Oct. 23, 1962 C. S. ALDRICH ETAL 3,060,286

CONTINUOUSLY ADJUSTABLE LIMIT SWITCH

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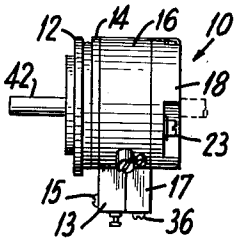


FIG. 1

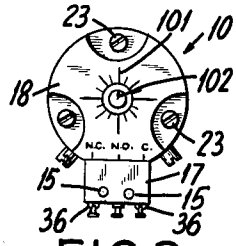


FIG. 2

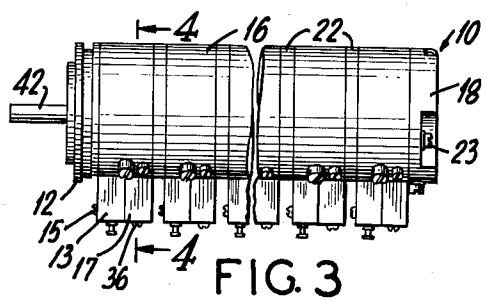


FIG. 3

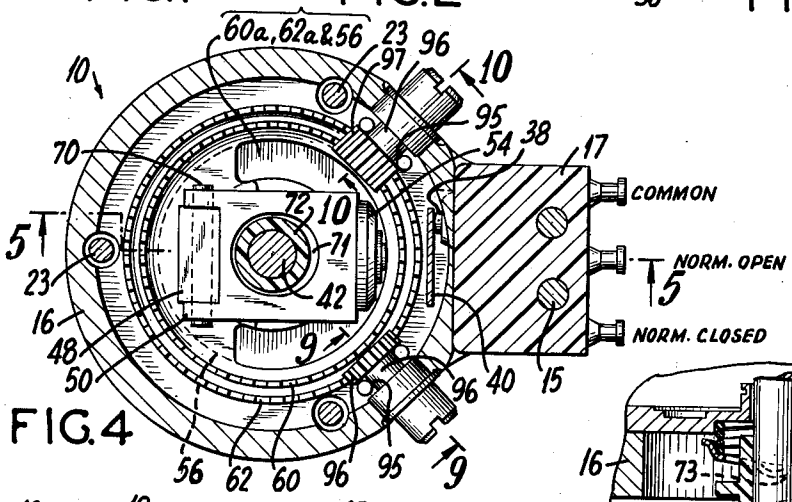


FIG. 4

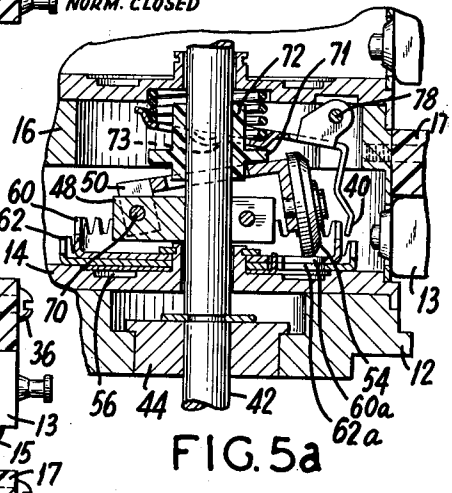


FIG. 5a

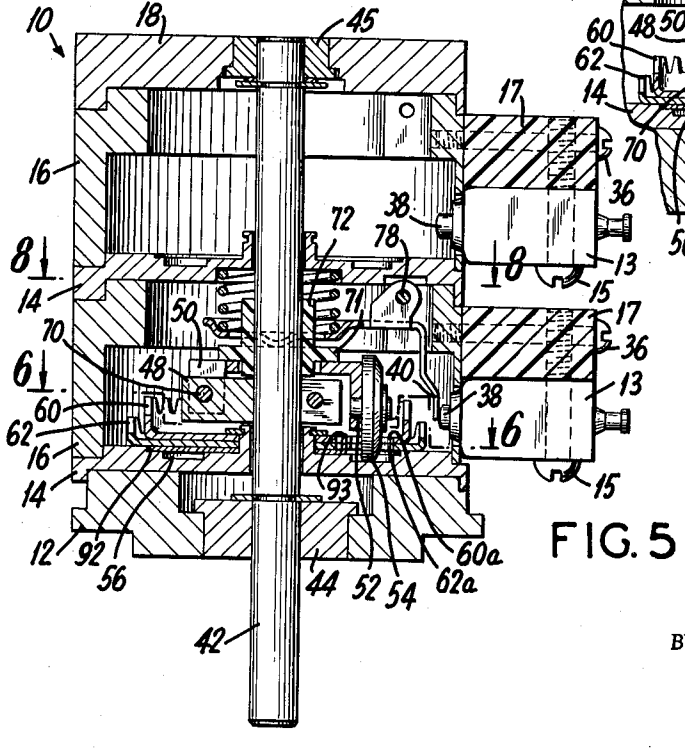


FIG. 5

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CONTINUOUSLY ADJUSTABLE LIMIT SWITCH

Filed Oct. 11, 1961 2 Sheets-Sheet 2

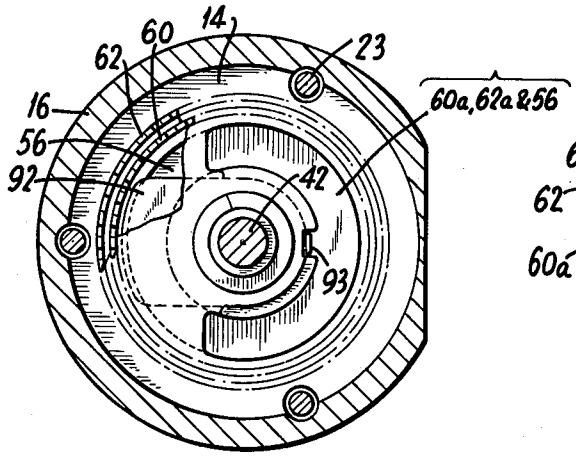


FIG.6

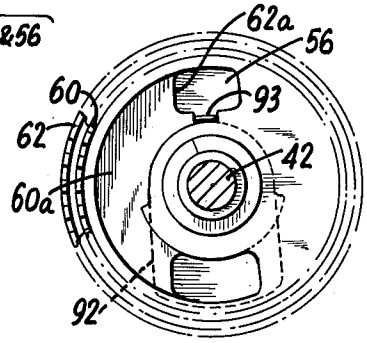


FIG.7

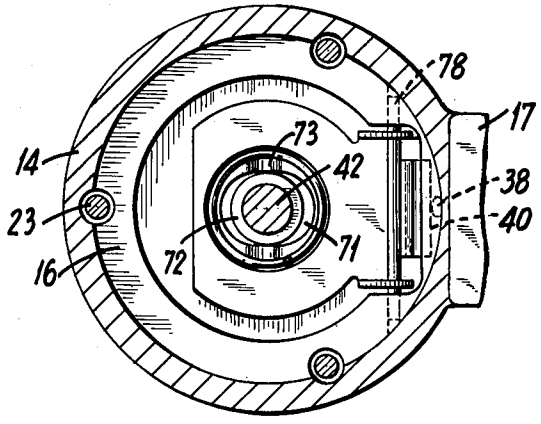


FIG.8

