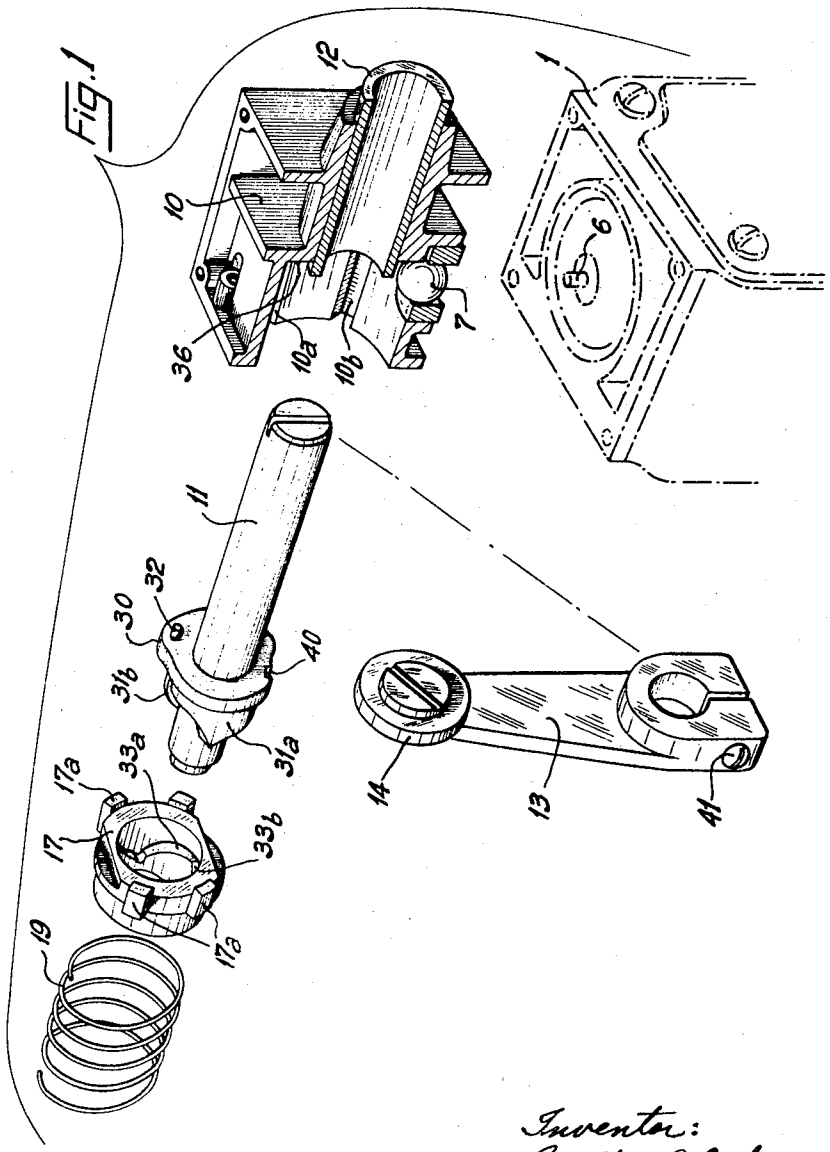
March 24, 1964 R. J. P. DUFOUR 3,126,460

LIMIT SWITCH CONTROL MECHANISM

Filed March 19, 1962 2 Sheets-Sheet 1

Fig. 1



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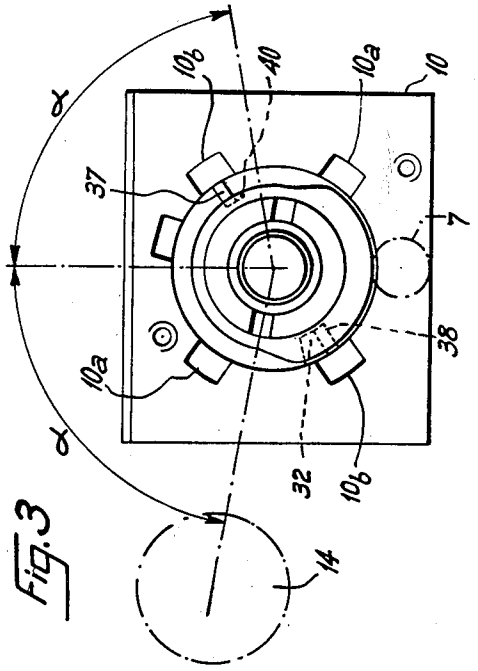

