United States Patent [19]

King

[11] **3,915,383**

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[54] **SPRINKLER WITH SEALED MAGNETIC ROTARY MOTION TRANSMITTING MECHANISM**

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[73] Assignee: **L. R. Nelson Corporation,** Peoria, Ill.

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[21] Appl. No.: **467,555**

[52] **U.S. Cl.** **239/242**

[51] **Int. Cl.**[2] **B05B 3/04**

[58] **Field of Search** 239/191, 192, 240, 241, 239/242, 263; 310/103

[56] **References Cited**

UNITED STATES PATENTS

2,132,314	10/1938	Needler	239/242
2,770,131	11/1956	Sparling	310/103 UX
2,914,255	11/1959	Jepson	239/242
3,128,047	4/1964	Rogers	239/191
3,169,398	2/1965	Sparling et al.	310/103 X
3,261,553	7/1966	Kooi et al.	239/242

Primary Examiner—John J. Love

Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] **ABSTRACT**

A sprinkler having a drive shaft and reduction gearing therefor operatively connected to a water flow powered motor by a permanent magnet coupling. By utilizing a magnetic coupling, the reduction gearing can be completely sealed from the water flow and all foreign materials carried thereby without any impairment of the rotation of the turbine of the water motor. Also, the utilization of planetary reduction gearing is facilitated. The drive shaft may drive both an oscillating fluid delivery tube and the wheels of a travelling sprinkler.

12 Claims, 10 Drawing Figures

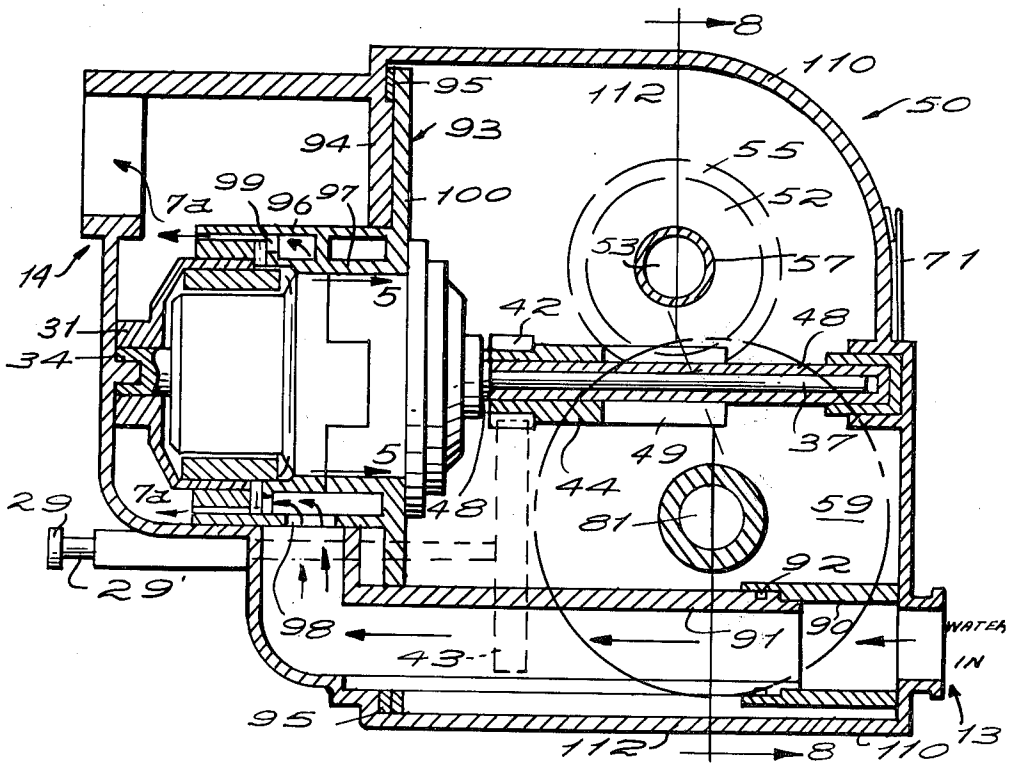
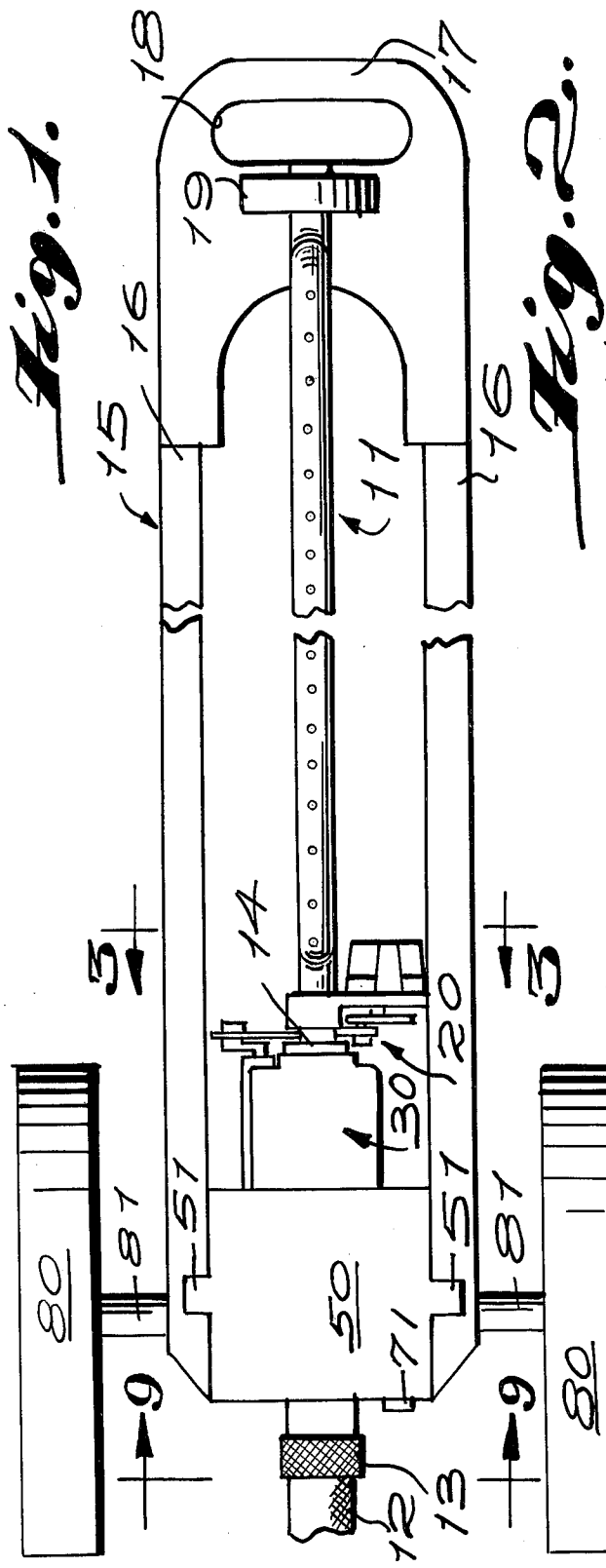


Fig. 1.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12
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Fig. 2.