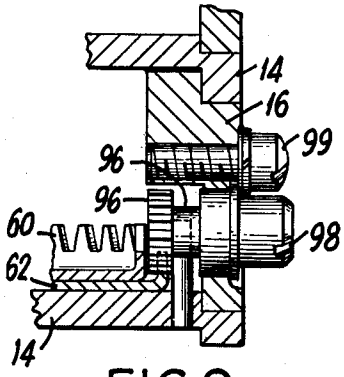


FIG.9

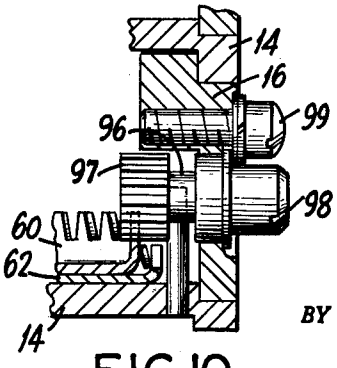


FIG.10

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CONTINUOUSLY ADJUSTABLE LIMIT SWITCH

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Filed Oct. 11, 1961, Ser. No. 144,382
17 Claims. (Cl. 200—19)

This invention relates to adjustable continuously rotating limit switches; and more particularly, but not limited thereto, to such a switch useful in connection with devices having a repetitive cycle of operation, in which use this limit switch renders possible the opening and closing of independent circuits within a desired angular position, and keeping the circuits open, or closed, for practically any desired angular travel.

