June 10, 1969 W. R. MALCOLM 3,448,660

FLUID MOTOR

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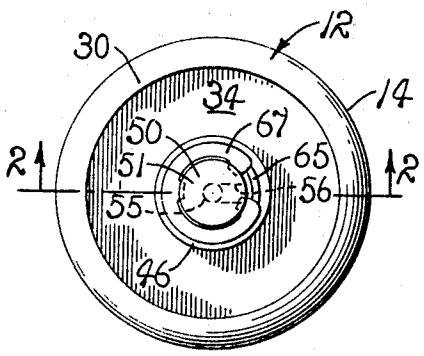


FIG. 1.

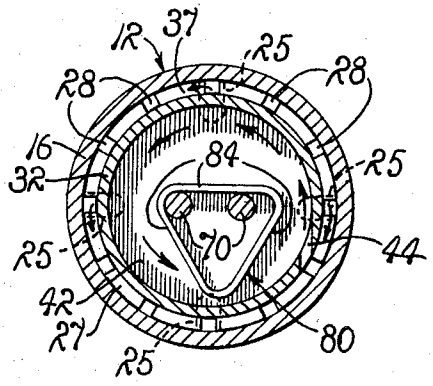


FIG. 3.

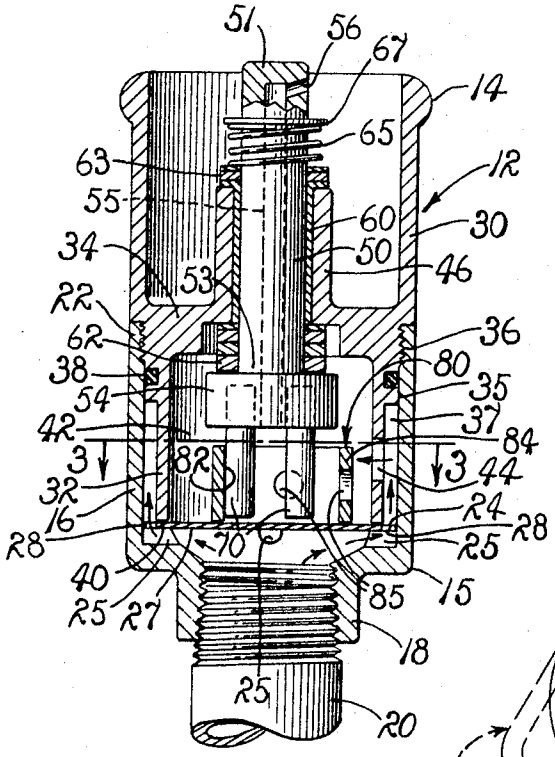


FIG. 2.

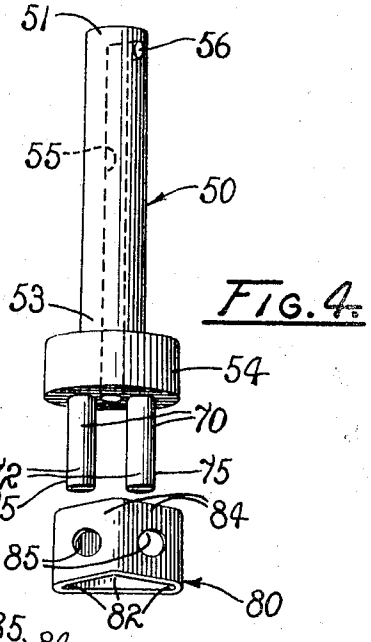


FIG. 4.

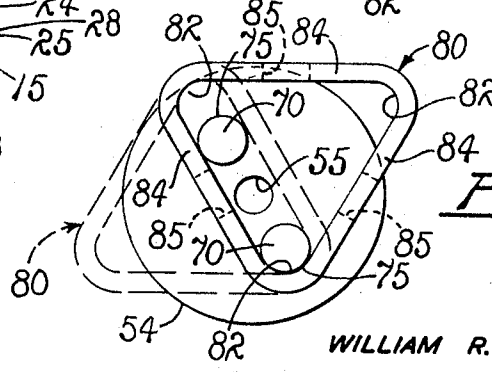


FIG. 5.