Fig. 3

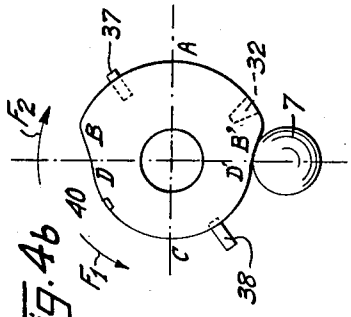

Fig. 4b

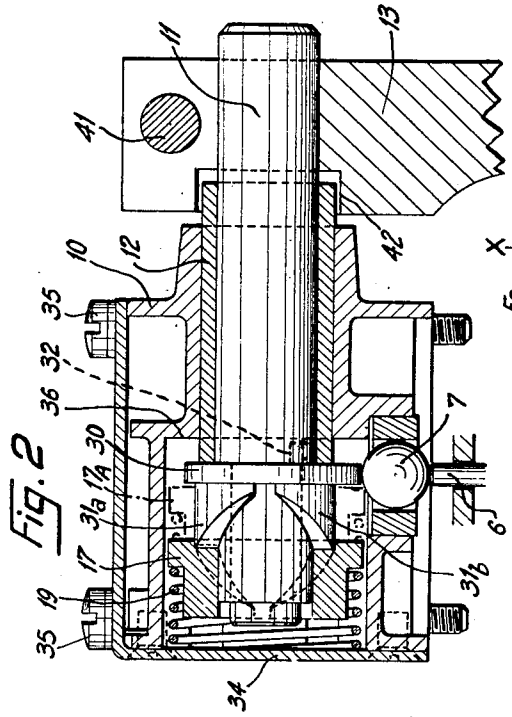

Fig. 2

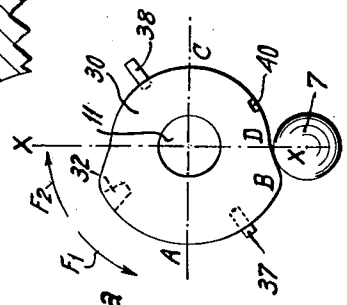

Fig. 4a

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LIMIT SWITCH CONTROL MECHANISM

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9 Claims. (Cl. 200—47)

This invention relates to switch control mechanisms of the type that are used in the automatic control of machinery including displaceable components such as sliders, carriages or the like. In controlling the movements of such mechanical components it is well known to provide switches interposed adjacent the path of motion of the displaceable component and adapted for actuation by stops or fingers projecting from the component. The switch when thus actuated may act to make and break energizing circuits for relay windings, contactors, solenoid-operated fluid valves, and for other electrical apparatus serving to control the desired automatic sequence of movements of the machinery. Such arrangements are especially useful in connection with machine-tools, hoisting and handling equipment, e.g. lifts, in handling installations including conveyers, where such arrangements may be provided for counting and/or indicating the presence of articles carried on the conveyers, as well as in various other fields of engineering.

The manner of operation of the switches used and the character of the electric signals transmitted thereby when operated may differ according to the circumstances in which they are used.

Thus it may be desired in some cases that a pair of switch contacts be closed or opened by a displaceable component of the controlled apparatus as said component is moving past the switch, and that said contacts will remain in their closed or open position until such time as the said component moves past again in the reverse direction, at which time they will be restored to their initial condition. In switch mechanisms designed for this type of service, while the switch contacts have two stable circuit-establishing conditions, the lever or arm actuated by the mechanical component may have either one or two stable positions.

Another type of operation is that wherein the switch actuated is to open or closed position by the component moving past it, and then returns to its initial position, whereby a short electric signal or pulse is sent as the component moves past. Switches designed for this type of operation are usually symmetrically constructed, with an actuating arm that has a stable midposition and is adapted to be deflected from that position to either right or left as the component moves past, and then being restored to its midposition by biasing means.

In yet another manner of operation that is sometimes desired, the switch has two stable positions, but is arranged to emit only a brief transient signal as it is shifted from one to the other of these positions.

The modes of operation just listed are representative of the chief modes most frequently used in practice, but are not exhaustive.