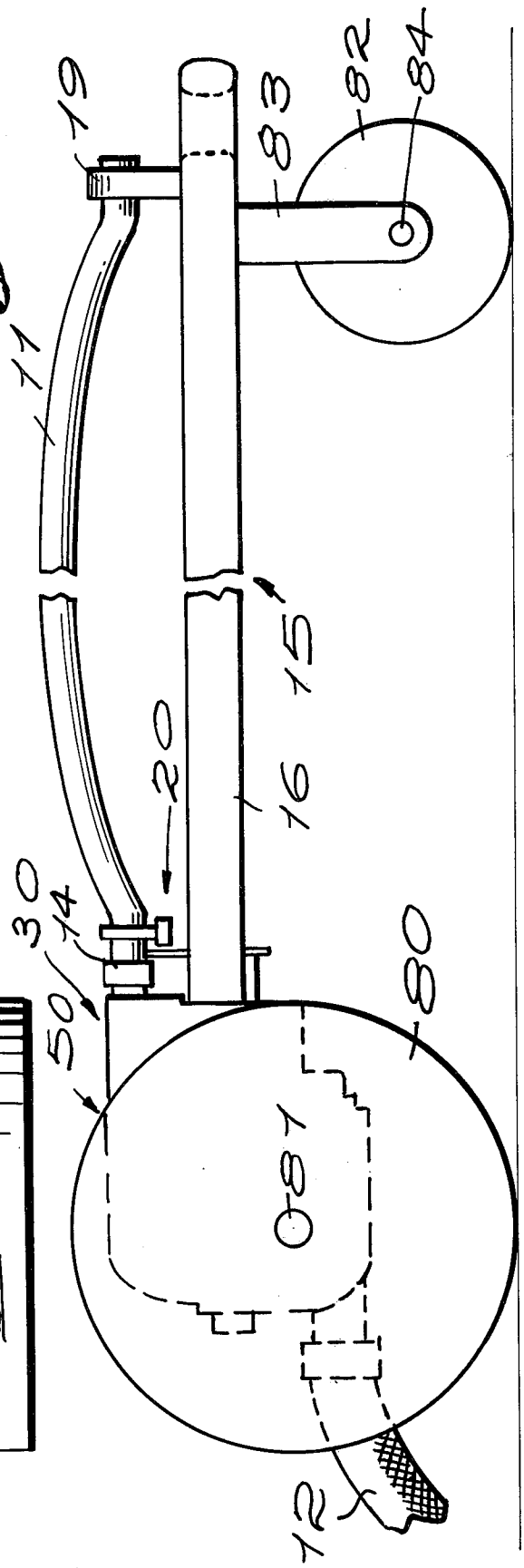
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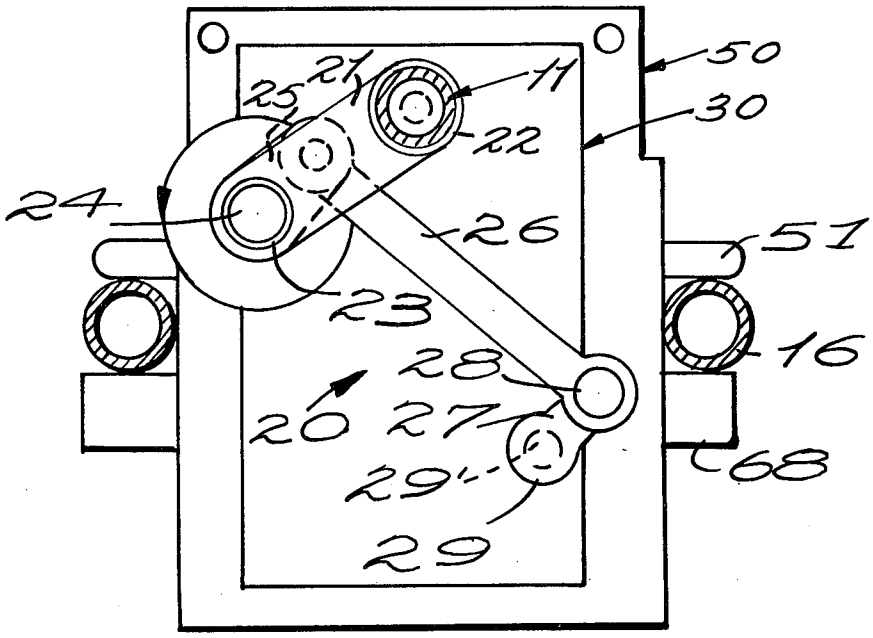
Fig. 3.


