June 8, 1965 W. G. ROWELL 3,188,421

FLUID FLOW SENSING MEANS

Filed Dec. 21, 1961 2 Sheets-Sheet 1

Fig. 1.

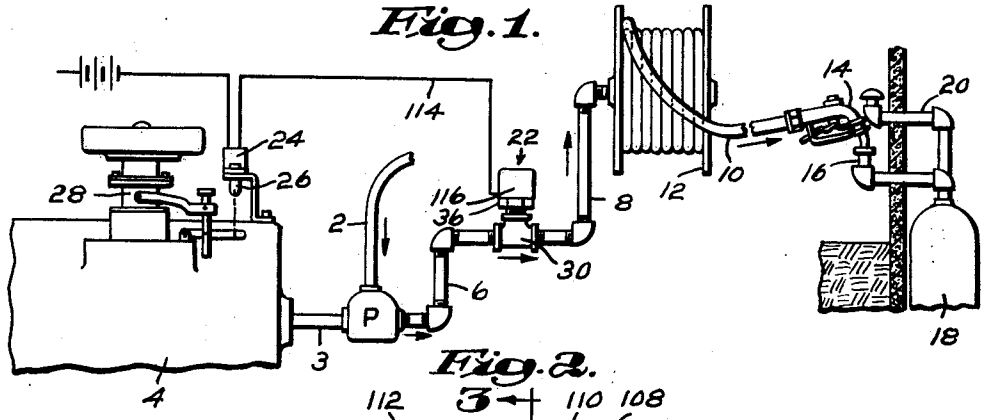


Fig. 2.

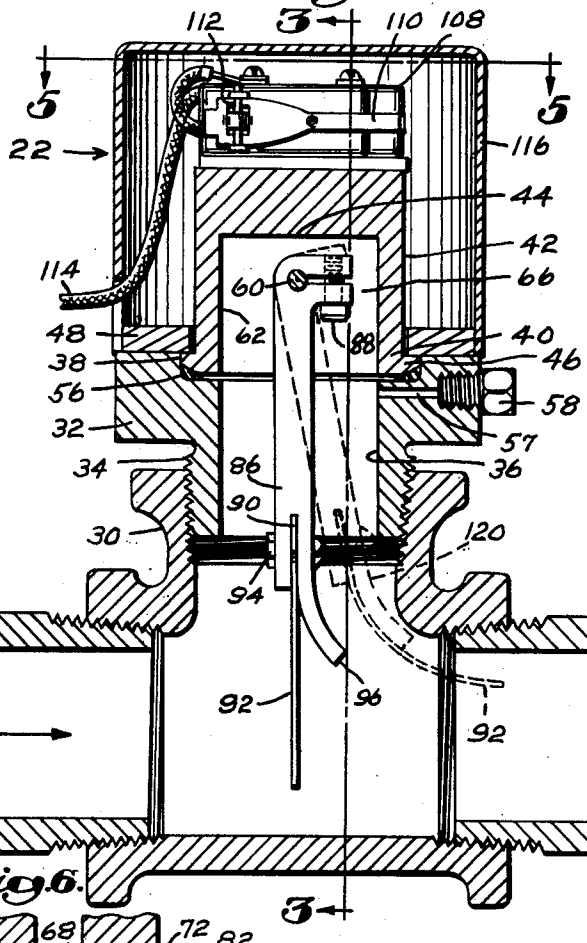
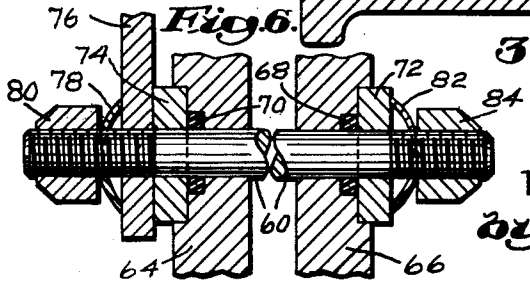


Fig. 6.