In one advantageous known form of such a switch control device there is provided a versatile switch control mechanism capable of being quickly and easily reset to provide any selected one of a variety of modes of operation such for example as those listed above. Experience has shown that there are many cases in practice where it would be entirely adequate to provide such mechanism making it possible to select one out of only two different modes of operation, or switch program sequences e.g. two opposite symmetrical sequences. The present

invention concerns a switch control device wherein such dual selection is provided for.

It is, accordingly, an object of this invention to provide an improved arrangement for controlling the condition of an electric circuit under control of a moving part, and in accordance with either of two different programmed sequences. Another object is to provide such an arrangement which will be simple, robust, easy to operate and of a foolproof character. Further objects will appear as the disclosure proceeds.

In accordance with an important aspect of the invention there is provided an arrangement for controlling the condition of an electric circuit under control of a moving part and in accordance with either of two different programmed sequences, comprising a switch connected to said circuit and having an actuating element displaceable to actuate the switch and thereby control the condition of the circuit; a rotatable shaft having an arm projecting therefrom for engagement by said moving part to rotate said shaft; a cam carried by the shaft and having a first peripheral contour portion presentable toward said switch-actuating element so as to actuate the switch on rotation of the shaft in accordance with a first programmed sequence as determined by the configuration of said first cam contour portion; means biassing said shaft to at least one stable angular position on disengagement of the arm by said part; disablable means for limiting the angular range of shaft rotation to a portion of a full circumference; and selectively operable means for momentarily disabling said limiting means so as to rotate the shaft beyond said angular range and thereby present a different contour portion of said cam toward said element, whereby said element on reenablement of said limiting means will be controlled in accordance with another programmed sequence as determined by said second cam contour.

An exemplary embodiment of the invention will now be described for purposes of illustration but not of limitation with reference to the accompanying drawings, wherein:

FIG. 1 is an exploded view in perspective, illustrating the principal components of the improved switch control mechanism of this invention;

FIG. 2 is a side view, chiefly in axial longitudinal section, of the mechanism, in which the actuating arm and the switch unit are only partly shown;

FIG. 3 is a rear view of the mechanism shown in FIG. 2, with the cover, compression spring and second cam removed for clarity;

FIG. 4*a* is a detail view, on the same plane as that of FIG. 3, showing the first cam of the mechanism and the ball actuated thereby, in a first setting of the mechanism for obtaining a first program sequence; and

FIG. 4*b* is a view similar to FIG. 4*a* but illustrating the cam in the alternative setting, for providing a second program sequence.

Referring to the drawings, the switch control mechanism shown comprises a casing **10** (see especially FIG. 2) having a bore therein in which is fitted a bearing sleeve **12**. A shaft **11** is rotatably and slidably mounted within the sleeve **12** and projects out of the casing. Removably secured to the end portion of shaft **11** outside the casing, e.g. by way of a set screw such as **41**, is an arm **13**, carrying at its free end a follower roller **14**. In the operation of the device, it will be understood that the roller **14** is arranged to project into the path of motion of some moving part, such as a machine-tool slide or an elevator cage for example, so as to be struck by said part and thereby impart a rotational displacement to the shaft **11** at predetermined point or points of the motion of said part.

Secured around the shaft **11** within the casing **10** is a first cam unit including a peripherally contoured cam **30**

and a pair of axially projecting diametrically opposed V-shaped ridges or teeth **31***a* and **31***b* (also see FIG. 1). In one advantageous construction, the cam unit is an integral molding of superpolyamid resin and is press fitted around shaft **11**, preferably around a castellated, flatted or fluted section of said shaft to improve the bond of the molding therewith.

A ball **7** is slidably and rollingly positioned within a suitable socket formed in casing **10** in register with the cam **30** so as to be actuated by it on rotation of the shaft, and said ball acts in turn upon a push-button **6** which constitutes the actuating element of a switch unit **1** of conventional construction, preferably of the type including a spring plate, such as a warped spring disk, actuatable between two oppositely sprung conditions by depression of the button **6**. Switches of this type are well known in the art and for this reason the switch unit **1** has been shown herein only in general outline (FIG. 1). The switch unit **1** may be supported through any suitable means, not shown, in fixed position with respect to the casing **10**.

