

July 1, 1969

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3,452,841

DAMPED SWITCH OPERATOR

Filed Aug. 29, 1967

Sheet 1 of 2

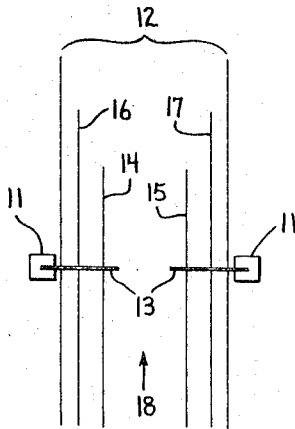


Fig. 1.

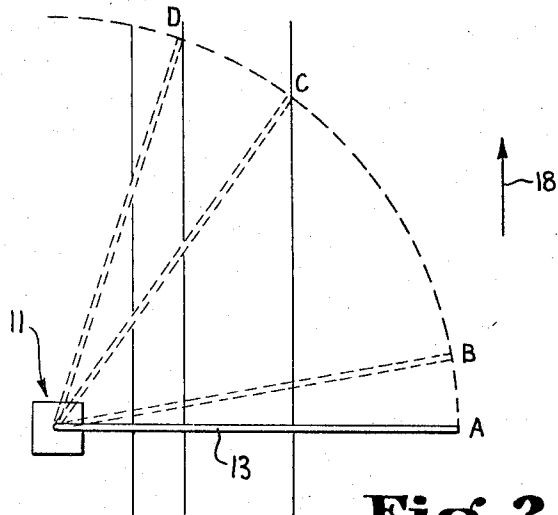


Fig. 2.

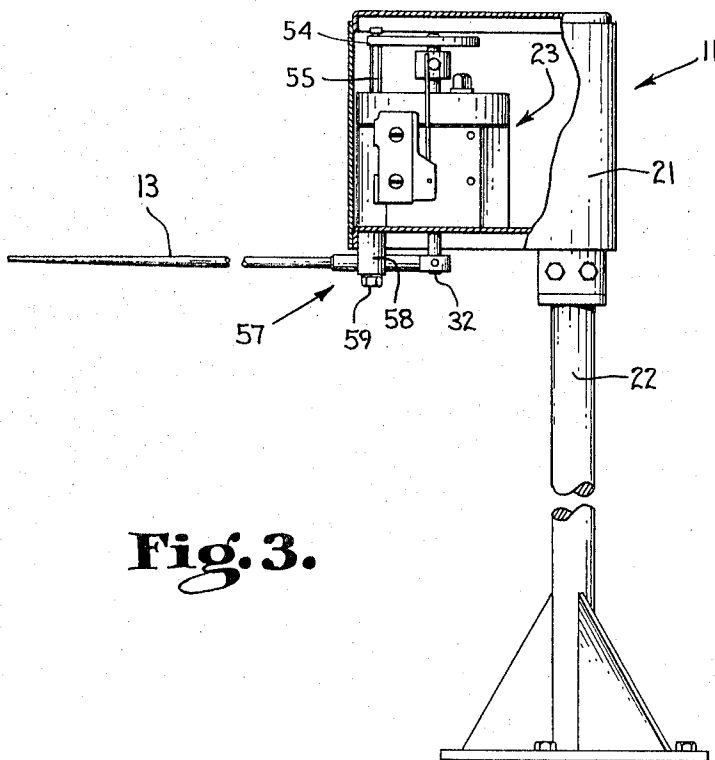


Fig. 3.

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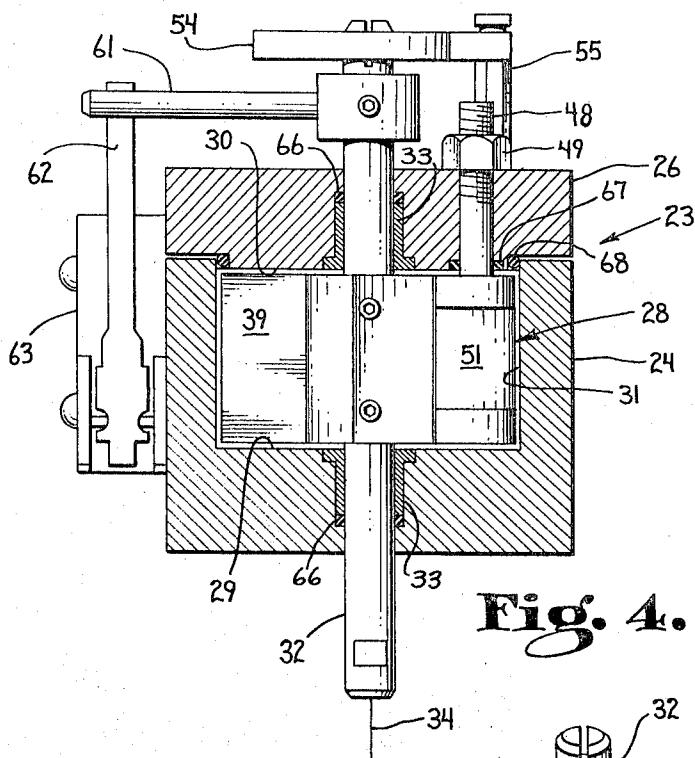