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FLUID FLOW SENSING MEANS

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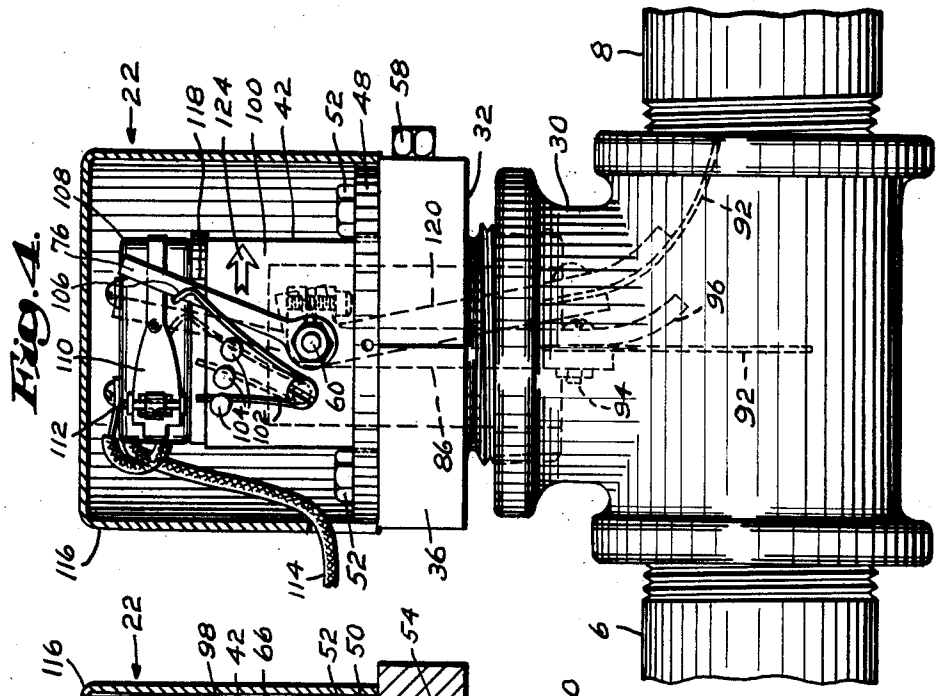


Fig. 4.

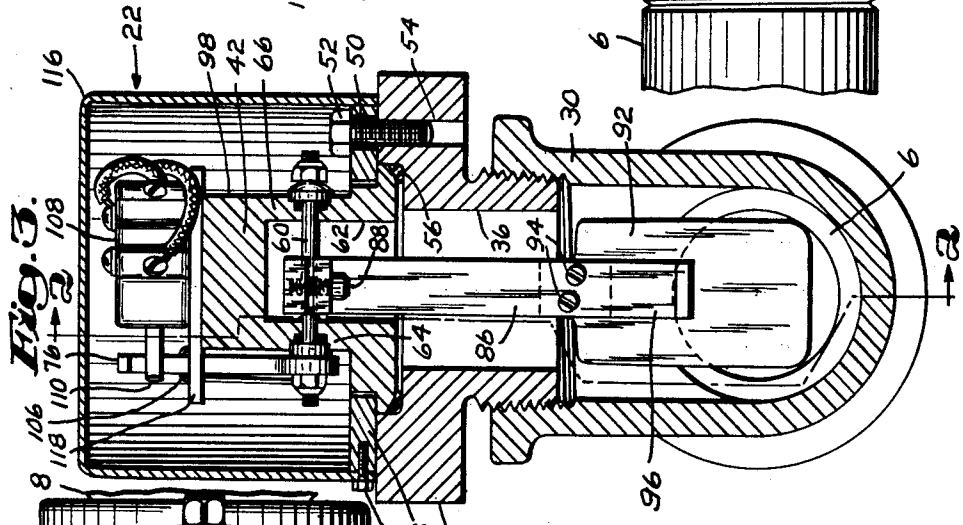


Fig. 3.

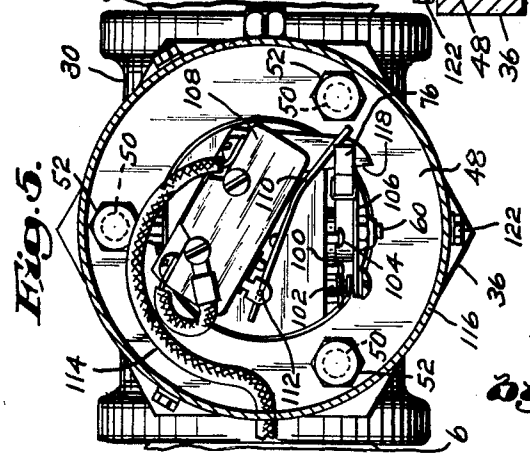


Fig. 5.

