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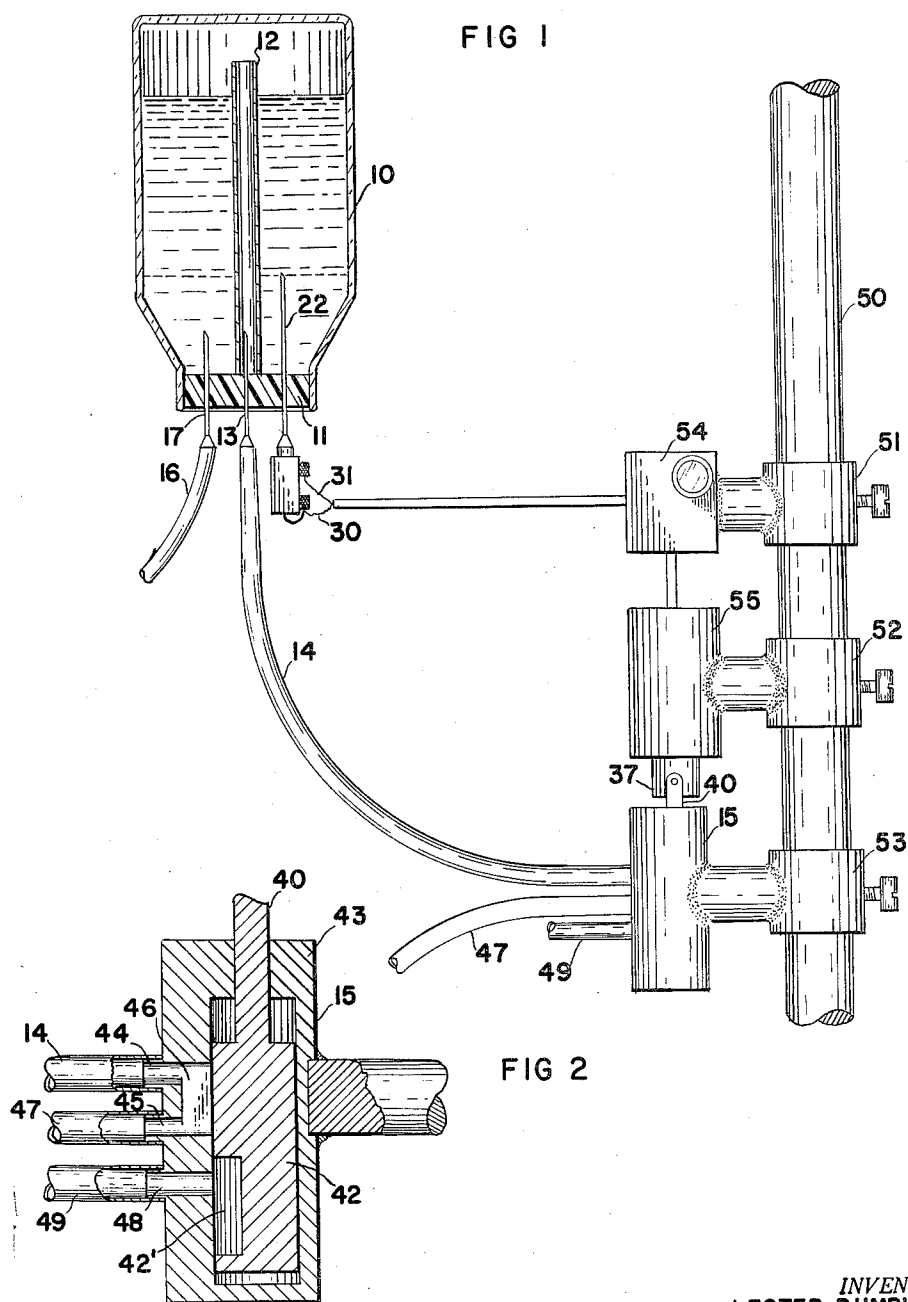
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3,014,481