Further the cam unit is formed with a stop pin, or preferably as shown two diametrically opposed stop pins **32** and **40** projecting from the transverse side face of the cam **30** opposite from the side thereof from which the teeth **31***a* and **31***b* project. The said transverse face of cam **30** is abuttingly seated, in an annular area of said face positioned radially inwardly of the pins **32** and **40**, against the adjacent end face of the sleeve **12**, as will be clear from FIG. 2, thereby limiting the axial displacement of shaft **11** in the rightward direction.

Seated against the other side of the cam unit **30**, i.e. the side formed with the ridges **31***a* and **31***b* therein, is a second cam **17** which is formed with an opposite pair of V-shaped recesses **33***a* and **33***b* complementary to and cooperating with said V-shaped ridges of the first cam **30**. Second cam **17** is freely rotatable and slidable about the shaft **11** and is prevented from rotation relatively to the casing **10** by means such as a set of angularly spaced ears or lugs **17***a* received in notches such as **10***a* and **10***b* formed in the inner peripheral wall of casing **10** as shown in FIG. 3. A compression spring **19** is coiled around the periphery of cam **17** and is seated at one end against an end cover **34** of casing **10**, secured to the casing body with screws **35**, and is seated at its other end against a flange of cam **17**. Thus the spring **19** at all times urges the second cam **17** axially against the first cam **30** and simultaneously urges the shaft **11** around which cam **30** is secured, towards an axially abutted, operative position within the casing. A pair of diametrically opposed stops **37** and **38** projecting inwardly from the surface **36** of casing **10** cooperate with the stop pins **32** and **40** of cam **30** to define the angular range of rotational displacement of said cam and hence shaft **11** within the casing **10**, as will presently appear.

In operation, it will be understood that in the idle condition of the device, i.e. in the absence of any mechanical action tending to rotate the arm **13**, the axial thrust of compression spring **19** upon the second cam **17**, which latter is prevented from rotating as earlier described, acts to rotate first cam **30** and with it shaft **11** to a stable neutral position in which the V-shaped teeth **31***a*, **31***b* of cam **30** are fully engaging the complementary notches **33***a*, **33***b* of cam **17**. In this condition the second cam **17** is projected axially to an advanced position indicated by the chain lines **17**A in FIG. 2. This neutral angular position of the shaft **11** is a stable position, in that the shaft tends to be restored thereto whenever displaced therefrom through mechanical action on arm **11**. The range of angular displacement of shaft **11** to either side from this stable neutral position is determined by the relative positions of stop pin **32** on cam **30** and stop lugs **37** and **38** on the casing. The arrangement is such that in the neutral position just described, pin **32** is midway between said two stop lugs.

Further, in this embodiment the two fixed stops **37** and **38** are shown diametrically opposite each other. Under these circumstances the angular range of permissible shaft displacement in each direction from its neutral position, which displacement is indicated as the angles α in FIG. 3, will be somewhat less than 90° owing to the circumferential thickness dimensions of the stop lugs **37** and **38** and the stop pin **32**. The fact that the maximum displacement in each direction from neutral is somewhat less than 90° further ensures that the V-shaped teeth or ridges **31***a* and **31***b* of cam **30** will not escape out of the notches **33***a* and **33***b* of cam **17**.

Referring to FIG. 4*a*, it will be noted that the contour of cam **30** is symmetrical to opposite sides from a midline AC. In FIG. 4*a* the cam is shown in the position assumed by it in the neutral or stable position of the shaft **11** carrying it. At this time, the midline AC of the cam contour is horizontal (as shown in FIGS. 2 and 3), while the line shown at XX is vertical (as shown in those figures), i.e. extends through the center of ball **7** and switch pushbutton **6**.

Of the two symmetrical contour portions of cam **30** above and below the line AC, only one portion is utilized at any given time during the operation of the device, the particular half of the contour actually utilized being selectable by means later described. It will first be assumed that the lower contour portion of the cam indicated ABDC in FIG. 4*a* has been selected for use. It will be noted that this portion of the cam contour is different on each side from the vertical midline XX. Thus, in the illustrative embodiment, the contour ABDC includes a first large-radius portion AB followed by a brief connecting portion BD of decreasing radius, leading to the point D on the midline XX, and finally a smaller-radius portion DC extending over the remaining arc of the contour. With the cam thus contoured in its active portion, it will be evident that when shaft **11** is rotated from its neutral position in the counterclockwise sense indicated by arrow **F1**, ball **7** and hence switch pushbutton **6** are depressed and remain depressed over the arm AB, thus placing the controlled circuit in one condition; on the other hand when shaft **11** is rotated from its neutral position in the clockwise sense indicated at **F2**, the switch pushbutton **6** remains projected so that the controlled circuit is in its other condition. Thus, with the device as so far described, assuming relative reciprocation of a mechanical part past the arm **13** first in one then in the opposite direction, the controlled circuit will be placed into and will remain in one or the other of its two conditions depending on the direction in which the said part last travelled past the control device of the invention.