50
30
11
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22
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26
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16
28
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29'
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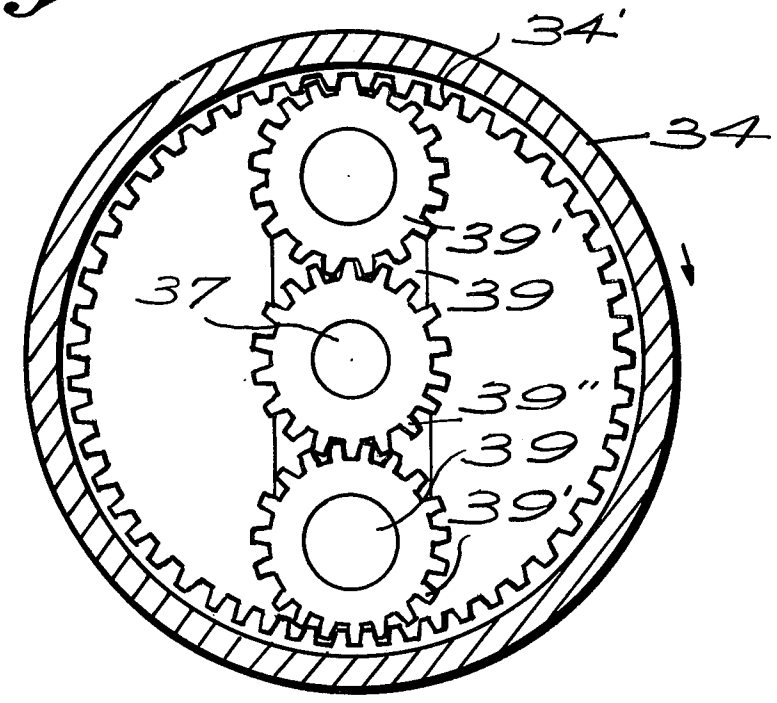
Fig. 5.


34'
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39'
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39
39"
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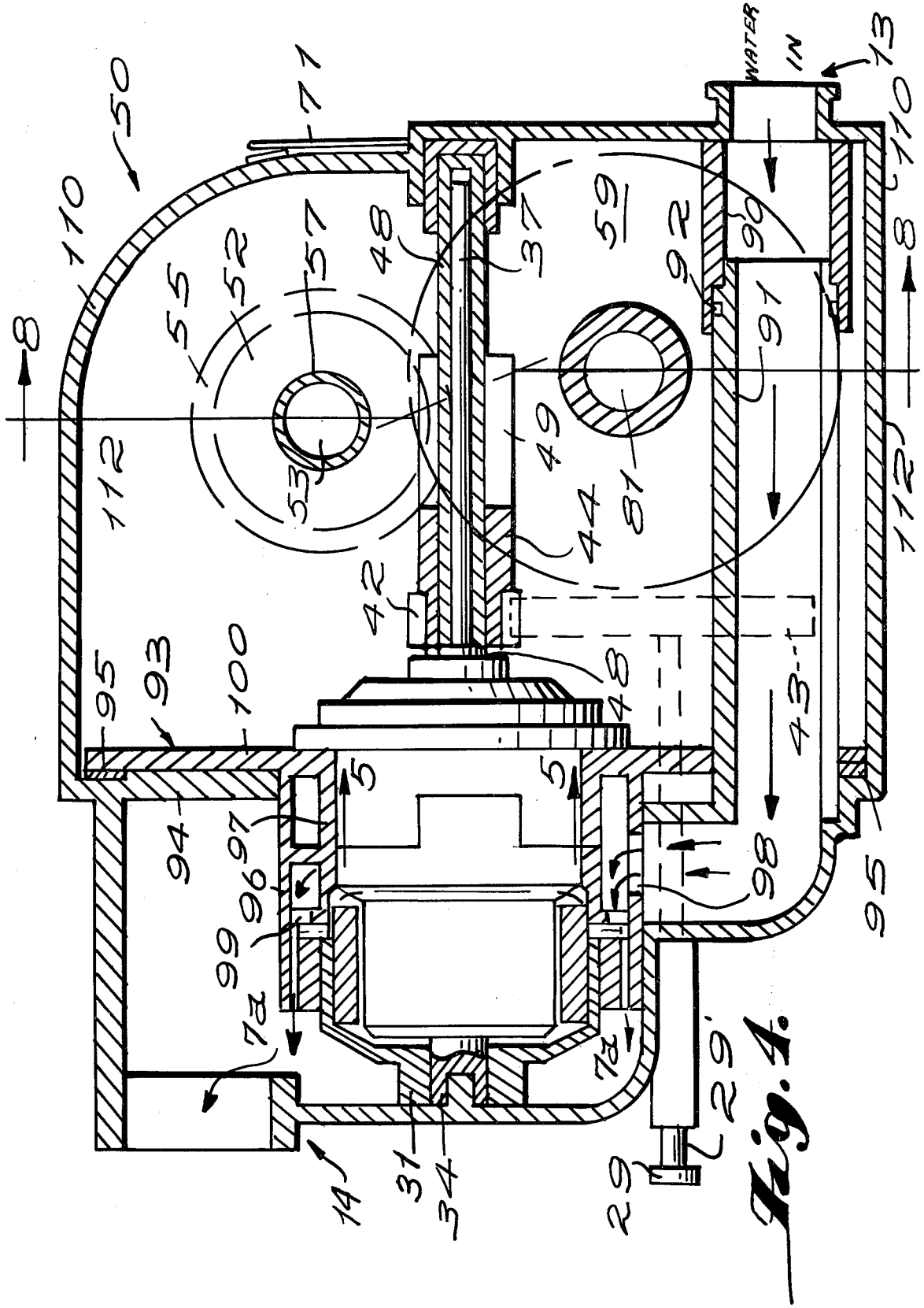
39'