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FLUID MOTOR

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ABSTRACT OF THE DISCLOSURE

A fluid motor for driving sprinklers and the like providing a housing having means for creating a swirling flow of fluid therein, a hollow spindle rotatably mounted in the housing and having spaced force transmitting means axially extended from the spindle substantially symmetrically thereof and of the swirling flow of fluid, and a triangular drive ring disposed in driven relation within said swirling flow and in loosely circumscribing relation to said force transmitting means for successive, alternate, pivotal swinging movement and impact engagement of the ring with the force transmitting means to rotate the spindle.

Background of the invention

Low pressure irrigation systems are customarily employed in areas requiring minimum rates of precipitation. These low pressure systems are frequently employed in remote hilly areas where it is desirable to provide a general relatively low density spray to minimize compaction of the earth, to attain gradual soaking, and to preclude run off of the irrigation water. Such low pressure systems are also desirable in other areas in that smaller pumps and conduits can be used for more economical transport of the irrigation water than required for high pressure, large capacity systems with consequent reduction in capital investment and maintenance costs.

It is therefore uneconomical to employ the highly sophisticated rotary sprinkler heads and drive mechanisms which are ordinarily used in high pressure irrigation systems in areas requiring a high density spray pattern. Furthermore, such high pressure sprinkler head drive mechanisms have relatively high starting torque requirements which cannot be supplied by the lower available fluid pressure in such low pressure systems. It is highly desirable therefore to provide an efficient sprinkler head drive mechanism which is capable of dependably operating under such low pressure conditions as well as being excellently suited to high pressure systems.

Heretofore, the conventional drive mechanisms for the purpose have not been successful primarily because of the difficulty in providing a drive requiring only a minimum starting torque which thereafter affords a substantially positive nonslip drive to the sprinkler head. Such conventional mechanisms ordinarily employ a rotary discharge spindle providing a plurality of force transmitting surfaces and journalled for rotation in the sprinkler body. A square drive ring is disposed within the body in loosely circumscribing relation to the spindle force transmitting surfaces. The relatively low pressure flow of fluid from the inlet conduit to the body is directed against the ring with sufficient force to cause the ring to spin about the force transmitting surfaces of the spindle. The sliding contact between the ring and the force transmitting surfaces thereby provides a frictional reduced speed drive to rotate the spindle. While the square drive ring requires only a minimum of starting torque the resulting frictional drive is highly inefficient.

In order to provide the desired driving relation between the square ring and the force transmitting surfaces of the spindle such components must be precisely fitted to each

other requiring relatively close tolerances during their manufacture. In view of the sliding frictional contact between the ring and the force transmitting surfaces of the spindle, the ring can become centered with respect to the force transmitting surfaces and spin freely without transmitting any drive whatsoever to the spindle. This situation is aggravated by the accelerated wear of the mating surfaces so that such spinning of the ring becomes continuous rendering the drive mechanism completely inoperable.

Summary of the invention

Accordingly, it is an object of the present invention to provide an improved fluid motor.

Another object of the present invention is to provide such an improved fluid motor for driving sprinklers and the like particularly in low pressure systems.

Another object is to provide a fluid motor of the character described which is less subject to wear and failure than existing fluid motors.

Another object is to provide an improved fluid motor which requires a relatively low starting torque and provides a dependable positive drive to the sprinkler discharge spindle.

Another object is to provide an improved fluid motor which is capable of affording a positive impact drive to the spindle with a minimum of frictional engagement between the drive member and the spindle.

Another object is to provide an improved fluid motor which utilizes a triangular drive ring precluding non-driving spinning of the ring relative to the spindle.

Another object is to provide an improved fluid motor which may be more economically produced than existing drive motors by permitting larger tolerances between the drive ring and force transmitting surfaces of the spindle.

Further objects and advantages are to provide improved elements and arrangements thereof in a device of the character and for the purposes set forth.

Still further objects and advantages will become apparent in the subsequent description in the specification.

Brief description of the drawing

FIG. 1 is a top plan view of a drive motor embodying the principles of the present invention.

FIG. 2 is a transverse vertical section through the drive motor taken on line 2—2 of FIG. 1 shown mounted on an inlet supply conduit in a low pressure irrigation system.

FIG. 3 is a transverse horizontal section taken generally along line 3—3 of FIG. 2 showing a fluid drive chamber within the fluid motor.

FIG. 4 is a perspective view of a sprinkler head spindle and triangular drive ring removed from the housing of the fluid motor.

FIG. 5 is a somewhat enlarged top plan view of spindle drive pins utilized in the motor and the triangular drive ring shown in a pivotal swinging position in full lines and swung to an impact drive position in dashed lines.