Fig. 4.

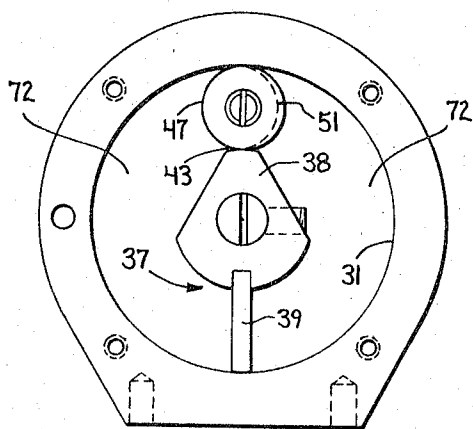


Fig. 5.

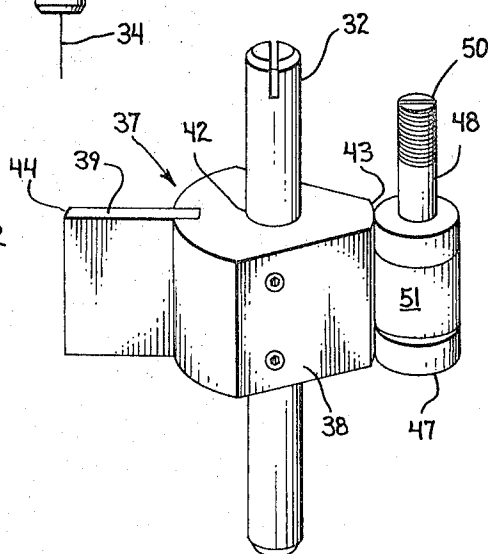


Fig. 6.

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DAMPED SWITCH OPERATOR

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5 Claims

ABSTRACT OF THE DISCLOSURE

This invention is concerned with a hydraulically damped electric switch operator having a case with a cylindrical interior. Positioned within the case is a shaft mounted for rotation upon the axis of the cylindrical interior, a vane assembly mounted on the shaft within the case, a cam mounted within the case and cooperable with the vane assembly to form an adjustable dashpot. The cam usually can be adjusted externally of the case.

BACKGROUND OF THE INVENTION

Field of the invention.—The field of the invention is generally hydraulic dampers, and more particularly, rotational hydraulically damped electric switch operators.

Description of the prior art.—Many automatic and semi-automatic machines and apparatus employ limit switches, proximity switches and other devices to start or stop motors, open and close valves, etc., when a piece of work has reached a certain position. Notwithstanding the development of many sophisticated devices for detecting when an item has reached a certain position, electric switches having mechanically operated contacts are still widely used because of their economy of manufacture and simplicity of construction.

A sensing arm is commonly used to operate the electric switches when an item moves against the arm and displaces it, the arm motion being translated to the switch contacts. The arm normally rests in a "home" position, and is commonly returned there by a spring where the arm encounters a stop. Because of the angular momentum of the sensing arm, the arm tends to rebound when it encounters the stop. If the rebound is too large, the sensing arm will improperly operate the switch, possibly causing equipment malfunctions, electrical current surges, and generally resulting in unnecessary wear and tear on associated equipment.

One application where this problem is encountered is in automatic car wash apparatus, where it is necessary to turn on and off different brushes, water jets and other devices as the automobile being washed reaches certain predetermined positions while being towed through the car wash apparatus. Because of large variations in the size of automobiles, the sensing arms used must be rather long and must be adapted to operate the switch or switches connected thereto upon small displacements of the arm. The combination of long sensing arm length, which tends to cause a large rebound, and the operation of the connected switch upon small displacement of the sensing arm results in unwanted operations of the switch.