Assume now that it is desired to reverse the operating conditions of the controlled system, so that the switch pushbutton will be depressed and projected, respectively, in the same conditions that said pushbutton was projected and depressed, respectively, in the operating mode first described. For this purpose, according to the invention, it is simply necessary to dismount the arm **13** from shaft **11**, as by loosening the set screw **41**, then force the shaft **11** axially inwards of the casing against the action of spring **19**, until the stop pin **32** has been retracted clear of the stop lugs **37** and **38**, and impart one half turn of rotation to said shaft. This operation is facilitated in the present embodiment by providing a diametric kerf in the projecting end of shaft **11**, as shown in FIG. 1, to permit its being readily depressed and turned with a screw driver or equivalent means. Screw **41** is then retightened to secure arm **13** back firmly on the shaft.

When this has been done the cam **30** in the new neutral position of shaft **11** is positioned as shown in FIG. 4*b*, i.e. 180° displaced from the neutral position of the cam in the first case described. As will be evident, this is due to the fact that the ridges **31***a* and **31***b* relatively to the notches **33***a* and **33***b* have been interchanged; that is, instead of ridge **31***a* engaging notch **33***a* and ridge **31***b* engaging notch **33***b* as before, in the new neutral condi-

tion ridge 31*a* is engaging notch 33*b* and ridge 31*b* is engaging notch 33*a*.

If the contour of cam 30 is symmetrical in both portions ABDC and AB'D'C on opposite sides of cam diameter AC as in the illustrated embodiment, then the new type of operation of the system will be the following: on rotation of shaft 11 from neutral in direction F1 the switch will not be actuated and on rotation from neutral in direction F2 the switch will be actuated.

It will be understood that various departures from the exemplary embodiment of the invention illustrated and described may be made without departing from the scope of the invention, including any desired variations in the contour of cam 30, depending on the programming sequence desired for the controlled circuit. The cam pattern described and shown is especially suitable, inter alia, for use in cases where the control device of the invention is associated with a reciprocating controlling object (for actuating arm 13 of the device) of heavy weight, such as an elevator cage for example, apt to overshoot its end position. In that case, with the control device preset so that cam contour ABDC is active as first described herein, the circuit controlled by the switch 1, e.g. a circuit for energizing a safety device of some kind, may be energized as the elevator cage reaches and overshoots an end of its reciprocatory stroke as determined by the position of control device arm 13 thereby actuating arm 13 in one direction (F1, FIG. 4*a*), but will be deenergized again as the elevator cage moves back to within the prescribed limits of its travel, thereby actuating arm 13 in the reverse direction (F2, FIG. 4*a*). However, in other applications, it may be desirable for instance to actuate switch 1 so as to cause the switch to produce one brief pulse of electric voltage on the arm 13 being rotated one way, and not to produce any voltage at all, or alternatively produce a persistent voltage, on the arm 13 being rotated the opposite way. Cam contours suitable to provide such a program as well as any other programmed sequence of switch actuation and deactuation will be readily devised by those familiar with the art of automatic control.

According to another modification of the invention, the cam 17 instead of being formed with only two diametrically opposed notches or recesses 33*a*, 33*b*, may be provided with more, e.g. two pairs of diametrically opposed such recesses symmetrically disposed on opposite sides of the plane indicated by the line XX in FIG. 4*a*. With such an arrangement, the shaft 11 instead of being provided in operation with a stable neutral position centrally of the range of shaft displacement, as described above, will have two stable end positions at both ends of its range of angular displacements, since the spring 19 will at all times be urging the assembly into one or the other of its two positions in which the ridges 31*a*, 31*b* of cam 30 are engaging one or the other of the two pairs of notches in cam 17, and these positions will then define the end points of the range of shaft displacement.