Switches of this invention have wide application in programming control and time-sequence operations.

A feature of the device is that it permits adjustment during operation of machines in which it is installed, thus facilitating the precise adjustment without repeated stopping of the machine, adjusting, and then starting up the machine again to check the results of the adjustment. This is especially important when two or more operations are so closely interrelated that the adjusting of one throws out the correctness of the prior adjustment of the other. For many applications it is desirable that the switch be compact, lightweight, capable of high speed rotation, and relatively insensitive to shock and vibration.

As the device of this invention is more fully described hereinafter it will become apparent that the criteria is satisfied.

Accordingly, a principal object of the present invention is to provide a rotating multiple limit switch in which the time and also the duration of each controlled operation is readily adjustable while the machine is in motion.

A further object is to devise such a switch which is readily adjustable from the outside without opening the switch device.

Still another object of this invention is to provide a compact switch.

Still other objects and advantages will, in part, be pointed out with particularity and will, in part, become obvious as the following description proceeds taken in conjunction with the accompanying drawing.

In the drawing:

FIG. 1 is a full size side view of a single unit cam switch.

FIG. 2 is a rear view of the cam switch of FIG. 1.

FIG. 3 is a full size side view of a multiple unit cam switch.

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 3.

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 4 showing a switch in activated condition.

FIG. 5A is a partial cross-sectional view similar to FIG. 5, but showing the switch in deactivated condition.

FIG. 6 is a plan cross-sectional view taken along line 6—6 of FIG. 5.

FIG. 7 is a plan cross-sectional view of the crown gears showing the slots in closed position.

FIG. 8 is a plan cross-sectional view of lines 8—8 of FIG. 5 showing the pivoting means of the actuator.

FIG. 9 is a cross sectional view of the outer crown gear showing the locking and adjusting means for said gear taken along line 9—9 of FIG. 4.

FIG. 10 is a cross-sectional view of the inner gear taken along line 10—10 of FIG. 4.

Referring now to FIG. 1, there is shown a side view of a single switch unit embodiment of the device, indicated generally by the reference character 10. The

single switch unit shown includes a front mounting plate 12, a switch 13, a plate 14, a housing 16, and an end plate 18. For multiple switch units, a plate 22 is interspersed between housing members 16. The basic structural members (14, 16, 18, and 22, but not including end member 12) have their circular shape interrupted by a "flat" formed on one side adapted to accommodate a switch 13. The assembly is secured together by bolts 23 of suitable length. The switches 13 are fixed to a composition block 17 such as a linen or cloth reinforced plastic by means of screws 15. In turn, the blocks 17 are secured to members 16 by screws 36 to hold the switches in place. The plunger pins 38 of the switches extend through a hole in the housing 16 to permit contact with an actuator crank 40. A shaft 42 is journaled in bearings 44 and 45 which are supported, respectively, by end plates 12 and 18. The bearings are preferably roller bearings for high speed applications. Clamp 48 secures arm 50 causing it to rotate with shaft 42. A fixed shaft 52 extends from the arm and rotatably supports a nylon wheel 54. Delrin or other suitable material may be employed for the wheel. Plate 14 is provided with an annular groove 56 which is covered by a pair of nesting crown gears 60 and 62. The crown gears 60 and 62 are provided with semi-circular slots 60*a* and 62*a*, respectively, and depending on the relative position of the semi-circular slots, a portion of annular groove 56 is exposed.

As the shaft 42 is rotated arm 50 drives the wheel 54 along the exposed portion of the annular groove 56 until interrupted by the portion of the crown gear defining the end of its respective semi-circular slot. When the wheel 54 contacts the end of the slot it rides upward to the webbed surface of the crown gear. As it rides upward, the wheel causes arm 50 to pivot upwardly about pivot pin 70 pushing upwardly plastic button 72 which, in turn, seats against actuator crank 40.