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FLUID FLOW SENSING MEANS

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4 Claims. (Cl. 200—81.9)

This invention relates to means for sensing the flow of fluid in a pipe. It is more particularly concerned with the sensing of the flow of liquid in a pipe by means movably disposed in the pipe and arranged to actuate a device located exteriorly of the pipe, whereby some other instrument or mechanism may be caused to function.

The invention is more particularly concerned with provision of means for sensing the flow of petroleum products in the delivery line from a tank truck to and through the hose leading to the tank in which the product is to be delivered. The purpose of the fluid flow sensing means is to provide mechanism whereby the truck engine that drives the pump may automatically be speeded up from idling speed to full pumping speed when the operator opens the hose nozzle at the storage tank fill pipe. More specifically, the invention has been found to be particularly valuable when put in use in the following manner:

In the delivery of fuel oil from a tank truck to the fuel storage tank in a building, the customary procedure is as follows: The driver stops at the tank location, leaving the truck engine idling in neutral. The clutch of the fuel pump is then thrown in, but since the valve at the end of the hose nozzle is closed there is no fluid flow from the pump. If the pump is of the positive displacement type, there is provided a by-pass so that undesirable pressures cannot develop at the idling speed. If a centrifugal pump is used, no damage can occur because centrifugal pumps are relatively ineffective at engine idling speed. The driver then unreels the hose, taking the nozzle to the fill pipe of the tank. Under current practice, the nozzle is connected in fluid-tight engagement with the fill pipe. The operator then opens the valve at the discharge end of the hose, permitting the fuel oil or other petroleum product to flow into the tank as it is pumped by the now-effective pump. Pumping, however, at engine idling speed would be in the order of 10 to 15 gallons per minute, which is much too slow for present day requirements. Accordingly, it is necessary to speed up the engine after the valve has been opened. In the past, this was accomplished by the driver returning to the truck and manually re-setting the throttle. In recent years, however, other more effective means has been devised in the form of control mechanisms actuated by a vane positioned in the metal piping part of the discharge line from the pump. This vane has been mounted on a pivoting shaft having a portion extending through the pipe to an exterior location. As the liquid begins to flow in the pipe when the hose nozzle is opened, the vane is caused to swing in the direction of flow. This in turn moves the shaft and related elements to cause the closing of an exteriorly positioned switch, establishing a circuit which actuates a solenoid. Movement of the solenoid in turn causes advance of the engine throttle so that the engine is automatically speeded up to produce the maximum desired pumping rate, which might be in the order of 80 to 100 gallons per minute. Thereafter, when filling has been completed, the operator, still standing by the valve at the end of the hose, closes the valve. This instantly stops the flow of oil through the delivery pipe and hose, and the vane, under the influence of a spring, returns to its original position. This opens the switch, de-energizes the solenoid, and the throttle is returned to idling position. The hose is then disconnected from the fill pipe of the tank and reeled up on the truck. With the fuel drop

completed, the driver than moves on to the next delivery station.

The invention disclosed and claimed hereinafter constitutes an improvement on the known fluid sensing means of the type described above and now available in the fuel oil delivery industry. The present invention, however, is not limited to use with fluids and may be used in gas lines as well. Furthermore, pipe pressure, which has an effect on the prior art constructions, is immaterial in the successful operation of the present device. The only requirement is that the fluid move at a rate sufficient to cause movement of the vane to actuate the exteriorly located switch. By varying the spring loading that constantly urges the vane in a direction against current flow, the switch can be actuated at any one of a number of different rates of fluid flow.

One of the main features of the present invention is the construction of the vane pivoting means whereby the end pressures on the shaft carrying the vane are balanced thereby to reduce the turning resistance and rendering it possible for a relatively light return spring to be effective to return the vane to off position when fluid flow has stopped.

A further important feature of the invention is the novel construction of the housing whereby the lower part of the housing may be screw threaded into the customary T in the piping system and set up tightly with the usually used large wrench at any angular position. Thereafter, the upper part of the housing to which the vane is attached may be positioned on the lower part of the housing in such maner that, regardless of the set up position of the lower part, the vane can always be installed in the pipe at right angles to the direction of fluid flow.

A further object of the invention is to provide novel, inexpensive and simply actuated means for connecting the upper and lower parts of the housing in permanent fluid-tight relationship.