PHYSIOLOGICAL FLUID INJECTION SYSTEM

Filed May 4, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

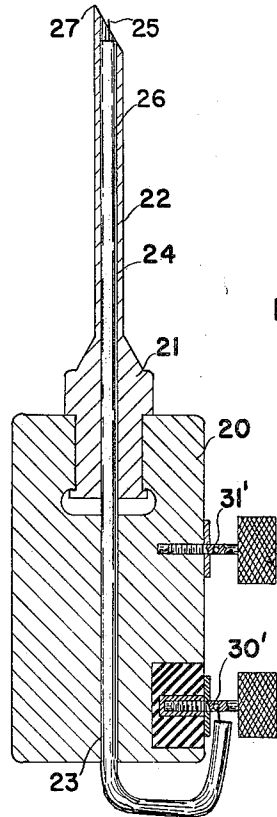


FIG 3

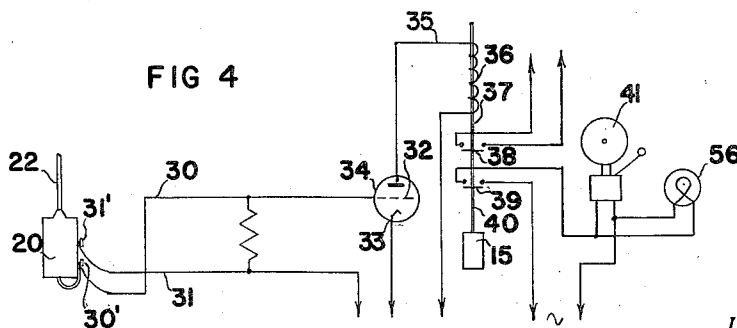


FIG 4

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PHYSIOLOGICAL FLUID INJECTION SYSTEM

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5 Claims. (Cl. 128-214)

This invention relates to fluid injection systems and is particularly concerned with the injection of physiological fluids into the blood stream.

While certain aspects of the present inventive concept may be generally applicable to various types of fluid injection systems and particularly those related to the physiological treatment of human beings, the present invention is particularly concerned with the pressurized intravenous and/or intra-arterial injections of physiological fluids as in the case of a blood transfusion or the like.

The practice of injecting fluid into the blood stream by the gravity flow of such fluid from a suitable flask or receptacle has long been a common expedient. However, certain circumstances indicate the advisability of providing a flow assisting pressure for the injection fluid. Where such pressurized flow is desired, a flow assisting pressure gas such as air is supplied to the surface of the treatment fluid to force the fluid from its flask irrespective of gravity. Such pressurization of such fluid presents a certain hazard in that in the event the fluid recedes to a point below the outlet of the receptacle, the pressurizing medium may then flow to the patient with the obvious and inherent danger of the occurrence of embolus. Thus a positive termination of injection fluid flow prior to exposure of the outlet port to the pressurizing gas is essential. In many instances, it may also be desirable to provide for a termination of the fluid flow prior to the approach of fluid level to the proximity of the discharge outlet of the flask as in the case of fluids which may have a tendency to stratify or which include substances which may settle from the body of the remaining treatment fluid.

In view of the ever present danger of serious and even fatal consequences of approach of the liquid level of the treatment fluid to the flask outlet, it has heretofore been required that an attendant be present at all times to vigilantly observe the liquid level and terminate the flow and the application of pressure before the fluid level reaches the flask outlet. Despite such vigilance, however, accidents have occurred and it is thus desirable to provide automatic means which will unfalteringly sense the level of the injection fluid and provide signal means for alerting the attendant to the condition of the fluid level. It is further advisable to provide means whereby the pressure may be automatically discontinued as the sensing member records a liquid level which may be dangerous.

It is therefore among the general objects of the present invention to provide a novel and improved liquid level sensing device particularly adapted for use in sensing the liquid level in the flask of a physiological treatment fluid.

It is a further object of the present invention to provide a sensing means of the character set forth adapted to control an electrical circuit whereby extraneous equipment, such as signals, valves and the like, may be automatically actuated in response to the sensing of such devices.

Another important object of the present invention is to provide automatically actuable means for terminating the flow of pressurizing medium to the fluid of a physiological treatment fluid flask.