One solution to the problem is to reduce the tension of the spring that returns the sensing arm to the "home" position. This is not a satisfactory solution, however, because small variations in the friction force required to rotate the sensing arm would greatly affect the response of the sensing arm, and the arm may fail to return to the "home" position. Another disadvantage in this approach is the length of time required for the arm to return home. While the arm is returning, the switch

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is still in the "on" position and keeping apparatus energized and using water, detergent and electrical energy. For economic operation, it is desirable that the arm return "home" rapidly after the car being washed has passed the sensing arm.

The best solution to the problem of unwanted switch operation caused by rebounding of the sensing arm is hydraulic damping. What is needed is a device that will permit a sensing arm to return rapidly to a position near the "home" position, and then bring it to a rapid halt without a rebound. The damping device, in order to do this, must allow the sensing arm to return most of the way "home" undamped, and then greatly damp the motion of the arm to very abruptly, but smoothly, reduce its angular velocity so that when it encounters the stop its momentum will be insufficient to cause a rebound large enough to operate the switch.

The damped switch operator of the present invention provides a device having these desirable operating features or characteristics, and further provides a device that is simple in construction, rugged and long lived.

SUMMARY OF THE INVENTION

The damped switch operator of the present invention is particularly adapted to damping rotational motion. It has a case with a cylindrical interior. A shaft is mounted for rotation in the case upon suitable bearings, the axis of the shaft lying upon the axis of the cylindrical interior of the case. Mounted upon the shaft and within the cylindrical interior of the case is a vane assembly having a cam portion and a vane portion. The cam portion has a cylindrical hole therethrough for receiving the shaft, and may be provided with set screws for fastening the vane assembly to the shaft. The cam portion has a length only slightly shorter than the length of the cylindrical interior of the case and has a partial cylindrical surface with its axis on the axis of the cylindrical interior and having a radius considerably shorter than the radius of the cylindrical interior. Extending radially from the cam portion and opposite the mid-point of the partial cylindrical surface of the cam portion is a vane portion. The vane portion resembles a paddle on a paddle-wheel, and its outer lateral edge almost touches the lateral surface of the cylindrical interior of the case.

Also mounted within the cylindrical interior of the case is a cam cylinder, having a generally cylindrical shape with a diameter substantially equal to the difference between the radius of the cylindrical interior of the case and the radius of the partial cylindrical surface of the cam portion of the vane assembly. As viewed in cross section, the cam cylinder is positioned so that it is tangent to the lateral surface of the cylindrical interior of the case and is also generally tangent to the partial cylindrical surface on the cam portion of the vane assembly when the vane assembly is in the "home" position. The cam cylinder has an end of reduced cross section extending through the case so that the cam cylinder may be rotatably adjusted from outside the case.

With the interior of the case filled with a viscous liquid, such as oil, it will be seen that when the shaft is rotated, thus rotating the vane assembly, oil will be forced around the ends of the vane assembly, between the vane portion and the lateral surface of the cylindrical interior, between the cam cylinder and the partial cylindrical surface of the cam portion of the vane assembly, and between the cam cylinder and the lateral surface of the cylindrical interior. If each of these surfaces is carefully formed, the clearances between them will be so small as to greatly restrict the flow of any oil between them.

The above is true so long as the vane assembly is near the "home" position where the partial cylindrical surface of the cam portion is tangent to the cam cylinder. When

the shaft has been rotated so that the edge of the partial cylindrical surface of the cam portion passes the point of tangency with the cam cylinder, there is no further restriction of the flow of oil between the cam cylinder and the cam portion of the vane assembly, although the restrictions continue between all the other surfaces.

If now the direction of rotation of the shaft is reversed, it will be seen that there is initially no restriction of the flow of oil between the cam portion and the cam cylinder. However, when the shaft rotates to bring the partial cylindrical surface of the cam portion into tangency with the cam cylinder, the restriction again exists. The restriction of the oil flows results in increased pressure between the vane portion and the cam cylinder as the vane portion moves rotationally toward the cam cylinder. This pressure exerts a force upon the vane portion which resists further motion of the vane portion toward the cam cylinder, thus retarding the motion of the shaft.