WATER IN
13
110
150
171
110
8
55
52
57
48
37
59
92
90
91
8
112
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53
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81
112
42
95
93
100
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43
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99
72
72
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31
34
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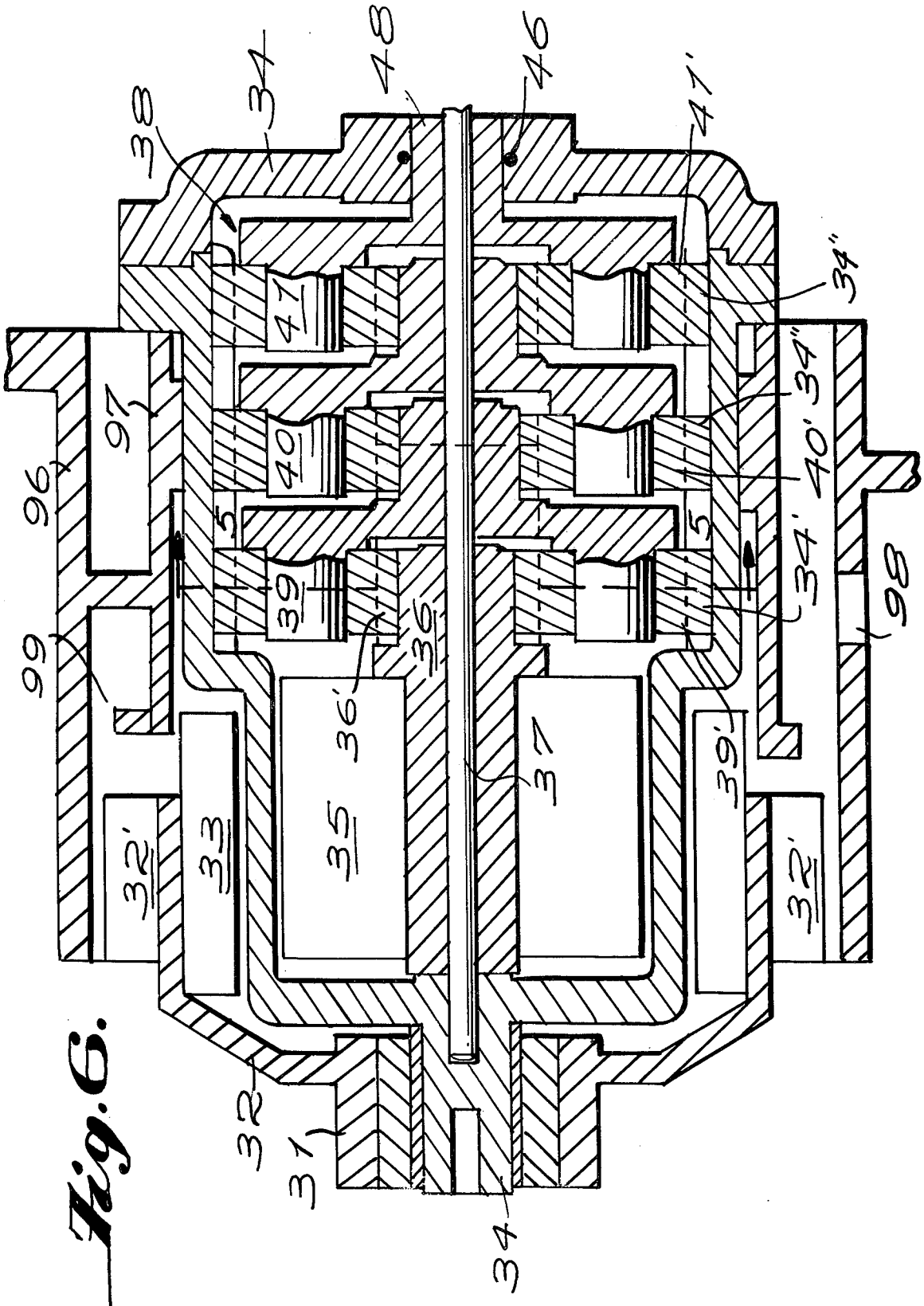
Fig. 4.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96
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Fig. 6.

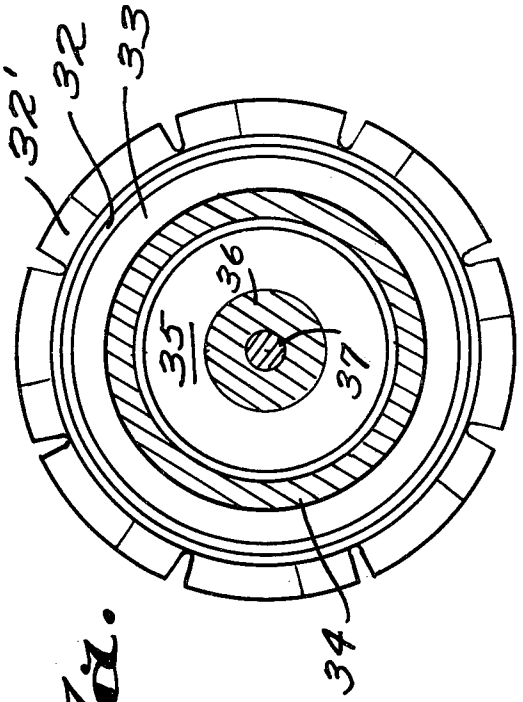


Fig. 7a.

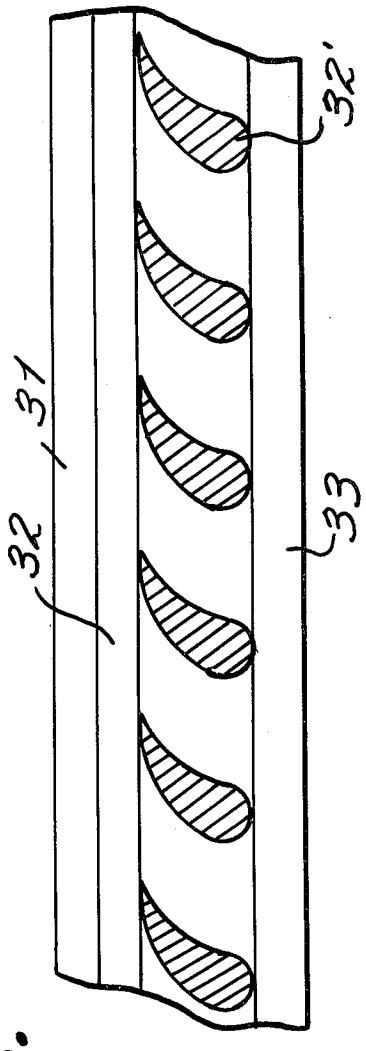
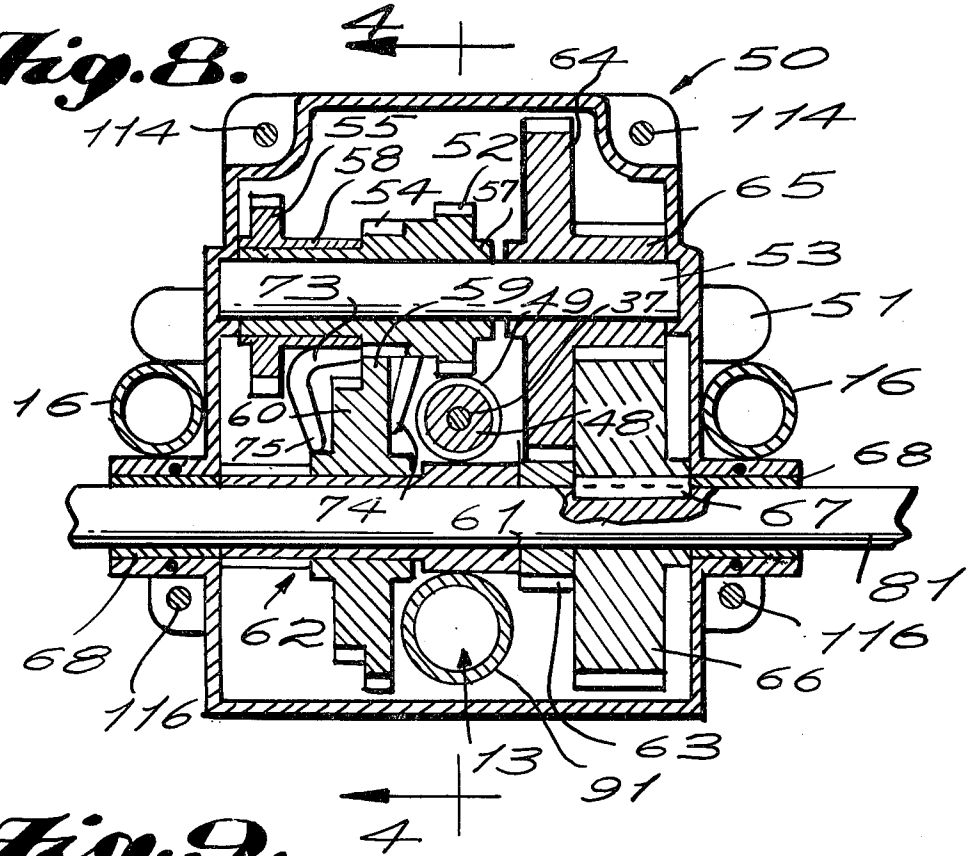