Referring to FIG. 5A, it wil be appreciated that shoulder 71 of plastic button 72 seats against the ridge 73 provided in actuator crank 40 so that the load is always applied at the center of the button which is along a line passing through the center of shaft 42 and the device is positive-acting. It should be noted that as little as 0.001" end play will actuate the device. As pressure is applied against ridge 73, the arm pivots on pin 78 and the end of the actuator arm moves inwardly toward shaft 42 releasing the actuating pin on switch 13. The switch is now in its unactuated position.

The two crown gears 60 and 62, as previously pointed out, have slots 60*a* and 62*a* in their webbed surfaces. When these slots are superimposed on each other, as shown in FIG. 6, the wheel 54 can ride in the annular groove through 180° of angular travel about shaft 42. When one of the crown gears is rotated with respect to the other, the length of the slot is altered. At the extreme of travel, the opening of the slot becomes too short to allow the wheel 54 to enter the annular groove. Thus, an adjustment can be made which allows the switching angle to approach 0°.

On the other hand, where the full open slot exists, the wheel is allowed to remain in the annular groove for 180° of angular travel.

Referring now to FIG. 7 it will be noted that a tabbed plate 92 is positioned under the crown gears. When the effective slot opening is near the zero angle or closed position, plate 92 functions to close off the other slot opening which results. The plate 92 has a bent up tab 93 which is clamped between steps in the crown gears 60 and 62 and is therefore positioned to perform its function of closing the false slot. Since switches 13 may be of the single-pole, double-throw type, the actual adjusting switching angle available is 0° to 360°.

The bent up tab 93 on the closure also functions as a stop for the crown gears when in their extreme position. Without this stop, the crown gears could get out of phase with each other and adjustment of the instrument would not be as simple a procedure.

Thus a feature of this invention is the combination of the crown gears and their slots together with the closure, which combination is not found in the conventional split cam arrangement.

Actual adjustment of the instrument is quite simple. The pinions 96 and 97 extend through holes in the cover 16 and mate with their respective crown gear, as shown in FIGS. 9 and 10. A pair of pins are press-fit into members 14 and fit in recess 95 of pinion shaft 96. These pins serve to prevent any side motion of the pinion which would result in backlash and hence, non-repeatability of on-off position; and secondly, they prevent the pinions 97 from coming out of engagement with the crown gears. The pinions are provided with a screw driver slot 98 on the outside of the unit. As a pinion is rotated, it causes its linking crown gear to rotate, thus controlling the length of the effective slot in the crown gears, and governs the angle of switch-on or switch-off.

After the instrument has been adjusted, setscrew 99 is tightened. This prevents inadvertent rotation of the pinion and maintains the setting of the instrument.

Another feature of the invention is shown in FIG. 2 wherein the back end cap is provided with a small dial or "compass rose" 101. An index line 102 on the exposed end of the shaft provides a convenient means of rough adjustment of the instrument. Fine adjustments can then be made quickly in the assembly in which the instrument is used. Such final adjustment may be made while the equipment is operating.

It is to be understood that various changes, omissions and additions may be made to the preferred embodiment of the invention herein described, without departing from the spirit of the invention, as stated in the disclosure.

What is claimed is:

1. Actuating means responsive to the angular position of a rotatable shaft comprising:
- a member transverse to said shaft provided with an annular groove coaxial with said rotatable shaft;
- a radial arm carried by said shaft, and rotatable therewith;
- a lever pivoted from said arm;
- a stud shaft extending from said lever;
- a wheel rotatably mounted on said stud shaft and arranged to ride in said groove;
- a pair of plates provided with arcuate slots, having substantially the same radius of curvature as said groove, overlying a portion of said groove;
- means to rotate said plates about said shaft with the arcuate slots aligned in juxtaposition with said groove;
- a sleeve axially slidable along said rotatable shaft; and
- a crank, arranged to pivot about an axis, having a first arm positioned to be moved by said sleeve sliding on said rotatable shaft and a second arm arranged to move radially with reference to said rotatable shaft when said first arm is moved.