The present invention also includes as an object the provision of a novel and improved circuit arrangement whereby associated electrical equipment may be accurately and automatically actuated in response to the sensing of a liquid level in a fluid treatment flask.

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With these and other objects, features and advantages of the present invention in mind, reference may be had to the following specification taken in conjunction with the accompanying drawing in which:

FIG. 1 is a side elevation of the apparatus of the present invention exclusive of the electrical circuit and signal.

FIG. 2 is a detailed cross-sectional view of the valve means forming part of the present invention.

FIG. 3 is a detailed cross-sectional view of the sensing device of the present invention.

FIG. 4 is a schematic diagram of the electrical circuit of the present invention.

While the inventive concept hereof may be embraced by various structural features and arrangements, that form of the invention here presented by way of illustration may be broadly defined as including an electrical sensing contact adapted to be disposed within a physiological fluid treatment flask with the exposed end thereof located at a predetermined point above the outlet port of such receptacle together with an electrical circuit under the control of the sensing contact whereby signaling and/or valve control means may be actuated by the sensing device to indicate a dangerous level of physiological fluid within the flask and/or to terminate the application of a feeding pressure to the surface of such physiological fluid.

In that form of the present invention depicted in the drawings, the physiological treatment fluid flask is indicated generally by the numeral 10 and as in most cases the mouth of the flask 10 is closed by a pierceable resilient stopple as indicated at 11. In the supply of physiological fluid from the flask 10 to the patient, the flask is usually disposed by suitable supporting means above the level of the patient and in inverted position with the mouth directed downwardly. For supplying pressure to the surface of the physiological fluid in the inverted flask 10 there is provided a centrally located tubular standard 12 the lower end of which is supported on the inner face of the stopple 11 and is sealingly engaged therewith to provide an upwardly extending tubular conduit for the flow promoting gas. Pressurizing gas is supplied to the tubular standard 12 through a needle 13 which pierces the stopple 11 within the limits of standard 12. Needle 13 is connected with a fluid pressure supply tubing 14 extending from a control valve generally indicated at 15 in FIG. 2 which will hereinafter be more fully discussed. The treatment fluid within the flask 10 is adapted to be delivered therefrom to the patient through a tubing 16, the flask end of which is provided with a stopple piercing needle 17 extending upwardly within the flask 10 externally of standard 12.

The foregoing arrangement being generally conventional, it will be understood that the treatment fluid will flow from the flask 10 through needle 17 and tube 16 to the patient under pressure admitted to the surface of the fluid from the standard 12 as supplied through needle 13 from the tube 14. Obviously, should the treatment fluid level recede to a point below the outlet port of the needle 17, the pressurizing medium would pass through the needle 17, tube 16 and to the patient with disastrous effect. It is therefore essential that the treatment fluid flow be terminated prior to any danger of such an occurrence.

For sensing the approach of the treatment fluid level within the flask 10 to the outlet port of the needle 17, there is provided a probe, the structural details of which are more clearly illustrated in FIG. 3 of the drawings. The sensing probe comprises a base 20 formed of conductive material and supporting the hub 21 of a tubular needle 22, the needle and the hub being formed of conductive material and thereby having electrical contact with the base 20. The base 20 includes a bore 23 communicating with the bore 24 of the needle 22 and through

such communicating bores there is mounted a conductor 25 encased within a conventional insulating sheath 26. The external diameter of the sheath of the conductor is preferably substantially equal to the internal diameters of the bores 23 and 24 so as to fully fill such bores to prevent the flow of treatment fluid through the needle and base 20. At the upper open end of the needle 22, the conductor 25 extends from its insulating sheath and thereby forms with the conducting material of the needle 22 an open electrical path which may be closed by the treatment fluid when surrounding the needle and conductor. Since such fluid is of conductive character, a circuit is thus established between the conductor 25 and the needle when the fluid is of a level above the upper end 27 of the needle. It will be seen from a consideration of FIG. 1 that the needle is of such length and is so disposed through the stopple 11 that the exposed end of the conductor 25 is substantially above the outlet port of the needle 17. It will further be seen that this arrangement is such that when the liquid level of the treatment fluid recedes below the upper end of the needle 22 the circuit between the exposed end 25 of the conductor and the upper end 27 of the needle is broken by the absence of conducting fluid therebetween. Since the position of the needle 22 is readily adjusted through the stopple 11, the relation of its height with respect to that of the needle 17 is readily adjustable.