These and other objects of the invention will become more apparent as the description proceeds with the aid of the accompanying drawings in which:

FIG. 1 is a somewhat schematic side elevation showing the invention positioned in the pipe line where it may be actuated by fluid flow to energize a solenoid which in turn will shift the throttle position on an internal combustion engine;

FIG. 2 is a vertical section of the fluid flow sensing device taken on the line 2—2 of FIG. 3;

FIG. 3 is another vertical section taken on the line 3—3 of FIG. 2;

FIG. 4 is a side elevation of the invention with the protective cover broken away showing the switch operating lever and the spring means for biasing the vane to normal non-flow position;

FIG. 5 is a plan view of FIG. 4 taken on the line 5—5 of FIG. 4; and

FIG. 6 is an enlarged fragmentary view of FIG. 3 showing the vane supporting shaft bearing construction.

Referring first to FIG. 1, the orientation of the invention is shown in relation to a conventional fuel oil delivery system. A pipe 2 leads from the truck tank (not shown) to the pump P, which may be either a centrifugal or positive displacement type. The pump P is driven by the engine 4 through shaft 3 and a conventional gear box and clutch (not shown). Suitable piping 6 and 8 runs to a hose 10 on reel 12 in conventional manner. A hose nozzle 14 is shown in tight connection with fill pipe 16 leading to tank 18 from which a vent pipe 20 extends to the atmosphere.

Interposed in the piping line 6, 8 is the fluid flow sensing device, generally referred to by the numeral 22, which constitutes the present invention. The device 22 includes as part thereof a vane which depends into the pipe flow line

and is caused to move by the flow of fluid at motor idling speed through pipes 6 and 8 when valve 14 is opened. Movement of the vane in turn actuates a switch which closes a circuit through solenoid 24. Upward movement of solenoid armature 26 shifts the position of the throttle on carburetor 28 from idling to some faster predetermined speed which steps up the pumping rate of the pump P to hasten the filling of tank 18.

When valve 14 is closed, flow of fluid through pipes 6 and 8 stops and the movable vane in the device 22 returns to neutral position, opening the solenoid circuit so that armature 26 reverses its movement, permitting return of the carburetor throttle valve to idling position. With the delivery completed, nozzle 14 is disconnected from fill pipe 16, the hose 10 is rewound on reel 12, pump P is unclutched from the engine 4, and the driver is then ready to move on to the next delivery point.

The invention found in the device 22 will now be explained in further detail by reference to FIGS. 2 to 6. Referring first to FIGS. 2, 3 and 4, a conventional T connection 30 is inserted between pipes 6 and 8. Into the upper threaded opening of the T is screwed a housing which is comprised of a lower tubular element 32 threaded as at 34. The upper periphery of element 32 is hexagonal in form as at 36 (see FIGS. 4 and 5) and is adapted to be engaged by a large wrench so that it can be screwed tightly into T 30. The final angular position of lower tubular element 32 when set up tight is immaterial.

The central part of element 32 is in the form of a cylindrical opening 36 terminating at the top in a larger annular recess 38. Into this recess fits the lower circular end 40 of an upper tubular element 42 which is closed at its upper end as at 44. The lower end 40 includes a circumferential outwardly extending flange 46 of sufficient width to be readily engaged by a flat ring 48. This ring has a plurality of holes drilled therethrough, preferably spaced 120 degrees apart as indicated at 50 in FIG. 5 to receive bolts 52 which are screwed into correspondingly threaded holes 54 in the upper portion of the lower tubular element 32.

From the description thus far, it can be seen that the upper tubular element 42 may be positioned on the lower tubular element 32 at any selected angular position and clamped in this position by the ring 48. An O-ring 56 is utilized to make a fluid-tight seal between the lower and upper tubular elements 32 and 42. The lower tubular element may include a port 56 to permit the utilization of pressure in the piping for the control of other instruments when desired. This port, however, is not used in connection with the present invention and is normally maintained closed by a plug 58.

As can be seen in FIGS. 2, 3 and 6, a shaft 60 extends across the interior cavity 62 in the upper tubular member 42. The shaft bearing construction is shown in detail in FIG. 6, wherein the shaft 60 extends through opposite walls 64 and 66, making a freely rotatable fit therewith. Suitable exterior circular recesses formed as shown contain the O-rings 68 and 70, which are held in place by washers 72 and 74 sufficiently tightly to make a fluid-tight seal along the shaft.

