Nov. 1, 1949. S. A. HENDERSON 2,486,405

TIDAL IRRIGATOR AND CYSTOMETER

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Fig. 1.

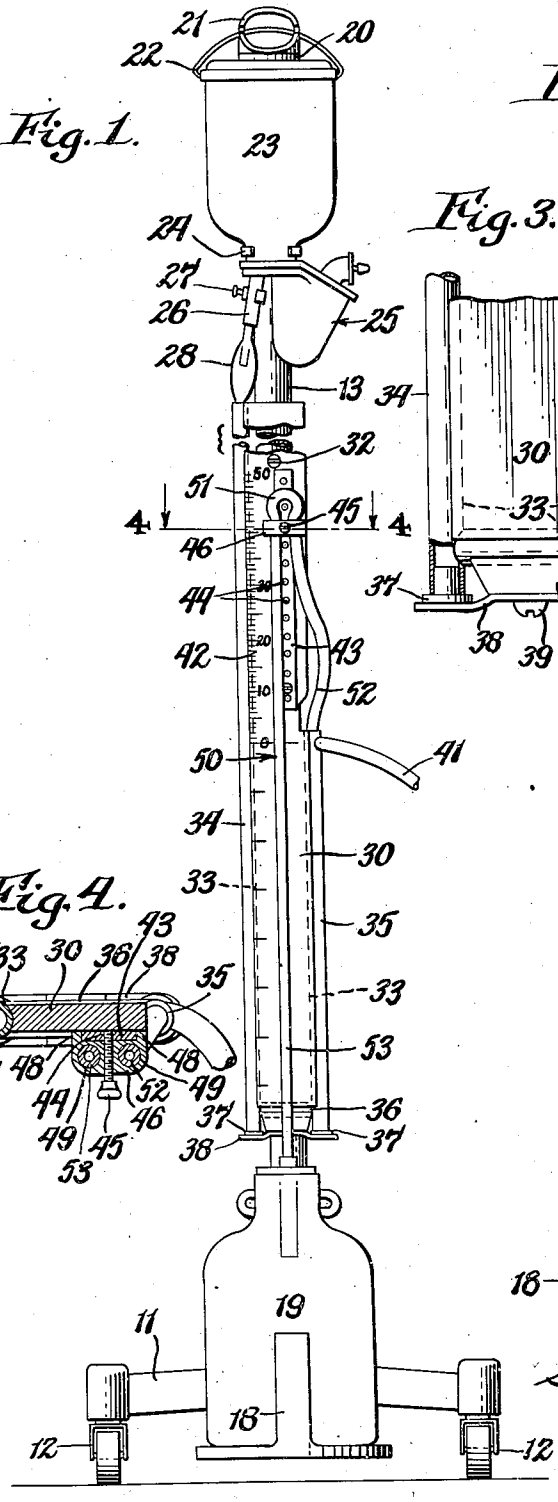


Fig. 2.

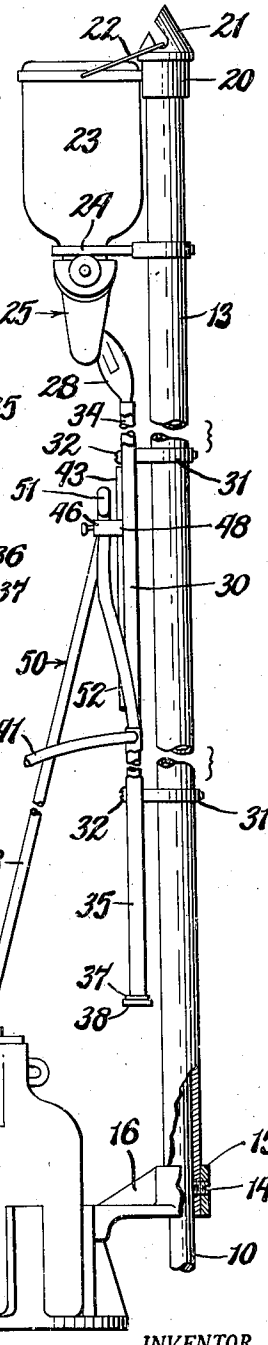


Fig. 3.

Fig. 4.

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TIDAL IRRIGATOR AND CYSTOMETER

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15 Claims. (Cl. 128—227)

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This invention relates to a tidal irrigator and cystometer and more particularly to such an irrigator and cystometer used for regular alternate emptying and filling of the bladder and for making cystometrograms. Such apparatus is particularly successful in caring for functional changes in association to the spinal cord and cauda equina or wherever alternate drainage and filling of the bladder is indicated.

One of the principal objects of the present invention is to provide such a tidal irrigator which is simple in construction and efficient in operation and in particular is devoid of complicated connections, reservoirs and valves, its operational principle being based on gravity.

Another object is to provide such a tidal irrigator which can be operated with a minimum attention on the part of the operator.

Another object is to provide such a tidal irrigator which can be easily cleaned and sterilized, a small number of large and uniformly sized, readily accessible tubes being used in its construction for this purpose.

Another object is to provide a stable, simple, accurate and readily adjusted control for regularly emptying and refilling the bladder at an adjustable level of intravesical pressure, in particular in which the control of the operation of the irrigator is through an air lock in contradistinction to the restricted orifices heretofore used, the air lock of the present invention avoiding the disadvantages inherent in a control depending upon a restricted orifice and also insuring against air entering the drainage legs until the bladder is fully emptied, thereby to insure complete emptying of the bladder on each alternation of the irrigator.

Another object is to provide such a tidal irrigator, the operation of which can be readily explained to house officers and nurses.

