AUTOMATIC DISPLACEMENT SYRINGE

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INVENTOR
Frank Liberson

BY
Munn & Co.

ATTORNEY
This invention relates to automatic displacement syringes and particularly to a syringe for medical purposes for removing small quantities of fluid from different parts of the body and substituting air or other gas therefor.

An object of the invention is to provide an improved automatic displacement syringe which is particularly adapted for removing liquid from the spinal column or from the brain and substituting air or gas therefor.

Another object of the invention is to provide an automatic displacement syringe for medical purposes which when used to withdraw fluid from a lumen puncture will overcome the dangers associated with sudden changes in intracranial and intraspinal pressures during the procedure of substitution of gas for the cerebrospinal fluid for the purpose of encephalography.

In the accompanying drawings,—

Figure 1 is a longitudinal vertical sectional view through an automatic displacement syringe disclosing an embodiment of the invention, the same being shown ready for use. Figure 2 is a view similar to Figure 1 but showing the plunger in an extreme outer position. Figure 3 is a fragmentary sectional view through Figure 1 on line 3—3. Figure 4 is a side view of the reversing rod disclosing certain features of the invention. Figure 5 is a view similar to Figure 4 but showing the rod and associated parts in a reverse position. Figure 6 is a view similar to Figure 1 but showing a modified construction wherein a single piston or plunger is used but divided into two parts. Figure 7 is a fragmentary view similar to one end of the structure shown in Figure 2 but illustrating the position of the parts when the plunger has been moved outwardly for its full stroke. Figure 8 is a fragmentary sectional view through Figure 6 on line 8—8. Figure 9 is a view similar to Figure 6 but showing a modified construction. Figure 10 is a view similar to the left-hand end of the structure shown in Figure 6 but with the plungers and associated parts in their outer positions.

Figure 11 is a side view on a reduced scale of the structure shown in Figure 1 as the same will appear when in use, the syringe being shown in connection with part of a spinal column. Referring to the accompanying drawings by numerals, 1 indicates a needle of a desired kind which is adapted to be inserted through a desired opening in the cranium or into the spinal column as illustrated in Figure 11. This needle is frictionally connected to a hollow discharge member 2, the same being preferably connected by friction, though other connections may be used without departing from the spirit of the invention.

The discharge member 2 forms part of what may be termed an adaptor 3, which adaptor is really an especially formed valve. A cylinder 4 is mounted on the casing 5 of the adaptor 3 and held in place by an adhesive, metal or other material 6. Arranged in the barrel 4 is an inner barrel 7 which is secured to the casing 5 in a similar manner as the barrel 4. These barrels are concentric and are open at the outer end so that there will be a central chamber 8 and a circular or outer chamber 9. A piston or plunger 10 is provided with a central plunger section 11 and an outer annular plunger section 12. These sections merge together into a knob 13 whereby the plunger 10 may be moved in and out as desired.

As it will be hereinafter noted the plunger 10 when pulled out acts to draw in air to the outer chamber 9 and to draw fluid into the central or inner chamber 8. Also, the parts are so proportioned that the adaptor or valve 3 is reversed as soon as the plunger 10 has been moved out to its extreme outer position and then moved in a very short distance toward its inner position. When the adaptor 3 is reversed and the plunger 10 is forced inwardly the air in the outer chamber will be forced through the outlet member 2 and the fluid in the central chamber will be discharged out through the fluid discharge member 14 and guided by a suitable flexible pipe 15 to a desired point or to a suitable container. It will be noted that from the outer chamber 9 a single passageway 16 leads, while from the inner chamber 8 two passageways, namely, passageways 17 and 18, lead. A valve key 19 is rotatably mounted in the casing 5 and is provided with passageways 20, 21, 22 and 23.

When the device is in the position shown in Figures 1 and 11, the first outward movement of the plunger 10 will draw in fluid through the outlet 2 through passageways 22 and 18 into chamber 9. At the same time air will be drawn in from a suitable container or filter, or some other supply, through the flexible pipe 24 through the hollow projection 25 and through passageways 20 and 18 into the central chamber.
8. The sucking action of the plunger will continue until the parts have been moved to their extreme outer positions as soon as moved to the extreme outer position the direction of movement of the plunger is reversed, and, as hereinafter fully described, will rotate the key 19 so that it will assume the position shown in Figure 1, whereas the air in the central chamber 8 would passageway 17 through passage ways 21, 22 through the outlet member 2, and thence into the spinal column to take the place of the fluid that has been withdrawn therefrom. At the same time that the air from the chamber 8 is forced into the spinal column the fluid in chamber 9 is forced out through the passageways 16 and 23 into the hollow projection 26, and thence through the pipe 15 to a container or suitable device for the reception of the fluid.

