March 5, 1968 J. D. FANN 3,371,786

FILTER PRESS

Filed Feb. 1, 1965

Fig. 1

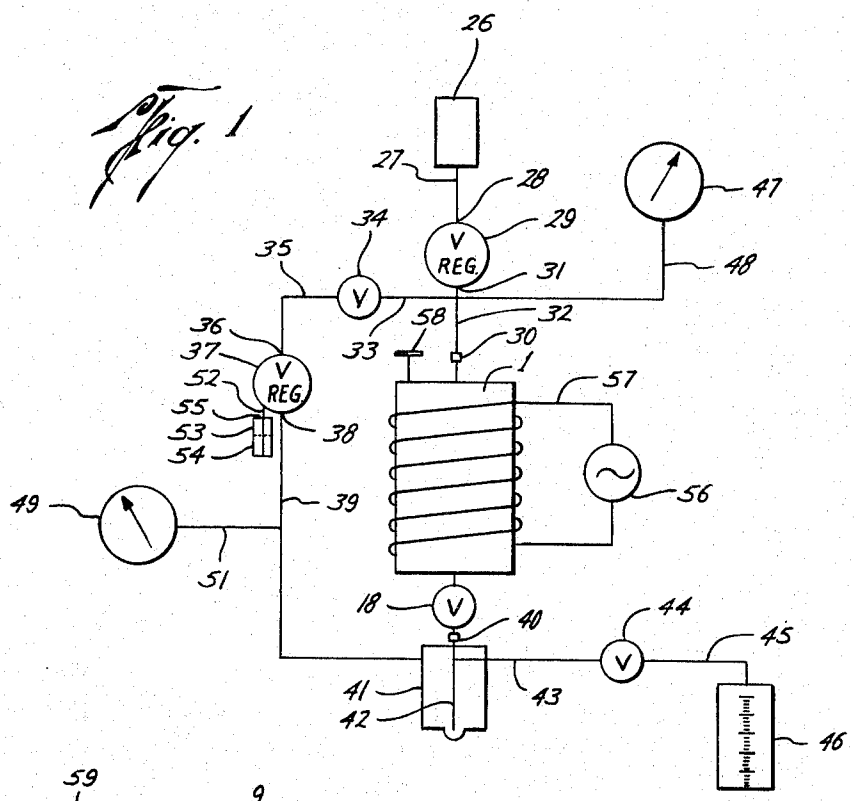


Fig. 2

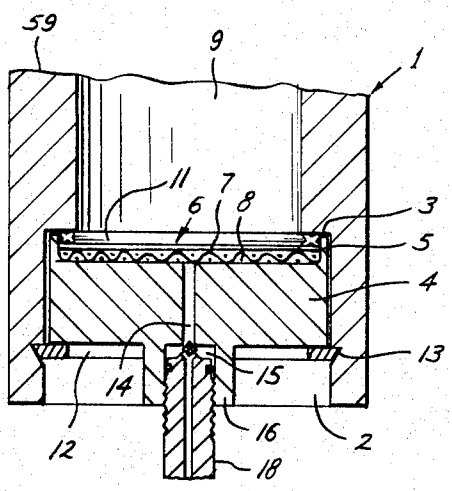
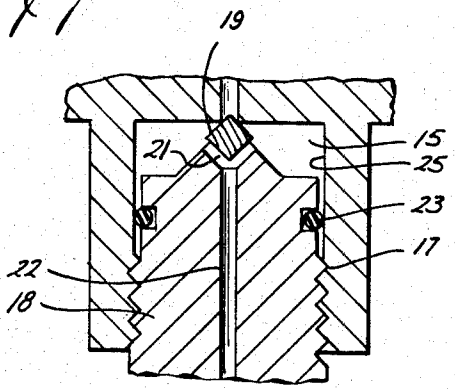


Fig. 3



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United States Patent Office 3,371,786
Patented Mar. 5, 1968

3,371,786

FILTER PRESS

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Filed Feb. 1, 1965, Ser. No. 429,397
6 Claims. (Cl. 210—90)

ABSTRACT OF THE DISCLOSURE

The disclosure is of filtration apparatus having pressure differential generating systems wherein both the filtration driving pressure and the back pressure are controlled. The back pressure is always maintained lower than the filtration driving pressure, and the back pressure is controlled against becoming excessive, so that the filtrate receiver assembly is protected against being subjected to excessive pressures.