To control the degree of retardation, or damping, the cam cylinder is provided with a centrally located cam surface that has a circumferential length of slightly less than π radians so that when the center of the cam surface is positioned perpendicularly with respect to the line of centers of the shaft and the cam cylinder, both the cam portion of the vane assembly and the lateral surface of the cylindrical interior are presented with full cylindrical tangency. However, as the center of the cam surface is rotated toward the shaft, the cam cylinder remains tangent only at its ends. The cam surface in the center opens wider and wider until it is maximum when the center of the cam surface is on the line of centers. Further rotation again closes the opening. In this manner rotation of the cam cylinder controls the dashpot effect of the present invention.

It is therefore an object of the present invention to provide an improved damped switch operator.

It is a further object of the present invention to provide a damped switch operator that will permit a sensing arm connected thereto to return rapidly to its "home" position without rebounding away from a stop.

It is still another object of the present invention to provide a switch operator that will prevent unwanted operations of a switch caused by rebounding of a sensing arm.

These and other objects and advantages of the present invention will become apparent as the description of the invention proceeds, reference being had to the following detailed description, the attached drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic representation of a car wash apparatus, showing how the device of the present invention may be mounted.

FIG. 2 is an enlarged diagrammatic representation similar to that of FIG. 1 and showing the displacement of a sensing arm.

FIG. 3 is a partially cut-away side elevation of one embodiment of the damped switch operator of the present invention.

FIG. 4 is a cross sectional view of the damped switch operator of the present invention taken generally along the line 4—4 of FIG. 5.

FIG. 5 is a cross sectional view of the damped switch operator of the present invention taken generally along the line 5—5 of FIG. 4.

FIG. 6 is a perspective view of the shaft, vane assembly and cam cylinder of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows diagrammatically how the damped switch operator of the present invention may be mounted alongside a tow way of a car wash apparatus. The switch operator, indicated generally at 11, may be mounted on either or both sides of the tow way, indicated by the lines

12. A sensing arm 13 affixed to the switch operator 11 extends substantially perpendicularly into the path of automobiles towed through the tow way 12.

So that substantially all automobiles, from small sports cars to large touring cars, may be washed in the car wash apparatus, it must be designed to accommodate a large range of automobile sizes. For example, a small sports car may have a width indicated by the lines 14 and 15, while a large touring car may have a width indicated by the lines 16 and 17. Thus, it will be seen that it is necessary for the sensing arm 13 to be comparatively long.

FIG. 2 shows a portion of the diagram of FIG. 1 greatly enlarged. The "home" position of the sensing arm 13 is shown in solid lines and indicated at A. The sensing arm 13 is also shown in positions B, C and D in broken lines. Position C represents the largest displacement of the sensing arm 13 by a small car and position D represents the largest displacement of the sensing arm 13 by a large car. It will be seen in FIG. 2 that because a small car engages the sensing arm 13 at a point farther from the switch operator 11 than does a large car, a small car must travel farther than a large car in the direction of the arrow 18 to displace the sensing arm 13 the same amount. In order that a switch operated by the sensing arm 13 will operate for all automobiles when they have advanced to about the same place in the tow way, the amount of displacement necessary to operate the switch must be made small. The position of the sensing arm 13 at which the switch is operated is indicated at B. In this manner, a small car will displace the sensing arm 13 to position B only slightly later than a large automobile.

So that the sensing arm 13 will return to its "home" position after an automobile has passed, it is spring loaded as will be subsequently described in more detail. The operation of a spring on the sensing arm 13, unless resisted by another force, acts to accelerate the sensing arm 13 continuously from the instant it is free of the automobile until it encounters a stop at the "home" position. Even if the sensing arm is formed of very light weight material, because of its length and consequent weight distribution, it has a large radius of gyration. Therefore, when it encounters the stop at the "home" position, it may possess a considerably large angular momentum and tend to rebound off of the stop and improperly reoperate the switch.

As will be subsequently described, the damped switch operator 11 prevents the sensing arm 13 from rebounding and causing undesirable operations of the switch.

Referring now to FIG. 3, there is shown a side elevational view of the damped switch operator of the present invention. The switch operator 11 may be enclosed within a suitable housing 21 and affixed to a mounting post 22. Within the housing 21 and affixed to the mounting post 22 is a case 23 having a body portion 24 and a cap portion 26. The cap portion 26 may be fastened to the body portion 24 by machine screws (not shown). The case 23, as may be better seen in FIGS. 4 and 5, has a substantially cylindrical cavity 28 with end surfaces 29 and 30 and a lateral surface 31. A shaft 32 is mounted for rotation within bearings 33 upon the axis of the cylindrical cavity 28, indicated at 34. Mounted upon the shaft 32 within the cavity 28 is a vane assembly 37 having a cam portion 38 and a vane portion 39 as best shown in FIG. 6. The cam portion 38 is provided with a central bore 42 for receiving the shaft 32. The length of the cam portion 38 is very slightly shorter than the axial length of the cavity 28. The cam portion 38 also has a partial cylindrical surface 43 having a radius substantially smaller than the radius of the cavity 28 and having its axis common with the axis 34.