Both ends of shaft 60 are threaded. On the left end, as viewed in FIG. 6, is screwed a switch arm 76 to the limit of threaded engagement, where it is held by a spring washer 78 and nut 80. The other end of the shaft 60 receives spring washer 82 and nut 84. Nut 84 is screwed up only tightly enough to prevent leakage past O-rings 68 and 70, but when in this adjusted condition there is very little resistance to rotation by shaft 60.

As a result of this construction, it can be seen that regardless of the fluid pressure in cavity 62 of the upper tubular element 42 the pressure on shaft 60 is balanced and there is no end thrust in either direction.

Positioned on shaft 60 is a vane holder 86 secured against relative rotation by the clamping screw 88. The lower end of the holder is slit as at 90 to receive the upper end of vane 92 which is secured therein by a pair of bolts 94. The vane holder at its lower end has an extension 96 which curves in the direction of fluid flow and acts as a support for the vane as the vane is increasingly bent in the direction of flow by the moving fluid.

The upper tubular element 42 has flattened parallel opposite outer sides indicated at 98 and 100, both of which are at right angles to shaft 60. Mounted on side 100 is a spring 102, one end of which may be set selectively against one of a plurality of stops 104 so that the pressure of the other end 106 of the spring against switch arm 76 may be varied for best results under different flow conditions.

Fixed to the top of the upper tubular element 42 is an electric switch 108 which has an actuating arm 110 arranged to engage switch arm 76 at a sliding angle. As can be seen in FIG. 5, when switch arm 76 is swung to the left, actuating arm 110 will move clockwise about its pivot 112 a distance sufficient to actuate the switch. Switch 108 is suitably wired with one side grounded and with wire 114 running to the solenoid 24. A protective cover 116, secured by a screw 122 to ring 48, encases all of the elements just described.

The construction above set forth makes it easy to install the vane 92 at right angles to the direction of the fluid flow through pipes 6 and 8. The flattened sides 98 and 100 are marked with arrows, one being shown at 124 in FIG. 4 and both pointing in the direction of fluid flow. With lower tubular element 32 screwed tightly into T 30, the vane 92 depending from the upper tubular element 42 is lowered through bore 36 until flange 46 is resting on O-ring 56. The flats 98 and 100 are then aligned with pipes 6 and 8 with arrow 124 pointing in the direction of flow. Under these conditions, the vane 92 will be at right angles to the line of flow and the vane holder 86, normally held in vertical position by engagement of switch arm 76 with a stop 118 under the urging of spring 102, will be available to be moved to dotted line position 120 shown in FIGS. 2 and 4 as moving fluid in pipes 6 and 8 presses against vane 92.

With upper tubular element 42 installed in correct position, it is then clamped securely to lower element 32 by ring 48 and cooperating bolts 52. With the wiring completed, the unit is then ready for operation. This may be briefly repeated as follows: Upon the opening of valve 14, fluid commences to flow slowly through pipes 6 and 8. This slow flow due to the idling motor speed is, however, adequate to cause vane 92 and the vane holder 82 to swing to the dotted line position 120 shown in FIG. 2. This in turn rotates shaft 60 and switch arm 76 counterclockwise to the dotted line position shown in FIG. 4. Such movement of switch arm 76 permits actuating arm 110 of switch 108 to swing counterclockwise as viewed in FIG. 5 to close the electrical contacts and establish a circuit through solenoid 24. This instantly shifts the throttle of carburetor 28 to a higher speed position, which in turn speeds up actuation of pump P to create the desired pumping speed of 80 to 100 gallons or more per minute. Under the high pumping speeds, the vane 92 bends around the support 96 as indicated in FIGS. 2 and 4 to a position where there is very little interference with the fluid flow through pipe 8.

When the operator closes valve 14 upon tank 18 having been filled, fluid flow through pipes 6 and 8 stops and vane arm 86 and vane 92 are promptly returned to vertical position under the influence of spring 106. Return movement is limited by the engagement of switch arm 76 with the stop 118. In this position, switch 108 will be opened, de-energizing solenoid 24 and causing return of the carburetor throttle valve to idling position, thereby removing any damaging load from pump P.

Because of the balanced pressure conditions exerted on shaft 60, there is little frictional resistance to rotative movement of shaft 60 in its bearings, and accordingly the spring 106 may be of relatively low strength. This is an advantageous condition because it permits vane 92

and arm **86** to be swung to operative position by low rates of fluid flow. In the prior art constructions, high frictional forces were present which had to be overcome by the fluid flow in order to actuate the switch initially and, conversely, a much stronger spring was required to return the spring arm and vane to neutral position.

