

[72] Inventor **Trajan Nitescu**
723 Riverdale Ave., Calgary, Alberta,
Canada
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 [33] **Canada**
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 now Pat. No. 3,377,867.

[50] Field of Search..... 137/117, 9;
 251/61, 61.2, 26, 122, 63.4, 61.1; 138/46

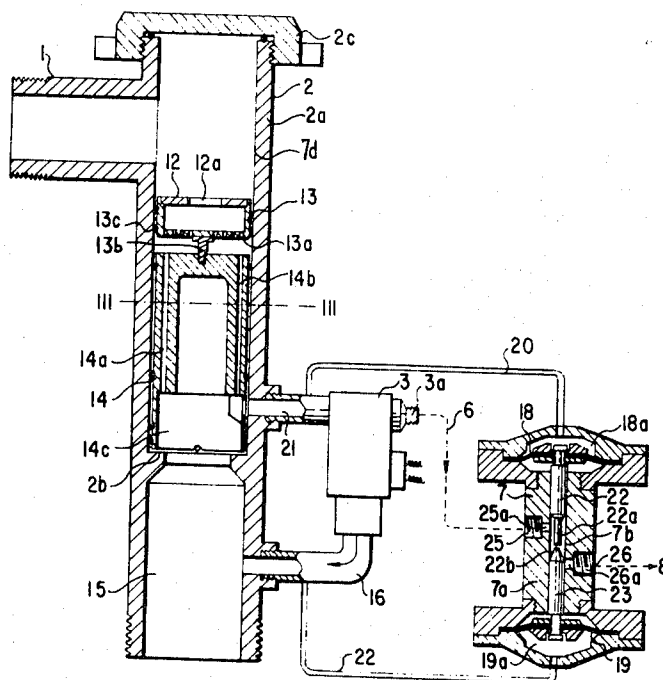
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Primary Examiner—William F. O'Dea
Assistant Examiner—Howard M. Cohn
Attorney—Cushman, Darby and Cushman

[54] **AUTOMATIC SAMPLER**
5 Claims, 9 Drawing Figs.

[52] U.S. Cl..... 137/117,
 251/61.2, 251/122
 [51] Int. Cl..... G05d 11/03,
 F16k 31/145

ABSTRACT: A fluid pressure regulator for equalizing the pressure on both sides of a bleeder point including a pressure sensitive diaphragm which is connected to the upstream end of the bleeder point. Also included is an oppositely activating pressure sensitive diaphragm connected to the downstream end of the bleeder point. Between these diaphragms there is a bleeder channel, the degree of aperture of which is related to the pressure differential between the diaphragms.



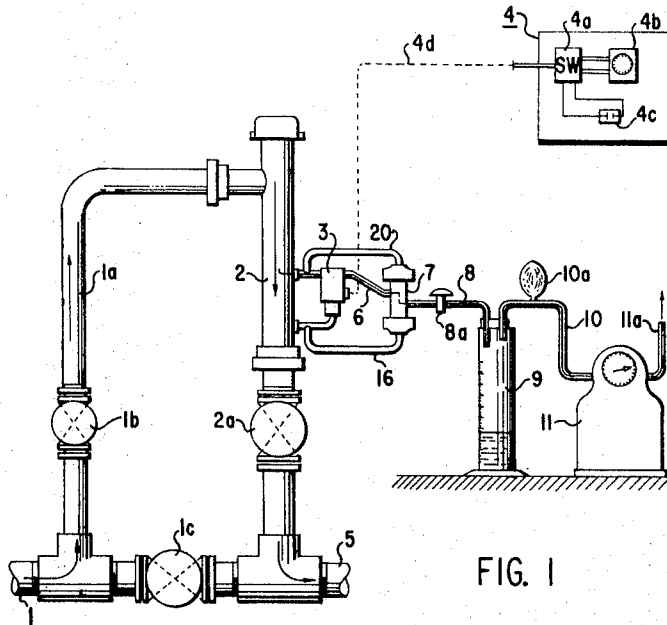


FIG. 1

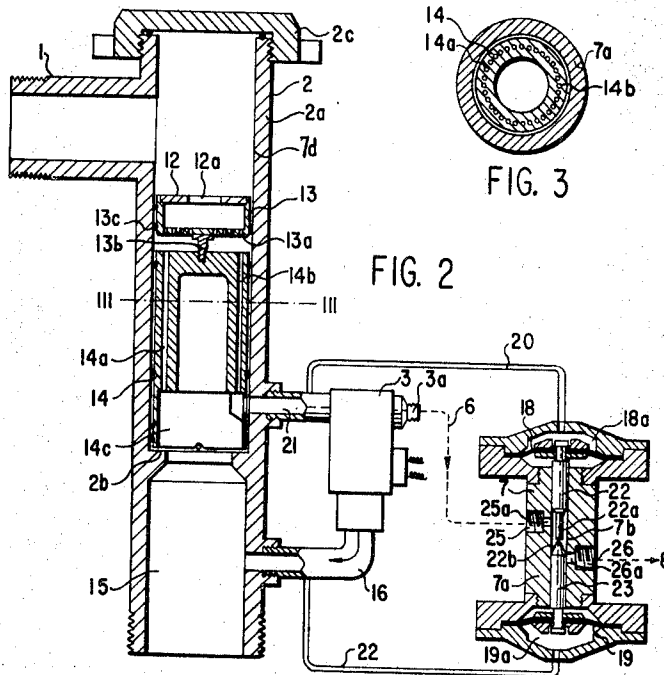


FIG. 2

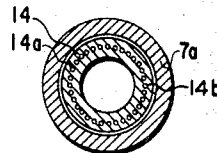


FIG. 3

INVENTOR
TRAJAN NITESCU

By
Cushman, Wakefield & Cushman
ATTORNEYS

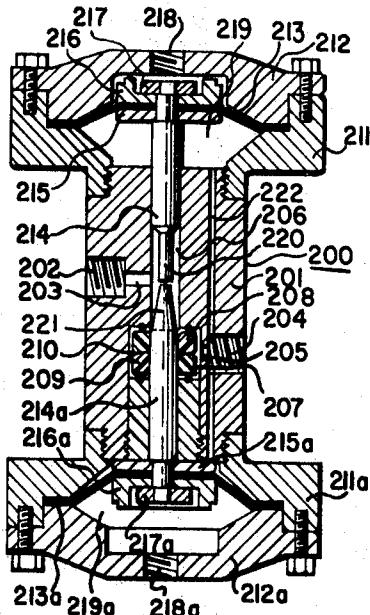


FIG. 4

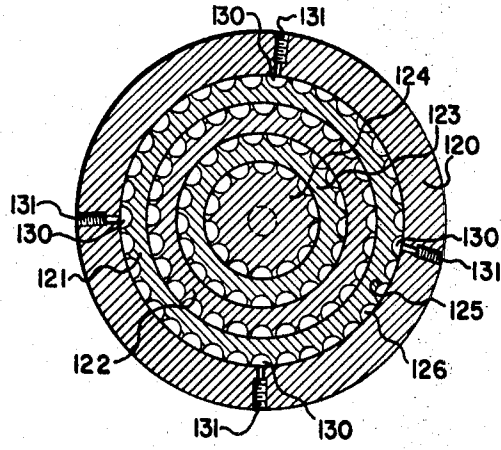


FIG. 6

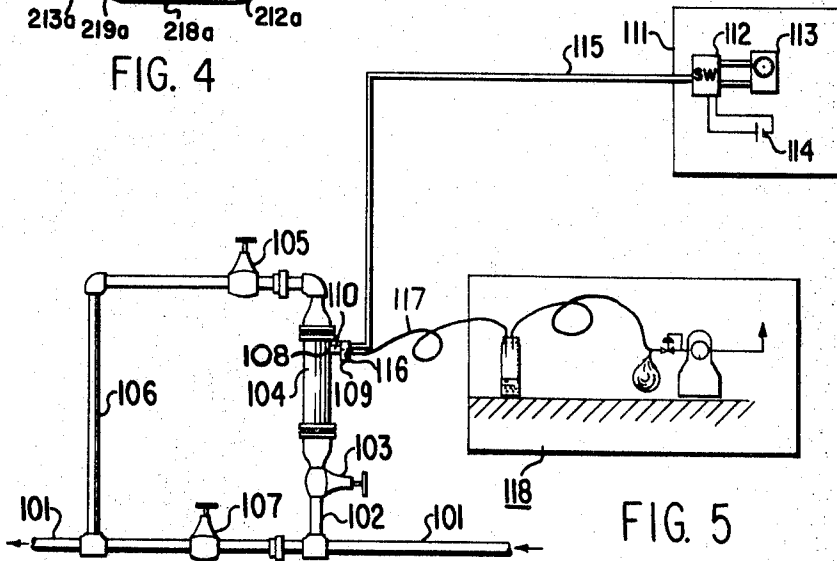


FIG. 5

INVENTOR
IRAJAN NITESCU

By
Cushman, Kistner & Cushman
ATTORNEYS

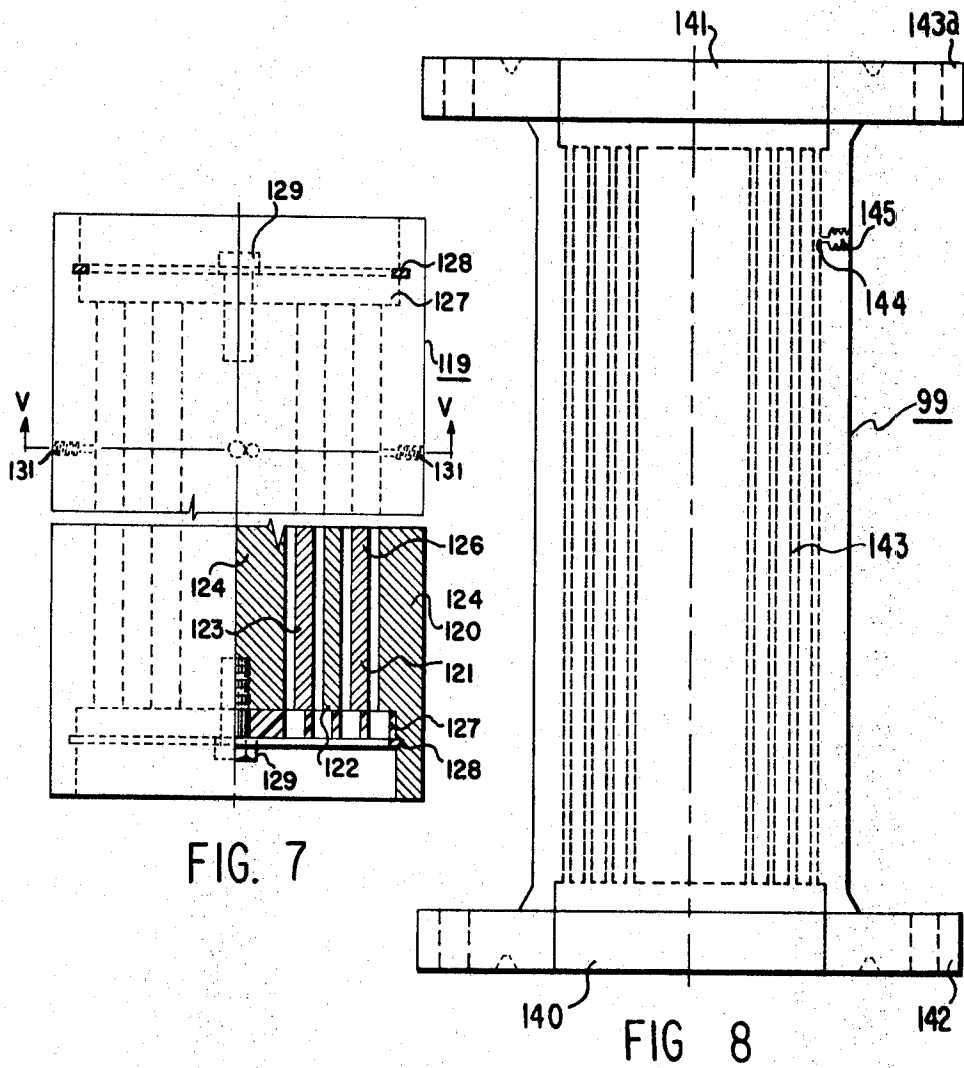


FIG. 7

FIG 8

INVENTOR
TRAIAN NITESCU

By
Cushman, Rosky & Cushman
ATTORNEYS

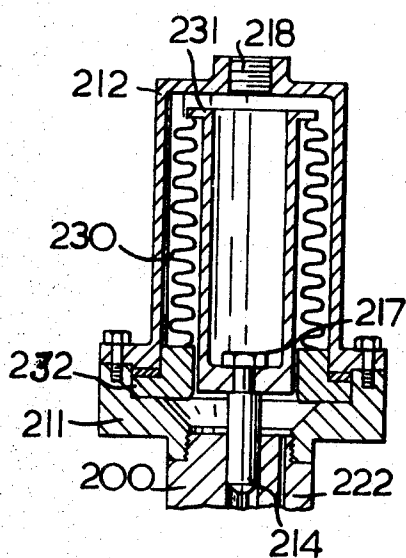


FIG. 9

INVENTOR
TRAJAN NITESCU

BY
Cushman, Quiley & Cushman
ATTORNEYS

AUTOMATIC SAMPLER

This application is a division of copending application, Ser. No. 434,882 filed February 24, 1965, now Pat. No. 3,377,867.

This invention relates to an automatic sampling device for a multiphase non-homogeneous fluid. more particularly it relates to an automatic device for determining the gas-liquid ratio in a multiphase fluid from producing oil wells.

At present, the oil and associated gas produced from a well is usually directed to a separator where the water, oil and gas are separated, measured independently and then directed to an oil storage center.

It is an object of one aspect of the present invention to determine the gas-liquid ratio of a single producing oil well connected in a gathering system of producing oil wells.

It is an object of another aspect of the present invention to provide an automatic sampling device which will determine the gas-liquid ratios of a composite of periodic samples.

By a broad aspect of the invention there is provided an automatic sampling device for use with a pipe line comprising: a flow divider having inlet means adapted to be connected to said pipe line and outlet means adapted to be connected to said pipe line downstream of the inlet connection, said flow divider consisting of a plurality of channels one of which may be connected to a measuring means by means of a valve; said valve being capable of being actuated by a conventional timing system for the regular periodic sampling of the effluent of said flow channel and a conventional sample measuring means. Preferably, this broad aspect of the invention also includes a pressure stabilizing means for equalizing the flow within the channels of the said flow divider.

By another aspect of the present invention, there is provided a process for determining the liquid-gas ratio of the effluent flowing through a pipe line, comprising: dividing the said effluent into a plurality of substantially identical channels, regularly intermittently sampling the effluent of one of the said channels, preferably by taking, during each sample interval, a volume less than the volume of said channel and measuring the liquid-gas ratio thereof. Preferably, also, this process includes the step of equalizing the flow pressure throughout all of the said channels.

By yet another aspect, there is provided a fluid pressure regulator for equalizing the pressure on both sides of a bleeder point which comprises: a pressure sensitive diaphragm connected to the upstream end of the said bleeder point, an oppositely activating pressure sensitive diaphragm connected to the downstream end of the said bleeder point and a bleeder channel therebetween; the degree of aperture of the said bleeder channel being related to the pressure differential between the two said diaphragms.

In the accompanying drawings:

FIG. 1 is a side, partially diagrammatic view of one embodiment of the sampler connected to an oil well line;

FIG. 2 is a longitudinal cross section elevation of the flow divider and zero differential flow controller and a diagrammatic view of the valve means;

FIG. 3 is a plane cross section of the flow divider along the line III-III of FIG. 2;

FIG. 4 is a central longitudinal sectional view of another embodiment of the zero differential flow controller of the present invention;

FIG. 5 is a side partially diagrammatic view of another embodiment of the present invention;

FIG. 6 is a cross section of the flow divider used in the embodiment of the present sampler shown in FIG. 4;

FIG. 7 is a central longitudinal section, partly in broken lines, of the channel divider block of FIG. 6;

FIG. 8 is a central longitudinal section of another channel divider block used in the present invention; and

FIG. 9 is a longitudinal cross section of one end of an alternative embodiment of the zero differential flow controller.

FIG. 1 shows an embodiment of the automatic sampling device in diagrammatic form connected to an oil well line. A bypass line 1a from line 1 from the oil well line (not shown) is connected, via valve 1b to a flow divider 2 having a plurality of

substantially identical channels. The downstream end of the flow divider is connected via valve 2a to outlet flow pipe 5 which may in turn be connected to a common oil gathering system (not shown). A valve means 3 such as a solenoid three-way valve capable of being actuated by a timing circuit shown at 4 (and including a switch 4a, a time controller 4b and a battery 4c and electrical lines 4d leading to solenoid valve 3) is connected to one of the channels of the flow divider 2. A bleeder line 6 from valve means 3 is connected to the zero differential flow controller 7. Line 8 from the outlet end of flow controller 7 is connected, preferably through a back pressure regulator 8a to a graduated cylinder 9 which in turn has a gas outlet 10, provided with a rubber expansion bag 10a connected to a gas meter 11, which is vented at 11a.

The flow divider 2 and zero differential flow controller 7 are shown in detail in FIG. 2. The by pass line 1 leads into the flow divider 2 which comprises a generally cylindrical member 2a provided with internal means for divided flow. These means include an orifice plate 12 provided with a central orifice 12a, mounted on a screen box 13, provided with screen apertures 13a and secured to a downwardly depending screw 13b. Screen box 13 is provided with circumferential O-rings 13c to provide sealing connection with the inner walls of cylindrical member 7a.

Resting on ledge 2b on the inner wall of cylindrical member 7a is a channel block 14. Channel block 14 is provided with a plurality of channels 14a which are identical in dimension and set in a substantially circular pattern, as can be seen with reference to FIG. 3. All of channels 14a except one are directly connected through header 14c to exit line 15 which leads to outlet flow pipe 5 shown in FIG. 1. One channel 14b is connected to exit 15 by valve inlet line 21 and valve outlet line 16 through valve means 3. When valve means 3 is actuated however, valve inlet line 21 is connected to bleeder line 6 shown schematically in FIG. 2, which leads to the zero differential flow controller 7. Cylindrical member 2 is provided with a top cap 2c.

The zero differential flow controller 7 shown in FIGS. 1 and 2 consists of a main body 7a provided with a longitudinal chamber 7b having two identical enlarged opposed end diaphragm chambers 18a and 19a provided with diaphragms 18 and 19 respectively. Main body 7a is provided with a radial inlet port 25, provided with a reduced inlet channel 25a, and radial outlet port 26 leading from an outlet channel 26a. Outlet port 3a of solenoid valve 3 is connected, via bleeder line 6 to inlet port 25. Diaphragm 18 is connected by pressure line 20 to valve inlet line 21. Diaphragm 19 is similarly connected by pressure line 22 to valve outlet line 16. Two metering rods 22 and 23, connected to diaphragms 18 and 19 respectively and provided with reduced diameter tips 22a and 22b respectively are pressed together in narrow butt-to-butt engagement and are slidably fitted in the longitudinal channel 7b by the pressure of their respective diaphragms 18 and 19. The pressure differential between diaphragms 18 and 19 will determine the position of the metering rods within the channel 7a. The position which the metering rods so assume determines the size of the flow channel between inlet channel 25a and outlet channel 26a through longitudinal channel 7a, i.e., between bleeder inlet port 25 and outlet port 26.

The operation of the embodiment of the automatic sampling device of FIGS. 1, 2 and 3 will now be described. The output from a typical well is diverted through bypass line 1a by means of opening cutoff valve 1b closing cutoff valve 1c and passed through flow divider 2. The pipe line effluent flows through aperture 12, for proper mixing and into screening means 13 for filtration of solid elements. The flow is then divided into a large number of streams by means of channels 14a. The oil and gas effluent then continues into exit 15 and then to outlet flow pipe 5. The stream flowing through channel 14b normally travels through valve inlet line 21 through valve 3 and out valve outlet line 16 to join the remaining well output at exit 15. When the valve means 3 is actuated however, the effluent of channel 14b is diverted from valve inlet 21 through

valve outlet 3a to bleeder line 6 which directs the well sample to the inlet of zero differential flow controller 7. The sample is then passed through outlet port 26 to a conventional liquid and gas measuring means, such as graduated cylinder 9 and gas meter 11, and is then vented at 11a.

The purpose of the zero differential flow controller is to nullify any pressure differential between the valve inlet line 21 and the exit 15. In this way, the flow through channel 14a will be identical to the flows of the other channels 14a. For example, if the pressure in line 20 and on diaphragm 18 tends to decrease below the pressure in line 22 and on diaphragm 19, the flow channel between inlet port 25 to outlet port 26 will be restricted in size and thus, the flow will decrease. By decreasing this flow, the pressure on diaphragm 18, which is, in fact, the pressure in channel 14b is automatically increased, because of the increased back pressure in line 6. Similarly if the pressure on diaphragm 18 is above the pressure on diaphragm 19, the downward pressure on metering rod 22 will enlarge the passage between inlet port 25 and outlet port 26, thus increasing the rate of flow of the sample and equalizing the flow through channel 14b with the flow through all the other channels 14a.

To reflect accurately the pressure at the channel 14b exit point and the pressures at exit points of the other channels, it is important to have lines 21 and 16 provided with much larger sections than those of channel 14a and 14b. For sampling effluents under very high pressures, it is preferable to install a back pressure regulator, such as 8a between outlet port 26 and the graduated cylinder 9 where the samples are collected.

With the use of a conventional time controller 4b the automatic sampling device of the present invention can be set either to take a reduced number of minute samples or hundreds of such samples during a 24 hour period. The number of samples to be taken depends on the homogeneity of the effluent to be sampled. For an oil producing well, it is preferred to take from 50 to 500 samples per day, each one of a few seconds duration. The total amount of these collected samples may represent only one five-thousandth of the total effluent sampled. Taking as an example a well producing 100 barrels per day, it will be necessary during a 24 hour period to take a composite sample measuring in the aggregate less than one gallon.

FIG. 4 shows another embodiment of the zero differential flow control of the present invention. The zero differential flow control 200 comprises a main cylindrical body portion 201 provided with a central longitudinal bore 206, a radial inlet port 202 and inlet channel 203 leading to bore 206, and a longitudinally offset radial outlet channel 205 leading from bore 206 to outlet port 204. Bore 206 is provided with an enlarged chamber 207, adjacent outlet channel 205. Within chamber 207 is an upper sealing element 208 and a lower sealing element 209, with a flow channel 210 therebetween.

Secured to the upper portion of body 201 is an upper flange plate 211, to which is secured an upper cover plate 212. Upper cover plate 212 also anchors the peripheral edge of diaphragm 213. Diaphragm 213 is secured to upper rod 214 by means of lower washer 215, upper ring 216 and nut 217. Cover plate 212 is provided with aperture 218 which is adapted to be connected to the pressure line 20 (see FIG. 1). Thus there is provided a pressure chamber 219 on which is acting the pressure on the inlet 218.

A similar arrangement is provided at the lower end of body 201, lower flange plate 211a, lower cover plate 212a, diaphragm 213a, lower rod 214a, washer 215a, ring 216a, nut 217a, inlet 218a and pressure chamber 219a. Again, the pressure in the chamber 219a is equal with the pressure acting through inlet 218a which is adapted to be connected to pressure line 16 (see FIG. 1). Rod 214 is provided with a terminal portion of uniformly reduced diameter 220 while lower rod 214a is provided with a terminal portion 221 of conical configuration. Portion 220 abuts portion 221.

As shown in FIG. 4 the pressure acting through inlet 218a is greater than the pressure acting through inlet 218. This causes

rod 214a to be moved upwardly to such an extent that there is no flow of fluid between bore 206 and chamber 207. As the pressure acting through inlet 218 increases rod 214 moves downwardly, thereby permitting fluid to flow from bore 206 to chamber 207. This then allows fluid to flow from inlet 202 to outlet 204. The connecting channel 222 is provided for the equalization of the pressures on the back side of the diaphragms 213 and 213a.

It is necessary that the pressure acting through inlets 218 and 218a be the same. If the pressure acting through inlet 218 should tend to decrease below the pressure acting through inlet, 218a, the flow of liquid from inlet 202 to outlet 204 is decreased. Conversely, if the pressure acting through inlet 218 tends to increase above the pressure acting through inlet, 218a, the flow from inlet 202 to outlet 204 tends to increase.

AS shown in FIG. 9, diaphragm 213 may be replaced with bellows 230 mounted between a cylindrical tube 231 which is held on rod 214 by nut 217, and a clamping piece 232 firmly held between cover plate 212 and flange plate 211. Similarly, diaphragm 213a may be replaced by a bellows (not shown).

Another embodiment of the present invention can be seen with reference to FIG. 5.

The inflow from a well (not shown) via line 101 is connected to a by pass line 102 and through valve 103 to a sampler 104. The effluent from sampler 104 is connected via valve 105 and outlet line 106 to main line 101. Main line 101 is also provided with a cut off valve 107.

Sample withdrawal port 108 is connected to solenoid valve 109 by a line 110. Solenoid valve 109 is actuated by automatic timing circuit 111, consisting of switch 112, time controller 113 and battery 114, and connected to solenoid valve 109 by electrical lines 115. The outlet port 116 of solenoid valve 109 is connected via line 117 to a conventional sample collecting and measuring equipment 118, which has already been described with reference to FIG. 1 and will not be described again.

The sampler 104 may have an internal construction as shown in FIG. 2 and 3. Alternatively, the construction of the channel divider block 99 may be as shown in the embodiment of FIGS. 6 and 7 or the embodiment of FIG. 8. As shown in FIGS. 6 and 7, for example, the channel block 119 of the flow divider 27 consists of a main outer pipe 120 and a plurality of concentric pipes 121, 122, 123 and plug 124. The pipes 121, 122, 123 and plug 124 are provided with external flutes 125 running longitudinally along the outside of the pipes to provide a plurality of channels 126 between the adjacent pipes. The pipes 121, 122, and 123 and plug 124 are mounted within tube 120 by means of upper and lower perforated plates 127, whose perforations are in tandem with channels 126, and a snap ring 128 holding plate 127 in place. Plate 127 is secured to plug 124 by bolt 129. Turbulence may be created upstream of the flow divider through enlargement in the pipe diameter (as shown in FIG. 4) or by insertion of an orifice screen box and orifice plate, as shown in FIG. 1. Four of the outer channels 130 of the channel divider block 99 are tapped at 131 to provide four alternative withdrawal ports 108. Only one of such ports 108 is connected to line 110, the other three being normally plugged. Port 108 is normally closed by valve means 109 except during the sample interval.

An alternative construction of the channel divider block is shown in FIG. 8. Here, the block is provided with an inlet header chamber 140 and an outlet header chamber 141. The block 99 is provided with a flange 142 to permit it to be connected to an inlet line, and a flange 143 to permit it to be connected to an outlet line. The channels 143 are provided in concentric circumferential pattern by drilling channels in the block 99. One of the external channels 144 is provided with a tapped radial aperture 145 to permit it to be connected to line 110.

When the automatic timing circuit 111 is actuated, the valve means 109 is opened for a predetermined length of time so that the quantity of flowing effluent admitted to the graduated cylinder is less than the volume of one of the channels

126, 143. The flow within all the channels of the flow divider is equalized by means of an enlargement of the pipe diameter on each side of the sampler 104.

With the present invention oil-producing wells can now be equipped with a meter installed for continuous measuring of the weight of the total effluent and a sampler of the present invention for determining the gas-liquid ratio of the effluent. By knowing the gas-liquid ratio and the specific gravity of the gas, oil and water components it is possible to calculate the amount of oil, gas and water produced at a certain well. In this manner, a large number of wells may be connected to a single gathering system without requiring an intermediate separating tank. The total effluent can then be directed to a central point where the entire production from the large number of wells can be separated into oil, gas and water components and subsequently used in any desired manner.

I claim:

1. A fluid pressure regulator for maintaining the fluid pressure in a bleedoff line from a main line at the same value as the fluid pressure in said main line at a point downstream of said bleedoff line, said regulator comprising: a housing having a pair of spaced chambers each accommodating a pressure actuable member, one of said members being actuable by fluid pressure in said bleedoff line and the other said member being actuable by fluid pressure in said main line downstream of said bleed off line; a bore connecting said chambers; a fluid inlet extending into said bore and adapted to be connected to said bleedoff line; a fluid outlet extending into said bore at a point

spaced longitudinally along said bore from said inlet; a shaped rod member connected to each of said pressure actuable members and slidable under the action of its associated member in said bore whereby to provide a chamber of varying volume in said bore between said inlet and said outlet; the ends of said rod shaped members abutting in said bore adjacent said fluid inlet, whereby rate of fluid entry to said chamber may be controlled; and a pair of sealing elements adjacent said fluid outlet, axially disposed around said rod shaped member adjacent said fluid outlet, and provided with a flow path therebetween whereby rate of exit of fluid from said chamber through said flow path and said fluid outlet is metered.

2. A fluid pressure regulator as claimed in claim 1 wherein said pressure actuable members comprise pressure diaphragms.

3. A fluid pressure regulator as claimed in claim 1 wherein said pressure actuable members comprise bellows means.

4. A fluid pressure regulator as claimed in claim 1 wherein said rod means comprises a pair of rods abutting at their ends remote from the pressure actuable means, said remote ends having shaped reduced dimensions.

5. A fluid pressure regulator as claimed in claim 4 wherein said remote end adjacent said fluid outlet has a conical shape and the remote end adjacent said fluid inlet has a uniformly reduced cylindrical shape.

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