The vane portion 39 of the vane assembly 37 is mounted to the cam portion 38 similarly to a paddle mounted to a paddle wheel. The vane portion 39 has a length equal

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to the cam portion 38 and extends radially from the cam portion upon a radius emanating from the axis 34 to the lateral surface 31 of the cavity 28. The vane portion 39 has an outer surface 44 that is cylindrical and concentric with the lateral surface 31 of the cavity 28. In the preferred embodiment, the vane portion 39 is positioned diametrically opposite the partial cylindrical surface 43. However, this is not essential to the functioning of the switch operator.

The vane assembly 37 is shown in FIG. 5 in the "home" position. When the vane assembly is in the "home" position, the partial cylindrical surface 43 is tangent to a cam cylinder 47 which has a diameter substantially equal to the difference between the radius of the lateral surface 31 and the radius of the partial cylindrical surface 43. A stem 48 is affixed to one end of the cam cylinder 47 and extends through a hole in the cap portion 23. The outer end of the stem 48 is threaded to receive a locking nut 49 and has a slot 50 adapted to permit the stem 48 to be rotated by means of a screwdriver.

The cam cylinder 47 has a cam surface 51 formed on its lateral surface. The cam surface, as best shown in FIGS. 5 and 6, is located centrally of the cam cylinder 47 and has a circumferential length less than pi radians. When the cam cylinder is positioned as shown in FIGS. 5 and 6 the damping action of the device is maximum. If the cam cylinder is rotated so that the maximum depth of the cam surface 51 is facing the partial cylindrical surface 43 when the vane assembly 37 is in the "home" position, the damping action of the device is minimum.

Affixed to the upper end of the shaft 32 as viewed in FIG. 3 is a coil spring 54. The spring 54 is tensioned and restrained by a post 55 affixed to the case 23 and exerts a torque upon the shaft 32 tending to rotate the shaft and sensing arm 13 so that the sensing arm encounters a stop 57 affixed to the case 23. The stop 54 may include a sleeve 58 and bolt 59 as shown in FIG. 3.

Also affixed to the shaft 32 is a switch operating arm 61, as best shown in FIG. 4. The switch operating arm 61 extends radially from the shaft 32 and may engage a toggle arm 62 which in turn operates an electric switch 63.

In order to render the cavity 28 oil tight, the shaft 32 may be provided with seals 66, the stem 48 with a seal 67, and the case with a gasket 68 between the body portion 24 and the cap portion 26. The case may also be provided with a threaded hole and removable plug for filling the cavity 28 with oil.

In operation, when the sensing arm 13 is in the "home" position, the vane assembly 37 is also in the "home" position and the switch 63 is held in the "off" position by the operating arm 61. As a car is towed through the tow way 12, the car encounters the sensing arm 13 and displaces it rotationally upon the shaft 32. This rotates the shaft 32, the vane assembly 37 and the operating arm 61. When the sensing arm 13 reaches a predetermined position, such as position B in FIG. 2, the operating arm 61 has moved to a position that operates the switch 63, permitting it to change from the "off" to the "on" state.

As viewed in FIG. 5, when the vane assembly 37 is in the "home" position, it cooperates with the cam cylinder 47 to divide the volume of the cavity 28 into two volumes indicated at 71 and 72. Displacement of the sensing arm 13 rotates the shaft 32 and the vane assembly 37 so that one of the volumes 71 or 72 is increased while the other is decreased. With the sensing arm 13 and vane assembly 37 in the "home" position, displacement of the sensing arm 13 by an automobile moving in the direction of the arrow 18 as shown in FIG. 1 will rotate the vane assembly 37 clockwise as viewed in FIG. 5. This rotation decreases the volume 72 and increases the volume 71, forcing oil from the volume 72 into the volume 71.

