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Malcolm

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[54] **IMPACT AND REACTANT STEP-BY-STEP ROTARY SPRINKLER HEAD**

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[52] **U.S. Cl.** **239/230;** 239/233; 239/507

[51] **Int. Cl.**[2] **B05B 3/16;** B05B 1/26

[58] **Field of Search** 239/230, 231, 232, 233, 239/507, 509–512

[56] **References Cited**

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1,997,901	4/1935	Englehart	239/230
2,256,737	9/1941	Englehart	239/230
2,310,796	2/1943	Lappin	239/230
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3,408,009	10/1968	Friedmann et al.	239/230

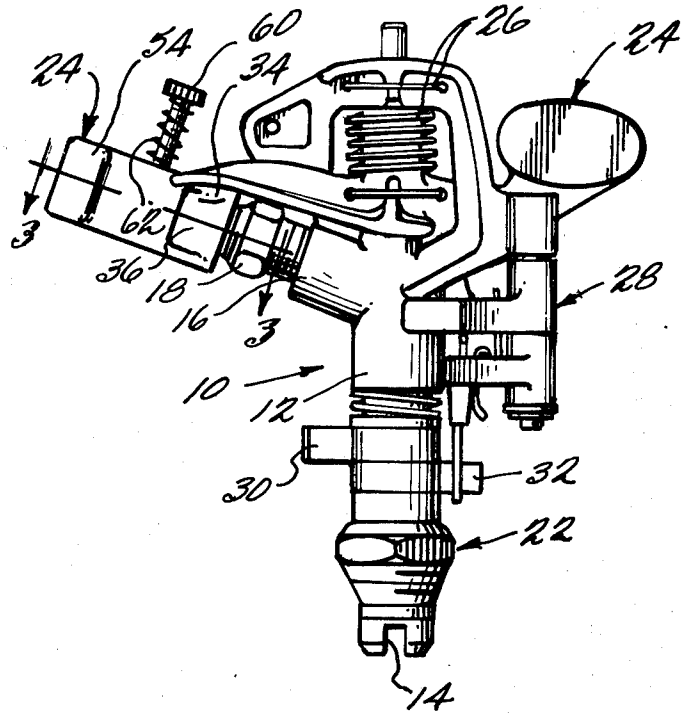
Primary Examiner—Robert S. Ward, Jr.

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[57] **ABSTRACT**

A reversible part-circle step-by-step rotary sprinkler head having an impulse arm of the impact type in which the impulse arm has a first reactant portion disposed in a position thereon radially outwardly of the outlet and within the flow axis thereof when the impulse arm is disposed in the impacting position which has a first reactant surface shaped to deflect water issuing from the outlet in a direction opposite to that of the impact movement and establish a reactant force on the impulse arm acting to move the same in a direction toward the impacting position, the sprinkler body has a reactant element thereon disposed radially outwardly of the first reactant portion in a position spaced in the aforesaid opposite direction from the flow axis of the outlet so as to receive the water deflected by the first reactant surface when the impulse arm is disposed in the impacting position and to permit unobstructed flow of water issuing from the outlet when the impulse arm is spaced from the impacting position, the reactant element has a second reactant surface thereon shaped to deflect the water impinging thereon further in the aforesaid opposite direction and establish a reactant force on the sprinkler body acting in the impacting direction, the impulse arm has a second reactant surface portion disposed in a position to receive the water issuing from the second reactant surface which has a third reactant surface thereon shaped to deflect the water laterally in the impacting direction so that it issues therefrom in a direction generally parallel with the flow axis of the outlet and establishes a reactant force acting on the impulse arm to move the same in the aforesaid opposite direction.