Fig. 7b.

Fig. 8.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64
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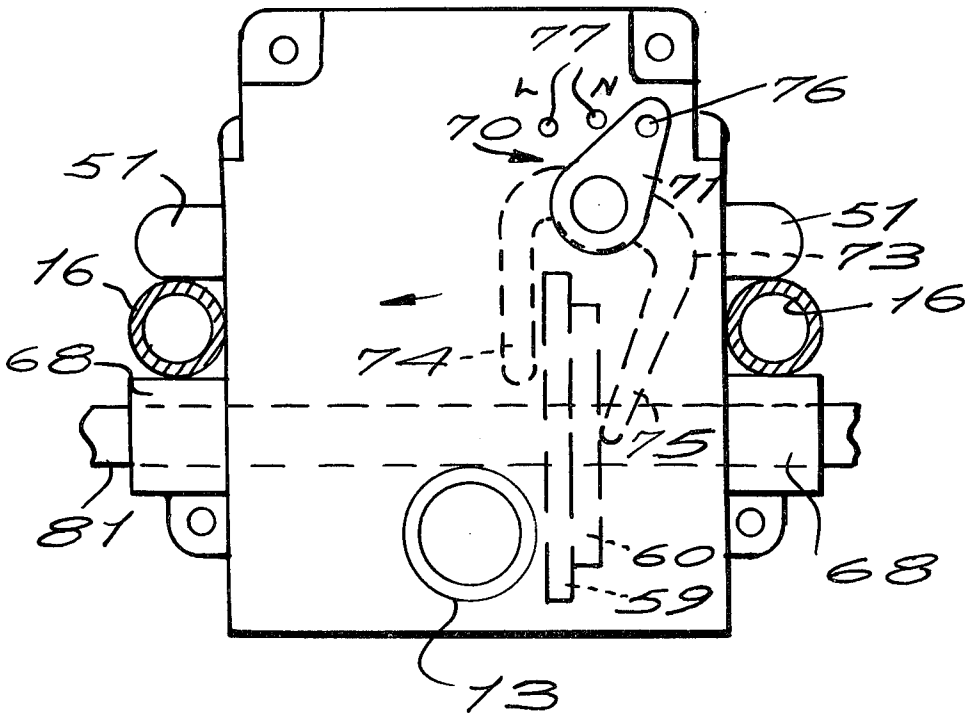
Fig. 9.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SPRINKLER WITH SEALED MAGNETIC ROTARY MOTION TRANSMITTING MECHANISM

BACKGROUND OF THE INVENTION

The invention relates generally to the art of lawn sprinklers, and more particularly to water flow responsive drive means for varying the ground area receiving water from a lawn sprinkler. In the past, it has been common practice to provide a water flow responsive motor unit that through a series of reduction gears drives some sort of means for varying the ground area receiving water from the sprinkler, such as an oscillating linkage as shown in U.S. Pat. No. **3,430,860.** There have been a number of hitherto unsolved problems associated with such motor and drive means however. The reduction gearing utilized has generally been cumbersome, taking up a great deal of valuable space within the sprinkler housing. Also, the gearing and drive mechanism have been subject to deterioration when exposed to the water flow and the grit and impurities carried thereby. Attempts have been made to seal the gear reduction unit by utilizing special bearings, as shown by U.S. Pat. No. **3,286,929,** or by including water-repellant grease in the gear reduction unit housing, as shown by U.S. Pat. No. **3,107,056,** but such means have not been completely effective in preventing fouling and deterioration of the reduction gears and drive mechanism over long periods of use, and/or have impaired the movement of the turbine thereby reducing the efficiency, power, and reliability of the unit.

Also, in the past a unit for powering a sprinkler has not been demonstrated that both powers a mechanical means for moving a fluid-distributing mechanism while at the same time providing power for driving the sprinkler unit as a whole. Prior devices related to this aspect are shown in U.S. Pat. Nos. **2,249,211, 2,788,241,** and **3,128,047.**

SUMMARY OF THE INVENTION

The present invention teaches the use of a water flow responsive turbine in a sprinkler that is magnetically coupled to reduction gearing and drive means thereby allowing the reduction gearing to be completely, effectively, and reliably sealed from the water flow by a unitary housing without impairing the movement of the turbine and the power delivered thereby. While fluid motors with magnetic couplings per se are known, such as shown by U.S. Pat. No. **2,466,468,** they are not known in sprinklers. Use of such a unit in a sprinkler effectively sealing the reduction gearing while not impairing turbine movement also allows planetary reduction gears to be used. The use of planetary reduction gears in a sprinkler is advantageous because of their efficiency and because of their compactness and small size for a given reduction, but in the past their use in sprinklers has been excluded for all practical purposes since they are very susceptible to fouling in a contaminated environment such as a sprinkler housing.