Various liquids containing suspended solids, such as drill muds used in oil and gas well boreholes, are tested by filtration to predict their behavior characteristics under operating conditions. In the testing of drill muds, for example, filtration is preferably conducted under differential pressure conditions to simulate as closely as possible pressure conditions in a borehole where the fluid may be used. One method employed to remove solids from a liquid under differential pressure conditions involves placing a test specimen of the liquid in a container which is provided with a filter medium. The filter medium communicates with a filtrate line through which a liquid after removal of solids may be discharged from the container. A pressure source is connected through an adjustable constant pressure discharge regulator to the container for generating a head pressure on the liquid, a head pressure being a pressure which tends to force the liquid containing suspended solids through the filter medium. A second pressure source is connected through a second adjustable constant pressure discharge regulator to the filtrate discharge line for creating a back pressure on the liquid, a back pressure being one which tends to oppose movement of the liquid through the filter medium. Frequently, however, in the testing of a liquid containing suspended solids, a back pressure will be applied to the liquid which is greater than the head pressure due to maladjustment of the back pressure regulator, causing the liquid to be discharged out of the container into the head pressure regulator. Discharge of liquid into a head pressure regulator can both render the regulator inoperable and cause data from tests being run to be inaccurate.

Additionally, receptacles for receiving filtrate from the container are generally subject to the back pressure of the apparatus and glass or plastic level gauges generally employed with these receptacles can be shattered due to maladjustments of the back pressure resulting in injuries to operating personnel.

Typical prior art apparatus for testing of various materials are illustrated by the following United States Letters Patent:

F. B. Lomax, 2,089,702, Aug. 10, 1937; E. M. Brunner et al., 2,437,935, Mar. 16, 1948; P. L. Boucher et al., 2,599,742, June 10, 1952; M. B. Standing et al., 2,646,678, June 28, 1953; H. L. Twining, 2,733,595, Feb. 7, 1956; K. T. Norell, 2,909,286, Oct. 20, 1959; J. P. Gallus, 3,055,208, Sept. 25, 1962; H. H. Ferrell et al., 3,139,747, July 7, 1964.

The apparatus herein disclosed has the ability to automatically maintain a constant back pressure. In some other systems, filtrate collects in the back pressure system causing the back pressure to increase due to presence of the extra fluid. The excess pressure generated is usually

relieved manually which requires that an operator be present at all times during the test to relieve the excess back pressure as it builds up.

Accordingly, it is an object of this invention to provide an apparatus for filtering of liquid containing suspended solids which eliminates the possibility of back pressure on the liquid exceeding the head pressure.

Yet another object is to provide an improved means for sealing the filtering medium in the liquid container.

Still another object is to provide apparatus capable of automatically relieving excess back pressure.

The invention may be described generally as an apparatus for removing solids from a liquid under differential pressure, which apparatus includes container means for containing the liquid under pressure, means for filtering solids from the liquid and means for introducing compressed gas into the container means for generating a head pressure on the liquid, which apparatus additionally includes the improvement comprising: first means serving to communicate gas generating head pressure on the liquid with the filtration means for generating a back pressure on the liquid; and second means associated with the first means for maintaining a lower back pressure than head pressure on the liquid.

To be more specific, reference is now made to the drawings.

In the drawings:

FIGURE 1 is a schematic illustration of one embodiment of the invention,

FIGURE 2 is a partial cutaway cross-sectional view of the liquid container of FIG. 1 illustrating the filter medium retaining means,

FIGURE 3 is an enlarged partial cutaway cross-sectional view of the needle valve illustrated in FIG. 2.

Referring now particularly to FIGS. 1 and 2, cylindrical container means **1** is provided for containing a fluid, such as a drill mud or the like, which has suspended solids. Container **1** is preferably formed of a metal, such as stainless steel, which is capable of withstanding pressures on the order of 1000 pounds per square inch. Container **1** is provided proximate its lower end with an annular recess **2** which terminates at annular shoulder **3**. Recess **2** is adapted to receive cup member **4** which has a circular peripheral configuration. Cup member **4** is provided with a circular lip **5** which defines a recess adapted to receive a filter medium **6** which is comprised of filter paper **7** which overlies a perforate screen material **8**. Obviously, other type filter media may be utilized. Above cups **4**, wall **59** of container **1** defines a chamber **9** for containing a test specimen of a liquid to be filtered.

To sealingly retain a liquid within container **1**, a resilient seal means is provided such as a Quad-Ring **11** which, as illustrated, resembles a four-leaf clover in cross-section. An O-ring or the like may be used, but a Quad-Ring is preferred. Quad-Ring **11** overlies the periphery of filter medium **6** and engages both lip **5** and shoulder **3** which, as illustrated particularly by FIG. 2, proximately abut. To assure sealing engagement of Quad-Ring **11** with shoulder **3** and lip **5**, cup member **4** is compressingly retained within recess **2** by means of a beveled C-ring **12**. C-ring **12** is accommodated in an annular groove **13** provided in wall **59** of container **1**. Annular groove **13** forms a surface inclined radially outwardly toward the shoulder portion of recess **2** to permit C-ring **12** to compressingly retain cup **4** in recess **2** upon insertion of C-ring **12** in groove **13**.

Cup **4** is provided with a passageway **14** which communicates at its upward end with the recess formed by lip **5** and at its lowermost end with an opening **15** defined by nipple **16**. Threadably engaged with nipple **16** through threads **17** is a needle valve **18** provided with a conical tip **19**.

The conical tip 19 upon full engagement of needle valve 18 with nipple 16 engages passageway 14 as illustrated in FIG. 3 to block fluid communication therethrough. Rotation of needle valve 18 to move valve 18 downward as viewed in FIG. 3 will permit communication between passageway 14 and passageways 21 which converge into a passageway 22. To prevent the leakage of fluid contained in chamber 15 around threads 17, an O-ring 23 is carried within groove 24 in needle valve 18 for sealingly engaging needle valve 18 with the interior wall 25 of nipple 16.

Referring back to FIG. 1, means are provided for establishing a differential pressure across fluid in container 1. These means include a pressure source such as the cartridge of pressurized gas 26 which communicates through conduit 27 with the inlet port 28 of a conventional adjustable constant pressure discharge regulator 29. Regulator 29 is adapted to reduce pressure applied to its inlet port 28 and apply the reduced pressure to its discharge port 31. Regulator 29 communicates through conduit 32 with chamber 9 of container 1 for applying a head pressure to any liquid contained therein. Conduit 32 is provided with a coupling 30 of conventional design to permit removal of regulator 29 from container 1. Discharge port 31 of regulator 29 also communicates through conduit 33, needle valve 34 and conduit 35 with the port 36 of a conventional adjustable constant pressure discharge regulator 37. Regulator 37 is provided with another port 38 which through conduit 39 communicates with a filtrate receiver 41 which is preferably formed of a metal, such as stainless steel, capable of sustaining pressures on the order of 1000 pounds per square inch (p.s.i.).

Filtrate receiver 41 is provided with conduit means 42 which communicates at its bottom end with the bottom of filtrate receiver 41 and at its uppermost end with needle valve 18 which is schematically illustrated in FIG. 1. Any suitable type of coupling 40 can be used to connect needle valve 18 and conduit 42. Needle valve 18, as explained before, communicates through cup 4 and filter medium 6 with chamber 9 of container 1. Conduit means 42 communicates through conduit 43, needle valve 44 and conduit 45 with the exterior of filtrate receiver 41. Conduit 45 conveniently terminates in a graduated cylinder 46.

To permit gauging of pressures applied through discharge port 31 of regulator 29, a conventional pressure gauge 47 is provided which communicates with discharge port 31 through a conduit 48. Similarly, pressure applied through port 38 of regulator 37 may be sensed through use of a conventional pressure gauge 49 which communicates with port 38 through conduit 51. Regulator 37 is preferably provided with conventional means for relieving pressure at its port 38 when the pressure at port 38 exceeds a predetermined pressure. Gas generating the excess pressure at port 38 is relieved to the atmosphere through a conduit 52 which terminates in a bubble trap 53 which is filled with a liquid 54 such as water and vented to the atmosphere through an opening 55.

Means are also provided for raising the temperature of the test specimen above atmospheric temperature. These means conveniently take the form of a conventional thermostat controlled power source 56 which drives a heating element 57 disposed about container 1. Visual perception of temperature in container 1 is permitted by use of a conventional thermometer 58 which is carried within a recess (not illustrated) within wall 59 of container 1.

In operation, container 1 is filled with a test specimen of a liquid containing suspended solids such as a drill mud by disconnecting couplings 30 and 40, removing and inverting container 1, removing beveled C-ring 12, cup 4, filter medium 6 and Quad-Ring 11. A cap (not illustrated) may be placed over coupling 30 to prevent flow therethrough, and then container 1 is filled with a test specimen of liquid. After filling of chamber 9 with the liquid, the Quad-Ring 11, filter medium 6 and cup 4 are inserted in recess 2 as illustrated in FIG. 2. C-ring 12 is then radially compressed, placed in recess 2 and permitted to expand into groove 13 as illustrated in FIG. 2 for compressingly retaining cup 4 in recess 2. Valve 18 is fully engaged to block passageway 14 and prevent loss of fluid through passageway 14 when container 1 is again inverted and placed in the position illustrated in FIG. 1. After removal of the cap (not illustrated) the couplings 30 and 40 are connected. Valves 34 and 44 are closed to prevent communication therethrough as are regulators 29 and 37. Gas cartridge 26 is then punctured, releasing gas to inlet port 28 of valve regulator 29. Regulator 29 is then adjusted to apply a relatively small head pressure to liquid in container 1, for example, 100 pounds per square inch, to assure that cup 4 has been properly inserted and no fluid leakage will occur about Quad-Ring 11. The temperature of the liquid is then brought to a predetermined level by operation of thermostat controlled power source 56. Regulator 29 is then adjusted to apply a predetermined head pressure on liquid in container 1, for example 1000 p.s.i. The amount of pressure being applied can of course be determined by viewing of gauge 47.

Valve 34 is then opened permitting communication of regulator 37 with the discharge port 31 of regulator 29. Regulator 37 is then adjusted to a predetermined pressure level, for example 200 p.s.i., which will be reflected by gauge 49. Valve 18 is opened permitting the pressure applied at port 38 of regulator 37 to apply a back pressure through passageway 14 on the liquid in container 1. When the desired back pressure is reached, valve 34 is closed. Since the head pressure will be greater than the applied back pressure, liquid in container 1 will flow through filter medium 6, depositing solids thereon, and the filtered liquid or filtrate will pass through passageway 14 and into filtrate receiver 41 through conduit 42. As filtrate receiver 41 begins to fill, the back pressure on the liquid in container 1 will increase above the predetermined discharge pressure of regulator 37 due to the confinement of gas creating back pressure. Regulator 37 through the relief means provided therein will relieve this excess pressure into bubble trap 53 to maintain a constant back pressure. An indication of amount of filtrate being retained in filtrate retainer 41 can be gained by observing the amount of gas flow through bubble trap 53.

When a desired filtration period has elapsed, valve 18 is closed and valve 44 opened to permit pressure in filtrate retainer 41 to force filtrate contained in the receiver 41 through conduit 43, valve 44 and conduit 45 into graduated cylinder 46 where the volume of filtrate can be measured.

If, at the end of a test it becomes necessary or desirable to remove regulator 29 from container 1 before cooling of the test specimen is completed, valve means, (not shown) may be provided between regulator 29 and container 1 to close communication therebetween after filtration of a liquid is completed. By closing these valve means before reduction of head pressure, the pressure in container 1 can be maintained during cooling of liquid therein to prevent boiling of the liquid which may occur if head pressure is reduced before the liquid cools.

Because both the head pressure applied to the fluid in container 1 and the back pressure applied through passageway 14 are derived from the discharge port of regulator 29, the possibility of back pressure exceeding head pressure is eliminated. Thus, possibility of damage to the head pressure regulator due to discharge of liquid out of container 1 is eliminated. Additionally, only one pressure generating source is necessary to create a differential pressure across a test specimen of liquid. Because an operator can with reasonable accuracy determine amount of filtrate being collected by viewing bubble trap 53, no glass or plastic level gauges are needed and danger to operators from shattered glass or plastic is eliminated. Additionally, because the filtrate receiver can be constructed entirely of metal, the size of the container to hold a given volume of liquid can be be reduced since glass ordinarily employed to contain routine pressure is of necessity quite thick.

Gas cartridge **26** which may contain carbon dioxide, nitrogen or the like may be any conventional type such as those manufactured by Walter Kidde Company. Regulator **29** may conveniently be a series 1100 regulator sold by Air Reduction Company, and regulator **37**, including relief means, may be a type 16–003 manufactured by the C. A. Norgren Company. Pressure gauges **47** and **49** may be of any conventional type such as those sold by Air Reduction Company. While rather specific terms have been used to describe one embodiment of the invention, they are not intended nor should they be construed to limit the scope of the invention as defined by the appended claims.

What is claimed is:

1. In apparatus for removing solids from a liquid under differential pressure, which apparatus includes container means for containing the liquid under pressure at one part thereof having means thereacross for filtering solids from the liquid and a filtrate discharge line from another part thereof at the opposite side of said filtering means from said one part, the improvement comprising:

a gas cartridge adapted to discharge pressurized gas;

a first adjustable constant pressure discharge regulator having an inlet port which communicates with the cartridge and a discharge port which communicates with said one part of said container for applying a predetermined head pressure on a liquid contained therein;

a second adjustable constant pressure discharge regulator having a first port which communicates with the discharge port of the first regulator and a second port;

the second regulator including means for relieving pressure to the atmosphere when pressure at its second port exceeds a predetermined pressure and also being adapted to maintain a predetermined pressure at its second port which is lower than the pressure impressed upon its first port;

first valve means interposed between the first and second regulators for opening and closing communication therebetween;

a fluid tight filtrate receiver which is in communication with the second port of the second regulator;

first conduit means communicating the bottom of the filtrate receiver with the filtrate discharge line;

second valve means interposed between the filtrate discharge line and the first conduit means for opening and closing communication therebetween;

second conduit means communicating the first conduit means with the exterior of the filtrate container for removing filtrate therefrom;

third valve means interposed in the second conduit means for opening and closing communication therethrough; and

gauge means in communication with the discharge ports of the first and second regulators for indicating pressure at the respective ports.

2. A filtration apparatus for removing solids from a mixture thereof with liquid under differential pressure,

comprising a chamber having thereacross a filter means for receiving said mixture on one side of said filter means, a fluid tight filtrate receiver, means communicating said receiver with said chamber on the other side of said filter means, pressuring means connected to said chamber for establishing a head pressure on said mixture on said one side, means for maintaining a predetermined back pressure in said receiver and on said other side below said head pressure by the amount of said pressure differential, comprising first conduit means extending between said chamber and said receiver, valve regulator means in said first conduit means controlling said back pressure, means associated with said valve regulator means to prevent the back pressure from exceeding a predetermined amount.

3. The combination of claim **2**, said pressuring means comprising pressure cylinder means containing a supply of fluid under pressure and second conduit means extending from said pressure cylinder means to a connection with said first conduit means between said chamber and said valved redgulator means, said second conduit means including pressure regulator means whereby pressured fluid delivered from said pressure cylinder means to said first conduit means and to said chamber is controlled at substantially constant pressure.

4. The combination of claim **3**, said first conduit means including valve means disposed in said first conduit means between said connection of said second conduit means to said first conduit means and said valved regulator means, pressure measurement means communicating with said first conduit means between said valved regulator means and said receiver means, and pressure measurement means communicating with said first conduit means adjacent its said connection to said chamber.

5. The combination of claim **4**, including valve third conduit means extending from the filtrate outlet of said filter means to said receiver, said first conduit means being releasably coupled to said chamber and said third conduit means being releasably coupled to said receiver means, whereby said chamber and filter means may be removed for cleaning and filling.

6. The combination of claim **5**, said receiver means being a steel pressure vessel having valved fourth conduit means for conducting filtrate flow from the bottom thereof to the exterior thereof, said third conduit means being flow connected to said fourth conduit means within said receiver means whereby filtrate introduced into said receiver means through said third conduit means is introduced into the bottom of said receiver means, said first conduit means connection to said receiver means being to the top of said receiver means.

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