7 Claims, 4 Drawing Figures



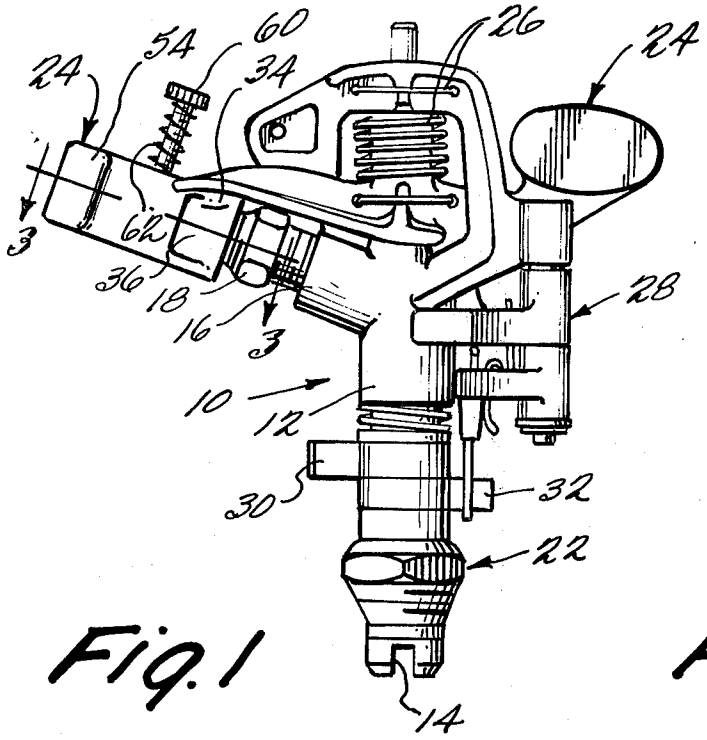


Fig. 1

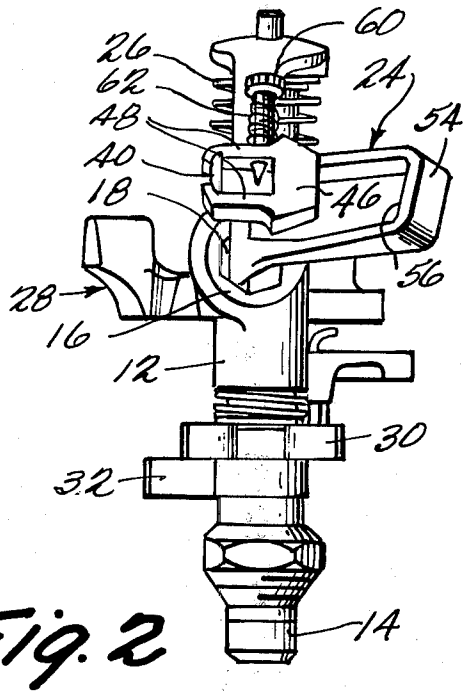


Fig. 2

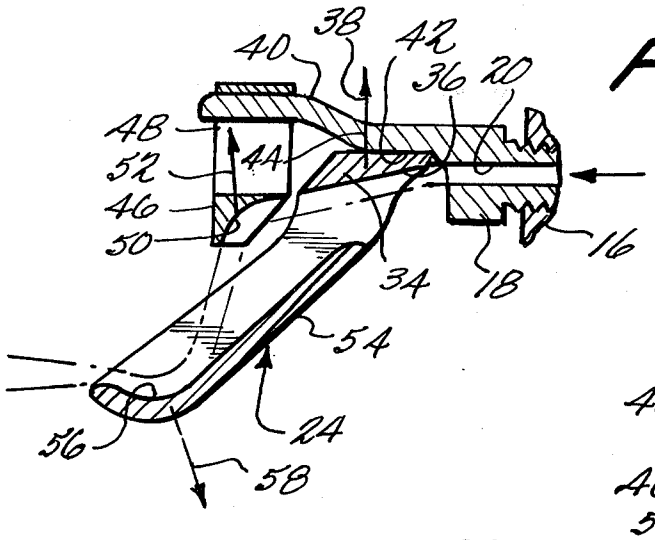


Fig. 3

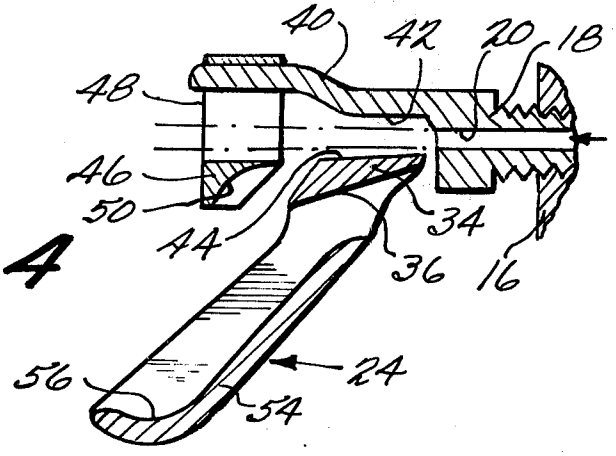


Fig. 4

IMPACT AND REACTANT STEP-BY-STEP ROTARY SPRINKLER HEAD

This invention relates to sprinkler heads and more particularly to step-by-step rotary sprinkler heads.

Step-by-step rotary sprinkler heads are well known in the art and constitute probably the most widely used sprinkler head because of the very favorable water distribution pattern which can be achieved in the operation thereof.

This favorable distribution pattern can be achieved by virtue of the favorable radial reach of the water during the periods of operation in which the water issuing from the outlet is unobstructed by the spoon of the impulse arm and the favorable radially inward distribution during the periods of operation in which the water issuing from the outlet is broken up and deflected laterally by engagement with the spoon of the impulse arm. The fact that during each impulse arm cycle the water distributed radially inwardly is displaced laterally or angularly with respect to the water distributed radially outwardly does not detrimentally effect the overall distribution pattern where full-circle operation is utilized since the lateral or angular displacement of two inner and outer full-circle distribution patterns has no effect. However, where part-circle operation is utilized, the effect of the lateral or angular displacement is noticeable.