2. The apparatus of claim 1 including a switch positioned to be actuated by said second arm.

3. The actuating means of claim 1 wherein said pivoted crank first arm is provided with a ridge extending along a line lying on a diameter of said shaft parallel to said crank pivot axis.

4. The actuating means of claim 1 including biasing means urging said wheel into said groove.

5. The actuating means of claim 1 including a housing having an opening in an outer wall proximate to said second arm;
- means for rotatably supporting said shaft with a portion thereof within said housing; and

- a switch mounted on said wall in juxtaposition with the opening for actuating by said second arm.

6. The actuating means of claim 1 wherein said pair of plates are rotated by means of a pair of pinions engaging respective ones of a pair of concentric crown gears which are integral with respective ones of said plates.

7. The actuating means of claim 1, wherein said annular slots cover over 180° of arc, including a cover plate arranged to cover one portion of the annular groove exposed whenever said annular slots are in such relative position so as to simultaneously expose two portions of said annular slot.

8. The actuating means of claim 7 wherein said slots are stepped with the steps in confronting relation and said cover plate is provided with a tab positioned between said steps.

9. Actuating means responsive to the angular position of a rotatable shaft comprising:
- a plate transverse to said shaft provided with an annular groove coaxial with said rotatable shaft;
- a radial arm carried by said shaft, and rotatable therewith;
- a lever having one end pivoted from said arm, a middle portion surrounding said shaft and a cantilevered end;
- a stud shaft extending from said cantilevered end;
- a wheel rotatably mounted on said stud shaft and arranged to ride in said groove;
- a pair of plates provided with arcuate slots having substantially the same radius of curvature as said groove overlying a portion of said groove;
- means to rotate said plates about said shaft with the arcuate slots aligned in juxtaposition with said groove;
- a sleeve axially slidable along said rotatable shaft engaging said middle portion; and
- a crank, arranged to pivot about an axis, having a first arm positioned to be moved by said sleeve sliding on said rotatable shaft and a second arm arranged to move radially with reference to said rotatable shaft when said first arm is moved.

10. The apparatus of claim 9 including a switch positioned to be actuated by said second arm.

11. The actuating means of claim 4 wherein said pivoted crank first arm is provided with a ridge extending along a line lying on a diameter of said shaft, said ridge being in contact with said sleeve.

12. A switching device comprising: a plurality of electrically independent switches responsive to the angular position of a common rotatable shaft comprising in association with each of said switches,
- a member transverse to said shaft provided with an annular groove coaxial with said rotatable shaft;
- a radial arm carried by said shaft and rotatable therewith;
- a lever pivoted from said arm;
- a stud shaft extending from said lever;
- a wheel rotatably mounted on said stud shaft and arranged to ride in said groove;
- biasing means urging said wheel into said groove;
- a pair of plates provided with arcuate slots having substantially the same radius of curvature as the groove overlying a portion of said annular groove;
- means to rotate said plates about said shaft with the arcuate slots aligned in juxtaposition with said groove;
- a sleeve axially slidable along said rotatable shaft;
- a crank, arranged to pivot about an axis, having a first arm positioned to be moved by said sleeve sliding on said rotatable shaft and a second arm arranged to move radially with reference to said rotatable shaft when said first arm is moved; and
- a tubular housing, provdied with an opening proximate said second arm, interposed between successive

ones of said members, one of said switches being mounted on a said tubular housing proximate the opening for actuation by a said second arm.

13. The switching device of claim 12 wherein said pivoted crank first arm is provided with a ridge extending along a line lying on a diameter of said shaft parallel to said crank pivot axis.

14. The switching device of claim 12 including biasing means urging said wheel into said groove.

15. The switching device of claim 12 including a crown gear coupled to each of said plates and a pinion gear, engaging each said crown gear, provided with a shaft extending out of a respective said housing.

16. The switching device of claim 12, wherein said annular slots cover over 180° of arc, including a cover plate arranged to cover one portion of the annular groove exposed whenever said annular slots are in such relative position so as to simultaneously expose two portions of said annular slot.

17. The switching device of claim 16 wherein said slots are stepped with the steps in confronting relation and said cover plate is provided with a tab positioned between said steps.

No references cited.