

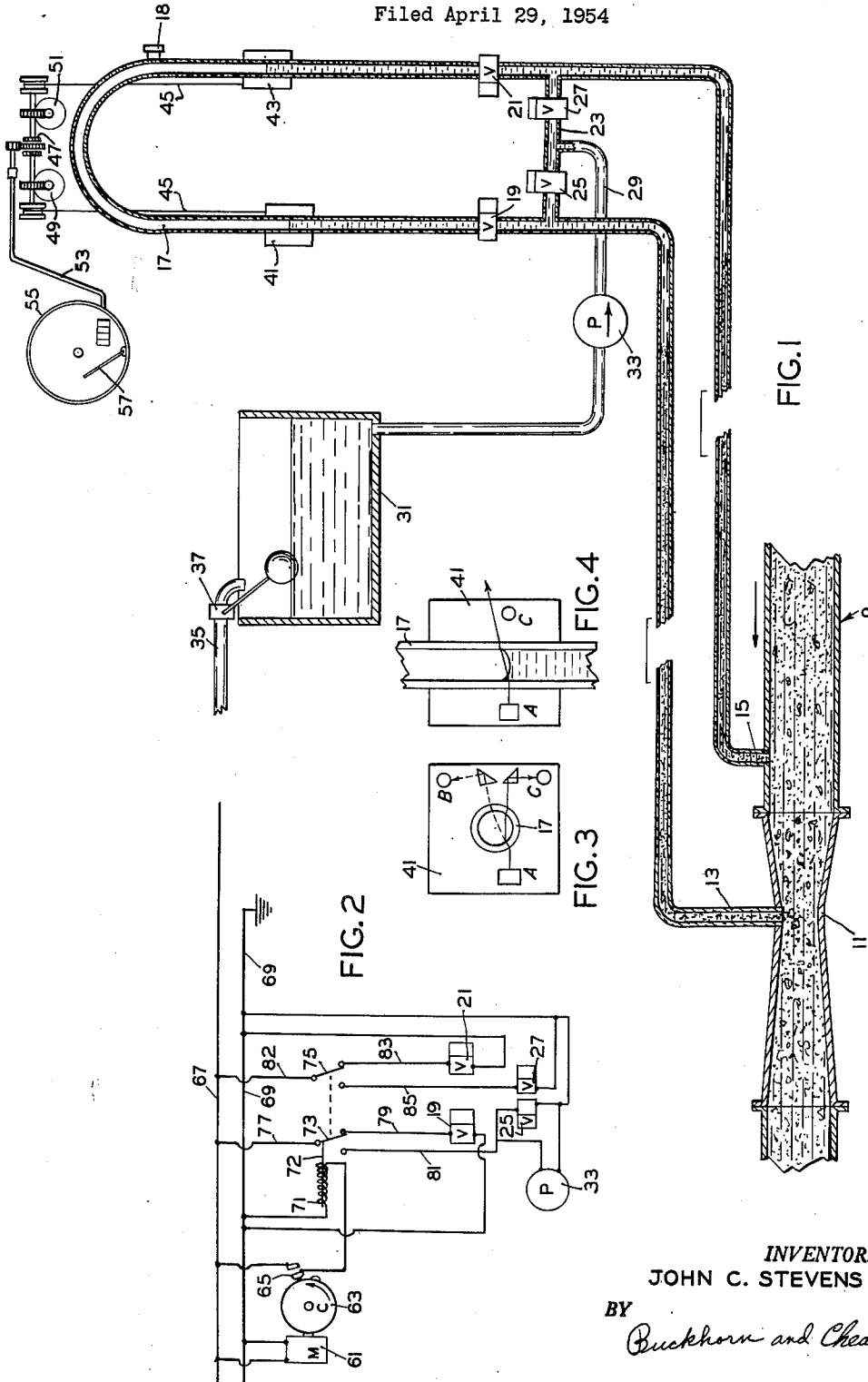
Dec. 24, 1957

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2,817,237

MANOMETER SYSTEM

Filed April 29, 1954



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2,817,237

MANOMETER SYSTEM

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Application April 29, 1954, Serial No. 426,490

1 Claim. (Cl. 73—401)

This invention relates to manometer systems, and particularly to registering or recording manometer systems adapted for use in pressure measurements of turbid liquids, especially flowing turbid liquids where pressure is a function of velocity and quantity flow.