As the plunger completes its full inward movement the bar 29 and associated parts, as hereinafter fully described, will function and cause a reversal of the key 19 so that it will reassume the position shown in Figure 1, and at the second outward movement of the plunger, will again draw in the fluid into the inner chamber 9 and air passageway 22 into the inner chamber 8. This action is repeated as often as desired to secure the amount of fluid necessary.

Heretofore, it has been customary to draw out somewhere from 5 to 10 c.c. upon each action of the syringe and then later inject the same amount of air into the spinal canal. This is more or less objectionable as it first reduces the pressure appreciably in the spinal canal and then increases the pressure. It will thus be seen that by removing large quantities of the fluid from the spinal canal and then substituting therefor large quantities of air will necessitate an appreciable time interval between the removal of the fluid and the supply of air. This interval is the time necessary to withdraw the fluid, eject the fluid from the syringe, draw in air and then inject the air into the spinal canal. During this interval the brain and spinal cord are trying to adjust themselves to diminished pressure but by the time they have adjusted themselves to this diminished pressure, they have to re-adjust themselves again in order to get increased pressure by reason of the injection of the air. This, therefore, makes a constant back-and-forth or see-saw movement in the spinal canal and brain as the increased and decreased pressures take place, the same lasting by the method heretofore used from one to three minutes. This causes objectionable and severe reaction in the patient in the way of headaches and other reactions. In order to obviate the major part of the interval of diminution of pressure and the see-saw movement of the pressures in the intrathecal and intracranial cavities, the present invention enables the operator to save at least one-half of the time of the total procedure, and thus save the patient a major part of the see-saw movement of the pressures, and it avoids removing large quantities of fluid at one time.

In the syringe shown in Figure 1 very small quantities of fluid may be removed on each actuation of the device and the device, of course, may be actuated as many times as desired to secure the full quantity necessary for a given purpose, for instance, for a test or to relieve pressure produced by an accident on the spinal column or produced by some other cause. The syringe is adapted to draw one, two or more c.c.'s on each outward movement and inject on each inward movement the same volume of air, thus destroying the diminution of pressure almost as soon as it has been created. By the automatic shifting of the key 19 the plunger may be moved back and forth regularly and comparatively fast without injury to the patient so that in the reduced time interval 5 or 10 c.c.'s. could be removed but at no time could there be more removed than a very small quantity, as, for instance, 2 c.c.'s.

As illustrated in Figures 1 to 5 inclusive, it will be seen that the key 19 is held against movement in one direction by the screw 27 and in the opposite direction by the screw 28 acting in connection with a reversing bar 29 and certain associated parts. The reversing bar 29 is connected by screw 30 to a clamp 31 which through the use of a screw 32 is clamped firmly to the plunger 10 so that the bar 29 will reciprocate with the plunger 10.

The bar 29, as shown in Figures 4 and 5, is provided with an enlargement 33 which has a slot 34 in which the reduced extension 35 of the key 19 fits. This extension is provided with a pin 36 adapted to be struck by the respective projections 37 and 38 as the rod 29 functions. As shown in Figure 1, the extension 35 is struck and caused to swing over the pin 36 and this key 19 to the position illustrated in Figure 2. When the plunger moves outwardly for its full distance on the last part of its travel, the lug 37 strikes the pin 36 and swings this pin and the key 19 to the position shown in Figure 2, whereupon the ports in the key 19 are reversed. If it should be desired at any time to remove the key 19, this screw 30 could be removed and screw 28 also, as well as screw 27. The key 19 could then be slipped out of the casing 5 and replaced whenever desired. However, immediately before the plunger 10 moves to its extreme outer position, the rod 29 causes the abutment or lug 37 to rotate the key 19 to the position shown in Figure 2, and immediately before the plunger 10 has moved to its extreme outer position the abutment 39 begins to function and functions to reverse the ports of the key 19. This action is automatic and does not require any particular attention by the person using the device. It will thus be seen that as the plunger 10 is moved back and forth slowly the device functions to draw in air and fluid out of the outward stroke and force the air and fluid outwardly on the inward stroke, the fluid passing to a desired container and the air passing back through the needle 1 into the place from which the fluid has been drawn. By this construction and arrangement there is no time lost in shifting valves and providing a four-cycle action instead of a two-cycle action.

