It may be desired in one instance to have a certain switch close at a given level of fluid and open at certain different fluid level, whereas in another instance it may be desired to have the same switch operate at other selected levels with or without a change in differential between the selected levels. Also it may be desired to have the several switches function in a given relation in some instances and in a different relation in other instances. Thus a very flexible adjustment is required to avoid need of a multiplicity of differently designed devices.

The present invention has among its objects to provide a highly satisfactory float operated device of the character set forth having the desired flexibility of adjustment.

Another object is to provide a very flexible multi-circuit device advantageous for various other uses, especially where the operating force available is small and where the quick action characteristic of mercury switches is desired.

Another object is to provide for such flexibility of adjustment in a multi-circuit device having oscillating cam operating means and to provide for switch closing and opening operations, each within a small part of the range of movement of the oscillating cam operating means.

Another object is to provide for reliability of functioning of the switches whatever the adjustment may be and to obtain such reliability without requiring a troublesome degree of exactness in constructing the device.

Other objects and advantages of the invention will hereinafter appear.

One embodiment of the invention is illustrated in the accompanying drawings, and the same will now be described, it being understood that the invention is susceptible of various modifications without departing from the scope of the appended claims.

In the drawings,

Figure 1 is a perspective view of a float operated device with its cover removed;

Fig. 2 is a detailed view, partly in section, showing one of the mercury switch units of Fig. 1;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 2;

Fig. 5 is an enlarged detail view of the trunnion bearings shown in Fig. 3;

Fig. 6 shows the cam parts of one switch, and

Fig. 7 shows, partly in section and partly in elevation, the cam assembly for the several switches of Fig. 1.

Referring to Fig. 1, the same shows four mercury switch units 1, 2, 3 and 4 carried by a supporting bar 5 which in turn is supported by brackets 6 and 7 mounted within a box 8 having a cover, not shown. The switch units have multiplate operating cams 9, 10, 11 and 12, respectively, carried by a shaft 13 mounted in brackets 6 and 7 and having fixed thereto at one end a gear 14 meshing with a gear 15 carried by a shaft 16 mounted in bracket 7, and having fixed thereto a sheave wheel 17 to which is attached a float 18 by a rope or cable 19. The opposite end of the cam shaft 13 has fixed thereto a sheave wheel 20 to which is connected a counterweight 21 by a rope or cable 22. Thus provision is made for oscillating the cam shaft as the float 18 is raised and lowered through variation in fluid level, the shaft being oscillated through a range of about 300 degrees.

As will be understood, such a device may be required for control of one or a plurality of motor driven pumps for either supplying or exhausting fluid, the motor or motors to be controlled in any of various different ways. Also as will be understood, according to the circuit commutations desired the number of switch units employed may be either increased or decreased, the switches commonly being adjusted for some difference in performance, although of course two or more switches might if desired be adjusted to function to make and/or break circuit at the same time, and the cams being provided to afford the desired performance of the several switches.

The several switch units are of like construction being constructed as illustrated in Figs. 2 to 5. Referring to Fig. 2, which may be assumed to show unit 1, said unit comprises a conventional type of mercury switch 25 shown only in outline, it being understood that said switch comprises metal electrodes and a body of mercury to make and break the circuit including said electrodes, and preferably providing a mercury to mercury break. Also as will be understood, the switch 25, as is customary, makes and breaks circuit upon

tilting thereof. The switch 25 as shown in Figs. 2, 3 and 5 is surrounded by a clamped on band 26 which as best shown in Figs. 3 and 5 has diametrically opposed openings to receive the heads of trunnions 27 and 28 respectively, carried by supporting plates 29 and 30, each attached to supporting base 5 through the medium of a pin 31. The pins 31 are carried by blocks 32 on base 5 and project from the blocks to enter openings in the plates, the latter being thereby loosely supported and being connected at their upper ends by a tension spring 33. Each of the trunnions 27 and 28 preferably has a drive fit with its respective supporting plate, and said supporting plates under the action of spring 33 press the heads of the trunnions against the casing of the switch, which may be Bakelite or other preferred material, to frictionally hold the switch against accidental oscillation about its axis afforded by the trunnions. However, the switch will respond to a slight pressure to turn on its aforementioned axis for making and breaking circuit, and it may be assumed that the switch is rotated anticlockwise to make circuit, and clockwise to break circuit, although the reverse action might be provided for if desired. For tilting or oscillating the switch there is provided a cradle comprising parallel plates 34 and 35 and a connecting end piece 36, said side plates receiving therebetween the switch supporting plates 29 and 30, and being respectively mounted on the trunnions 27 and 28 whereby said cradle is pivotally supported by the switch supporting plates, the latter having square ends adjacent the upper surface of the base 5 which insure against an appreciable oscillation of said switch supporting plates on pins 31. The cradle has at its outer end a roller 37 carried by a shaft 38 having bearings in the side plates 34 and 35 of the cradle. Also the cradle carries transversely extending pins 39 and 40 passing through and supported by its side plates, these pins, as best shown in Fig. 2, affording a lost motion connection between the cradle and the switch 25.