Description of the preferred embodiment

Referring more particularly to the drawing, the fluid motor embodying the principles of the present invention provides an elongated substantially cylindrical housing **12** having an upper outlet end **14** and a separable lower inlet end **15**. The lower inlet end of the housing provides a substantially circular side wall **16** which has a lower, reduced diameter, internally threaded portion **18** screw-threadedly to mount the housing on an irrigation fluid supply pipe **20** and an opposite internally screw-threaded upper end **22**. The lower inlet end **15** of the housing includes an internal annular ledge **24** having a plurality of equally circumferentially spaced grooves **25** extended radially through the ledge adjacent to the side wall **16**. A circular screen plate **27** is disposed within the lower inlet end

15 of the housing upon the ledge 24 and provides a plurality of peripheral notches 28 alignable with the grooves 25 in the ledge.

The upper outlet end 14 of the housing 12 provides an upper annular wall 30 of substantially the same diameter as the wall 16 of the lower inlet end 15 and a lower annular divider wall 32 of a diameter somewhat smaller than the diameter of the walls 16 and 30. The upper outlet end of the housing further includes an intermediate web portion 34 having an outer pilot portion 35 providing external screw-threads 36 engageable with the upper screw-threaded end 18 of the lower end of the housing. As best shown in FIG. 2, the divider wall 32 is disposed in inwardly spaced concentric relation within the wall 16 of the lower end of the housing to provide an annular passage 37 above the grooves 25 in the ledge and the notches 28 in the screen plate 27. An O-ring 38 is carried in the outer periphery of the pilot portion 35 of the upper outlet end of the housing to provide a seal between the upper and lower ends of the housing. The divider wall 32 provides a lower edge 40 which engages the screen plate 27 with the divider wall, screen plate and web of the upper end of the housing providing a fluid drive chamber 42 within the housing. As best shown in FIGS. 2 and 3, an inlet opening 44 is tangentially formed through the divider wall 32 for directing the flow of fluid from the supply pipe 20 into the drive chamber 42 in a circular swirling path. The web 34 includes a tubular protuberance 46 disposed in outwardly extended relation from the web and in concentric relation within the upper wall 30 of the outlet end 14.

An elongated sprinkler spindle is disposed through the tubular protuberance 46 and includes an upper end 51 extended outwardly a short distance from the upper edge of the outlet end 14 of the housing 12. The spindle further includes an opposite inner end 53 having an enlarged diameter head portion 54 disposed within the fluid drive chamber 42. An elongated axial bore 55 is formed through the spindle in communicating relation with the fluid drive chamber at the head portion of the spindle and terminating short of the upper end 51 of the spindle. A radially upwardly angularly extended fluid discharge orifice 56 is formed in the upper end of the spindle 50 in communication with the bore.

The spindle 50 is journalled for rotation within a sleeve bearing 60 disposed within the tubular protuberance 46. A pair of sealing thrust washer assemblies 62 and 63 are respectively disposed around the spindle between the head portion 54 thereof and the web 34 of the housing and at the upper end of the protuberance 46. The spindle is axially constrained within the protuberance by a compression spring 65 disposed in precompressed relation between the upper sealing washers 63 and a snap ring 67 disposed within an annular groove in the spindle in downwardly spaced relation from the upper end thereof.

A pair of elongated rod-like spindle drive pins 70 are mounted in the head portion 54 of the spindle in endwardly longitudinally extended relation from the head portion to terminate in lower ends 72 disposed in closely spaced relation to the screen plate 27. The drive pins provide oppositely spaced substantially parallel outer force transmitting surfaces 75 which are symmetrically related to the bore 55 within the spindle.

A drive ring 80 is disposed within the fluid drive chamber 42 in loosely circumscribing relation about the drive pins 70. As best shown in FIG. 4, the drive ring is constructed of a continuous, transversely substantial flat strip of rigid sheet material and in the form of an equilateral triangle having three arcuate corners or bearings 82 and three interconnecting substantially straight sides or legs 84. Each of the sides has a circular opening 85 therethrough to insure the passage of an adequate supply of fluid therethrough to the discharge bore 55 in the spindle. The drive ring is rested in edgeward sliding engagement upon the screen plate 27 within the fluid drive chamber 42 with the sides 84 thereof disposed in coplanar relation with the tangential opening 44 in the divider wall 32. It will be noted from FIGS. 3 and 5 that the distance between the outermost portions of the force transmitting surfaces 75 of the pins is slightly less than the distances from the inner peripheries of the corners 82 of the ring to the mid portion of their respectively opposite sides 84. This permits free swinging movement of the ring about each of the drive pins 70 to strike the other. It will also be noted that the outermost portions of the force transmitting surfaces 75 are spaced a distance greater than the diameter of a circle drawn concentrically within the drive ring tangential to each of its sides. This precludes free spinning movement of the ring about both of the drive pins.