This detrimental effect has long been recognized in the art. For example, in Englehart U.S. Pat. No. 2,256,737, there is provided on the nozzle insert a fin or finger (7*a* of FIG. 6) which projects beyond the outer extremity of the outer reactant surface of the impulse arm spoon so as to be in the path of the water issuing laterally therefrom so as to deflect the flow back into a position of lateral or angular alignment with the unobstructed flow. With this arrangement, the fin becomes a reactant element on the sprinkler body and the surface thereof receiving the water a reactant surface.

Attempts to actually utilize the Englehart fin with the reactant surface disposed in a vertical radial plane, as shown in the patent, have not proven successful due to the excessive torque applied to the sprinkler body as a result of the reactant force applied to the reactant surface. Commercial sprinkler heads utilizing an Englehart-type reactant fin have usually provided a reactant surface which is angled downwardly to thereby reduce the horizontal component of the reactant force applied thereto by water impingement. This reduction in the reactant force is achieved with a corresponding reduction in the effectiveness of the fin to deflect the water back into alignment.

It is an object of the present invention to provide a sprinkler head having a reactant element on the sprinkler body which is operable to deflect the water laterally only when the water is being obstructed by the spoon of the impulse arm in which the torque applied to the sprinkler body by the reactant force applied to the reactant surface thereof is substantially reduced without a corresponding lessening of the effectiveness of maintaining the deflected water in angular alignment with the direction unobstructed flow. In accordance with the principles of the present invention, this objective is obtained by moving the reactant element radially inwardly into a radial position intermediate the inner and outer reactant surfaces of the impulse arm spoon. Torque reduction is achieved since the reactant force is