As will be understood, the roller 37 is provided to rest upon one of the aforementioned operating cams, being biased into engagement therewith by its own weight and the weight of the cradle and when the cradle is lifted it acts through the medium of the pin 40 to move the switch 25 counterclockwise, whereas when it drops it acts through the medium of the pin 39 to move the switch 25 clockwise. However, it will be observed that when the cradle has been lifted to rotate the switch 25 counterclockwise, the cradle must be lowered an appreciable distance to bring the pin 39 into engagement with the casing of switch 25 and that in the meantime switch 25 is frictionally held by trunnions 27 and 28 in its extreme position. Similarly the switch 25 is frictionally held in its opposite extreme position during takeup of the play between the switch and the pin 40 of the cradle. Thus after each operation of the switch the cradle may be returned to an intermediate position for a purpose hereinafter set forth, whereas the switch will be frictionally retained in an extreme position to interrupt or preserve continuity of circuit, as the case may be.

The cam 9 which is typical of all of the aforementioned cams, comprises, as best shown in Fig. 6, a circular plate 42 against opposite sides of which are to be clamped cam members 43 and 44. The cam member 43 is of circular form with a flat peripheral portion 45, said cam being of greater diameter than the disk 42. The cam member 44 is of rectangular form with a tapered extremity 46 extending radially beyond the periphery of the cam member 43. The roller 37 of one of the switch cradles rides on the edges of these cam members and when it rides onto one of the converging edges 47 of cam member 44 it lifts its cradle to move its switch counterclockwise into one extreme position. On the other hand, when the roller 37 passes onto the flat edge 45 of cam member 43 it permits the cradle to drop to move the switch clockwise into its other entreme position. Riding of the roller on the curved edge of cam 43 causes the cradle to assume the aforementioned intermediate position. Thus provision is made for opening and closing the switch in given angular positions of the driving shaft of plate 42 according to the relation in which cam members 43 and 44 are clamped against plate 42, and obviously the angular movement of the shaft required to move the switch from one extreme position to the other may be varied by turning one cam member relative to the other for varying the spacing of the high and low points of the cam. Moreover it will be observed that when the cam members are relatively adjusted for movement of the switch from one extreme position to another by a given angular throw of the driving shaft of plate 42, the cam members may be shifted together relative to the plate 42 to change the angular positions to which the shaft must be moved to open and close the switch. Accordingly with the angular position of the shaft governed by the position of the float the switch may be readily adjusted to open and close at predetermined levels to be selected as desired with any desired differential regardless of the adjustment of any other switch. Also it will be observed that close adjustments of each switch are made possible since the switch necessarily attains one extreme position during travel of the cam over one of the relatively short converging edges 47 of cam member 44 and necessarily attains its other extreme position as the roller passes onto the relatively short flat edge 45 of cam member 43.

Referring to Fig. 7, the shaft 13 carrying the cams has an intermediate portion 48 which is rectangular in cross section to closely fit rectanglar central openings in the several plates 42. The plates 42 are thereby keyed to the shaft, whereas their respective cam members are provided with circular central openings having clearance with the shaft. Between adjacent cam members are arranged tubular spacers 50 which have rectangular openings closely fitted by the shaft and which are provided with annular shoulders 51 forming bearings for the cam members spaced thereby. One extreme cam member is supported on an annular shoulder 52 of tubular element 53 which spaces said cam member from a nut 54 screwed onto the shaft at its left hand end, said element enclosing a coiled spring 55 surrounding the shaft and bearing against the nut 54 to bias the assembly of plates, cam members and spacers longitudinally of the shaft toward the right hand end of the shaft. The right hand end of the shaft has threaded thereon a nut 56 bearing against a washer 57 which forms an abutment for the outside cam member 44 and which also has an annular shoulder similar to those of the spacers for supporting said cam member. With the nut 56 set up tight on the shaft the parts mounted on the square section of the shaft are driven against nut 54 for tight

clamping of the cam members against their respective plates **42**, and when it is desired to adjust one or more cam members the nut **56** is loosened. The spring **55** then comes into play to maintain friction between each of the cam members and its respective plate **42** whereby adjustment of any cam member may be effected by overcoming this friction while the remaining cam members are held by such friction against accidental displacement.

