United States Patent [19]

McMahan

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[45] **March 6, 1973**

[54] **DRIP IRRIGATION NOZZLE**

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[52] **U.S. Cl.** **239/454,** 239/541, 239/542

[51] **Int. Cl.** **B05b 1/30**

[58] **Field of Search**.....239/542, 547, 550, 454, 456, 239/447, 203, 204, 205, 206, 452, 570, 541; 137/202

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[57] **ABSTRACT**

A drip irrigation nozzle having pressure regulating and self-cleaning characteristics. The nozzle includes a resilient closure member which in a flow limiting position partially blocks the nozzle metering orifice in proportion to the pressure of the supplied fluid. The nozzle discharge or "drip" rate thus is substantially independent of fluid supply pressure. When the irrigation fluid is turned on or off, the transient burst of fluid past the closure member cleans debris from the nozzle.

19 Claims, 10 Drawing Figures

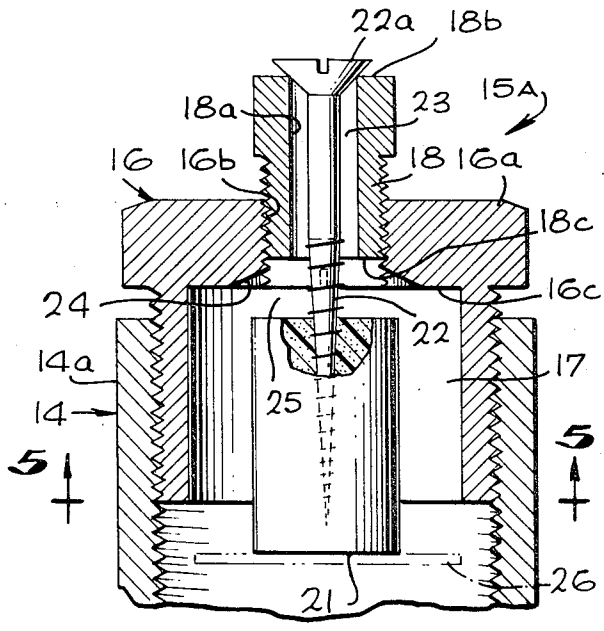


Fig. 1

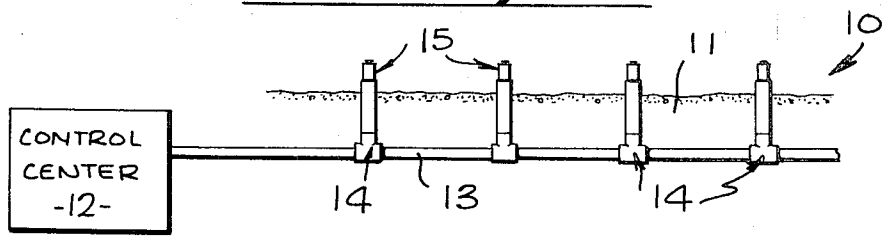


Fig. 2

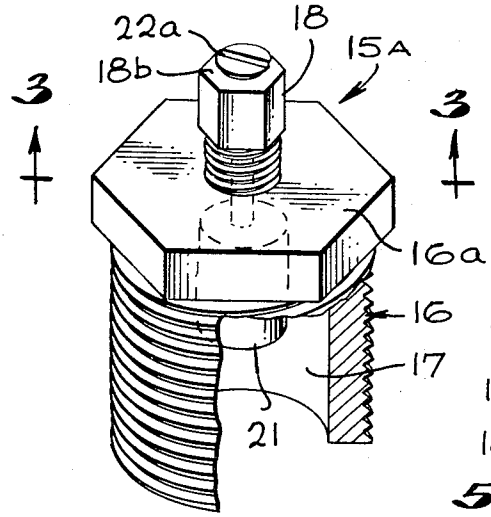


Fig. 3

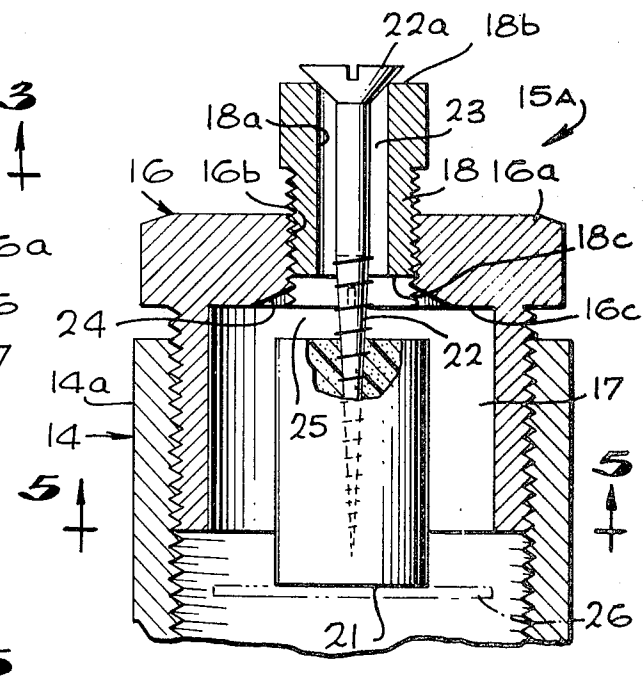


Fig. 5

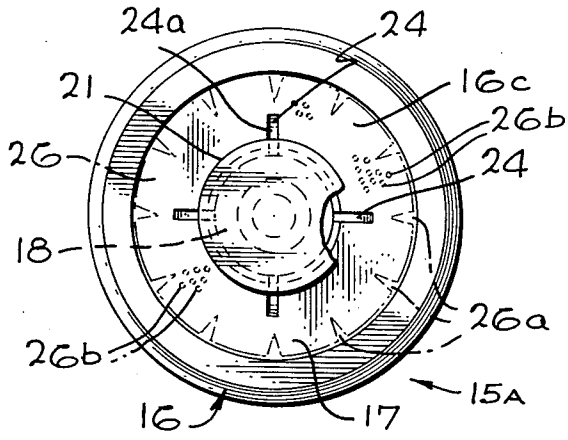
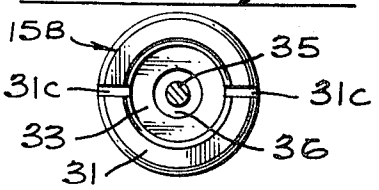