Operation

The operation of the described embodiment of the subject invention is believed to be readily apparent and is briefly summarized at this point. With the drive motor installed, as in FIG. 2, fluid under pressure is supplied through the pipe 20 and is directed into the housing through the lower inlet end 15 thereof. Such flow, as represented by the arrows in FIG. 2, passes through the grooves 25 in the annular ledge 24 and through the notches 28 in the screen plate 27 and into the annular passage 37 between the divider wall 32 and the wall 16 of the housing. As best shown in FIG. 3, the flow of fluid within the passage is directed through the tangential opening 44 in the divider wall to produce a swirling flow of fluid in the direction of the arrows, as shown in FIG. 3, within the fluid drive chamber 42. Such swirling or circular flow impinges against the sides 84 of the drive ring 80 to pivot one of the corners of the ring about one of the force transmitting surfaces 75 of the drive pins 70. It is noted that the initial swinging movement of the drive ring is substantially unrestricted except for the minimal drag imposed by its lower edge in sliding engagement against the screen plate 27. Accordingly, a relatively small force is sufficient to provide a starting torque for pivoting the ring in the described manner about one of the drive pins with the spindle 50 imposing substantially no resistance to such initial pivotal swinging movement of the ring.

As best shown in FIG. 5, the drive ring 80 is swung in a counterclockwise direction about the lower drive pin by the impingement of the fluid flow within the chamber 42. Such swinging movement continues until the adjacent side 84 of the ring engages the opposite or uppermost drive pin 70, as shown in the dashed lines of FIG. 5. Upon impact of the adjacent side of the drive ring with the drive pin, the spindle 50 is rotated through an arc proportional to the pressure exerted against the ring by the flow of fluid within the drive chamber. The impact of the side against the struck drive pin imposes no appreciable resistance to the further rotation of the drive ring.

After impact, the drive ring 80 is permitted to slide relative to the drive pins 70 whereupon the upper drive pin, as shown in FIG. 5, is received within an opposite corner 82 of the ring. The ring is then immediately pivoted about the upper drive pin 70 for swinging movement of the now adjacent side 84 against the lower drive pin further to rotate the spindle 50. Upon such impact, the ring is again permitted to slide along the drive pins longitudinally of the engaged side thereof until the opposite drive pin is received within the adjacent corner of the drive ring for further swinging and impacting of its side against the drive pins. Accordingly, the drive ring continually walks around the drive pins for successively alternate pivotal swinging movement and impact engagement of the ring with the drive pins to rotate the spindle. It is noted that the drive ring provides three impacts per revolution of the ring relative to the pins. Accordingly, the spindle is driven at approximately one-third (⅓) the speed of rotation of the ring so that variations in the pressure or flow of fluid within the drive chamber 42 do not appreciably affect the speed of rotation of the spindle.

During such operation the flow of fluid within the drive

chamber **42** is directed outwardly from the housing through the bore **55** and the discharge orifice **56** at the upper end of the spindle. A portion of the flow of fluid through the tangential opening **44** in the divider wall **32** is directed over the driving ring and directly into the discharge bore. An additional flow of fluid is permitted through the openings **85** in the drive ring **80** to insure a sufficient supply of fluid to the discharge bore. Between periods of use, the openings **85** in the drive ring further serve to bleed the fluid from the discharge bore and from the drive ring itself so as to preclude an hydraulic block upon a subsequent cycle of operation of the drive motor.