The circuit herein presented as admirably adapted for use with the structure of the present invention and as set forth in schematic diagram of FIG. 4 includes conductors 30 and 31 leading respectively from the binding post 30' of the base 20 of the probe to which the conductor 25 is connected and from the binding post 31' conductively associated with the base 20 and thus with the needle 22. The presence of treatment fluid within the flask and surrounding the needle with its level above the top thereof will maintain the establishment of current flow between the conductors 30 and 31. The conductor 30 leads to the grid 32, of an electronic relay valve 34. Direct current is supplied through the tube 34 and through solenoid 36; however, the current is limited by grid 32 of tube 34. While there is a conducting path through probe 22, the grid resistance of tube 34 is shunted out with the result that there is a sufficiently high negative potential on grid 32 to limit the current to such an extent that it is insufficient to actuate the solenoid 36. When the conducting fluid in bottle 10 is lowered below the tip of probe 22, the circuit shunting the grid resistance is opened causing a large voltage drop thereacross, with the result that the potential on grid 32 of tube 34 approaches zero. Since the limiting potential is so reduced, there will be a large current flow through the tube 34 and solenoid 36, such current being sufficient to actuate the solenoid, the armature 37 of which is associated with switches 38 and 39 and with a valve stem 40 of the valve 15 hereinafter to be described. Associated with the switch 39, there may be provided suitable signal means such as a bell 41 and/or a signal lamp 56, arrangement being such that upon energization of the solenoid winding 36, such signal devices will be energized to warn the attendant of the diminished liquid level of the treatment fluid. Switch 38 may control other signal devices or various types of associated electrical mechanism as may be desired.

Referring now to the valve 15 disclosed in FIG. 2 of the drawings, it will be understood that the valve stem 40 thereof is engaged by the armature 37 of the solenoid so as to provide for reciprocation of the valve body 42 within the valve housing 43 as the solenoid is energized upon diminishment of the fluid level below the top of the needle 22. The valve body 42 is provided with the side recess 42' and the housing 43 is formed with ports 44 and 45 intercommunicating by a recess 46 in the housing. The port 45 is connected by tube 47 with a suitable source of fluid pressurizing medium such as compressed air which is thus supplied from the port 44 to the tube

14 leading to the needle 13. The valve housing 43 is also provided with a port 48 engaged by tube 49 open to the atmosphere or, if desired, with a diminished pressure or vacuum so as to facilitate the prompt action of the valve in terminating the flow of pressurized medium to the treatment fluid.

From the foregoing discussion, it will be apparent that as the solenoid coil 36 is energized, the valve body 42 will move in the valve housing 43 to cause the outlet port 48 to communicate with the inlet port 45 associated with the tube 47 leading from the source of pressure. Thus, as the solenoid is energized, the delivery of pressure through the tube 14 to the surface of treatment fluid will be automatically terminated as the level of such fluid diminishes below the end 27 of the needle 22.

By further reference to FIG. 1 of the drawing, it will be noted that the mechanical structure of the present device can be suitably supported from a standard 50 upon which is adjustably mounted collars 51, 52 and 53, the collar 51 supports a housing 54 for the electronic valve 34 and associated electrical means. The housing 55 is supported by the collar 52 and encloses the solenoid and switches 38 and 39. The armature 37 extends downwardly from housing 55 and engages valve stem 40 of valve 15 supported by the collar 53. It will thus be seen that a convenient and readily adjustable supporting assembly is provided for the structural mechanism of the present invention.

