United States Patent [19]

Purtell

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[54] **WATER REGULATOR AND POWER GOVERNOR**

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[52] **U.S. Cl.** **417/34**, 417/53, 417/211.5, 417/279

[51] **Int. Cl.** **F04b 49/04**, F04b 49/00

[58] **Field of Search** 137/202; 417/34, 38, 44, 417/53, 211.5

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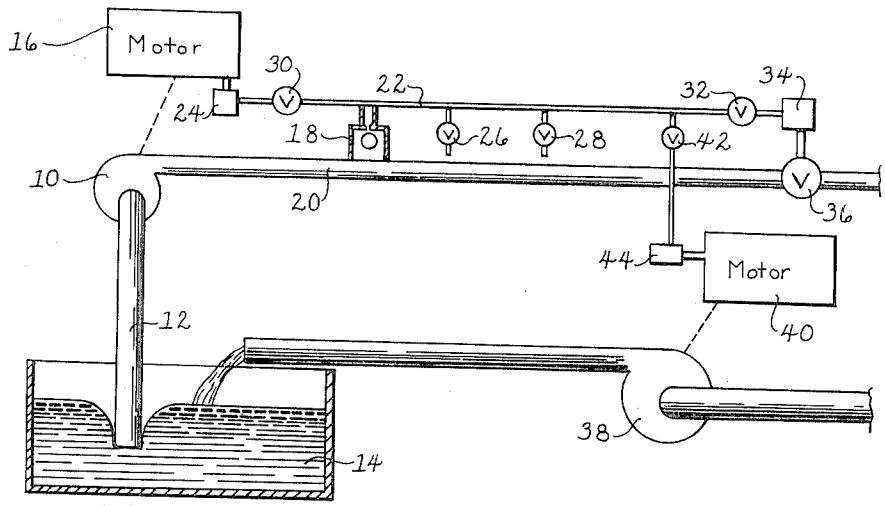
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Attorney, Agent, or Firm—Wendell Coffee

[57] **ABSTRACT**

Equipment detects the first small amount of air which is pumped from a liquid source and uses it for governing the power or liquid flow. This is accomplished by attaching an air separating relief vent to the discharge pipe of the pump. The vented pressurized air is captured and used to activate air driven cylinders which control the water flow or the power source by decreasing the speed of the pump or by choking the outlet of the pump or by increasing the fluid supply to the pump.

12 Claims, 9 Drawing Figures



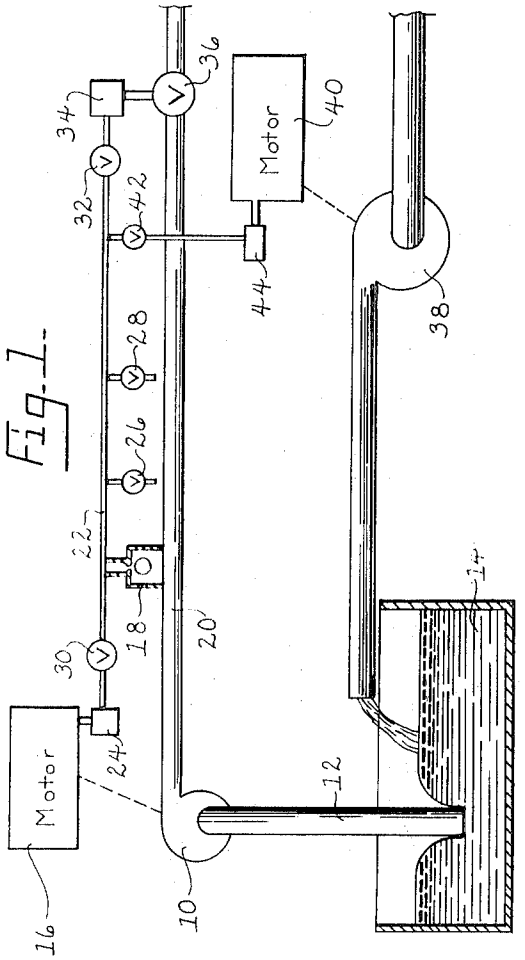

Motor
Motor
10
12
14
16
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Fig. 1

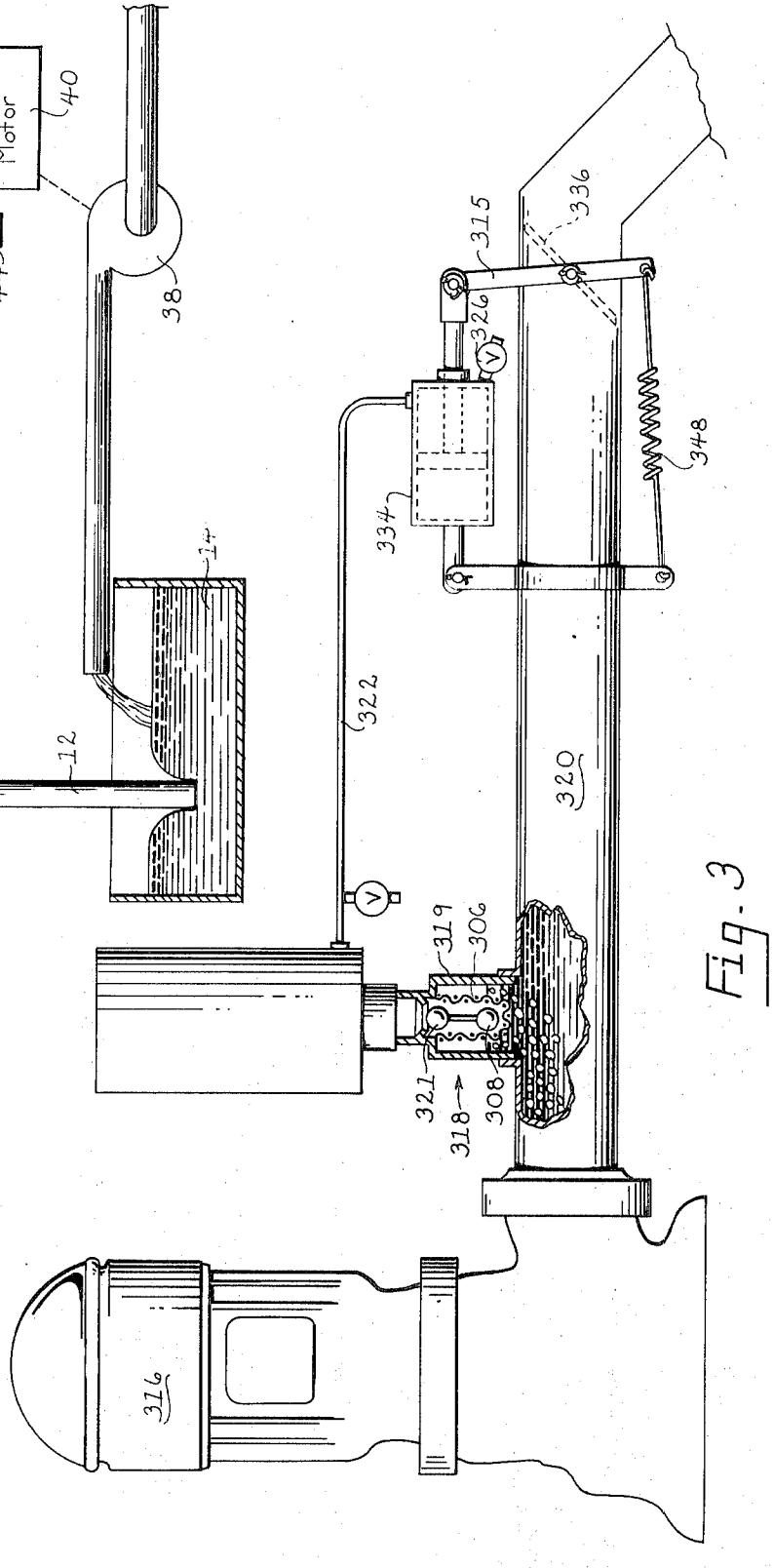

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348

Fig. 3

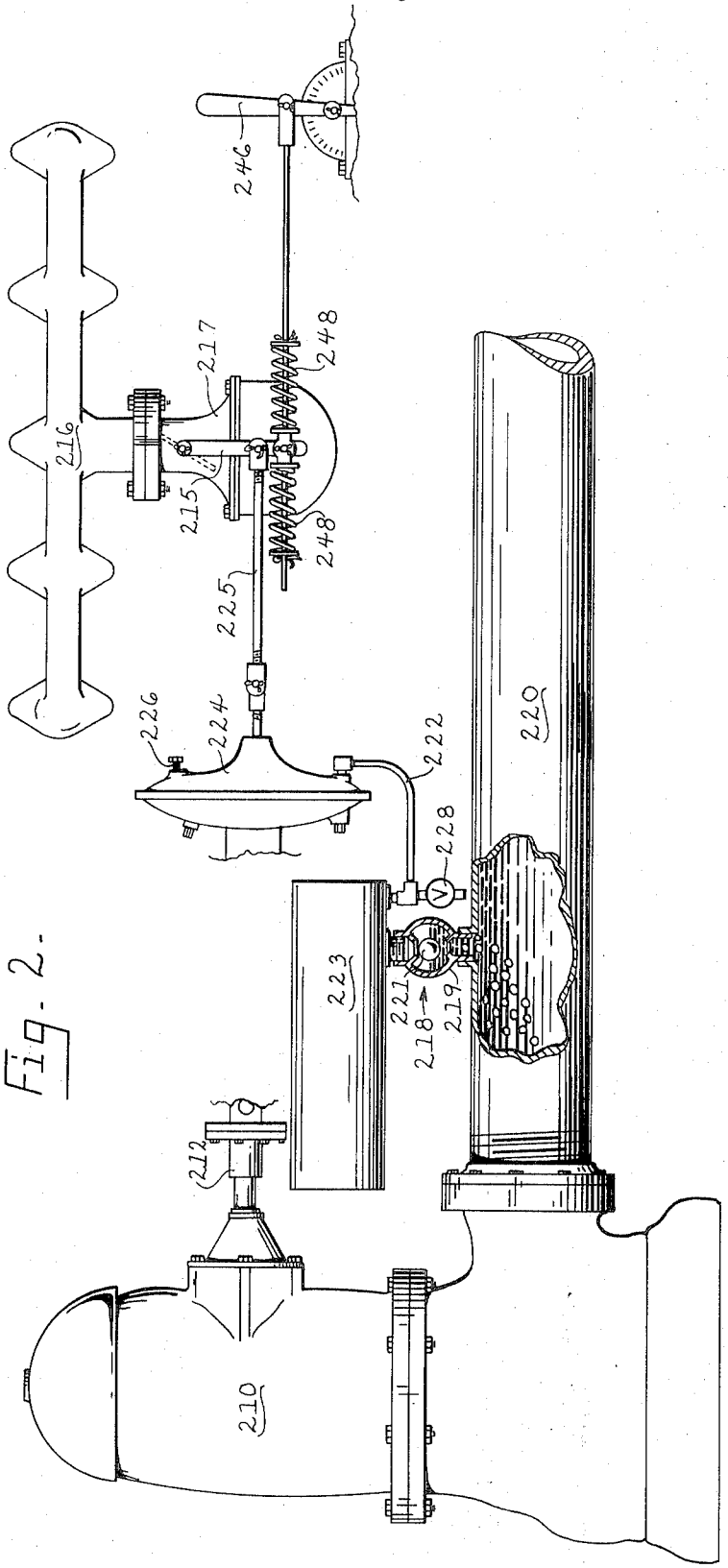

246
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217
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222
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212
210

Fig. 2.

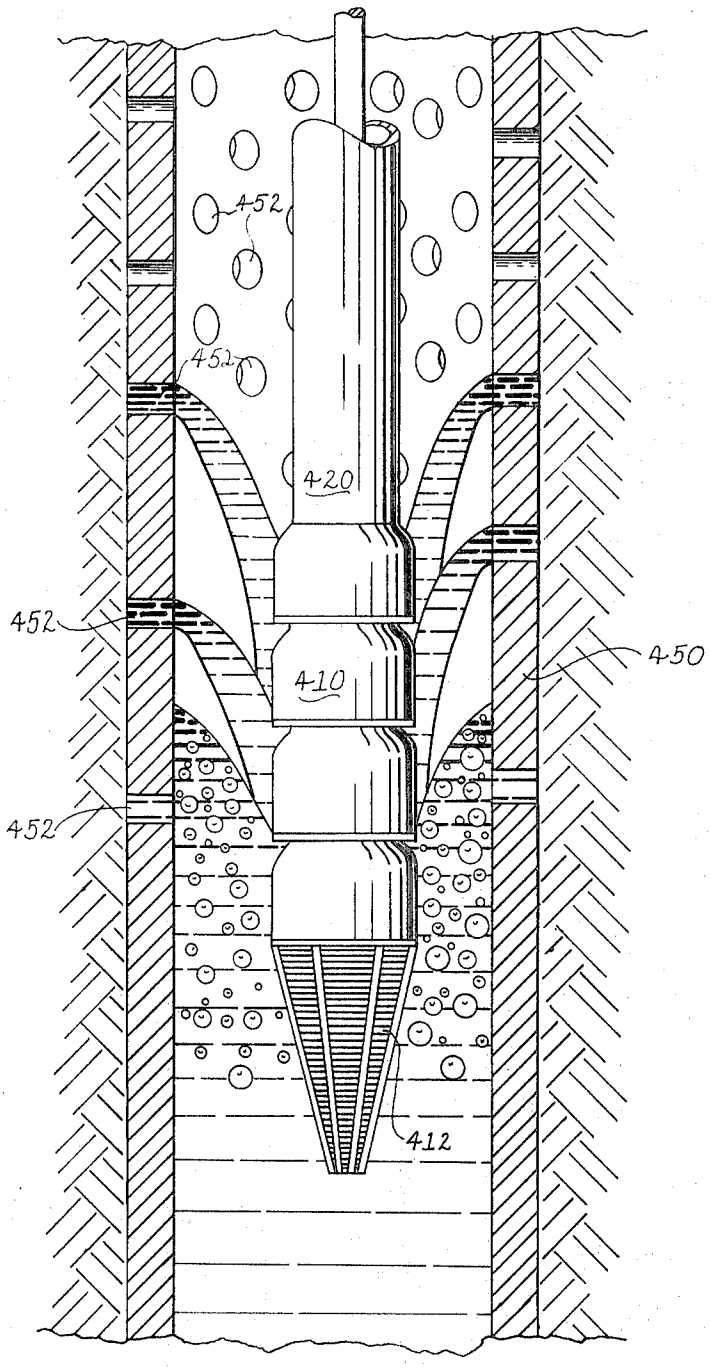


Fig. 4

WATER REGULATOR AND POWER GOVERNOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fluid flow by pumps and more particularly to regulators for liquid pumps.

2. Description of the Prior Art

Problems exist when pumping from confined reservoirs.

Particularly in the field of agricultural irrigation, a problem exists when pumping from underground water sources.

Specifically, when a pump is pumping from an underground water source, often the reservoir is over 100 feet below the surface of the earth. The water flow characteristics of the underground formations result in only a limited flow of water being available. If the pump is operated at a capacity greater than the availability of water, the pump "breaks suction," which means that the inlet of the pump is above the liquid level within the reservoir. When this happens, a slug of air is pumped. Of course, this reduces the load upon the pump. If the pump is being powered by a spark ignition internal combustion engine with conventional throttle control, the motor will race wildly, often causing damage to the motor and the pump. Since most all of the pump bowl bearings are water lubricated, pumping large volumes of air will destroy the bowls.

Various measures have been suggested in the prior art. E.g., the pump could be run with a speed regulating governor. A float valve could be placed in the reservoir and the pump speed adjusted responsive thereto.

In other installations, an electric motor is used. If the pump is pumping more than the water supply, the pump will not race wildly ahead, but will continue to operate, pumping air which will wear out the pump. A common practice means of regulation is to place a choke in the outlet of the pump and to manually increase the choke until the pump only operates to pump the water available. This practice is very hard to do as the supply fluctuates from time to time.

Because a specific example of agricultural irrigation has been used, it does not mean that the invention is so limited. There are other situations where pumps require regulation. One example is pumping water from construction excavations, another is water in basement sumps, or the like.

SUMMARY OF THE INVENTION

New and Different Function

I have solved the problem outlined above by detection of the minimum liquid level permissible above the inlet of the pump by detecting the presence of small amounts of air in the outlet of the pump.

Although it might appear easier to detect the fact that the liquid level is undesirably low at the inlet of the pump by a float at the inlet, the mechanism is such case is more complex. For example, in the case of an irrigation well, the inlet of the pump at the reservoir would be 100 feet below the surface of the earth and the controls would be on the surface of the earth. In the case of draining water from excavation projects, normally, the pumps are portable, receive rough handling by the workmen and the inlet may be in different relationships to the pump.

The mechanism to carry out my invention includes a simple float chamber upon the top of the outlet pipe of the pump which can be rigidly attached thereto in a rugged fashion. A simple air conduit leads to an air pressure motor, which can be rigidly attached to the member it controls. In the case of a spark ignition internal combustion engine, it would be the throttle. Therefore, it is possible to attach a diaphram motor immediately adjacent to the throttle arm. It is emphasized that a connection between the air detection device and the motor is an air conduit and this can be by flexible tubing or otherwise.

Although it is more complicated conceptionally than the float valve, mechanically it is much simpler.

Objects of this Invention

An object of this invention is to regulate a pump system to maintain the liquid level a preset distance above the pump inlet.

Other objects are achieve the above with a device that is sturdy, compact, durable, lightweight, simple, safe, efficient, versatile, and reliable, yet inexpensive and easy to manufacture, install, adjust, and maintain.

Further objects are to achieve the above with a method that is versatile, rapid, efficient, and inexpensive, and does not require skilled people to install, adjust, operate, and maintain.

The specific nature of the invention, as well as other objects, uses, and advantages thereof, will clearly appear from the following description and from the accompanying drawing, the different views of which are not necessarily to the same scale.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic representation of a system according to this invention in generalized application.

FIG. 2 is a side elevational view of an irrigation wellhead as driven by a spark ignition internal combustion engine with parts fragmentarily shown and other parts broken away for clarity.

FIG. 3 is a side elevational view of an agricultural irrigation wellhead as driven by an electric motor with parts broken away for clarity.

FIG. 4 is a vertical sectional schematic representation of the flow of water in a well.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring specifically to FIG. 1, there may be seen a general layout schematically representing the pumping system. Pump **10** has its inlet **12** within reservoir **14.** Motor **16** powers the pump. Air separator or air relief valve **18** is located upon outlet **20** of the pump **10.** If the liquid within the reservoir **14** gets below the minimum level above the inlet **12** of the pump, pressurized air will be exhausted from the air relief valve **18.** The released air is connected by conduit **22** to air pressure motor **24** connected to the motor **16** which is the power source for the pump **10.** By means described later, the air pressure motor will decrease the speed of the power source; therefore, causing the pump **10** to pump less water. If less water is pumped from the reservoir **14,** the liquid level within the reservoir may rise so less air is pumped. Captured air within conduit **22** is gradually discharged or bled off by air bleed valve **26.** Therefore, after the air which was trapped within the conduit because the pump **10** pumped air has had a chance to

equalize and bleed off, the pressure within the conduit **22** is at atmospheric pressure. Then the air pressure motor **24** relaxes, permitting the motor **16** to regain its normal speed. It may be seen that if the speed of the motor and the rate of pumping of the pump **10** were such so the pump pumped a small amount of air at the same rate as the bleed-off valve **26** exhausts it to the atmosphere, a state of equilibrium would exist, allowing maximum water to be pumped and a minimum amount of air.

When the pump **10** is first placed into service, the entire system may be filled with air. As the pump **10** first begins to pump liquid, there will be a large amount of air pumped at that time. It is not desired at that time to slow down the pump **10.** Opening start valve **28** in the conduit **22** prohibits the build up of pressure within the conduit. Thus, the regulator system is inactivated by opening the start valve **28.**

If valve **30** is closed to the air pressure motor **24** leading to the power source **16** and the valve **32** is opened which connects the conduit **22** to air pressure motor **34** attached to choke valve **36,** another method of operation is in effect. In this mode of operation, the fluid flow within the system is regulated by increasing the back pressure upon the pump **10** by closing the valve **36** or choking the outlet **20** of the pump.

Analysis of operation will show that it is quite similar to the previous operation in that when the pump **10** pumps the liquid from the reservoir **14** below the desired level and air is present in the outlet **20,** this air pressure will activate the air pressure motor **34** to close the choke valve **36.** There again, a state of equilibrium is reached when the pump pumps the amount equal to the refill rate in the reservoir.

If the operator has any control at the rate of refill of the reservoir, this control may be utilized to alter the fluid flow within the system. I.e., assuming that the reservoir is being filled by refill pump **38** controlled by reservoir motor **40,** then, if the level of the reservoir drops below the level desired, an increase in speed of the reservoir motor **40** will cause an increase of flow to refill the reservoir. In such a case, the other conduit valves are closed and valve **42** in conduit **22** is opened which is connected to air pressure motor **44** which is connected to reservoir motor **40.** In this instance, the operation is different from the previous instance because in the previous two instances, when the air was detected in the outlet pipe **20,** thus indicating a low level of the reservoir, the fluid flow was decreased. However, in this instance, the fluid flow would be increased by increasing the speed of the motor so there would be an increase in the amount of liquid pumped. In each case, the liquid level in the reservoir is controlled.

Referring to specific embodiments, FIG. **2** shows a specific embodiment as would be used on an irrigation well using an internal combustion engine. The pump itself is not illustrated in FIG. **2** inasmuch as the pump would be located far below the surface of the earth. (See FIG. **4**). However, the pump is driven through gear head **210,** setting upon top of wellhead and the outlet **220** extends therefrom. The gear head is driven by drive shaft **212** leading from power source or motor, which is not shown, but only the manifold **216** and carburetor **217** thereof are shown. The air separator valve **218** is shown to include a simple ball valve which floats and if the air chamber **219** is full of water, the ball **221** floats against its seat; therefore, preventing any air from flowing from it. Air accumulates in the chamber **219** and the air is released through the valve **218** into conduit **222.** Air reservoir tank **223** may be considered as part of the conduit **222.** Start valve **228** is located on the bottom of the reservoir tank so any condensate may be readily exhausted.

The conduit **222** in the form of tubing is connected to diaphram motor **224** which is a form of an air pressure motor and is connected by rod **225** to the throttle arm **215** of the throttle within the carburetor **217.** Air bleed valve **226** is mounted on top of the diaphram motor. I prefer to mount it at a high point. The bleed valve **226** will be set at a very minute opening and at a high point, it will not become clogged with dirt. The advantage of attaching it to a low point is that it would also drain off the condensate. The throttle valve normally is set by manual arm **246** control through compression springs **248.** Therefore, pressure within the diaphram motor **224** will cause it to move to the left as shown in FIG. **2** which will decrease the speed of the motor. When air ceases to be produced by the well and after the valve **226** bleeds off the accumulated pressure within the accumulation tank **223,** the motor will increase in speed and return to normal operation. Also, the speed of response and the speed of recovery can be adjusted by making the accumulation tank **223** larger or smaller. Setting the opening of the bleed valve **226** controls the level of the reservoir.

Referring to FIG. **3,** there may be seen another installation. In this case, the motor is in the form of electric motor **316,** the power source to the pump which also is not shown. (See FIG. **4**). Air chamber **319** is considerably enlarged to form an air accumulator. Air separator valve **318** includes valve ball **321** with float ball **308** suspended vertically under it, all contained within cage **306.** The air pressure motor in this instance is in the form of cylinder **334** with a piston therein. Conduit **322** which connects the air chamber **319** to the motor **334** is of small diameter. Also, the opening from the valve ball **321** to the conduit **322** is of small diameter. Therefore, the operation is smoothed out or adjusted as to responsiveness by the size of the accumulator capacity of chamber **319** and the balance between bleed valve **326** opening upon the motor **334** and the restriction from the chamber **319** to the motor **334.** The output of the motor **334** is connected to arm **315** of choke butterfly valve **336** in outlet **320.** The piston operates against spring **348** on the other end of the arm **315.** Therefore, if the pump pumps air, it will change the fluid flow in the system, decreasing it so there is an increase in the water in the reservoir. I.e., so the liquid will again be above the top of the inlet of the pump, (not shown in FIG. **3**).

FIG. **4** is a representation of the flow of water from underground reservoir into the inlet **412** of pump **410.** The pump outlet **420** is vertically above the pump **410** and would extend vertically upward to a wellhead as shown in both FIGS. **2** and **3.** The pump outlet **420,** pump **410,** and inlet **412,** are all contained within casing **450,** which is perforated as seen at **452.** As illustrated, the water flows through the perforations in a cascade or waterfall-like manner to form a reservoir from which the pump **410** takes its suction. It will be understood that there will be considerable turbulence. Even though the "water level" within the well might be 20 feet above the pump inlet, there will still be considerable entrained air within the water entering into the

pump inlet. Also, it will be understood that as the "water level" lowers, more air will be pumped. There will not be an on-off situation where at one instance absolutely no air will be pumped and at another instance no water will be pumped, but there will be a transitional situation. Therefore, by regulating the air discharged or bled from the conduit, the "water level" in the reservoir can be adjusted or controlled. This phenomenon of a whirlpool of air being entrained into the water, even though the water level of the reservoir is above the pump inlet, will also occur where the water is being pumped from a large reservoir. I have definitely observed air being pumped when the inlet pipe is 2 feet below the surface of a reservoir when the water is being pumped through an inlet 10 inches in diameter at the rate of 1200 gallons per minute.

Thus it may be seen that I have provided a mechanically simple system to regulate fluid flow of a system to insure at all times the liquid in the reservoir is above the inlet of the pump.

The embodiments shown and described above are only exemplary. I do not claim to have invented all the parts, elements or steps described. Various modifications can be made in the construction, material, arrangement, and operation, and still be within the scope of my invention. The limits of the invention and the bounds of the patent protection are measured and defined in the following claims. The restrictive description and drawing of the specific examples above do not point out what an infringement of this patent would be, but are to enable the reader to make and use the invention.

I claim as my invention:

1. In a liquid pumping system including
a. a reservoir, and
b. a pump having
  i. an inlet in the reservoir,
  ii. an outlet and
  iii. a power source for the pump,
c. the improved method of regulating the system comprising the following steps:
d. detecting if the liquid level in the reservoir is near the pump inlet by
e. detecting if there is air in the pumped liquid at the outlet,
f. controlling the level in the reservoir by
g. making partial fluid flow adjustment responsive to said detection, by
h. partially choking the outlet to the pump.

2. In a liquid pumping system including
a. a reservoir, and
b. a pump having
  i. an inlet in the reservoir,
  ii. an outlet and
  iii. a power source for the pump;
c. the improved method of regulating the system comprising the following steps:
d. detecting if the liquid level in the reservoir is near the pump inlet by
e. detecting if there is air in the pumped liquid at the outlet,
f. controlling the level in the reservoir by
g. making partial fluid flow adjustment responsive to said detection,
h. attaching a float chamber to the outlet of the pump thus detecting if there is air in the pumped liquid,
j. connecting the air from the float chamber to an air pressure motor,
k. slowly bleeding air from the connection to the air pressure motor, and
m. utilizing the output of the air pressure motor to make the fluid flow adjustment.

3. In a liquid pumping system including
a. a reservoir,
b. a pump having
  i. an inlet in the reservoir,
  ii. an outlet, and
  iii. a power source for the pump,
c. adjustment means for adjusting fluid flow in the system, and
d. an air separator attached to the outlet;
e. the improved regulator comprising in combination with the above:
f. an air pressure motor,
g. a conduit connecting the air separator to the air pressure motor,
h. a connection from the air pressure motor to said adjustment means, and
j. start means attached to the regulator for inactivating the regulator during periods of abnormal operation such as starting.

4. The invention as defined in claim **3** wherein said start means is
j. a vent valve in said conduit.

5. In a liquid pumping system including
a. a reservoir, and
b. a pump having
  i. an inlet in the reservoir,
  ii. an outlet and
  iii. a power source for the pump;
c. the improved method of regulating the system comprising the following steps:
d. detecting if the liquid level in the reservoir is near the pump inlet by
e. by detecting if there is air in the pumped liquid at the outlet,
f. controlling the level in the reservoir by
g. making partial fluid flow adjustment responsive to said detection,
h. capturing the air detected in the outlet,
j. discharging a portion of the captured air, and
k. using the retained captured air to perform said control steps.

6. The invention as defined in claim **5** with additional limitations of
m. controlling the level in the reservoir by
n. adjusting the rate of discharge of the captured air.

7. The invention as defined in claim **6** wherein said control is by
o. decreasing the speed of the power source of the pump.

8. The invention as defined in claim **6** wherein said control is by
o. choking the outlet to the pump.

9. In a liquid pumping system including
a. a reservoir,
a pump having
  i. an inlet in the reservoir,
  ii. an outlet, and
  iii. a power source for the pump,
c. adjustment means for adjusting fluid flow in the system, and

d. an air separator attached to the outlet;
e. the improved regulator comprising in combination with the above:
f. an air pressure motor,
g. a conduit connecting the air separator to the air pressure motor,
h. a connection from the air pressure motor to said adjustment means, and
j. an air accumulator in the conduit.

10. The invention as defined in claim **9** with an additional limitation of

j. an adjustable air bleed in the conduit.

11. The invention as defined in claim **10** with an additional limitation of

m. start means attached to the regulator for activating the regulator during periods of abnormal operation such as starting.

12. The invention as defined in claim **11** wherein said start means is

n. a vent valve in said conduit.

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