In Figures 6 and 7 a slightly modified structure is shown to that illustrated in Figures 1 to 5 inclusive. In these two figures modified structures will be given separate numbers and the remaining structures will use the numbers shown in Figures 1 and 2.

As shown in Figure 6, the casing 5 is provided with a division plate 39 so that the plunger 40 must be provided with a slot 41 for accommodating this division plate. As illustrated in Figure 8 a division plate 39 extends from one side to the other of the cylinder 42, and therefore, the sections 43 and 44 of the piston 40 act as separate plungers so that the chambers 45...
and 48 will act as the chambers 8 and 9. It will be understood that this form of the invention, as well as the form shown in Figure 1, may be made from any desired material or a combination of material without departing from the spirit of the invention.

In Figure 6 the parts are shown ready for an outward movement for drawing in a quantity of fluid. In Figure 7 the parts are shown in their reversed position so that when the piston has moved back to its inner position air will be forced into the spinal column, while the fluid previously drawn in will be forced into the container.

In Figures 8 and 9 a further modified form of the invention is shown and additional numbers will be given for the modified structure. The casing 5 in this form of the invention is provided with internally threaded bosses 47 and 48 for receiving the threaded extensions 49 and 50 of the respective cylinders 51 and 52. These cylinders are provided with plungers 53 and 54 which are connected to a suitable clamp 55, said clamp in turn being secured by a screw 30 to the rod 29. The plungers 53 and 54 are ready to move outwardly and draw in a supply of liquid into the cylinder 52 and a supply of air into the cylinder 51.

Figure 10 shows the same structure as illustrated in Figure 9 but with the plungers in their outer positions and starting inwardly. As the plungers move inwardly the air previously drawn into chamber 51 would be forced out through the discharge member 2 into the spinal column and the liquid from the cylinder 52 would be discharged through the pipe 15 to the container provided to receive the same.

It will be seen that in all forms of the invention the same rod 29 is used and also the same adaptor 3 for providing a switching of the fluid and air upon the return movement of the respective plungers. Also, in all forms of the invention the parts are automatic throughout and after it has once been placed in position, as illustrated in Figure 11, it is only necessary to pull the plunger outwardly and then force the same inwardly a desired number of times to secure a desired volume of fluid and replace the fluid with an equivalent in air.

1. An automatic displacement syringe including a pair of chambers, means in the chambers acting as plungers, a valve connected to said chambers, said valve having a key provided with four passageways and a casing having a center and two side discharge members and three passageways, two of said passageways continuously registering with one of said chambers and the other of said passageways registering with the remaining chamber, said key being positioned so that the passageways therein when in one position will register with two of said passageways, said central discharge member and one of said side discharge members, and when in a second position the other two passageways in the key will register with said central discharge member and the other of said side discharge members, and means for automatically rotating said key so that said plungers move from one extreme position to the other, all of said passageways being so arranged that when said plungers are moved to their extreme outer positions matter will be drawn into one of said chambers from the central discharge member and matter will be drawn into the other of said chambers through one of said side discharge members, and when said plungers are moved to an inner position the key will be changed to permit the matter previously drawn in to be discharged through the central discharge member and the other of said side discharge members.

2. A displacement syringe comprising means forming two chambers, a plunger arranged in each chamber, said plungers functioning as one, a valve connected to said chambers and means for shifting said valve automatically as the plungers move to an extreme outer position and an extreme inner position, said valve being provided with ports to draw in a supply of fluid from a source to one of said chambers as the plunger moves outwardly and at the same time draw in air to the other of said chambers, said valve being also constructed with ports so that when said plungers are moved inwardly the fluid drawn in will be discharged out of a different passageway and the air drawn in will be simultaneously discharged out through the fluid port so as to furnish a displacing agent for the withdrawn fluid.