applied to the reactant element through a much smaller lever arm. Moreover, the reactant surface need not be as large in area since it is contacted by the water much nearer the outlet at an earlier time before the flow has had an opportunity to break up. Thus, not only is the applied torque reduced by the reduction in surface area but the time of application is more nearly simultaneous with the application of the impact force. Where the reactant element is disposed radially outwardly of outer reactant surface of the impulse arm spoon, much greater torque conditions exist due to the greater area needed to control the more dispersed flow, the greater lever arm through which the reactant force acts, and the later time of force application after impact. Moreover, this outermost positioning of the reactant element gives rise to size problems both in packaging and in operation. In terms of packaging, rather than to increase the package size, it is more usual to removably mount the fin to the sprinkler body so that it can be installed after opening the package. This gives rise to expense and possible misalignment problems. In terms of operation, a severe cost problem is presented where the sprinkler head is to be used in a pop-up system since it becomes necessary to substantially increase the diameter of the pop-up housing just to accommodate the added radial extent of the fin.

Another object of the present invention is to provide a sprinkler head of the type described which is simple in construction, effective in operation, and economical to manufacture and maintain.

These and other objects of the present invention will become more apparent during the course of the following detailed description and appended claims.

The invention may best be understood with reference to the accompanying drawings wherein an illustrative embodiment is shown.

In the drawings:

FIG. **1** is a side elevational view of a sprinkler head embodying the principles of the present invention;

FIG. **2** is a front elevational view of the sprinkler head;

FIG. **3** is an enlarged fragmentary sectional view taken along the line **3—3** showing the reactant portions of the impulse arm in its limiting position; and

FIG. **4** is a view similar to FIG. **3** with the reactant portions of the impulse arm disposed in spaced relation from its limiting position.

Referring now more particularly to the drawings, there is shown therein a step-by-step rotary sprinkler head, generally indicated at **10**, embodying the principles of the present invention. The sprinkler head **10** includes the usual sprinkler body **12**, having a lower inlet portion **14** and an upper outlet portion **16** which communicates with the inlet portion. Formed in the outlet portion **16** is an outlet nozzle element **18** having an outlet **20** formed therein having a flow axis which, when the sprinkler head **10** is disposed in operative relation, extends generally upwardly and outwardly, as best shown in FIG. **1**.

The sprinkler head **10** also includes the usual bearing assembly, generally indicated at **22**. The bearing assembly **22** serves to mount the sprinkler head **10** in operative relation on a supply conduit (not shown) with the sprinkler body disposed in a vertically extending position for rotational movement about a vertical axis coincident with the inlet **14**. The bearing assembly **22** also serves to communicate the inlet **14** with a source of water under pressure within the supply conduit and to

provide a controlled resistance to the rotational movement of the sprinkler body **12** during operation.

The sprinkler head **10** also includes an impulse arm, generally indicated at **24**, which is mounted on the sprinkler body **12** for oscillatory pivotal movement about a vertical axis, which, as shown, is coincident with the axis of rotation of the sprinkler body **12**. The impulse arm **24** is resiliently biased into a limiting position of abutment with the sprinkler body by any suitable biasing means as, for example, a coil spring **26** of conventional construction.

The preferred sprinkler head **10**, as shown in the drawings, also includes a conventional reversing mechanism **28** operable to effect a reverse step-by-step movement of the sprinkler body **12**, when the sprinkler head **10** is in a part-circle mode of operation, between two adjustable limiting positions determined by a pair of adjustable stops **30** and **32**. Since the reversing mechanism **28** is of a conventional well-known nature (see the aforesaid U.S. Pat. No. 2,256,737) it is believed that no further detailed description thereof is needed.

The present invention is more particularly directed to the improved structure and mode of operation for effecting the oscillatory movement of the impulse arm **24** and the step-by-step rotary motion of the sprinkler body **12**. Referring now more particularly to FIGS. **3** and **4**, it will be noted that the impulse arm **24** includes a first reactant portion **34** disposed in a position thereon radially outwardly of the outlet **20** and within the flow axis thereof when the impulse arm is disposed in its resiliently biased limiting position, as shown in FIG. **3**. The reactant portion **34** includes a reactant surface **36** shaped to deflect the water issuing from the outlet **20** in a direction laterally away from the normal direction of step-by-step movement of the sprinkler body **12** as shown in phantom lines. The impingement of the water on the reactant surface **36** establishes a reaction force, indicated by the arrow **38**, which acts on the impulse arm **24** in the aforesaid one direction tending to maintain the impulse arm in contact with the water flow.