Fig. 9



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Fig. 4

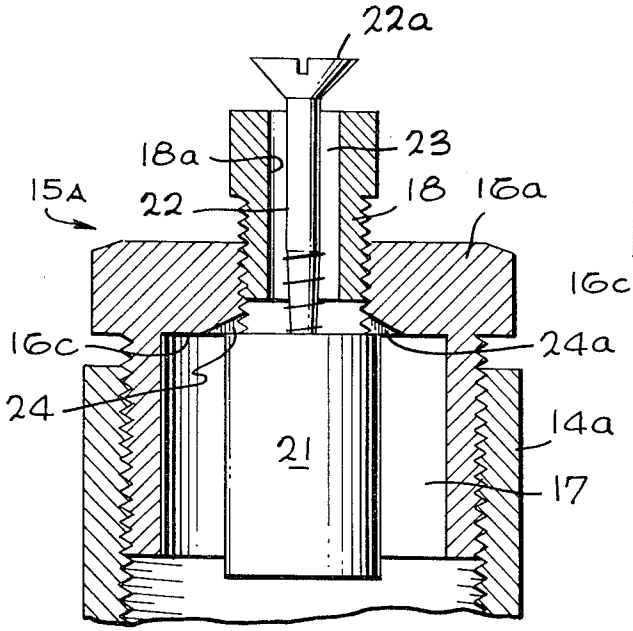


Fig. 6

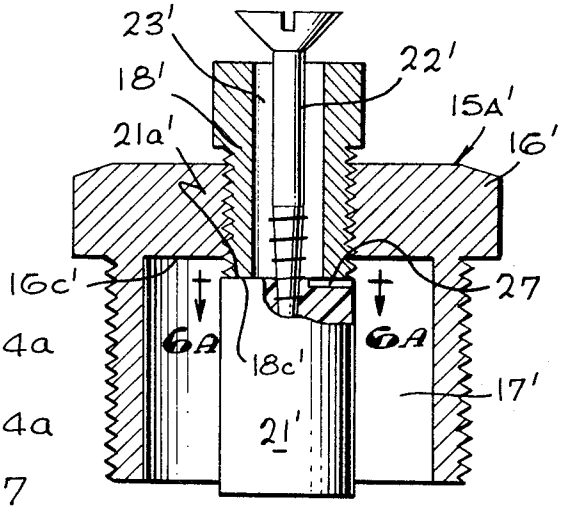


Fig. 6A

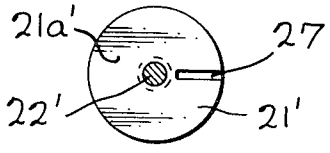


Fig. 7

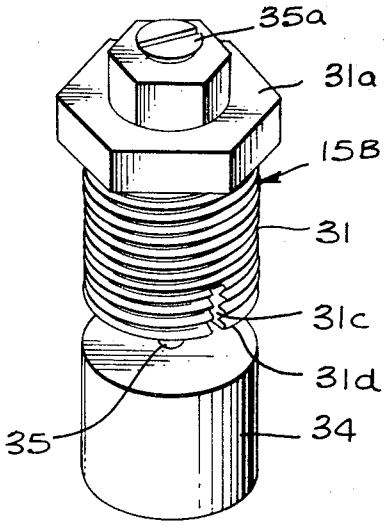
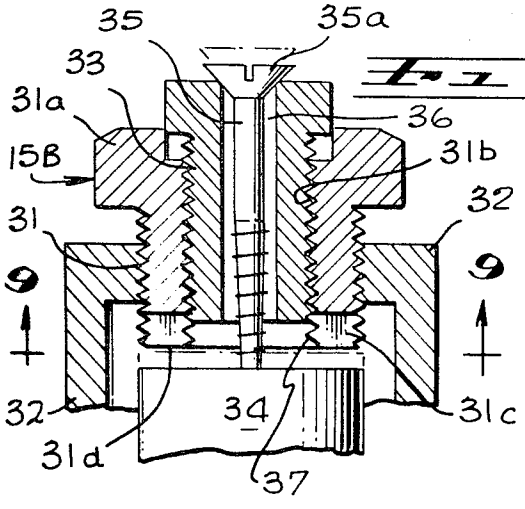


Fig. 8



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DRIP IRRIGATION NOZZLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to drip irrigation systems, and particularly to fluid nozzles, emitters or droppers for such systems.

2. Description of the Prior Art

Extensive research has determined that the productivity of plants is increased vastly if the root zone is not subjected to extremes in wetting and drying. Thus the objective of a drip irrigation system is to provide regulated moisture content for the soil surrounding the plant roots. Such an irrigation system typically consists of (1) a control center cooperable with a water supply and including filters, control valves, pressure gauges and apparatus for dissolving fertilizer into the irrigation water; (2) water distribution pipes of suitable size, including laterals and T-connects; and (3) nozzles, emitters or droppers attached to the T-connects. Preferably, the nozzles include metering orifices which discharge irrigation water at a rate of less than about two gallons per hour.

Several problems are associated with prior art drip irrigation systems. First, due to the small size of the metering orifices, the nozzles tend to become clogged by the accumulation of dirt, residue, or impurities from the water supply. Such blockage is unacceptable, since no water will be provided to the root zone irrigated by that nozzle. Efforts to prevent orifice blockage have related to improving the filters used at the control center. Such filters are costly to install, require periodic maintenance, and are of limited effectiveness. An object of the present invention is to provide a drip irrigation nozzle which is self-cleaning, thereby permitting some laxity in filtering system performance.