The present invention also teaches the use of mechanical drive means powered by the output shaft from the planetary reduction gear unit of the invention that operates both an oscillating linkage for a water delivery tube and drive wheels for the sprinkler unit as a whole to move it along the ground. Through the use of accessory reduction gearing and speed selecting means, the motor output shaft of the present invention is able to power both such units.

OBJECTS OF THE INVENTION

It is an object of the present invention to provide an improved motor unit for a lawn sprinkler.

It is a further object of the present invention to completely seal the reduction gearing unit of a lawn sprinkler motor unit from the water flow through the sprinkler.

It is a further object of the present invention to provide a turbine magnetically coupled to reduction gearing and an output shaft in a lawn sprinkler motor unit.

It is a further object of the present invention to utilize planetary reduction gears for reducing the speed of an output shaft relative to a water flow responsive turbine.

It is a further object of the present invention to provide means for driving means for moving a sprinkler itself while also driving water delivery means on the sprinkler.

It is a still further object of the present invention to provide a sprinkler that is automatically movable with respect to the ground while also having a water delivery tube that is oscillatable.

These and other objects of the invention will become clear from an inspection of the detailed description of the invention and from the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan view of the travelling oscillating sprinkler according to the teachings of the present invention;

FIG. **2** is a side elevational view of the travelling oscillating sprinkler according to the teachings of the present invention;

FIG. **3** is a sectional view taken along lines **3—3** of FIG. **1** showing the oscillator linkage according to the teachings of the present invention;

FIG. **4** is a cross-sectional view partly in elevation taken along lines **4—4** of FIG. **8** showing the interrelationships of the motor, oscillating gearing, water delivery system, and drive gearing according to the teachings of the present invention;

FIG. **5** is a cross-sectional view taken along lines **5—5** of FIG. **6** showing a planetary reduction gear arrangement according to the teachings of the present invention;

FIG. **6** is a cross-sectional view of the water motor unit according to the teachings of the present invention;

FIG. *7a* is a view taken along lines *7a—7a* of FIG. **6** showing the turbine and magnetic coupling means according to the teachings of the present invention, while FIG. *7b* is a fragmentary development of the turbine and associated structures according to the teachings of the present invention;

FIG. **8** is a cross-sectional view taken along lines **8—8** of FIG. **4** showing the drive gearing for the sprinkler wheels according to the teachings of the present invention;

FIG. **9** is a sectional view taken along lines **9—9** of FIG. **1** showing the speed selector knob in solid line and the speed selecting means in dotted line according to the teachings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

A travelling oscillating sprinkler according to the present invention is shown generally at **10** in FIG. **1.** A conventional oscillating fluid distributing tube **11** is

supplied with fluid through hose **12**, inlet connection **13**, and outlet connection **14**. The complete assembly is mounted on a frame shown generally at **15**, comprising tubular rod side frame members **16**, cross-portion **17** having an aperture **18** therein, and tube supporting bracket **19**. The oscillating linkage, shown generally at **20**, the motor-housing sector, shown generally at **30**, and the gearing housing sector, shown generally at **50**, are supported by drive-shaft **81** of wheels **80**. Frame members **16** rest on bushings **68** of shaft **81**, and supportively engage plates **51** of gearing housing sector **50** (as most clearly shown in FIGS. **3**, **8**, and **9**.) The front part of frame **15** is supported by small wheel **82**, which may be of the type adapted to be guided by a hose, and which is rotatable about axle **84** connected to cross-member **17** by bracket **83**.

FIG. **3** shows in detail the oscillating linkage **20** for oscillating the fluid distributing tube **11** according to the teachings of the present invention. Linkage arm **21** has terminating collar portions **22**, **23**, for respectively engaging fluid distributing tube **11** and pin shaft **24**. Pin shaft **24** is received in a hole in linkage arm **25**, which is pivotally attached to arm **26**. Arm **26**, is in turn connected to right angle terminating portion **28** of arm **27**. The other right angle terminating portion, **29**, of arm **27** is fixed to drive shaft **29'**, shown in dotted line in FIG. **3**. As can be clearly seen in FIGS. **1** and **3**, the oscillating linkage is supported in front of motor housing sector **30**.

The novel motor structure according to the teachings of the present invention is shown generally at **30**. As is clearly shown in FIGS. **4–7**, the motor is comprised generally of two distinct sections; (**1**) a turbine, **31**, **32**, 32', magnetically coupled via permanent magnets **33**, 35 to (**2**) a sealed output shaft-gear reduction arrangement, **36–41**, **48**, sealed within a housing **34**. The turbine is composed of shaft portion **31** rotatably supported by a tubular end extension of housing **34**, arm and support portion **32**, and turbine blades **32'**. Outer coupling magnet **33** is attached to support portions **32**. As shown most clearly in FIGS. *7a* and *7b*, the turbine is preferably formed of eight turbine blades **32'** responsive to water flowing in an axial direction.

Outer and inner magnetic coupling members **33**, **35**, are coupled through housing wall **34**. The permanent magnets **33**, **35**, are preferably formed of sintered barium-ferrite, the outer magnet **33** magnetized with multiple poles on its inner diameter, and the inner magnet **35** magnetized with multiple poles on its outer diameter. As with all magnetic couplings, magnetic coupling **33**, **35** has a break-away feature so that should turbine **32** turn too fast, it will break the magnetic coupling between it and the planetary gear train **38**, thereby preventing damage to the gear train.

Inner magnetic coupling member **35** is rigidly attached to support shaft **36**, which is rotatable about shaft **37**. Support shaft **36** has a sun gear **36'** formed thereon. Sun gear **36'** is the drive gear for the planetary reduction gearing system, shown generally at **38** in FIGS. **5** and **6**. Sun gear **36'** drives planetary gears **39'**, which are attached to support segment **39** and are also in engagement with inner-toothed sector of **34'** of casing **34**. Since planetary gears **39'** are rotatable about portions of support member **39**, they drive gear **39''** formed on the upper portion of support member **39**. Gear **39''** then in turn drives planetary gears **40'** on support member **40** — which gears are in engagement with toothed sector **34''** of housing **34** — thus driving gear **40''** formed from support member **40**. Gear **40''** in turn drives planetary gears **41'** of support member **41** — which gears are in engagement with inner toothed sector **34''** of housing **34**. Formed on the upper extremity of support member **41** is motor output shaft **48** — which drives both the oscillating linkage and the rear wheels, as will be further explained below. The preferred reduction of the planetary gear train **38** is **81.4-1**.