As shown in FIGS. **3** and **4**, the nozzle insert **18** is formed with an integral rigid arm **40** which extends outwardly therefrom spaced laterally from the flow axis of the outlet **20** in the aforesaid one direction. The rigid arm **40** includes an abutment surface **42** facing laterally in the opposite direction which is engageable by an opposed abutment surface **44** on the reactant portion **34** when the impulse arm **24** is moved into its limiting position. In the embodiment shown, the abutment surfaces **42** and **44** serve to impart an impact force to the sprinkler body **12** when interengaged which moves the latter an incremental step in the aforesaid one direction, the amount of such movement being resiliently controlled by the bearing assembly **22** in conventional fashion. It will be understood that other abutment surfaces may be provided, if desired.

The first reactant surface **36** deflects the water impinging thereon so that it issues therefrom laterally in a direction opposed to the direction of aforesaid incremental movement of the sprinkler body. In accordance with the principles of the present invention, the sprinkler body **12** has provided thereon a reactant element **46** disposed radially outwardly of the first reactant portion **34** in a position spaced laterally in the aforesaid opposite direction from the flow axis of the outlet **20** so as to receive the water issuing from the first reactant surface **36** when the impulse arm **24** is disposed in its limiting position, as shown in FIG. **3** and to permit unobstructed flow of water issuing from the outlet when the impulse arm is spaced from its limiting position as shown in FIG. **4**. The reactant element **46** may be mounted in the aforesaid position by any suitable means and, as shown, the arm **40** is utilized to effect a rigid securement by means of a pair of spaced leg portions **48** formed integrally with the reactant element **46** and fixed to the outer end of the arm **40**.

The reactant element **46** has a reactant surface **50** thereon which serves to deflect the water impinging thereon issuing from the first reactant surface **36** further in the same lateral direction as shown in phantom lines in FIG. **3**. The impingement of the water on the reactant surface **46** establishes a reactant force, represented by the arrow indicated at **52** in FIG. **3**, which acts on the sprinkler body in the same direction as the impulse force.

The impulse arm **24** also includes a second reactant portion **54** which is disposed in a position to receive the water issuing from the second reactant surface **50** when the impulse arm is disposed in its limiting position, as shown in FIG. **3**. The second reactant portion includes a third reactant surface **56** shaped to deflect the water laterally back into the aforesaid one direction so that it issues therefrom in a direction generally parallel with the axis of the outlet as clearly shown in phantom lines in FIG. **3**. The impingement of the water on the third reactant surface **56** establishes a reactant force acting on the impulse arm in the direction indicated by the arrow **58** in FIG. **3**, so as to move the impulse arm in the aforesaid opposite direction.

If desired, a spray diffuser pin **60** may be utilized with the sprinkler head **10** to perform its usual function. While the pin **60** could be mounted in the outer end of the arm **40**, as shown, the pin is threadedly mounted within a threaded opening in the upper leg portion **48**. In accordance with usual practice the pin has a knurled head on one end thereof and a conical point on the other. A coil spring **62** is mounted in surrounding relation to the pin between the head and leg portion to resiliently retain the same in any desired position of adjustment.