From the foregoing, it is believed that the operation of the present invention will be clearly apparent to those skilled in the art. Suffice it therefore to say that with the patient prepared for reception of the treatment fluid, the flask 10 is suitably supported in inverted position with the standard 12 mounted therein and the needles 13, 17 and 22 positioned through the stopple 11. It will be understood of course that the exposed upper end of the conductor 25 within the needle 22 is disposed at a level above the outlet port of the needle 17. With the tube 16 communicating with the needle 17 and with the patient, gas under pressure is supplied through the tube 47 and the valve 15 to the tube 14 whereby such pressure is delivered to the surface of the treatment fluid thus forcing the same through the needle 17 to the patient. When the liquid level of the treatment fluid recedes below the top of the needle 22 the circuit between conductors 30 and 31 is broken, the electronic valve 34 is thus caused to pass activating current through the windings 36 of the solenoid switch and thus the signals will be energized and the valve 15 will act to immediately terminate the flow of pressurized medium to the flask 10.

In considering the present invention, it will of course be understood that the structural details herein set forth are presented by way of illustration and that numerous changes, modifications and the full use of equivalents may be resorted to with respect thereto without departure from the spirit or scope of the invention. Furthermore, it will be understood that the circuit herein presented while admirably suited to the demands of the present equipment may be varied by substitution of equivalents to provide similar actuating phenomena without recourse to the specific circuit presented.

We claim:

1. In a fluid treatment apparatus, a flask for supplying physiological treatment fluid, fluid discharge means mounted in said flask comprising a hollow discharge needle inserted through a stopple for said flask, means for supplying flow promoting fluid pressure to the treatment fluid within said flask including a pressurizing gas supply needle inserted through said stopple, and sensing means responsive to the approach of the treatment fluid level to said discharge means including spaced electrical conductors adapted to be electrically bridged by a conductive treatment fluid in said flask.

2. Apparatus for the pressurized supply of physiological treatment fluid comprising a treatment flask, an outlet for

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treatment fluid disposed in said flask, a tube for supplying fluid from said outlet to a patient, means for supplying pressure to fluid within said flask to assist in the discharge thereof through said outlet, a fluid level sensing device mounted in said flask above the treatment fluid outlet and means responsive to said sensing device for giving notice of the diminishment of treatment fluid below a predetermined level.

3. Apparatus for the pressurized supply of physiological treatment fluid comprising a treatment flask, an outlet for treatment fluid disposed in said flask, a tube for supplying fluid from said outlet to a patient, means for supplying pressure to fluid within said flask to assist in the discharge thereof through said outlet, a fluid level sensing device mounted in said flask above the treatment fluid outlet, means responsive to said sensing device for giving notice of the diminishment of treatment fluid below a predetermined level and means responsive to said sensing device for terminating the supply of pressure to said fluid upon the diminishment of treatment fluid below a predetermined level in said flask.

4. Apparatus for the pressurized supply of physiological treatment fluid comprising a treatment flask, an outlet for treatment fluid disposed in said flask, a tube for supplying fluid from said outlet to a patient, means for supplying pressure to fluid within said flask to assist in the discharge thereof through said outlet, a fluid level sensing device mounted in said flask above the treatment fluid outlet, means responsive to said sensing device for giving notice of the diminishment of treatment fluid below a predetermined level and means responsive to said sensing

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device for terminating the supply of pressure to said fluid upon the diminishment of treatment fluid below a predetermined level in said flask, including signal means for notification when said pressure supply is terminated.

5. Apparatus for the pressurized supply of physiological treatment fluid comprising a treatment flask, an outlet for treatment fluid disposed in said flask, a tube for supplying fluid from said outlet to a patient, means for supplying pressure to fluid within said flask to assist in the discharge thereof through said outlet, a fluid level sensing device mounted in said flask above the treatment fluid outlet, means responsive to said sensing device for giving notice of the diminishment of treatment fluid below a predetermined level and means responsive to said sensing device for terminating the supply of pressure to said fluid upon the diminishment of treatment fluid below a predetermined level in said flask, including signal means for notification when said pressure supply is terminated and an electronic valve under the control of the sensing device providing the means for terminating pressure and actuating the signal means.

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