The center shaft, **37**, supports the planetary gear sets and locates the output shaft **48** axially and radially due to a press fit with the rotary output shaft **48**. Shaft **37** is preferably formed of stainless steel, while rotary output shaft **48** is preferably formed of acetyl plastic. A high friction sealing element, O-ring **46**, is fitted between housing **34** and output shaft **48** to prevent entry of any water or gritty material carried therewith into the housing **34**. O-ring **46** provides a sufficient seal here since housing sector **50** with which it communicates is essentially free of water and since shaft **48** is a low-speed, high torque component.

As can be clearly seen, a completely sealed gear reduction unit driven by a turbine is provided through the utilization of a magnetic coupling. Thus, the high-speed low-torque turbine can turn reliably at any flow rate desired, while a compact planetary gearing arrangement can be sealingly separated therefrom so that no water or grit can affect the operation thereof, thus resulting in a more reliable, more efficient, and more compact motor for a sprinkler.

Gearing arrangements by which the output shaft **48** drives the rear wheels **80** and the oscillating linkage **20** are shown most clearly in FIGS. **4** and **8**. Collar **44** is keyed to shaft **48**, and has spur gear **42** and worm gear **49** formed thereon. The drive for the oscillating linkage is shown in dotted line in FIG. **4**. Reduction spur gear **43** is driven by gear **42**, thereby rotating shaft **29'** and operating oscillating linkage **20**.

Rear wheels **80** are driven by the gearing arrangement shown generally in housing sector **50**. Worm gear **49** drives gear **52** formed on sleeve **57** rotatably supported by shaft **53**. Gear **54**, also formed on sleeve **57**, drives gear **59**, which is splined at **62** to sleeve **61** rotatably supported by rear wheels shaft **81**. Rotation of gear **59** also results in rotation of gear **63** formed on sleeve **61**, which in turn rotates gear **64**, which gear is rotatably supported by shaft **53**. Gear **64** is connected to gear **65**, so that rotation of gear **64** rotates gear **65** which in turn drives gear **66**. Since gear **66** is keyed to shaft **81** at **67**, rotation of gear **66** drives shaft **81**, thereby driving rear wheels **80**. Note that shaft **81** is supported by bearings **68**.

The gearing arrangement above described is for driving the sprinkler at a relatively high speed. For driving the sprinkler at a relatively low speed, gears **55** and **60** are utilized in place of gears **54** and **59**. Gear **55** is keyed to sleeve **57** at **58**, while gear **60** is rigidly attached to gear **59**. FIG. **8** shows the gears arranged to drive the sprinkler at the relatively high speed. To change to neutral or low speed, the selecting means shown generally at **70** in FIGS. **8** and **9** is used. Selecting means **70** is composed of a selector knob **71** located on the outside of the gear housing sector, and rotatable about shaft **72**. Shaft **72** extends into the interior of the housing, and is rigidly attached to selector member **73** having arms **74** and **75**, formed thereon. A detent

means **76, 77,** may be utilized to hold the selector knob in one of the three positions, and the positions may be indicated by raised lettering on the housing.

To change from high to low speed, selector knob **71** is rotated to the right (as shown in FIG. **9**) thereby moving arm **74** of selecting member **73** against the side of gear **59.** Since gear **59** is splined to shaft **61,** it slides to the left (as viewed in FIGS. **8** and **9**) passing through a neutral position to the low position wherein gears **60** and **55** engage. Engagement of gears **55** and **60** will result in rear wheels **80** being driven at a slower speed than when gears **54** and **59** are utilized. Thus it will be seen that a compact, efficient, powerful reduction gear driving arrangement has been disclosed.

Water flow for the sprinkler is provided through inlet **13,** conduits **90, 91,** and flow-directing – motor mounting member **93,** as shown in FIG. **4.** Conduit **90** is affixed to the interior of the gearing housing sector **50** at the water inlet **13,** and is attached through O-ring **92** to conduit **91.** Conduit **91** directs flow from the inlet to flow directing member **93.** Flow directing member **93** has a plate portion **100.** Extending from the plate portion **100** of member **93** are concentric generally tubular flow-directing portions **96, 97.** Water flowing from conduit **91** flows through hole **98** in portion **96,** and holes **99** in connecting members between portions **96** and **97,** and is then axially directed against turbine blades **32'** for driving them.

In addition to directing the flow of water from the inlet **13** through the turbine blades **32',** and then into the outlet **14,** member **93** also supports the motor gear-reduction housing **34,** and sealingly separates the driving gears in housing sector **50** from the water. Plate **100** of member **93** is shaped to generally conform to the inside of housing sector **50,** having peripheral holes for receiving conduit **91** and oscillating linkage driving shaft **29'** formed therein. The extremities of plate **100** engage gasket **95** on housing extension **94** to seal housing sector **50** from the water flow. A large aperture in the center of plate **100,** defined by tubular member **97,** receives motor gear-reduction housing **34** therein. The housing **34** may be affixed to the plate **100,** or may be held in contact therewith by the forces applied through shaft **48** in holding the shaft in place within the housing sectors **30, 50.** It will thus be seen that member **93** performs the functions of sealing the gear housing sector from the water flow, mounting the motor gear-reduction assembly, and directing the water flow through the turbine.

Although the housing can be formed in any suitable manner, and assembly of components likewise may be effected by any suitable means, preferably, the housing is formed in two parts **110, 112,** divided generally along lines **8—8** in FIG. **4.** Part **112** contains motor-containing housing sector **30** and a substantial portion of gear housing sector **50,** while part **110** contains the remaining portion of sector **50** including the selector knob **71** and the raised lettering associated therewith. The parts **110, 112** may be held together after insertion of all the parts into them by bolts passed through holes **114** and **116** formed in extensions of the outer housing periphery. Note that bushings for the shafts **53, 81** are formed half way in each of the parts **110, 112,** thereby facilitating assembly of the components.