In prior manometer systems adapted for use in connection with turbid or debris carrying liquid, such as sewage or liquid industrial wastes, it has been found necessary to provide a separation chamber between the turbid liquid and the manometer tube in order to keep the tube clean. The separation chamber conventionally has included a diaphragm or similar member which functions to separate the manometer liquid from the turbid liquid. The diaphragm has disadvantages in that it makes the system less sensitive than those systems wherein the pressure liquid is clean or clear and no separation chamber need be employed, and furthermore the diaphragm is difficult to clean and in general raises considerable maintenance problems.

It is a main object of the present invention to provide a manometer system adapted to be used in connection with turbid liquids, wherein the need for a separation chamber is eliminated and direct communication between the turbid liquid and the manometer tube by means of an open conduit is provided. This advantageous arrangement is made possible by the provision of a periodic flushing means which is operable to periodically flush the conduit free of polluted liquid with a higher pressure clear liquid, at a time prior to that at which the polluted liquid would reach the manometer tube, and to replace such polluted liquid with clear liquid.

It is a further object of the present invention to provide a manometer system of the type just set forth, wherein a valve arrangement is provided for preventing the higher pressure flushing liquid from affecting the level of the liquid in the manometer, to thus avoid not only highly erroneous records, but also to avoid overworking and possible damage to the portions of the manometer system operable in response to changes in the liquid level.

A more particular object of the present invention is to provide a manometer system of the type just set forth immediately above, wherein the operation of the flushing means and the valve arrangement is controlled by the recording mechanism of the manometer system.

It is another object of the present invention to provide a recording manometer system having liquid level sensing means dependent for its proper operation upon the maintenance of substantially constant light transmitting properties of the manometer liquid, the system including an open conduit communicating the turbid liquid with the manometer liquid, the system further including periodic flushing means operable to flush the conduit free of the liquid therein, including the polluted portions thereof, prior to the time that polluted liquid would enter the manometer tube. Thus the light transmitting properties of the manometer liquid may be maintained constant.

It is a still further object of the present invention to provide a manometer system as described immediately

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above wherein the proper operation of the system is dependent upon maintaining the manometer liquid clear for proper transmission of a light beam therethrough.

Various other objects of the present invention will be apparent from the following description taken in connection with the accompanying drawings, wherein:

Fig. 1 is a schematic view of a manometer system embodying the concepts of the present invention;

Fig. 2 is a schematic wiring diagram of the system;

Fig. 3 is a schematic view in plan, showing the photocell setup of a rider, the figure illustrating an equilibrium condition; and

Fig. 4 is a schematic view in side elevation of the Fig. 3 structure.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, there is disclosed in Fig. 1 a sewage line 9 having a restricted portion at 11 providing a Venturi section. Flowing through the sewage line is sewage which may be characterized for the purpose of this invention as turbid or debris carrying liquid. Instead of sewage, line 9 could contain other solids or gas carrying liquids known as industrial wastes. In any event, such liquid may be considered as containing diffusible molecules capable of creating a turbid condition in clear water, that is, darkening, clouding or otherwise altering or impairing the light transmitting qualities of the clear liquid. Such turbid or debris carrying liquid may also be considered as containing buoyant and nonbuoyant light reflecting, refracting or absorbing particles, elements or matter. For convenience in description, gas or air bubbles may be considered as refracting particles, elements or matter.

Communicating with sewage line 9 at the restricted portion thereof is a conduit 13, and communicating with line 9 at a place upstream of such restricted portion is a conduit 15. Each of the conduits is shown as having considerable length, for a reason to appear hereinafter, and also including a horizontal run portion which functions to substantially bring to a halt the travel of buoyant particles along said conduits in a direction away from line 9. Each run portion may be arranged to extend slightly downwardly in a direction from left to right, as the parts are depicted in Fig. 1, to make certain that no buoyant travel occurs.

Conduits 13 and 15 are shown as having vertical end portions communicating respectively with the lower ends of the legs of an inverted U-shaped transparent manometer tube 17. It will be evident that the conduits 13 and 15 will normally comprise piping of various forms, whereas the manometer tube will normally be formed of glass tubing. A gaseous medium under pressure may be provided in the upper portion of tube 17, and thus the tube may be considered as closed. A suitable valve 18 is connected to the upper portion of tube 17 to permit a gaseous medium to be pumped into the tube.