3. A displacement syringe of the character described including a pair of simultaneously operating pump structures, each of said pump structures having a pair of passageways acting respectively as an inlet and an outlet, a rotatable valve constructed with ports so positioned that when said pump structure functions the fluid drawn in will be discharged out of a different passageway, and the air drawn in will be simultaneously discharged out through the passageway through which the fluid has been drawn in so as to furnish a displacing agent for the withdrawn fluid, and means operated by part of the pump structures for automatically actuating said valve for changing the ports thereof at the respective extreme positions of the pump structures.

4. A displacement syringe include means presenting a pair of pump structures, said pump structures operating simultaneously, a valve connected to said pump structures, said valve having a casing provided with a central outlet member and two side outlet members, said casing also being provided with three ports leading from the respective chambers of the two pump structures, two of said ports leading from one chamber, a valve key provided with four ports arranged so that two will connect the central outlet and one side outlet at one time with the respective chambers of said pump structures and the other two at a second setting to connect the respective pump structures with the central outlet and the other side outlet, said means connected to the pump structures for actuating said key at the beginning of each stroke.

5. A displacement syringe for medical purposes adapted to remove spinal fluid from the spinal canal and substitute air comprising two cylindrical members open at both ends, a valve having a casing, said cylindrical members having one end embedded in said casing, said cylindrical members being arranged concentrically, a plunger having an inner tubular section fitting within the inner cylinder, an outer annular section fitting within the outer cylinder and exteriorly of the inner cylinder, and means actuated by said plunger for shifting from ports of said valve so that on the outward stroke fluid from the spinal canal will be drawn into one of said cylinders and air will be drawn into the other.
and upon the inward stroke the fluid drawn in will be discharged at a given point and the air drawn in will be forced into the spinal canal.

A displacement syringe for medical purposes adapted to remove spinal fluid from the spinal canal and substitute air therefor comprising a cylinder, a valve connected to one end of said cylinder, said valve having a division plate extending therefrom merging into said cylinder whereby said cylinder for the length of said division plate is divided into two chambers, a plunger formed with a bifurcated structure of a shape to fit into said chambers and means connected with said plunger for automatically shifting the ports in said valve whereby when said plunger is moved outwardly spinal fluid will be drawn into one of said chambers and air into the other and when the plunger is moved inwardly the drawn-in spinal fluid will be discharged at a given point, and the drawn-in air will be forced into the spinal canal, said air and fluid being of the same volume.

7. A displacement syringe for medical purposes adapted to remove spinal fluid from the spinal canal and substitute air therefor comprising a pair of cylinders, a single valve connected to both of said cylinders, a plunger arranged in each cylinder, a clamp for connecting said plungers so they will work in unison, and means actuated by said clamp for causing said valve to shift its ports as said plungers move to their respective extreme positions whereby when said plungers move outwardly spinal fluid will be drawn in one of said cylinders and air of the same volume into the other cylinder and when said plungers are forced inwardly said air will be forced into the spinal canal and the fluid will be forced out through a discharge point.

8. A displacement syringe of the character described including a pair of simultaneously operating pump structures constructed so that each pump structure will draw in the same volume of matter on the intake stroke each of the pump structures having a pair of passageways respectively acting as inlet and outlet openings, a valve having four ports, there being one port for each of said passageways, said ports being so positioned that when said pump structures function, one pump structure will draw in fluid through one of said passageways and one of said ports, while another pump structure will draw in air through a second passageway and a second port, said pump structures when functioning on the return stroke acting to force the air previously drawn in out through a third passageway and a third port and into the space from which the fluid has been drawn so as to furnish a displacement agent for the withdrawn fluid and simultaneously discharge the fluid previously drawn in out through a fourth passageway and a fourth port, and means operated by part of the pump structures for automatically changing the ports of the valve at the respective extreme positions of the pump structures.

9. A displacement syringe for medical purposes including means for substituting air in the spinal canal for the spinal fluid, including a pair of reciprocating pumps each having an inlet and an outlet passageway and a rotatable valve having a port for each of said passageways functioning to cause the spinal fluid to flow out of the spinal canal through one of said ports and one of said passageways into one of the pumps on the outward stroke of said pump, and an equal volume of air to flow into the spinal canal through a second passageway and a second port from the other pump on the return stroke of said pumps, the first mentioned pump discharging the spinal fluid on said return stroke through a third passageway and a third port.

FRANK LIBERSON.