OPERATION

All of the component parts of the travelling oscillating sprinkler according to the present invention having been described, the operation will now be set forth. A hose **12** is connected to inlet **13** of the sprinkler **10,** and water under pressure is provided thereby. The water enters conduit **91,** and passes through flow-directing member **93** to exert an axial force on turbine blades **32',** thereby rotating turbine **31, 32.** The water then continues flowing through the housing to outlet **14.** From outlet **14** it is supplied to oscillating water-distributing tube **11** to be supplied to the ground.

Rotation of the turbine also rotates outer magnetic member **33** attached thereto. Magnet **33** is magnetically coupled to inner magnet **35** in sealed housing **34,** and rotation of sun gear **36'** on support shaft **36** at the same speed as the turbine is thereby effected. The speed of the motor output shaft **48** is reduced through planetary reduction gear train **38.** The output shaft then drives both the oscillating linkage **20** for oscillating the fluid-delivery tube **11,** and the rear wheels **80** for moving the sprinkler along.

The oscillating linkage **20** is driven by motor output shaft **48** via gear **42,** reduction gear **43,** and drive shaft **29'.** Rear wheels **80** are driven by shaft **48** via worm gear **49,** spur gear **52,** either high-speed gear train **54,** 59, or low-speed gear train **55, 60,** reduction gears **63,** 64, 65, and **66,** and rear-wheel drive shaft **81.** After the area to be watered has been sufficiently sprinkled, or the travelling sprinkler has completed its travel, the sprinkler may be shut down by turning off the water power to hose **12,** or by any suitable conventional automatic shut-off means.

Many modifications of the sprinkler according to the teachings of the present invention are possible. For instance, instead of driving an oscillator and travelling wheels, the output shaft of the magnetically coupled motor according to the teachings of the present invention could instead drive a rotary spinkler head and/or a hose windup drum or a cable windup wheel. A gear train other than a planetary reduction gear train could be used in the motor to reduce the speed of the output shaft, although planetary gears are preferred because of their compactness, efficiency, reliability, and the large reduction possible within a small area. Many other modifications are also possible.

It is thus apparent that a sprinkler with an improved drive means therefore accomplishing all the objectives of the invention has been clearly set forth. Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of the invention which is not to be limited to details disclosed but is to be accorded the full scope of the claims so as to embrace any and all equivalent structures and devices.

What I claim is:

1. A sprinkler comprising:

a. a water inlet for supplying water under pressure from a hose to the sprinkler,

b. delivery means for delivering water from said inlet to a ground area,

c. a rotary output shaft rotatable about a first axis of rotation,

d. means operable in response to the movement of said rotary output shaft for changing the ground area receiving the water from said delivery means, and

e. means for converting the flow of water from said inlet to said delivery means to rotary motion of said output shaft including (i) a turbine having turbine blades responsive to said water flow, said turbine blades being rotatable about said first axis of rotation, (ii) planetary gear reduction means operatively connected to said rotary output shaft for reducing the speed of said shaft relative to the speed of said turbine, said planetary gear reduction means comprising a first gear member rotatable about said first axis of rotation, a pair of second gear members, said second gear members being operatively connected to said output shaft and said second gear members being rotatable about second and third axes of rotation respectively, said second and third axes of rotation being spaced from but parallel to said first axis of rotation, an inner housing toothed annular sector, said sector being concentric with said first axis of rotation, said second gear members being disposed on opposite sides of said first gear member and each simultaneously cooperating with said sector and said first gear member for providing gear reduction of said output shaft, whereby a compact arrangement is provided, (iii) housing means for completely sealing said gear reduction means from said water flow, said housing means having said inner toothed sector formed thereon, and (iv) permanent magnet coupling means for coupling said gear reduction means to said turbine through said housing means, said magnet coupling means including a first permanent magnet ring operatively connected to said turbine blades and being rotatable about said first axis, and a second permanent magnet ring operatively connected to said first gear member of said gear reduction means, whereby said gear reduction means will be permanently and efficiently sealed from said water flow without any impairment of the movement of said turbine.

2. A sprinkler as recited in claim **1** wherein said turbine blades are responsive to water flow in a direction generally parallel to the axis of rotation of said turbine.

3. A sprinkler as recited in claim **2** further comprising means for directing the water flow from said inlet through said turbine blades in said direction generally parallel to the axis of rotation of said turbine.

4. A sprinkler as recited in claim **3** further comprising means for mounting said housing means for completely sealing said gear reduction means from said water flow.

5. A sprinkler as recited in claim **4** further comprising means for sealing gear means driven by said rotary output shaft from said water flow.

6. A sprinkler as recited in claim **5** wherein said means for directing the water flow, said means for mounting said housing means, and said means for sealing gear means driven by said output shaft are all part of an integral member contained in a housing for said sprinkler.

7. A sprinkler as recited in claim **1** wherein said means for changing the ground area receiving the water from said delivery means includes means for oscillating said delivery means.

8. A sprinkler as recited in claim **7** wherein said means for changing the ground area receiving the water from said delivery means further includes means for automatically moving said sprinkler relative to the ground.

9. A sprinkler as recited in claim **8** wherein said means for automatically moving said sprinkler comprises a worm gear mounted on said output shaft, reduction gears driven by said worm gear, and a drive gear keyed to a drive axle having wheels mounted thereon, whereby said worm gear drives said reduction gears which in turn drive said drive gear which in turn drives said drive axle thereby rotating said wheels to move said sprinkler with respect to the ground.

10. A sprinkler as recited in claim **9** wherein said means for moving said sprinkler further comprises speed selector means for selecting said reduction gears to vary the speed at which said wheels are rotated and thus the speed at which said sprinkler is driven.

11. A sprinkler as recited in claim **7** wherein said oscillating means includes a gear mounted on said output shaft, a reduction gear in operative relationship with said gear mounted on said output shaft, a drive shaft keyed to said reduction gear, and an oscillating linkage connected to said delivery means and in operative relationship with said drive shaft, whereby said output shaft drives the gear mounted thereon which in turn drives said reduction gear which in turn drives said drive shaft which in turn drives said oscillating linkage which in turn oscillates said delivery means.

12. A sprinkler as recited in claim **11** wherein said delivery means comprises an elongated fluid delivery tube mounted at both ends thereof.

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