OPERATION

The sprinkler head **10** embodying the principles of the present invention is operable to perform an overall sprinkling cycle in which water is distributed within a part-circle pattern, the angular limits of which are determined by the setting of the adjustable stops **30** and **32**. For purposes of illustration it is assumed that the stops **30** and **32** are set to provide a half-circle pattern. The cycle of operation will be described beginning with the sprinkler head disposed in a position intermediate the ends of the sprinkler pattern commencing with the communication of water under pressure therewith. It will be understood that prior to the communication of water under pressure with the sprinkler head **10**, the impulse arm **24** will be disposed in its limiting position as illustrated in FIGS. **1–3** by virtue of the resilient bias provided by the coil spring **26**. When the water is communicated with the sprinkler head, the water flows outwardly of the outlet **20** and impinges first upon the first reactant surface **36** which then directs the water onto the second reactant surface **50** which, in turn, directs the water onto the third reactant surface **56**. As previously indicated, the impingement of the water on each

of the reactant surfaces establishes a reactant force having a tangential component with respect to the vertical axis of rotation of the sprinkler body **12** and impulse arm **24**, as indicated by the arrows designated **38**, **52**, and **58** respectively. It will be noted that the reactant forces represented by the arrows **38** and **58** act upon the impulse arm whereas the reactant force represented by the arrow **52** acts upon the sprinkler body. With respect to the impulse arm, since the reactant force represented by the arrow **58** acts through a greater lever arm than the opposed reactant force represented by the arrow **38**, the impulse arm **24** will be moved in a counter-clockwise direction as viewed in FIG. **3** or in a direction away from the flow axis and against the bias of the spring **26**. When the torque acting on the impulse arm equals the increasing resistance of the coil spring **26**, the movement of the impulse arm will be arrested and the spring **26** will commence the movement of the impulse arm in the opposite direction toward the limiting position shown in FIG. **3**. As the impulse arm approaches the limiting position, as shown in FIG. **4**, the first reactant surface **36** will be moved into the flow path of the water issuing from the outlet **20**. This initial impingement of the water on the reactant surface **36** serves to insure that the impulse arm will be moved inwardly until the abutment surface **44** engages the abutment surface **42**. The impact of these abutment surfaces serves to impart rotary motion to the sprinkler body **12** which rotary movement is controlled by the bearing assembly **22**. As the impulse arm reaches the limiting position, the water impinging on the reactant surface **36** will be directed onto the reactant surface **50** which, as previously indicated, establishes a reactant force represented by the arrow **52**, which applies additional torque to the sprinkler body tending to move the same in a clockwise direction as viewed in FIG. **3**. The reactant surface **50** also serves to direct the water impinging thereon laterally onto the reactant surface **56**. This establishes a reactant force on the impulse arm represented by the arrow **58** which, as aforesaid, will effect the outward movement of the impulse arm. It will be noted that the shape of the reactant surface **56** is such that the water impinging thereon issues therefrom in a direction which is generally parallel with the flow axis of the outlet **20**. In this way, the water deflected by the impulse arm reactant surfaces is retained within the desired part-circle pattern. It will also be noted that when the impulse arm moves away from the limiting position to the position shown in FIG. **4** and beyond, the water issuing from the outlet **20** will flow therefrom along the flow axis unobstructed by the reactant element **46**.

It will be understood that the above cycle of the impulse arm is repeated moving the sprinkler body **12** in step-by-step fashion in a clockwise direction until the stop **30** is engaged by the reversing mechanism **28**. At this point, the reversing mechanism is actuated to move an abutment into the position of movement of the impulse arm, so that as it is moved away from the limiting position the abutment is engaged causing the sprinkler body **12** to move in a counter-clockwise direction. In this way, the sprinkler body is moved in rapid step-by-step fashion through a return stroke until the opposite stop **32** is engaged and the reversing mechanism **28** is moved into its opposite position wherein the abutment is no longer disposed within the path of movement of the impulse arm and the operation in the first direction can take place.

It is important to note the effect of the reactant force represented by the arrow **52** in the cycle of operation. First, it will be noted that the reactant surface **50** has a relatively small area. This is possible due to the fact that the reactant surface is disposed quite close to the outlet **20** so that the water issuing therefrom engages the same at a time before the stream has had an opportunity to significantly break up or disperse. Second, it will be noted that the lever arm through which the reactant force acts upon the sprinkler body **12** is relatively small, as compared for example with the lever arm through which the reactant force represented by the arrow **58** acts. Finally, it will be noted that the torque applied as a result of the impingement of the water on the reactant surface **50** is timed between the application of the torque as a result of the reactant forces represented by the arrows **38** and **58**. In this way, the torque established as a result of the reactant force represented by the arrow **52** is minimized and operation throughout a full cycle with the sprinkler body **12** moving in step-by-step fashion in both directions is accomplished.