It should further be noted that the vane **92** is located symmetrically with respect to the vertical axis of the cross-sectional area of the pipe. Furthermore, the vane is so designed that as the vane moves toward the limit of its travel under the influence of the moving fluid in the pipe the vertical projected cross-sectional area of the vane becomes progressively less so that at full flow through the pipe there is very little obstruction.

The flexibility of the vane permits it to bend also in the opposite direction to normal flow. This might occasionally come about upon the emptying of a tank. By the use of a spring of proper strength, it is also possible at the end of the filling operation to open valve **14** slightly to top off the tank **18**, the fluid flowing through pipes **6** and **8** so slowly that vane **92** will not move, thus maintaining switch arm **110** in closed position. Another advantageous feature of the construction is that the pressure in the piping system has no influence whatsoever on the actuation of the vane. It is only the fluid flow that produces the operative effect desired.

It is my intention to cover all changes and modifications of the examples of the invention herein chosen for purposes of the disclosure which do not constitute departures from the spirit and scope of the invention.

I claim:

1. Fluid flow sensing means comprising a housing having a lower tubular element adapted to be positioned in an opening in the side of a fluid flow line and an upper tubular element closed at its remote end, means for securing the upper and lower tubular elements in fluid-tight engagement at any selected angular disposition relative to each about their common longitudinal axis, a shaft extending through opposite sides of the upper tubular element of said housing whereby the shaft ends will be subject to equal atmospheric pressures, sealing means for preventing leakage along said shaft from the interior of said upper tubular element, a vane fixed with respect to said shaft and positioned beyond said lower tubular element and adapted to be located in the said flow line whereby movement of said vane will cause rotative movement of said shaft, a switch associated with the upper tubular element of said housing, means on said shaft exterior of said housing for actuating said switch as the vane is moved by fluid flow in said flow line, and biasing means acting on said shaft for continuously urging said vane in the direction opposite to said fluid flow.

2. Means for supporting the vane of a fluid flow sensing means, said means comprising a housing formed of a lower tubular element threaded at one end to be screwed into a correspondingly threaded opening in the side of a pipe, the upper portion of said lower tubular element shaped to receive a wrench whereby the threads of said lower tubular element can be set up in tightened relation

to said pipe, an annular recess surrounding the upper end of the passage through said lower tubular element, an upper tubular element closed at its upper end and having an annular lower end adapted to rest in the said annular recess of the lower tubular element in any selected angular position, sealing means between said lower and upper tubular elements, means for forcing said lower and upper tubular elements together to maintain them in fixed fluid-tight relation, a shaft extending transversely through opposite walls of said upper tubular element in rotatable relationship thereto, means for preventing fluid leakage past said shaft through the said opposite walls, an arm fastened to said shaft and extending downward through both said tubular elements, and a vane secured to said arm and positioned below said lower tubular element.

3. Fluid flow sensing means comprising a two-part tubular housing closed at one end and threaded at the other to make connection with a correspondingly threaded opening in the side of a pipe, means permitting rotation of the said closed end of said housing with respect to the threaded end to a selected angular position, a rotatable shaft extending through opposite walls of the closed end portion of said housing and set at right angles to the axis of said pipe, a vane attached to said shaft and positioned in the line of fluid flow in the pipe, an arm attached to said shaft exterior of said housing, a spring bearing on said housing and arm to urge said arm in one direction, and a stop for limiting movement of said arm under the influence of said spring to a position in which said vane is substantially transverse of said pipe.

4. Means for supporting a fluid actuated vane in a pipe, said means comprising a two-part housing in which the lower part comprises a tubular member threaded at one end and having a nut-shaped configuration at the other, and the upper part comprises an inverted cup-like member which rests on and is initially adjustable with respect to the lower part about their common vertical axis, means for securing the upper and lower parts together in fluid-tight relation and in any selected relative angular position, a rotatable shaft extending through bearing surfaces in opposite walls of the upper part, sealing means for preventing fluid leakage past said shaft bearing surfaces, a vane secured to said shaft and located below said lower part for swinging movement on said shaft, a switch mounted on said upper part, and means on said shaft for actuating said switch when said vane is moved by fluid flow in said pipe.

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