In view of the foregoing, it is readily apparent that the structure of the present invention provides an improved drive motor for sprinklers and the like which is particularly adapted for low pressure irrigation systems by providing a triangular drive ring which requires only a minimum starting torque and efficiently transmits the drive forces to the spindle with less speed variation due to changes in the flow of fluid from the supply. The triangular drive ring further provides a positive impact drive against the drive pins of the spindle and is dimensioned so as to be incapable of undesirable free spinning about the drive pins which, as described, greatly accelerates the wear upon the drive components of conventional fluid motors utilizing square drive rings and results in periods of drive failure. Accordingly, the triangular drive ring of the present invention provides improved efficiency of operation, greater durability and permits larger manufacturing tolerances for more economical production.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is not to be limited to the details disclosed herein but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices and apparatus.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A fluid motor comprising a housing having an inlet end connected to a source of fluid under pressure and an opposite outlet end, flow diverter means disposed within the housing adjacent to said inlet end for producing a swirling flow of fluid within the housing, a driven element rotatably journaled in the housing having eccentrically spaced force transmitting surfaces, and a triangular drive ring disposed in the housing in the path of said swirling flow of fluid for rotation by the impingement of said flow of fluid thereagainst and disposed in loosely circumscribing relation to said force transmitting surfaces for successively alternate pivotal swinging movement and impact engagement of the ring with the force transmitting surfaces to rotate the spindle.

2. The fluid motor of claim **1** in which said driven element is hollow and is extended outwardly from said outlet end of the housing to provide a fluid discharge orifice from the housing.

3. The fluid motor of claim **1** wherein said drive ring is constructed of a continuous substantially flat rigid edgewardly disposed band in the form of an equilateral triangle having three corners interconnected by straight sides with said corners being spaced from their respectively opposite sides a distance slightly greater than the distance between said force transmitting surfaces of the driven element to permit swinging movement of said opposite side of the drive ring passed its adjacent force transmitting surface for impact of one of the adjacent sides of the drive ring with said adjacent force transmitting surface.

4. The fluid motor of claim **3** in which said driven element is an elongated spindle having opposite inner and outer ends rotatably journaled in said outlet end of the housing and which has an axial bore extended between its ends to provide a fluid discharge orifice from the housing, and a pair of drive pins mounted in longitudinal extension from said inner end of the spindle in oppositely spaced substantially symmetrical relation to said bore and extended into said triangular drive ring for rotating the spindle.

5. The fluid motor of claim **4** wherein said drive pins individually provide outer peripheral force transmitting surfaces equally spaced from the center of the bore a distance less than the distance between the center of the bore and said opposite side of the drive ring when one of its corners is disposed against the force transmitting surface of one of said drive pins.

6. A fluid motor comprising a housing having an inlet connected to a source of fluid under pressure and an opposite outlet end, said housing enclosing a fluid drive chamber adjacent to said inlet end and providing a flow diverter member for producing a swirling flow of fluid within the drive chamber; a screen plate mounted in the housing in separating relation between the inlet end and drive chamber; an elongated spindle having opposite inner and outer ends rotatably journaled in said outlet end of the housing, said spindle having an elongated axial bore extended between its ends to provide a fluid discharge orifice from the housing and an annular head portion at said inlet end thereof disposed within said drive chamber of the housing; a pair of drive pins mounted in longitudinal extension from said head portion of the spindle in oppositely spaced substantially parallel relation to each other and in equally spaced symmetrical relation to said bore in the spindle; and a spindle drive ring constructed of a continuous substantially flat rigid band in the form of an equilateral triangle and being edgewardly slidably supported on said screen plate in loosely circumscribing relation about said drive pins within the path of said swirling flow of fluid within the drive chamber for rotating the spindle during the discharge of said driving fluid from the bore at the outer end of the spindle.

7. The fluid motor of claim **6** in which said triangular drive ring provides three corners interconnected by straight sides with said sides individually providing bores for insuring a supply of fluid to the bore during operation and for draining fluid from within the drive ring outwardly of said drive chamber upon the termination of fluid pressure to the inlet of the housing.

8. A fluid motor comprising

(A) a housing having a substantially cylindrical chamber,

(B) a spindle rotatably mounted in the chamber substantially concentrically of the chamber,

(C) means mounted on the spindle and endwardly extended therefrom into the chamber providing oppositely laterally disposed, spaced bearing surfaces,

(D) a substantially equilateral triangular drive member mounted in circumscribing relation to the means providing the bearing surfaces having an internal bearing at each corner thereof fitted to said bearing surfaces for pivotal movement thereon,

(1) the sides of the drive member being of a length greater than the spacing of said bearing surfaces and less than the diameter of a circle drawn within said drive member tangentially to its sides, and

(E) means for directing fluid through the chamber in a swirling action in driving relation to the drive member whereby the drive member is rotated and alternately pivots on said bearing surfaces for driving impact against the other thereof.

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