Another problem associated with drip irrigation systems relates to the pressure drop along a particular lateral. It is common practice to connect 30, 40 or even more droppers or nozzles to a single lateral. While the pressure drop between successive nozzles may be small, the pressure drop between the nozzle nearest the control center and those at the end of the lateral is substantial. Also there can be a significant difference in relative height of emitters due to hilly terrain; the resultant variation in water pressure along the lateral will cause substantially different amounts of water to be emitted at different stations. Another object of the present invention is to provide a nozzle structure having an automatically adjusting orifice which compensates for such pressure differences, and which has a manual adjusting feature to control the emitter "drip" rate.

Still another prior art problem relates to nozzles wherein the metering orifice remains open even when the fluid supply is turned off. Various types of insects like to spin webs in the small nozzle holes. Such webs then tend to impede the flow of irrigation water through the nozzle. Another object of he present invention is to provide a drip irrigation nozzle in which the orifice is maintained closed when not in use. While in operation this device ejects a small stream of water that is readily visable from a distance thus making routine checking simple. Should the emitter become plugged, a tap of the foot on the plunger will clear it.

Water from emitters spreads by capillary action as well as by gravity. Salts in the water tend to concentrate near the edge of the wet zone. A normal rain after prolonged use of emitters will diffuse the salt into the root zone where it could do much damage to the tree or plant. By a simple adjustment the inventive emitter can be changed into a full circle sprinkler which can be used to drive the salts below the root zone, thereby eliminating the need for standby portable sprinklers.

SUMMARY OF THE INVENTION

To accomplish the foregoing objects, there is provided a simple drip irrigation nozzle having self-cleaning and pressure regulating characteristics. The nozzle includes a resilient closure member which assumes a flow limiting position partially blocking the metering orifice by an amount directly proportional to the pressure of the supplied fluid. Accordingly, the higher the irrigation water pressure, the smaller the effective orifice. A regulating function thus is achieved.

The nozzle is purged of accumulated deposits when the fluid supply is turned on and off. This cleaning function is accomplished by the transient high volume fluid flow through the nozzle which remain substantially open during the transient period as the closure member moves into or away from the flow limiting position. When the fluid supply is off, the flanged top of the shaft supporting the closure member covers the nozzle outlet to keep out insects.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of the invention will be made with reference to the accompanying drawings. These drawings, unless described as diagrammatic or unless otherwise indicated, are to scale.

FIG. 1 is a simplified, diagrammatic view of a drip irrigation system.

FIG. 2 is a perspective view of a drip irrigation nozzle in accordance with the present invention, partly broken away to show the closure member.

FIG. 3 is a transverse sectional view of the nozzle of FIG. 2, as viewed generally along the line 3—3 thereof; the nozzle is shown in the quiescent state.

FIG. 4 is a transverse sectional view in the same aspect as FIG. 3, but with the closure member shown in the flow limiting position.

FIG. 5 is a bottom sectional view of the nozzle shown of FIG. 3, as viewed generally along the line 5—5 thereof.

FIG. 6 is a transverse sectional view, and FIG. 6A is a plan view, partly in section, of another nozzle embodiment similar to that of FIG. 2, with a flow metering notch provided on the closure member.

FIG. 7 is a perspective view of another drip irrigation nozzle in accordance with the present invention.

FIG. 8 is a transverse sectional view of the nozzle of FIG. 7, as viewed generally along the line 8—8 thereof.

FIG. 9 is a bottom sectional view of the nozzle of FIG. 7, as seen generally along the line 9—9 thereof.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following detailed description is of the best presently contemplated modes of carrying out the in-

vention. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention, since the scope of the invention best is defined by the appended claims.

Structural and operational characteristics attributed to forms of the invention at first described also shall be attributed to forms later described, unless such characteristics obviously are inapplicable, or unless specific exception is made.

Referring now to the drawings and particularly to FIG. 1 thereof, there is shown diagrammatically a drip irrigation system **10** for maintaining regulated moisture content of the soil **11** in the root zone of plants under cultivation. The irrigation system **10** includes a control center **12** at which water from a supply is connected via appropriate control valves and pressure gauges (not shown) to a distribution network including a lateral **13**. Fertilizer may be mixed with the irrigation water at the control center **12**.

The lateral **13** typically is underground, and provided with a plurality of T-connects **14** each of which conducts the supplied irrigation water upward above ground level to a drip irrigation nozzle **15** of the type disclosed herein. Each nozzle **15** functions to dispense the irrigation fluid at a slow but constant rate, independent of the fluid pressure present at the particular T-connect **14** associated with that nozzle. Uniform, regulated soil moisture content is achieved.

A first embodiment of the invention is shown in FIGS. **2** through **5**. Referring thereto, the drip irrigation nozzle **15A** includes a generally cylindrical outer body member **16** which may be exteriorly threaded to facilitate attachment to the upper end **14a** of a T-connect **14**. With such arrangement, the chamber **17** within the outer body member **16** is in fluid communication with the supply conduit or lateral **13**.

The upper end **16*a*** of the member **16** is closed except for a central, interiorly threaded opening **16*b***. A generally cylindrical inner body member **18** screws into the opening **16**, and includes an axial opening **18*a*** which functions as the fluid outlet path for the nozzle **15A**. The member **18** has a hex-headed end **18*b***.

Situated within the chamber **17** is a closure member **21**, preferably fabricated of a resilient plastic or rubber material and having a diameter slightly greater than the diameter of the opening **16*b***. Supporting the closure member **21** is a shaft **22** extending through, and having a diameter somewhat less than the opening **18*a***. The upper end of the shaft **22** includes a flange **22*a*** which limits the downward travel of the shaft **22** and the closure member **21**, and which serves as a cover for the opening **18*a*** when the nozzle **15A** is in the quiescent state illustrated in FIG. **3**. For simplicity, the shaft **22** may comprise a wood screw, the head of which forms the flange **22*a***.

One or more notches **24** are cut in the underside **16*c*** of the outer body member end **16*a***. Each notch **24** may have a generally triangular shape as viewed in transverse section (FIG. **3** or **4**), and extends radially outwardly from the opening **16*b***, as shown in FIG. **5**. As described below, the notches **24** serve as the metering orifices for the nozzle **15*a***.

When fluid is supplied through the lateral **13**, the water pressure within the T-connect **14** and the chamber **17** forces the closure member **21** upward against the lower surface **16*c*** of the outer body member end **16*a***. In this flow limiting position (FIG. **4**), the closure member **21** substantially blocks off fluid flow between the chamber **17** and the annular space **23** surrounding the shaft **22** within the opening **18*a***. However, the diameter of the closure member **21** is less than the maximum radial extend of the notches **24**. As a result, a fluid flow path remains from the chamber **17** through the exposed portion **24*a*** of each notch **24** to the annular space **23** and thence out from the top end **18*b*** of the inner body member **18**. The size of the metering orifice **24*a*** determines in part the fluid flow or "drip" rate from the nozzle **15A**.

As noted earlier, the closure member **21** is resilient. Accordingly, this closure member **21** will extrude into the notches **24** to a greater or lesser degree depending on the pressure of the fluid supplied via the T-connect **14**. If the pressure is high, as at the source end of the lateral **13**, the closure member **21** will extrude to a greater degree into each notch **24**, and a smaller orifice **24*a*** will result, Conversely, near the terminal end of the lateral **13** the pressure will be lower, and the member **21** will extrude to a lesser degree into notches **24**. The openings **24*a*** will be larger. In either case (high pressure and a small opening **24*a*** or low pressure and a larger opening **24*a***), the resultant fluid flow rate through the annular discharge passageway **23** and out of the nozzle **15A** will be substantially the same. Thus a pressure regulating function is achieved.

The drip rate of the nozzle **15A** may be adjusted by changing the relative position of the inner body member **18** within the opening **16*b***. Thus if the member **18** is screwed in sufficiently far, the lower end **18*c*** of the inner body member **18** will partially eclipse the notch **24**, thereby reducing the effective size of the orifice **24*a***. The net flow rate thereby is reduced. This adjustment function is described more thoroughly in conjunction with the embodiment of FIGS. **7** to **9**.

When the irrigation fluid in the lateral **13** first is turned on, there will be transient period as the closure member is carried upward from the quiescent position of FIG. **3** to the flow limiting position of FIG. **4**. During this transient period the supplied fluid will flow relatively freely through the space **25** (FIG. **3**) above the upper end of the closure member **21** and out through the discharge passageway **23**. The resultant pulse of fluid will flush out any residue which may have accumulated within the nozzle **15A**. When the closure member **21** reaches the flow limiting position, the transient burst of water will terminate.

Later, when the supply of water to the lateral **13** is turned off, there will occur another transient period. As the water pressure decreases, the closure member **21** will drop away from the flow limiting position of FIG. **4**, and another burst of water will flow through the space **25** and the passageway **23** again to flush out the nozzle **15A**.

As an optional feature, a disc shaped filter screen **26** may be attached coaxially to the lower end of the closure member **21**, as shown in phantom in FIG. **3**. The screen **26** may include peripheral grooves **26*a*** or small holes **26*b*** through which water but not debris can flow. When the closure member **21** is in the flow limiting position shown in FIG. **4**, the periphery of the screen **26** will be in relatively close contact with the inner surface

of the body member **16**, so that all of the water supplied via the T-connect **14** will be filtered by the screen **26**.

Another modification of the invention is shown in FIGS. **6** and **6A**. Therein, the nozzle **15A'** is configured like the nozzle **15A** of FIG. **2**, however the inner body member **16'** is not notched. Rather, a notch **27** is provided in the upper surface **21***a'* of the resilient closure member **21'** supported by the shaft **22'**. Further, the inner body member **18'** is of sufficient length so that the lower end **18***c'* thereof projects beneath the inner body member surface **16***c'*.

The pressure the irrigation fluid supplied via a T-connect **14** forces the closure member **21'** into the flow limiting position shown in FIG. **6**. In this condition, a limited amount of fluid flows from the chamber **17'** through the notch **27** to the discharge passageway **23'**. The cross-sectional dimension of the notch or metering orifice **27** establishes the drip rate. When considerable fluid pressure is present, the closure member **21'** will be compressed against the inner body surface **18***c'*, effectively reducing the size of the metering orifice **27**. Conversely, with a lower fluid supply pressure the closure member **21'** will not be compressed as much, and the effective dimension of the metering orifice **27** will be greater. Thus the drip rate will be substantially independent of the fluid supply pressure; a regulating function again is achieved.

Although not specifically illustrated, the notched closure member **21'** (FIG. **6**) may be employed together with a notch outer body member **16** (FIGS. **3** to **5**). The notches **24** and closure member notch **27** then may cooperate as metering orifices.

Another embodiment of the invention is shown in FIGS. **7**, **8** and **9**. Therein, a drip irrigation nozzle **15B** includes a generally cylindrical outer body member **31** exteriorly threaded for attachment to a coupling **32** connected to the upper end of a T-connect **14**. The outer body member **31** may be fabricated of metal and include a hex head **31***a* to facilitate insertion into the coupling **32**. The threaded interior opening **31***b* is of uniform diameter throughout the entire length of the outer body member **31**. A pair of slots or notches **31***c* are provided at the lower end **31***d* of the outer body member **31**. The notches **31***c* are of generally rectangular cross-section and extend radially from the opening **31***b* to the exterior surface of the outer body member **31**.

An inner body member **33**, like the inner body member **18** described above, is threadingly received within the opening **31***b*. The length of the inner body member **33** is sufficient so as to eclipse more or less the notches **31***c*. The extend to which the inner body member **33** eclipses or covers the slots **31***c* establishes the drip rate from the nozzle **15B**.

The nozzle **15B** also includes a resilient closure member **34** supported at a lower end of a shaft **35** which extends through the inner body member **33** to define an annular discharge passageway **36**. The elements **34**, **35** and **36** correspond respectively to the closure member **21**, the shaft **22** and the passageway **23** in the embodiment of FIG. **2**.

Preferably, the diameter of the closure member **34** is greater than the diameter of the opening **31***b*, and may equal the external diameter of the outer body member **31**. Thus, the pressure of the irrigation fluid in the T-connect **14** will force the closure member **34** against the outer body member over end **31***d*, as shown in phantom in FIG. **8**. In this flow limiting position, fluid can drip through the uneclipsed portion **37** of the notched **31***c*, thence out through the discharge passageway **36**.

A relatively high fluid supply fluid will cause the resilient closure member **34** to extrude partway into the notches **31***c*, reducing the effective size of the metering orifice **37**. Conversely, a lower fluid pressure will result in less extrusion of the closure member **34**, and hence in a larger effective size of the metering orifice **37**. Again, the pressure regulating function is achieved.

As described above in conjunction with the nozzle **15A**, a transient burst of water also will flow past the closure member **34** to cleanse the discharge passageway **36** as the fluid supplied via the lateral **13** is turned on an off. Note that when the supply fluid is on, the shaft upper end **35***a* may be depressed by hand or foot to permit unimpeded fluid flow past the closure member **34** and out through the passageway **36**. The resultant rush of water will further cleanse the nozzle **15B**. Moreover, the flanged end **35***a* of the shaft **35** functions as a lid or cover to close the discharge passageway **36** when the nozzle **15B** is in the quiescent condition. This prevents insects from entering and spinning webs within the passageway **36**.

The nozzle **15B** may be used as a full circle sprinkler by unscrewing the inner body member **33** (FIG. **8**) sufficiently far as to expose completely the slotted orifices or notches **31***c*. The substantial quantity of water flowing through the uneclipsed notches **31***c* will be discharged via the passageway **36** and deflected into a full circle spray by the inclined undersurface of the shaft end **35***a*.

Thus there is provided a novel drip irrigation nozzle having both self-cleaning and pressure regulating characteristics, which can be flushed out by depressing the exposed shaft end, and which can be converted easily to a full circle sprinkler.

Intending to claim all novel, useful and unobvious features shown or described, the applicant:

I claim:

1. A drip irrigation nozzle comprising:

a generally cylindrical outer body member adapted for connection to a fluid supplying conduit,

a generally cylindrical inner body member threadedly mounted within said outer body member to permit adjustment of the relative axial position of said inner and outer body members,

a resilient closure member,

a closure supporting shaft extending through said inner body member with a fluid flow permitting discharge passageway therebetween, said closure member being attached to said shaft, fluid supplied via said conduit forcing said closure member toward a fluid flow limiting position against said inner or outer body member, and

a metering orifice allowing fluid to drip past said closure member and through said discharge passageway when said closure member is in said fluid flow limiting position, said resilient closure member more or less closing said metering orifice in response to variation in fluid supply pressure, thereby providing a substantially uniform fluid drip rate independent of fluid supply pressure.

2. A drip irrigation nozzle according to claim 1 wherein said outer body member has a conduit connecting portion forming a housing for said closure member, one end of said housing being closed except for an interiorly threaded opening therethrough.

3. A drip irrigation nozzle according to claim 2 wherein the diameter of said closure member is greater than the interior diameter of said interiorly threaded opening, said housing one end being notched to form said metering orifice.

4. A drip irrigation nozzle according to claim 2 further comprising a filter disc disposed transversely across the interior of said housing and attached to the lower end of said closure member.

5. A drip irrigation nozzle according to claim 2 wherein a surface of said closure member is notched, and wherein said inner body member projects beyond said housing one end, said notched closure member surface seating against said inner body member in said fluid flow limiting position.

6. A drip irrigation nozzle according to claim 1 wherein said metering orifice comprises at least one notch in the surface of said closure member which is forced against said body member in said fluid flow limiting position.

7. A drip irrigation nozzle according to claim 1 wherein the end of said outer body member facing said conduit is notched radially, said relative axial position establishing the degree to which said inner body member eclipses said notch to control the amount of fluid dripping therethrough when said closure member is in said flow limiting position against said notched end.

8. A drip irrigation nozzle according to claim 1 wherein the other end of said shaft includes a flange abutting against said inner body member to limit the extent of travel of said closure member away from said flow limiting position and to cover the discharge passageway through said inner body member when no fluid is supplied by said conduit.

9. A drip irrigation nozzle according to claim 8 wherein said shaft is disposed vertically, said closure member dropping downward away from said flow limiting position when said fluid supply is terminated, said closure member being forced upwardly toward said flow limiting position by the pressure of said fluid when said supply is turned on, said nozzle being cleaned by the burst of fluid flowing past said closure member during the transient period taken for said closure member to reach or drop away from said flow limiting position.

10. A drip irrigation nozzle according to claim 1 wherein said metering orifice comprises at least one notch in the end of said inner body member facing said closure.

11. A drip irrigation nozzle according to claim 1 wherein said metering orifice comprises at least one notch in the surface of said outer body member facing said closure.

12. For use in a drip irrigation system wherein irrigation fluid is supplied via a conduit to a plurality of nozzles, a nozzle including:

a. a first body member having associated means for connection to said conduit and having a discharge passageway therethrough,

b. a resilient closure member fabricated of rubber or plastic,

c. said closure member being attached to a shaft loosely extending through said discharge passageway, the other end of said shaft cooperating with said first body member to permit limited travel of said closure member toward or away from said first body member,

d. a metering orifice in the fluid path from said conduit to said passageway,

e. fluid from said conduit forcing said closure member toward a position in which fluid flow between said conduit and said passageway is limited only to said metering orifice, the extent to which said closure member blocks said orifice being proportional to the supplied fluid pressure, thereby providing a uniform drip rate substantially independent of pressure variation along the conduit.

13. A nozzle according to claim 12 wherein said metering orifice comprises a notch in the end of said closure member facing said first body member.

14. A nozzle according to claim 10 adapted to be flushed clean by depression of said other shaft end to move said closure member away from said flow limiting position, thereby permitting water to rush through said discharge passageway.

15. A nozzle according to claim 12 wherein said first body member is adjustably positioned within a second body member adapted for connection to said conduit.

16. A nozzle according to claim 15 wherein said metering orifice comprises a notch in said second body member.

17. A nozzle according to claim 16 wherein said first body member may be adjustably positioned to eclipse a portion of said notch to establish said drip rate.

18. A nozzle according to claim 15, said nozzle being convertible into a full circle sprinkler by adjustably positioning said first body member not to eclipse said metering orifice, said shaft having a conical upper end, fluid flowing through said discharge passageway being deflected into a circular spray by said shaft conical upper end.

19. A drip irrigation nozzle comprising:

a generally cylindrical outer body member adapted for connection to a fluid supplying conduit,

a generally cylindrical inner body member adapted for mating engagement within said outer body member,

a resilient closure member,

a closure supporting shaft extending through said inner body member with a fluid flow permitting discharge passageway therebetween, said closure member being attached to said shaft, fluid supplied via said conduit forcing said closure member toward a fluid flow limiting position against said inner or outer body member, the other end of said shaft including a flange abutting against said inner body member to limit the extent of travel of said closure member away from said flow limiting position and to cover said discharge passageway when no fluid is supplied by said conduit, said shaft comprising a screw, and

a notched metering orifice allowing fluid to drip past said closure member and through said discharge passageway when said closure member is in said fluid flow limiting position, said resilient closure

member more or less closing said metering orifice in response to variation in fluid supply pressure, thereby providing a substantially uniform fluid drip rate independent of fluid supply pressure.

* * * * *