While it is preferred to provide lost motion connections between the switches and their cradles and to provide friction means for the switches as set forth, it should be noted that the cam operating means disclosed enables both aforementioned provisions to be dispensed with where each mercury switch can be relied upon to maintain circuit and alternatively to prevent establishment of circuit while occupying a given position intermediate its extreme positions. As will be understood, many mercury switches after being tilted either to break or make circuit may be returned to a given position without further circuit communicating action of the mercury, but in many instances such return movement leaves the mercury in a very unstable state. On the other hand, certain switches are of such design that when returned to an intermediate position they will reliably preserve the last circuit commutation whether it be interruption or completion of circuit. Thus where the device is equipped with the latter type of switch it is possible, assuming positive connections between each switch and its cradle, to use the cam surfaces **47** and **45** to effect movement of the switch to its extreme positions respectively and the curved edge of cam member **43** to effect return of the switch to said intermediate position immediately following movement to either extreme position and to maintain it in such position without change of the last established circuit condition pending a directed change in circuit condition. Moreover since the switch occupies an intermediate position a very slight further tilting thereof will render it effective for further circuit commutation.

In either case provision is made for effecting tilting of the switch from its position of rest to the desired circuit changing position by a relatively small angular motion of the cam shaft and for rendering available for range variation the remaining angular motion of the cam shaft. As will be understood, either cam member might be made double acting within the angular throw provided therefor, if desired. Also as will be understood, the lost motion and friction provisions hereinbefore set forth have the advantage of enabling successful use of mercury switches responsive upon slight angular movement thereof and without necessitating the troublesome exactness of design and manufacture of the operating mechanism which would be required should a small throw switch be employed without such lost motion and friction provisions.

Obviously complementary cam members **43** and **44** may be adjusted into a relation whereby their respective switch roller will pass directly from the edge portion **45** of member **43** to an edge portion **47** of member **44**, or vice versa, to effect uninterrupted and quick movement of the switch from one extreme position to its other extreme position. Also it will be obvious that if after a switch roller has ridden up one edge **47** of a cam member **44** and down its other edge **47** onto the curved edge of cam member **43**, the cam member **44** may be moved to again lift and drop the roller without effecting circuit change by the switch pending dropping of the roller onto the flat edge portion of cam member **43** and with the lost motion connection and frictioning means aforedescribed the position of the switch would remain unchanged during such oscillations of member **44**.

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

1. In a circuit device, the combination with a mercury switch supported for oscillation, of a rotary cam having high and low camming surfaces and an intermediate active surface coextensive with the space between said high and low surfaces and concentric with the axis of rotation of said cam, and operative connections between said mercury switch and said cam comprising a cam follower to engage said three surfaces, said mercury switch upon movement of said follower onto and over said intermediate active surface maintaining the circuit commutation last effected thereby.

2. In a circuit device, the combination with a mercury switch supported for oscillation, of a rotary cam having relatively adjustable members providing high and low camming surfaces to be adjusted relatively and an intermediate active surface which is coextensive with the space between the high and low camming surfaces for different adjustments of the latter and which is concentric with the axis of rotation of said cam, and operative connections between said mercury switch and said cam comprising a cam follower to engage said three surfaces, said mercury switch upon movement of said follower onto and over said intermediate active surface maintaining the circuit commutation last effected thereby.

3. An adjustable switch operating cam to be mounted for rotation comprising relatively adjustable members adjustable about the axis of said cam and providing high and low camming surfaces to be adjusted relatively and an intermediate active surface which is coextensive with the space between the high and low camming surfaces for different adjustments of the latter and which is concentric with the axis of rotation of said members.