Provided in the upper ends of conduits 13 and 15 are solenoid controlled valves 19 and 21, respectively, said valves being biased toward closed positions but being normally energized to be open. Connecting the upper ends of conduits 13 and 15 at places below valves 19 and 21 is a conduit section 23. Disposed in conduit section 23 are solenoid controlled valves 25 and 27, which are biased toward closed positions and are normally de-energized and thus normally closed. Between valves 25 and 27 is a conduit 29 communicating with conduit section 23 and leading to and communicating with a clear liquid or water tank 31. Provided in conduit 29 between the tank and conduit section 23 is a normally inactive electric motor driven pump 33. Pump 33 may be eliminated by positioning tank 31 sufficiently high to achieve the desired pressure. For supplying the tank with clear water, a supply pipe 35 is provided, there being a float controlled valve

37 adjacent the outlet of pipe 35 and operable to close the pipe during normal operation of the manometer system, at which time the water level in the tank will be high.

Slidable along the left-hand leg of manometer tube 17 is a photocell rider 41 and slidable along the right-hand leg of manometer 17 is a second photocell rider 43. These riders are of the general type disclosed in my prior Patent No. 2,376,459, and are connected by flexible means 45 to the opposite ends of a differential unit 47. The riders are electrically connected to control the operation of electric motors 49 and 51, respectively, in a manner to be presently indicated. Connected to the center of the differential unit is a flexible shaft 53 leading to a recorder 55 to control the position of a pen 57. Pen 57 makes a record on a circular chart which is driven by a conventional electric motor operated clock mechanism within the recorder, such mechanism being indicated at 61 in Fig. 2.

In my prior Patent No. 2,376,459, the riders are adapted for operation with a manometer tube carrying an opaque liquid. Each rider projects a beam of light across the surface of the opaque liquid toward vertically offset photocells, the rising and falling opaque liquid being adapted to cut off or permit momentary unnatural light reception by the photocells to control the associated motors in a manner, as indicated in said patent, to cause the riders to follow the liquid levels in their respective tubes.

In the present invention, similar rider-following movement may be attained, although clear liquid occupies the manometer tube, by making use of the different refractive effects of liquid and air on the light beam. Figs. 3 and 4 schematically show the idea employed, where an equilibrium condition is shown. A light beam from source A is refracted by the meniscus of the liquid in tube 17 and thus passes above the photocells B and C, which are disposed at the same level. In practice, a prism, see Fig. 3, is provided for each photocell, because the photocells are too bulky to be conveniently placed side by side for direct reception of the light beam.

Photocells B and C are connected in a circuit, not shown, identical to that disclosed in Fig. 3 of Patent 2,376,459, except that each of the photocells B and C is connected by a normally open switch, similar to switch 53 in said patent, to the associated motor winding. Thus, under equilibrium conditions, the associated motor is de-energized because the light beam, as above mentioned, passes above the photocells.

If the liquid level should rise, the light beam would level out and be refracted along the dotted line path by the liquid to strike the prism for photocell B. Photocell B would then be effective to cause the associated motor winding to become energized so that the motor rotates in a direction to elevate the rider until the meniscus again intercepts the light beam. On the other hand, if the liquid level should fall, the light beam would level off and strike the prism for photocell C, as shown in full lines in Fig. 3. Photocell C would then be effective to cause the associated motor winding to become energized to cause the motor to rotate in a direction to lower the associated rider until the meniscus again intercepts the light beam.

It is pointed out at this time that the operation of the photocell means of the riders will become erratic if the light beam is substantially diminished in intensity or misdirected, such as might be caused by foreign matter polluting the clear manometer liquid and collecting on the walls of the manometer tube. It will be noted that air and gas bubbles in the manometer liquid would refract the light differently than would liquid without such bubbles. Also, such air and gas bubbles would tend to diminish or alter the pressure in the upper end of the manometer tube, particularly if the upper end is filled with a gaseous medium under pressure. Such alteration would obviously affect the liquid levels in the manometer legs.

Referring to Fig. 2, the electric motor driven clock mechanism of the recorder 55 is indicated at 61 in driving relation to a cam 63. Associated with the cam is a

normally open switch 65 operable when closed to control the supply of electrical energy in a predetermined manner to solenoid valves 19, 21, 25 and 27 and electric motor driven pump 33, provided a pump is employed.