In cases where the arm 13 is not required to be rocked a maximum angle of nearly 90° either way from its central neutral position, the stop lugs 37 and 38 on the casing may be provided spaced by an angle less than 180°; in such case, after the shaft 11 has been rotated one half turn to alter the active contour of cam 30, the stop pin 40 earlier mentioned will serve to limit the shaft displacement instead of the stop pin 13. Alternatively, in similar circumstances there may be provided a single stop pin 32 cooperating with an additional pair of stop lugs symmetrical with respect to stop lugs 37 and 38. However, the stop pin 40 shown herein may have utility in all cases, including the embodiment specifically illustrated herein, in that the provision of the pair of pins 32 and 40 will serve to distribute the impact created on arresting the rotation of arm 13 as between the two stop pins.

Referring again to FIG. 2, it will be noted that the arm 13 is shown as being recessed at 42 in one of its sides, the recess fitting freely over and around a projecting portion of the sleeve 12, or a corresponding projecting boss of the casing 10. The relative dimensioning is such that when the arm 13 is secured in position upon the shaft 11 the bottom of the recess in the arm will abuttingly engage the outer end surface of the sleeve, or casing, before the stop pins 32 and 40 have moved clear of the stop lugs 37 and 38. This arrangement ensures that it is necessary to loosen the screw 41 fixing the arm to the shaft before it can be possible to rotate the shaft 11 as described in order to reverse the active cam contour, and thus positively prevents inadvertent change in the desired control program sequence during operation. However, the latching means thus provided are only exemplary, and may be replaced by some other latching means, not involving the arm 13, or may be altogether omitted.

What I claim is:

1. An arrangement for controlling the condition of an electric circuit under control of a moving part and in accordance with either of two different programmed sequences, comprising a switch having an actuating element displaceable to actuate the switch and thereby control the condition of said circuit; a casing; a shaft rotatable in the casing and having an arm projecting therefrom for engagement by said moving part to rotate said shaft; a first cam carried by the shaft and having a first peripheral contour portion presentable towards said switch-actuating element so as to actuate the switch on rotation of the shaft in accordance with a first programmed sequence as determined by the configuration of said first cam contour portion; a second cam non-rotatably mounted in said casing for axial sliding displacement relatively to said shaft coaxially therewith; complementary camming surfaces on said second cam and shaft respectively and spring means biassing said camming surfaces into mutual engagement thereby to urge said shaft to rotate to at least one stable angular position in the casing on disengagement of the arm by said part; disable stop means for limiting the angular range of shaft rotation to a portion of a full circumference; and means for momentarily disabling said stop means to permit shaft rotation beyond said angular range and thereby to present a different contour portion of said first cam towards said element.

2. The arrangement claimed in claim 1, wherein said complementary camming surfaces comprise a pair of diametrically opposed generally V-shaped camming ridges and a pair of complementary diametrically opposed camming recesses respectively.

3. The arrangement claimed in claim 1 wherein said complementary camming surfaces are formed on said second cam and on an adjacent side of said first cam respectively.

4. The arrangement claimed in claim 1 wherein said shaft is mounted for axial displacement in said casing and said spring means are arranged to urge said second cam axially against said shaft and simultaneously urge said shaft axially to an operative axial position in said casing, and wherein said disable stop means comprise cooperating stops on said shaft and casing arranged to limit shaft rotation in said operative axial position thereof, whereby axial displacement of the shaft away from its operative position against said spring means will disengage said stops and allow the shaft to be rotated beyond said annular range.

5. The arrangement claimed in claim 4 wherein said stops include a stop projecting from said first cam and a pair of cooperating angularly spaced stops in said casing.

6. The arrangement claimed in claim 4, including latching means for normally preventing axial displacement of the shaft away from its operative position to disengage said stop means.

7. The arrangement claimed in claim 4, wherein said arm is removably mounted on the shaft outside said casing and when thus mounted prevents said axial shaft displacement away from operative position.

8. The arrangement claimed in claim 4, wherein said first and second cam contour portions are symmetrical with respect to each other on opposite sides from one cam diameter.

9. The arrangement claimed in claim 8, wherein each

of said cam contour portions includes two concentric arcuate sections of different radius and an interconnecting intermediate section.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,126,460 March 24, 1964

Robert J. P. Dufour

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, lines 41 and 61, for "disable", each occurrence, read -- disablable --.

Signed and sealed this 14th day of July 1964.

(SEAL)

Attest:

ESTON G. JOHNSON
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents