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Heaton

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[54] **WELL SERVICE STRUCTURE**

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[52] **U.S. Cl.** **166/88,** 138/30, 220/22

[51] **Int. Cl.** **E21b 33/03**

[58] **Field of Search** ..... 166/88; 138/30; 220/22; 61/46, 69 R

[56] **References Cited**

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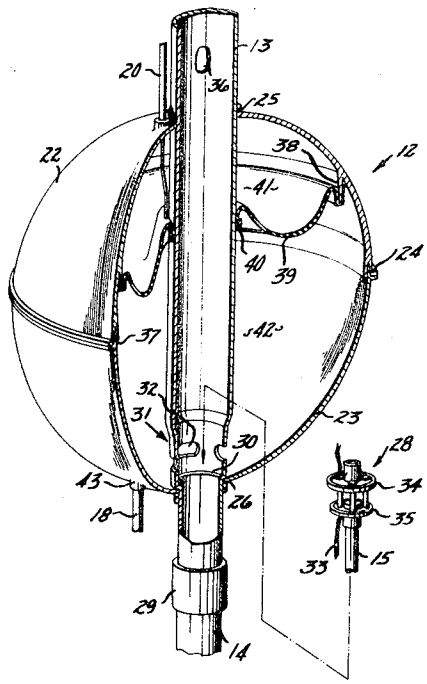
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Primary Examiner—James A. Leppink
Attorney—Miller, Morriss, Pappas & McLeod

[57] **ABSTRACT**

A well service structure for remote positioning in respect to residences served and comprising a top pipe section connected to a wall casing that extends vertically downward. The top pipe is itself encased partially by a spherical resin tank cast in hemispheres and joined to the top pipe and to each other. The interior of the top pipe is provided with a taper portion, the lower portion of the taper is shouldered and is slightly smaller in diameter than the upper taper portion and the top pipe is perforated intermediate the limits of the tapered portion. A flow director supporting well pipe and pump is provided which is connected to the upper section of well pipe so that water from the well enters the distributor axially and is diffused radially through the perforations in the top pipe extension and into the spherical tank. The top plate closure of the flow director includes a taper faced ring seal and the lower plate closure on the flow director includes a similar but smaller taper faced seal and both are seated on the tapered portion provided in the top pipe. In addition, a flange portion of the taper faced seal rests on an internal shoulder provided in the top pipe. The spherical tank is provided with a resilient membrane in the upper portion which separates the tank into two parts, the part below the membrane being vented to atmosphere via a bent tube and the lower part is provided with a delivery nipple connectable to a remote use facility. The tank is preferably buried and in some situations, may be housed above ground and preferably remote from the residence or dwelling served. The upper portion of the top pipe extends above the ground and is preferably closed by a protective clousre but may be selectively opened to permit axial removal of flow director, well pipe, pump, strainers, foot valves, and the like.

7 Claims, 6 Drawing Figures



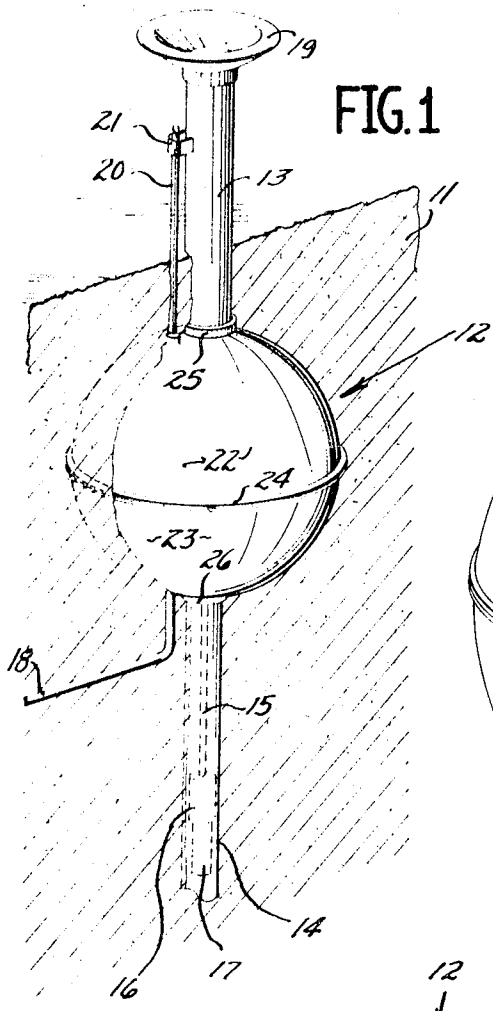


FIG. 1

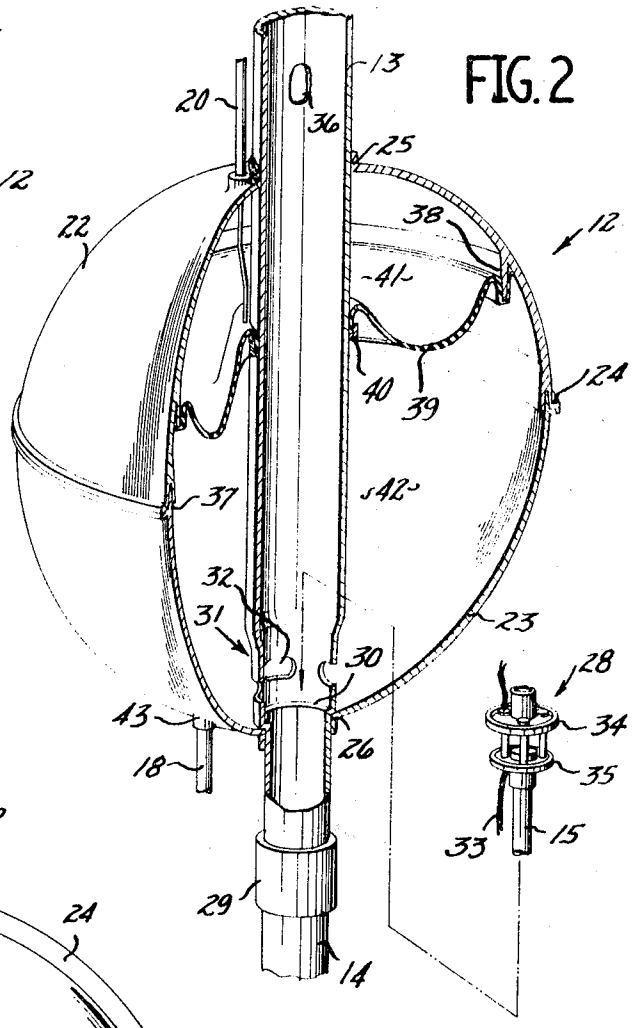