The electric circuit depicted in Fig. 2 includes supply conductors 67 and 69, conductor 69 being the ground conductor. Clock motor 61 is connected across the supply conductors as shown to be normally operating so as to drive cam 63 at a slow rate of speed and also to drive the chart in the recorder. A master switch, not shown, may be actuated to de-energize the electrical system when desired. Switch 65 is connected at one side to conductor 67 and at its other side to a solenoid winding 71, the other side of such winding being connected to conductor 69 as shown. The solenoid winding 71 controls the operation of a movable solenoid element 72, which is mechanically connected to the switch arms 73 and 75 of a pair of single pole, double throw switches. Switch arm 73 is connected to conductor 67 by a conductor 77, and is shown in engagement with the contact of a conductor 79, the latter being connected to solenoid valve 19, which is connected to ground as shown. Switch arm 73, when thrown clockwise as the parts are depicted in Fig. 2, is adapted to be brought into engagement with the contact of a conductor 81, the latter being connected to solenoid valve 25, which is connected to ground as shown. The electric motor operated pump 33, if employed, is connected in parallel with solenoid valve 25 as shown.

Switch arm 75 is connected by a conductor 82 to supply conductor 67 and in the position shown is disposed in engagement with the contact of a conductor 83, the latter being connected to solenoid valve 21, the other side of which is connected to ground as shown. Switch arm 75 when thrown counterclockwise is adapted to engage the contact of a conductor 85, the latter being connected to solenoid valve 27, which is connected to ground as shown.

Operation

Since conduits 13 and 15 are open so as to place the manometer tube in communication with sewage line 9, polluting substances or matter in the sewage liquid in line 9 may travel into conduits 13 and 15 toward the manometer tube. Such travel may occur, for instance, because of the diffusion of turbid creating molecules in the sewage liquid into the liquid within the conduits; or because of the buoyancy of buoyant particles, elements or matter in the sewage liquid entering the conduits, such particles or elements including solids, or semisolids, or even liquids such as oil, and also including air or gas bubbles; or because of the effect on particles by the rising and falling motion of the manometer liquid; or because of the effect of convection currents unavoidably occurring in the conduits; or for any combination of the above effects.

For purposes of explaining the operation of the system, it is assumed that a flushing operation is just about to commence so that the liquid in the conduits 13 and 15 is shown as being polluted up to a point short of conduit section 23, and cam 63 is shown in a position as just about to contact switch 65. Closing of switch 65 causes arms 73 and 75 to swing clockwise from the positions shown, to thus de-energize previously energized solenoid controlled valves 19 and 21 to allow them to close, and to energize previously de-energized solenoid controlled valves 25 and 27 to cause them to open. Also, if a pump 33 is employed, it will be energized, said pump having an output pressure higher than that in line 9, and thus clear water from tank 31 is pumped into conduit section 23 from which it travels into conduits 13 and 15 and moves downwardly therein because the closed solenoid valves 19 and 21 prohibit upward movement of such liquid. Thus, liquid in legs 13 and 15 is forced into line 9.

The lobe on cam 63 is designed to have a circumferential extension correlated to the rate of travel of the cam so that switch 65 is closed for the required period

of time; that is, long enough so that pump 33 will pump sufficient clear liquid into conduits 13 and 15 as to discharge all of the conduit liquid from said conduits, including the polluted liquid portions thereof, and replace the same with clear liquid. In fact, it is contemplated that clear liquid will be supplied by pump 33 in such quantities and at such pressure that it rushes through conduits 13 and 15 at a fairly high velocity so as to have a cleansing effect on the walls of the conduits to remove debris or polluting substances therefrom. As the pump removes water from tank 31, float valve 37 operates to supply additional quantities of clear water to the tank to eventually bring the level back to normal.

When the lobe of cam 63 leaves switch 65 the switch opens causing valves 19 and 21 to open, valves 25 and 27 to close, and pump 33 to stop operation, to thus place the system back in condition for normal operation. The operation of clock motor 61 is so correlated to the travel time of the polluting substances from the line 9 to the conduit section 23 that cam 63 once again engages and closes switch 65 to cause another flushing operation to commence prior to polluting substances reaching conduit section 23.

It is pointed out that during the flushing operation the high pressure clear liquid in the conduits 13 and 15 has no effect on the liquid level in the legs of manometer tube 17 because of closed valves 17 and 21, so that the riders 41 and 43 remain stationary. Thus, although the recorder does not record pressure changes occurring during the flushing period, the flushing period is relatively short and the resulting record is much more accurate than that which would be produced were the high pressure liquid permitted to elevate the liquid levels in the manometer legs.

It is evident that if the polluting substances are to be kept from reaching conduit section 23, that the period between supply operations must be made less than the travel time of the polluting substances from line 9 to conduit section 23. The travel time of the polluting substances is equal to the ratio of the length of the conduit to the rate of travel of the polluting substances. The rate of travel of the polluting substances depends primarily on the kind and types of matter in the sewage line and to some extent on operating conditions. The travel effects due to buoyancy can be considerably decreased or entirely stopped by providing horizontal run portions in the conduits, or portions which incline slightly downwardly in a direction away from line 9, or even inverted U-shaped bend portions. However, in some installations this may not be desirable or possible, and thus the buoyancy effects must be taken into account in some situations. However, the rate of travel of the polluting substances, which primarily has to be taken into account, is caused by the diffusion of turbid creating molecules into the clear liquid in the conduits 13 and 15. Also to be considered are the effects of convection currents, and rising and falling liquid levels in the manometers.

For any particular system, the travel time may be readily determined by making a trial run and noting when the polluting substances reach the manometer tube. It will be normally more economical to provide conduits 13 and 15 of considerable length to thus increase the periods between supply operations. For instance, in one installation a conduit length of approximately twenty feet was employed, and it was found that a period of as long as six hours between flushing operations could be tolerated. In this system a flushing period of one minute was found satisfactory.

By the present invention, a manometer system has been provided wherein the manometer tube may be placed in direct communication with a sewage line, thus eliminating the necessity for separation chambers and the like and their accompanying disadvantages. Specifically, the concept of the present invention is particularly adaptable to

a system wherein the sensing means includes photocells dependent for proper operation upon substantial constant intensity and proper direction of a beam of light projected at least in part through clear manometer liquid.

Having described the invention in what is considered to be the preferred embodiment thereof, it is desired that it be understood that the invention is not to be limited by the specific details shown unless they constitute critical features of the present invention, all of which will be apparent by reference to the following claim.

I claim:

In a manometer system, an upright transparent manometer tube, a line for turbid liquid under pressure, a conduit connected at one end to the line and connected at its other end to the lower end of said tube, a continuous column of water entirely filling said conduit and extending upwardly into and partially filling said manometer tube and initially being clear, said column being immediately and directly responsive to changes in pressure in said line to shift along said conduit to cause an immediate and direct change to the level of the column of water in the manometer tube, clear water supply means connected to said conduit, said clear water supply means being operable to supply water at a pressure higher than that of the turbid liquid, means controlling said supply means periodically operable to supply liquid from said supply means to said conduit a quantity of clear water, a valve in the conduit between the place of communication of said supply means with said conduit and the level of said column of water in said tube, means for closing said valve during the time that clear water is supplied to said conduit from said supply means, and means responsive to changes in the height of the water in said tube for giving an indication of such changes, said responsive means including a housing surrounding said tube, means for projecting a beam of light through said tube along a predetermined direction, first and second light responsive means on said housing positioned so that when said beam of light passes through the meniscus of said column of water the beam will be deflected along a path not falling on either of said light responsive means, said projecting means directing said light so that said beam of light enters said tube along a path other than along a diameter of said tube so that when said beam passes through clear water, such as when the water level in said tube rises, the beam will exit from said tube along one path and when said beam passes through air in said tube, such as when the water level in said tube drops, said beam will exit from said tube along another path, said first light responsive means being positioned to intercept said beam when said beam is directed along said one path and said second light responsive means being positioned to intercept said beam when said beam is directed along said other path, and motor means controlled by said first and second light responsive means for raising said housing when said first light responsive means receives light and for lowering said housing when said second light responsive means receives light to thereby maintain said housing at the place where said beam of light passes through the meniscus of said column of clear water, said clear water supply means functioning to prevent said clear water from becoming turbid which would interfere with the proper operation of said responsive means.

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