The oil is forced between the ends 29 and 30 of the cavity 28 and the ends of the vane assembly 37 and the cam cylinder 47; between the lateral surface of the cam cylinder 47 and the lateral surface 31 of the cavity 28; between the cam cylinder 47 and the partial cylindrical surface 43 of the vane assembly; and between the outer surface 44 and the lateral surface 31. The greater the clearances between these surfaces, the less resistance there will be to the oil flowing from the volume 72 to the volume 71. The clearances between all of the above mentioned surfaces are substantially constant except for the clearance between the partial cylindrical surface 43 and the cam cylinder 47. Therefore, with the cam cylinder positioned as shown in FIGS. 5 and 6, the resistance to the oil flow is maximum when the vane assembly 37 is rotated near the "home" position.

It will be recognized by those skilled in the art that this structure forms a dashpot assembly, and that decreasing the volume 72 increases the pressure of the oil therein an amount that is proportional to, among other factors, the viscosity of the oil, the cross sectional area of the paths the oil may travel from volume 72 to volume 71 and the velocity with which the oil must travel from volume 72 to volume 71. Because the displacement of the sensing arm 13 by an automobile being towed through the tow way 12 is comparatively slow, and therefore the rotation of the vane away from the "home" position is slow, the force retarding displacement of the sensing arm 13 away from the "home" position is quite small.

When the vane assembly 37 has rotated to a position where the partial cylindrical surface 43 is no longer tangent to the cam cylinder 47 a very large opening between volumes 72 and 71 exists, and consequently the retarding force is extremely small. This situation exists throughout the remainder of the displacement of the sensing arm 13 by an automobile.

Throughout the displacement of the sensing arm 13 by an automobile, the shaft 32 is tensioning the coil spring 54. When the automobile has been towed to a certain position, the sensing arm will be free of the automobile and the coil spring acts to return it to the "home" position. In the absence of damping, the spring 54 would continuously accelerate the sensing arm 13 past position B where the switch 63 is turned "off" and toward the "home" position until it encountered the stop 57, whereupon, because of the angular momentum of the rotating sensing arm 13, it would tend to rebound off of the stop 57 and improperly re-operate the switch 63.

In the device of the present invention, as the spring 54 drives the sensing arm 13 toward the "home" position, and at a position near the "home" position, the partial cylindrical surface 43 becomes tangent to the cam cylinder 47, abruptly restricting the passage of oil from volume 71 to volume 72. This re-creates the dashpot arrangement described above and because the rotational velocity of the vane assembly 37 is comparatively high, the resulting retarding force is quite large, bringing the sensing arm 13 substantially to a halt as it encounters the stop 57, thereby preventing any rebound.

As noted above, the only variable clearance between the surfaces between which the oil flows from volume 71 to volume 72 is between the cam cylinder 47 and the partial cylindrical surface 43. This structure provides an adjustment for varying the damping effect of the present device. As the cam cylinder 47 is rotated away from the position shown in FIG. 5, the cam surface 51 is presented to the partial cylindrical surface 43, thereby creating a greater clearance between the two surfaces and consequently reducing the retarding force exerted on the sensing arm 13. This feature is desirable because the length and mass of sensing arm 13 or the force of the spring 54 may vary in different installations, necessitating somewhat different amounts of damping.

It will be apparent from the above description to those skilled in the art that the present invention provides an improved damped switch operator which is comparatively simple in construction, and can economically be made rugged, long-lived and substantially maintenance free.

The invention claimed is:

1. A damped switch operator comprising:
 - (a) a case having a cylindrical cavity with a lateral surface cylindrical about an axis;
 - (b) a shaft mounted for rotation upon said axis;
 - (c) a vane assembly mounted to said shaft within said cavity; said vane assembly having a partial cylindrical surface thereon; and
 - (d) a cam cylinder rotatably mounted within said cavity tangent to said lateral surface and to said partial cylindrical surface for adjusting the passage between said cam and said partial cylindrical surface of said vane assembly.
2. The invention according to claim 1 further comprising a stem affixed to said cam cylinder and extending through an opening in said case.
3. The invention according to claim 1 wherein said vane assembly includes a cam portion and a vane portion, said partial cylindrical surface being on said cam portion and

said vane portion extending radially from said cam portion.

4. The invention according to claim 1 wherein said cam cylinder has a cam surface located centrally thereon and having a circumferential length less than pi radians.

5. The invention according to claim 1 further comprising a spring affixed to said shaft for returning said shaft to a home position and a stop adapted to engage a member affixed to said shaft to stop said shaft at said home position.

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