FIG. 2

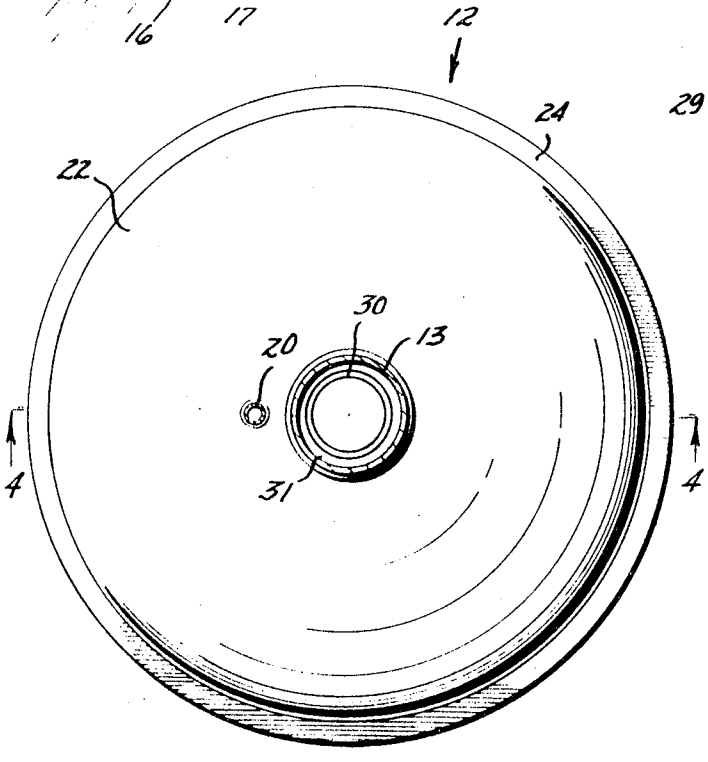
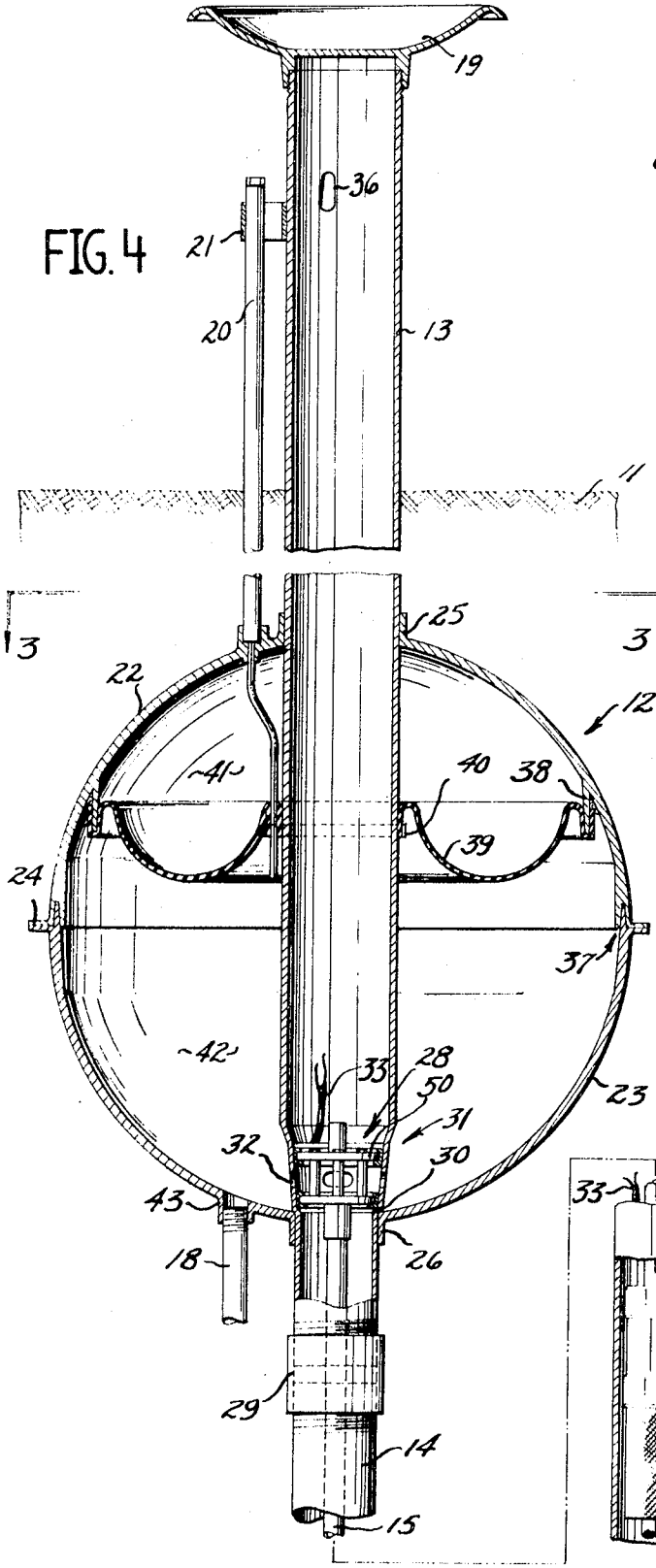


FIG. 3

FIG. 4



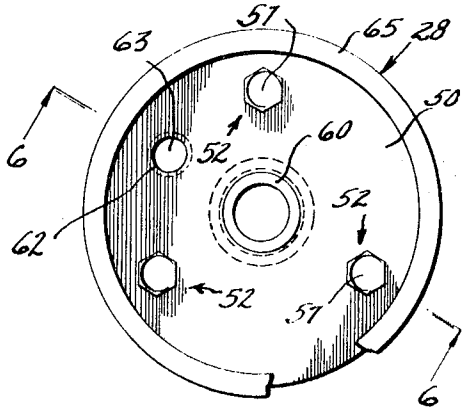


FIG. 5

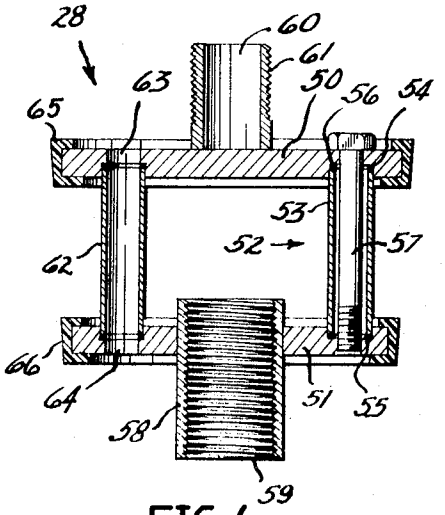


FIG. 6

WELL SERVICE STRUCTURE

The present invention relates to a well service structure and more particularly to an improvement in a well head construction which includes a casing extension protruding above ground and an improved flow director or distributor seating in the casing extension and through which distributor water is diffused to a spherical tank immediately surrounding the casing extension and providing stored resiliently backed delivery pressure and distribution while avoiding water logging of the system and where well, tank, and controls are thereupon outside of the residence or property served to achieve attendant quiet and continuous reliable performance. A diaphragm in the tank separates water from air space, the air providing a compressible drive medium. When it is necessary to pull the well pipe, pump, and foot valves or strainers for repair and replacement, the tank and delivering structure is left intact but the distributor is lifted vertically off of the unique taper seats and carries with it the pipe, pump, valves and strainers.

In cold climates the tank of the present improved device is located beneath the freeze depth since the tank and its resin construction assure long trouble-free performance. The unique diaphragm assures proper storage of pressure and an external vent provides bleed access to the stored water and suitable connection for pressure gages and pressure switches. The foot valve performance in the pump line is vastly improved and life of the pumps (submersibles) is extended because the more regular and less erratic performance demands are somewhat better handled by the diaphragm and compressed gas. The householder or pump user is pleased because service access is maintained, performance is quiet, the resin character of the tank prevents tank deterioration as experienced in the underground metal installations, and the seals at the flow director achieve excellent seating and locating support of the pump string since the lower seal aside from radial contact on the taper also rests on a thrust shoulder.

THE BACKGROUND OF THE INVENTION

Remote well delivering systems generally are old as seen in the U.S. Pat. No. 3,065,792 to V. L. Andrew and U.S. Pat. No. 2,917,113 to E. R. Ortman. However, as in the U.S. Pat. No. 3,064,736 to H. A. Tubbs, the tanks therefor were remotely positioned in respect to the well head. In a subsequent patent, U.S. Pat. No. 3,168,867, H. A. Tubbs shows a tank provided around the well casing and the U.S. Pat. No. 3,435,896 to C. C. Williams shows a casing mounted storage tank.

The present disclosure is directed to a resin tank of spherical configuration which is made to include a resilient diaphragm membrane and which tank surrounds and is sealed to a top pipe arranged to provide in cooperation with a flow distributor or director a pair of spaced apart tapered seats and a thrust shoulder against which the well string weight bears, the thrust being transmitted by the flow distributor of unique design. Those skilled in the art will perceive other distinctions between the present device and devices of the prior art as the description proceeds.

OBJECTS

Hence, the objects of the present invention are to provide a well service structure which performs quietly and efficiently in a position remote from the residence or property served thereby and where the resin tank with integrated diaphragm provides a pressurized storage at the well head and may be buried beneath the soil when desired. Another object is to provide a self-controlling storage tank substantially free from water logging and which is undisturbed by pulling the whole well string of pipe, pump, strainers and valves. Other objects including obvious economy and simplicity of servicing will be increasingly recognizable by those skilled in the art as the description proceeds.

GENERAL DESCRIPTION

In general the well service structure of the present invention is located on the well casing as an extension thereof. This is accomplished by coupling a top pipe to the well casing. The top pipe has a tapered portion providing a pair of spaced apart internal tapered seats, the uppermost portion being larger in diameter than the lower seat portion and radial openings are provided intermediate upper and lower extremities of the taper. An internal thrust shoulder of smaller diameter than the lower taper portion is provided in the top pipe. This permits the axial insertion of a well string comprising, for example, a strainer, foot valve, submersible pump and well pipe. The well pipe at the top is connected to a flow distributor which is provided with cast seals that seat on their tapered shoulders in tapered portion of the top pipe and the lowermost seal bears on the thrust shoulder. The manipulation of the well string and distributor is by the connection of a handling pipe section axially to the distributor and lowering the whole assembly into mating seal engagement on the tapered seats and against the thrust shoulder. Then the handling pipe may be removed. This suspends the string in the well and the pump leads are threaded through the flow distributor to connect with suitable electricals and controls, not a part of the present invention. A spherical tank is fitted in sealed relation around the top pipe so that the liquid delivered vertically to the flow distributor is diffused radially through the radial openings in the top pipe and into the tank. The tank is preferably formed from hemispherical shells joined together and sealed against the top pipe to provide a storage tank capacity. It is preferred that the tank is formed from a thermoplastic resin material, as for example, polyvinyl chloride and filled or reinforced to withstand the pressure range anticipated in use and to provide resistance to corrosion or deterioration in exposure to soil conditions. The spherical construction enhances the strength of the tank.

At the phase separation between liquid and compressible gas a membrane in the form of a resilient diaphragm is provided, sealed against the top pipe internally of the tank and sealed within the tank to separate the spherical tank into top and bottom compartments or chambers. The lower chamber receives the liquid such as water and by virtue of a delivering nipple, also dispenses the liquid or water to points of use remote from the tank, as for example, residences or other facilities. A vent tube runs through the diaphragm to the lower chamber selectively allowing removal of the accumulated gas from the water chamber and removing the source for water logging. Pressure gages and pressure switches can also be attached to the vent tube providing a control access to tank conditions. The air (compressed as the tank fills) provides a resilient drive

cushion. This assists in delivery and takes considerable burden off of the system and the pump in particular. The top pipe is closed against the weather and the vent line is normally closed unless it is required to be opened for bleeding air out from under the resilient membrane or separator. The electricals pass upwardly through the flow distributor or director to suitable connection with adequate controls.

The spherical tank is easily and economically constructed and sealed to the top pipe. Then the top pipe and tank are coupled to the well casing and the well string, pump, pipe strainers and valves are dropped axially into the casing until the flow director element seats and seals on the taper shoulder and against the thrust shoulder. This lands and seals the well service structure and the entire installation is complete, except burying the tank and connecting the electrical leads from the pump. If a tendency to water log occurs, bleeding can be accomplished by opening the vent tube and purging collected air from the system. Otherwise, gages and control switches are attached thereto. If difficulties arise in the pump, strainer, foot valve, or the well requires deepening, all of these things can be accomplished by opening the well service structure and axially lifting the entire well string through the top pipe and off of the tapered seats. By virtue of the seal design, the distributor can be repeatedly used or new taper faced rings can be secured peripherally to the distributor plates. The major weight thrust is against the thrust shoulder of the top pipe at the small diameter end of the taper.

IN THE DRAWINGS

FIG. 1 is a partially sectional perspective view of a well service in accord with the present invention and indicating the spherical tank located underground and the top pipe extending above the ground and closed.

FIG. 2 is an enlarged exploded perspective view of the structure as seen in FIG. 1 and indicating the construction of the membrane tank, the top pipe coupled to the well casing and accommodating the flow distributor which is supported in the top pipe and in turn supports the well pipe and pump, strainer and foot valve.

FIG. 3 is a top plan view of the structure of FIG. 2 and indicating the top pipe upon which the spherical tank closes, and the selectively openable vent tube and switch and gage connection.

FIG. 4 is a full cross-section elevation view taken on the line 4—4 of FIG. 3 and expanded slightly to indicate the pump and strainer accommodated and supported by the flow distributor.

FIG. 5 is a top plan view with the seat partially broken away and to indicate the construction of the flow distributor.

FIG. 6 is a full section elevation view taken on the line 6—6 of the FIG. 5 and indicating the simplicity of the distributor, its accommodation for running of electrical lines therethrough and the taper faced seals peripherally provided on the upper and lower closure plates.

SPECIFIC DESCRIPTION

Referring to the drawings and particularly to the FIG. 1 thereof, the earth 11 is cut away to reveal the tank 12 surrounding and secured to the top pipe 13 which extends vertically above and is connected to the well casing 14. The casing 14 is seen to enclose the well pipe 15, the pump 16 (of the submersible type as shown) and the strainer 17 and foot valve not separately shown. A water delivery pipe 18 is indicated which runs from the storage tank 12 to a remote point of water use. A closure 19 closes the upper end of the top pipe 13 and may be removed for access to the well string of well pipe 15, pump 16 and strainer 14 without interfering with the tank 12 which remains buried, for example, below the frost level and remote from the point of ultimate water use, but directly over the well. A vent pipe 20 extends upwardly from the tank 12 and is bracketed by the fixture 21 to the top pipe 13. This, as will be seen, permits bleeding off of air in the tank 12 on the water side and provides a connection for gages and pressure switches (not shown) as desired. The electrical leads from the pump 16 also conveniently exit from the top pipe 13 adjacent the vent bracket fixture 21. The tank 12 is formed as by molding or casting in two hemispheric shells 22 and 23. These are then sealed together in a flange connection 24 and are peripherally sealed to the top pipe 13 at the seal collars 25 and 26. This forms the spherical tank 12 which is made of tough reinforced resin material such as polyvinylchloride which is resistant to deterioration in soil environments and is easily fabricated and glued or welded in integral thermal bonding.

In FIG. 2 the internal construction of the tank 12 in relation to the top pipe 13 and the flow director or distributor element 28 is best understood. The top pipe 13, at its lower end is reduced in size and threaded so that it is axially connectable to the casing 14 by the threaded pipe collar 29 and hence the top pipe 13 is a mere extension of the casing 14. The top pipe 13 expands at the thrust shoulder 30 and then bells outwardly and upwardly in tapered throat portion 31. Intermediate the extremes of the tapered portion 31 are radial openings 32 which open into the tank 12 adjacent the lower end thereof. The flow director 28, connected axially to well pipe 15, is lowered into the top pipe 13 and casing 14 until the upper and lower taper faced casing seals 34 and 35 seat on the tapered portion 31 of the top pipe 13 and the seal 35 is shouldered on the thrust shoulder 30. The electrical lead to the pump 16, attached to the well pipe 15, extends upwardly parallel to the pipe 15 and through the flow director 28 and thence upwardly to the top of the top pipe 13. An outlet 36 allows the leads 33 to pass through the top pipe opening below the closure 19 and adjacent the vent pipe 20. This allows for convenient connection to pressure switch and relay controls as desired.

The hemispheric shells 22 and 23 are closed on each other at the flange 24 and an interlocking male-female connection 37, as between the perimeter edges of the shells 22 and 23, allow an excellent cemented or thermal weld closure of the tank 12 while the flange 24 reinforces the structure. The upper shell 22 is provided with an internal annular seal flange 38 to which is connected the outer periphery of a diaphragm or membrane 39 of neoprene or the like and the resilient diaphragm 39 extends from the internal outer perimeter of the shell 22 to sealed relation as shown on the top pipe 13. The membrane seal 40 is a ring or cuff element retaining the membrane 39 in sealed relation against the outer portion of the top pipe 13 as indicated. The vent tube 20 is also connected and sealed adjacent the cuff or membrane seal 40 as in a thickened portion of the membrane 39 and the tube 20 selectively communi-

cates the pressure condition below the membrane or diaphragm **39** to the atmosphere or to selected gages and pressure switches. As will be appreciated from the FIG. **2**, the diaphragm membrane **39** separates the tank **13** into an upper chamber **41** and lower chamber **42**. Volumetrically, the upper chamber **41** represents about one-third of the internal volume of the tank **13** and the lower chamber **42** represents about two-thirds of the volume. The lower chamber **42** contains water flowed into the chamber **42** through the opening **32** by the pump **16** delivering water upwardly through the pipe **15** to the flow director **28** which radially diffuses the water through the openings **32**. On demand, water is flowed out of the chamber **42** through nipple **43** and into pipe **18** for delivery to a remote point of water use as, for example, a residence.

The diaphragm **39**, accordingly, separates the liquid phase in the chamber **42** from the gas phase in the upper chamber **41**. The flexure or resilience in the membrane **39** allows the entrapped gas in chamber **41** to be compressed and hence to provide a pressure cushion augmentation for water delivery and the vent **20** provides a vehicle for removal of gas entrapped on the liquid phase of the diaphragm **39**. FIG. **3** in top plan view clearly indicates that the internal diameter of the top pipe **13**, beneath the shoulder **30** is approximately the same as the internal diameter of the casing **14** and then the top pipe **13** bells outwardly at the tapered portion **31**. This clearly indicates the facility of insertion of a well string and the facility of removal from the well as may be needed for cleaning, dispersing or repairs.

The FIG. **4** best shows the assembled relationship of all elements with the flow director **28** in seated, sealed and shouldered relation and in support of the well pipe **15**, pump **16** and strainer-foot valve **17** in the casing **14**. The flow director **28** receives the water from the pump **16** axially since it is in flow communication with and attached to the well pipe **15**. However, the upper plate **50** of the flow director **28** diffuses flow radially through the openings **32** and into the tank **12** and more particularly the lower chamber **42** thereof. Water is thus stored in the tank **12** and compresses the gas in the chamber **41** providing a resilient drive cushion but with the liquid and gas phases separated by the diaphragm membrane **39**. Hence, tank **12** and all control details can be located at the well head rather than in a pump house of the like and the tank and delivery pipes are locatable below ground **11** as seen. The structure operates substantially free from water logging and when it is necesssary to bleed the water chamber **42**, this is easily accomplished by opening the vent tube **20** to atmosphere.

In FIGS. **5** and **6** the construction of the simple flow director **28** is clearly revealed. As best seen in FIG. **6** the flow director **28** comprises an upper closure plate **50** and lower closure plate **51**. Both are circular and disc-like except that the upper plate **50** is somewhat larger in diameter than the lower plate **51**. Both of the plates **50** and **51** are held in spaced apart relation by the spacer posts **52**. These are illustrated as spacer tubes **53** seated in recesses **54** and **55** against gaskets **56** and drawn into compression relation by the studs **57**. The lower plate **51** is provided with a control opening therethrough and a collar **58** is extended therethrough and secured as by welding and provided with threads **59** for connection to the well pipe **15**. The upper closure plate **50** has a central tubular boss **60** extending axially upwardly but the tubular boss **60** is closed by the plate **50**. The boss **60** is welded or otherwise affixed to the closure disc **50** and the threads **61** thereon provide selective gripping means so that a pulling device may be coupled to the boss element **60** and the whole assembly including connect well pipe **15**, pump **16** and strainer foot valve **17** with the flow director **28** can be withdrawn axially from the well. One spacer tube **62** is sealed against the gaskets **56** at each end by the compression of the other spacers **52** and is in register with openings **63** and **64** so that the electrical wires **33** may be extended therethrough without interrupting the flow direction seals as best seen in FIG. **4**. In another embodiment the spacer parts **52** may be welded or brazed to the plates **50** and **51** to achieve satisfactory support and seal. A casting may also be the base of the element **28** but was considered more expensive than the described expedients until relatively high production is completed.

Peripherally, the closure plates **50** and **51** are both provided with jacket-like resin seals **65** and **66** respectively which are cast or otherwise provided as shown around the edges of the plates **50** and **51**. The upper seal element **65** is larger in diameter than the lower seal element **66** but in cross section both are U-shaped and both are provided with an outer taper face mating ultimately with the tapered portion **31** in the top pipe or barrel **13**. As will also be appreciated, the lower closure plate **51** is larger in diameter than the internal diameter of the thrust shoulder **30** so that the weight of the well string assembly not only seals the flow director but also the weight is absorbed by the thrust shoulder. This allows the entire string to be selectively removed from the well and from the top of the well. The seals are of neoprene or other resin material such as Teflon (a fluorinated resin compound of I. E. DuPont de Nemours).

OPERATION

Devices in accord with the foregoing invention and disclosure have been extensively tested under typical environmental conditions and using various resin materials and various analogous constructions and performance has been excellent to the point that noise complaints by well water users has been substantially eliminated. The tank appears impervious to usual soil deterioration and the service of wells has been vastly simplified. The burying of the tank and its compact assembled relation makes the units easy to install and maintain. The seals as described herein have done very well in use and the resin character of the tank has made it proof against damage from chance earth movement. The diaphragm construction has substantially avoided water logging and the control accommodations are considered excellent by well drillers and installers. Most importantly, when service is required, the servicing is done at the well head and not within the confines of a home or the like and not in the restricted confines of a well or pump house. A wide variety of submersible pumps have been used satisfactorily. The neoprene diaphragm, based on projections, appear to have a use life beyond the average life existing tank equipment subject to underground installation.

Having thus described my invention and one embodiment thereof, others skilled in the art will shortly perceive obvious improvements, modifications and changes therein and such obvious improvements, modifications and changes are intended to be included here

limited only by the scope of my hereinafter appended claims.

I claim:

1. In a well service structure wherein a flow distributor is located within a top pipe extension of well casing the combination comprising:
- a spherical tank secured to the top pipe and around radial openings through the top pipe;
- diaphragm means for resiliently confining a compressible gas media above liquid in said tank; and
- a connecting nipple through said tank whereby liquid may be drawn from said tank.

2. In the combination as expressed in claim 1 wherein a resilient nonporous diaphragm separates said liquid phase from said gas phase in a relationship of about one-third gas to two-thirds liquid.

3. The combination as expressed in claim 1 and including a selectively usable vent tube from said liquid side of said diaphragm.

4. A well service structure comprising:
- a top pipe connectable to well casing and extending thereabove which includes a tapered portion providing seal seats, the upper part of said tapered portion being of larger size than the lower part of said tapered portion and radial openings through said top pipe intermediate the upper and lower parts of said tapered portion;
- a thrust shoulder adjacent and below the said lower part of said tapered portion;
- a flow director having a pair of tapered faced resin seals insertable axially through said top pipe and closing on said tapered portion and said shoulder above and below said openings and said flow direction connectable to well pipe extending axially below said top pipe;
- a spherical tank surrounding said top pipe and secured thereto and said radial openings communicating the interior of said top pipe isolated by said flow director to the interior of said tank; and
- a resilient diaphragm separating said tank into an upper gas chamber and a lower water chamber.

5. The combination as set out in claim 4 wherein said resilient diaphragm is sealed centrally to said top pipe and sealed peripherally to the interior of said tank.

6. In a well service structure comprising a top pipe extension of well casing having a tapered portion and radial openings therethrough intermediate the ends of said tapered portion seats in spaced apart axial relation above and below said openings, said tapered portion having the upper seat larger than the lower seat, and a spherical resin tank having a phase separating diaphragm surrounding and sealed to the top pipe, the flow director comprising:
- an upper plate closure disc;
- a lower plate closure disc in spaced apart parallel relation to said upper plate, said lower plate having a smaller diameter than said first plate;
- spacers maintaining a spaced parallel interval between and secured to said plates, one of said spacers being hollow and through said upper and lower plates;
- a threaded nipple axially through the lower of said plates;
- a threaded coupling secured to the upper of said plates and extending axially thereabove; and
- a pair of taper faced resin seals molded to the periphery of said upper and lower plates, whereby said seals seat on a mating taper in said top pipe and against a thrust shoulder when said flow distributor is axially secured to well pipe and lowered into well casing.

7. A spherical tank for well service structures which include a flow distributor and a top pipe extension above well casing, comprising:
- a pair of hemispheric shells formed from reinforced resin material, said shells closing on a top pipe and sealed thereto and peripherally connected to each other forming a hollow sphere axially penetrated by said top pipe;
- a resilient diaphragm secured to said top pipe and secured internally to at least one of said hemispheric elements whereby two chambers are formed in said tank by said diaphragm, the upper of said chambers containing gas and the lower of said chambers in communication through said top pipe with liquid;
- a delivery nipple through said tank communicating with the lower of said chambers; and
- a tube through said diaphragm selectively openable and closable to atmosphere whereby gases collecting on said liquid phase side of said membrane may be selectively vented and used for gaging and controlling.

* * * * *