Of primary significance is the fact that during the cycle all of the water is substantially confined within the desired part-circle pattern. It will be understood that the present sprinkler head, while having particular advantages in part-circle operation, is useful in full circle operation as well. Likewise, it is not absolutely critical to the operation of the invention that the water issue from the reactant surface **56** be exactly parallel with the flow axis of the outlet **20** as some slight convergence or even divergence can be utilized, if desired.

It thus will be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that the foregoing preferred specific embodiment has been shown and described for the purpose of illustrating the functional and structural principles of this invention and is subject to change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.

What is claimed is:

1. A step-by-step rotary sprinkler head comprising a sprinkler body having an inlet and an outlet having a flow axis, means for mounting said sprinkler body for rotation about a vertical axis with said inlet in communication with a source of water under pressure and with the flow axis of said outlet extending upwardly and outwardly, an impulse arm mounted on said sprinkler body for oscillatory movement about a vertical axis toward and away from a limiting position of abutment with said sprinkler body, means for biasing said impulse arm into said limiting position so as to impart an impact force to said sprinkler body in one direction, said impulse arm having a first reactant portion disposed in a position thereon radially outwardly of said outlet and within the flow axis thereof when said impulse arm is disposed in said limiting position, said first reactant portion having a first reactant surface shaped to deflect water issuing from said outlet in an opposite direction and establish a reactant force on the impulse arm acting to move the same in said one direction toward said limiting position, said sprinkler body having a reactant element thereon disposed radially outwardly of said first reactant portion in a position spaced in said opposite direction from the flow axis of said outlet so as to receive the water deflected by said first reactant surface when said impulse arm is disposed in said limiting position and to permit

unobstructed flow of water issuing from said outlet when said impulse arm is spaced from said limiting position, said reactant element having a second reactant surface thereon shaped to deflect the water impinging thereon further in said opposite direction and establish a reactant force on said sprinkler body acting in said one direction, said impulse arm having a second reactant surface portion disposed in a position to receive the water issuing from said second reactant surface, said second reactant portion having a third reactant surface thereon shaped to deflect the water laterally in said one direction so that it issues therefrom in a direction generally parallel with the flow axis of said outlet and establishes a reactant force acting on said impulse arm to move the same in said opposite direction.

2. A sprinkler head as defined in claim **1** including adjustable reversing means for effecting movement of said sprinkler body in the opposite direction between two adjustable limiting positions as a return stroke in a part-circle repetitive cycle the operative stroke of which includes movement of said sprinkler body between said two adjustable limiting positions in said one direction as aforesaid.

3. A sprinkler head as defined in claim **2** wherein said reversing means includes means for effecting said return stroke by rapid oscillatory movements of said impulse arm.

4. A sprinkler head as defined in claim **1** wherein said reactant element is fixed to said sprinkler body.

5. A sprinkler head as defined in claim **1** wherein said sprinkler body outlet is defined by a nozzle insert fixedly threadedly engaged with said sprinkler body, said nozzle insert having a rigid arm extending outwardly therefrom spaced laterally in said one direction from the flow axis of said outlet.

6. A sprinkler head as defined in claim **5** wherein said reactant element is rigidly secured to the outer end of said rigid arm by a pair of rigid webs spaced vertically on opposite sides of the flow axis of said outlet.

7. A sprinkler head as defined in claim **6** wherein said rigid arm includes an abutment surface facing in said opposite direction engageable by said first reactant portion of said impulse arm when the latter moves toward its limiting position to apply said impact force.

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