4. In a multi-circuit device, the combination with a plurality of switches each provided with an oscillatable actuating element having a lost motion connection therewith and biased in one direction and each of said switches having means to restrain the same in its extreme positions subject to release by movement of its actuating element, of a plurality of cams supported for oscillation together to cooperate with said actuating elements of said switches for effecting movement of said switches each to opposite extreme positions selectively, said cams each having in a spaced relation relatively short and steep camming surfaces and a surface which is coextensive with the space between said camming surfaces and which is concentric to the axis of said cams.

5. In a multi-circuit device, the combination with a plurality of mercury switches supported for oscillation individually and having means resisting movement thereof away from either of its extreme positions, of a plurality of members supported for oscillation individually and having lost motion connections with said switches respectively, each of said members being biased in one direction and being operable to release its respective switch from either extreme position, and a plurality of cams supported for oscillation

together to cooperate with said members for effecting movement of said switches each to opposite extreme positions selectively, said cams each having in a spaced relation relatively short and steep camming surfaces and also having a surface which is coextensive with the space between said camming surfaces and which is concentric to the axis of said cams.

6. In a multi-circuit device, the combination with a plurality of mercury switches supported for oscillation individually and having means frictionally to retain the same in extreme positions, of a plurality of members supported for oscillation individually and having lost motion connections with said switches respectively, each of said members being biased in one direction, of an oscillatable cam member having a plurality of cams to cooperate with said members respectively for effecting movement of said switches each to opposite extreme positions selectively, certain of said cams each having relatively adjustable members providing high and low camming surfaces to be adjusted relatively and an intermediate surface which is concentric to the axis of oscillation of said cam member and which is coextensive with the space between the high and low cam surfaces for different adjustments of the latter.

7. In a circuit commutating device, the combination with a switch provided with an actuating element to be reciprocated, said switch being movable to open and closed positions selectively by movements of said element to extreme positions and said element being returnable to a given intermediate position after opening or closing of said switch without effecting further circuit change by the latter, of a cam having a surface which is engaged by said element under bias and which effects said intermediate positioning of said element throughout a range of movement of said cam, and said cam having relatively adjustable high and low camming surfaces pitched abruptly from the first mentioned surface for effecting movement of said element into its extreme positions selectively.

8. In a circuit commutating device, the combination with a switch provided with an actuating element having a lost motion connection therewith, said switch being movable to open and closed positions selectively by reverse movements of said element to extreme positions and said element being returnable to a given intermediate position after opening or closing of said switch without effecting return movement of said switch, of a cam having a surface which is engaged by said element under bias and which effects said intermediate positioning of said element throughout a range of movement of said cam and said cam having spaced and relatively adjustable high and low camming surfaces pitched abruptly from the first mentioned surface for effecting movement of said element into its extreme positions selectively.

9. In a circuit commutating device, the combination with a switch provided with an oscillatable actuating element, said switch being movable to open and closed positions selectively by reverse movements of said element to extreme positions, and said element being returnable to a given intermediate position after opening or closing said switch without effecting further circuit change by the latter, of a cam having a surface which is engaged by said element under bias and which effects said intermediate positioning of said element throughout a range of movement of said cam, and said cam comprising relatively adjustable parts respectively provided with high and low camming surfaces which are relatively short and steep and which are engageable with said element to effect movement of the latter from said intermediate position to its extreme positions selectively.

10. In a circuit commutating device, the combination with a switch provided with an oscillatable actuating element, said switch being movable to open and closed positions selectively by reverse movements into extreme positions and said element being returnable to a given intermediate position after opening or closing said switch without effecting further circuit change by said switch, of an oscillating cam having a surface which is engaged by said element under bias and which is concentric to the axis of oscillation of said cam, and also having spaced and relatively adjustable high and low camming surfaces pitched abruptly from the first mentioned surface and engageable with said element to effect movement thereof in opposite directions from said intermediate position.

11. In a circuit commutating device, the combination with a switch provided with an oscillatable actuating element biased in one direction, said switch being movable to open and closed positions selectively by reverse movements of said element to extreme positions and said element being returnable to a given intermediate position after opening or closing said switch without effecting further circuit change by the latter, of an oscillatable cam engaged by said element under its bias, said cam comprising relatively adjustable parts providing high and low camming surfaces to be adjusted relatively and an intermediate active surface which is coextensive with the space between the high and low camming surfaces for different adjustments of the latter and which is concentric to the axis of said cam and of a radius to cause said element to assume said intermediate position.

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