Another object is to provide such a tidal irrigator which can be used for making cystometrograms.

Other objects and advantages of the invention will appear from the following description and drawings in which

Fig. 1 is a front elevational view of a tidal irrigator and cystometer embodying the present invention.

Fig. 2 is a fragmentary side elevational view thereof.

Fig. 3 is an enlarged fragmentary front elevational view, partly in section, of a part of the apparatus.

Fig. 4 is an enlarged horizontal section taken on line 4—4, Fig. 1.

The tidal irrigator, and cystometer forming the subject of the present invention is adapted to be readily moved to and from the bedside of the patient to be treated and for this purpose is

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shown as comprising an upright standard including a supporting rod 10 mounted on a spider 11, the arms of which have casters 12 which permit the irrigator to be readily rolled from place to place. A tube 13 is telescopically supported on the upright rod 10 and is held at any adjusted elevation by a setscrew 14. This setscrew also extends through and supports the tubular support 15 for an arm or bracket 16 carrying a stand or platform 18 for a waste or drainage bottle 19, this tubular portion 15 embracing the lower end of the telescopic tube 13.

The upper end of the telescopic tube 13 is provided with a cap 20 having an angularly disposed cylindrical extension 21 which is provided with a pair of opposite, axially extending slots to receive and support the bottom bail 22 of an inverted reservoir bottle 23 which contains the solution used in irrigating the bladder. The neck of this inverted reservoir bottle 23 is carried in a pair of prongs of a supporting bracket 24 projecting outwardly from the telescopic supporting tube 13 and to this neck is secured a conventional air vent stopper 25. The outlet from this air vent stopper connects with a flexible tube 26 provided with a conventional hose clamp 27 which can be adjusted to regulate the rate of discharge of the solution from the reservoir bottle 23. The lower end of the flexible tube 26 connects with a conventional transparent dropper 28 through which the rate of discharge of the solution can be observed and timed.

The remainder of the parts are supported by an upright elongated panel 30 carried by upper and lower brackets 31 projecting outwardly from the telescopic supporting tube 13. This panel 30 is preferably made of a transparent plastic and can be secured to the brackets 31 so as to be readily removable therefrom by screws 32 or in any other suitable manner. This panel 30 is provided along its bottom edge, one vertical edge and the lower part of its opposite vertical edge with a rounding groove 33 adapted to receive the two parallel upright transparent branch tubes 34 and 35 and a horizontal tube 36 connecting the two parallel branch tubes 34 and 35 a short distance above their lower ends. It will be seen that the tubes 34, 35 and 36 constitute a U-tube having upright branches. This horizontal connecting tube 36 is fused air tight to the lower ends of the branch tubes 34 and 35. The three so connected tubes or U-tube 34, 35 and 36 can be secured in the grooves 33 cementitiously or in any other suitable manner.

The lower end of each of the branch tubes 34 and 35 is closed by a removable stopper 37. These stoppers are held in the branch tubes by the ends of a leaf spring 38 pivoted at its center, as indicated at 39, to a block 40 shown as secured to the underside of the connecting tube 36. By

the simple expedient of turning the leaf spring about the pivot 39 its ends are removed from under the stoppers 38 which can then be readily removed to permit cleaning of the U-tube 34, 35, 36.

The upright branch tube 34 is higher than the upright branch tube 35, the former rising to the top of the panel 30 and having an open upper end into which the solution from the bottle or reservoir 23 is discharged by the dropper 28. The shorter branch tube 35 is provided near its top with a horizontal branch or nipple which is connected with a length of flexible tubing 41. The opposite end of this length of flexible tubing is connected with a catheter (not shown) of the type ordinarily used in irrigating the bladder of a patient. The connection between the shorter branch tube 35 and the length of flexible tubing 41 is disposed at the zero point on a vertical scale 42 provided on the upper part of the panel 30, this scale being preferably calibrated in centimeters of water above its zero level. The zero point on the scale 42 also represents the symphysis level and must be adjusted to the patient's symphysis pubis.

A vertical metal strip 43 is secured to the forward face of the plastic panel 30 alongside this scale 42. This metal strip is provided with a vertical series of uniformly spaced threaded holes 44 adapted to receive a thumb screw 45. This thumb screw extends through a threaded hole in a supporting block 46 having side flanges 48 which embrace the sides of the metal strip 43 so as to hold the supporting block 46 in the horizontal position shown. This supporting block is provided with a pair of spaced vertical bores 49 through which a length of flexible tubing 50 is passed so as to form a small upstanding siphon loop 51 above the block 46. One end 52 of the flexible tubing 50 has an air tight connection with the upper end of the shorter branch tube 35 while its other end 53 discharges into the waste bottle 19. The outlet of the end 53 of the tubing 50 is at a lower level than the U-tube 34, 35 and 36, the tubing 50 providing a siphon having a long leg 53.

In the use of the tidal irrigator and cystometer, with the reservoir bottle 23 filled with any of the usual solutions used in bladder irrigation, the symphysis level marked by the zero point of the scale 42 on the panel 30 is adjusted to the level of the patient's symphysis pubis by loosening the setscrew 14 and raising or lowering the telescopic tube 13 of the standard along the supporting rod 10 of the standard and thereafter tightening the setscrew 14. Since the panel 30 is fast to the telescopic tube 13 of the standard it will be seen that the zero point of the scale 42 can be brought to any level. Following this the operator adjusts the height of the loop 51 to provide the desired intravesical pressure which the patient requires. This vertical adjustment of the loop 51 is readily effected by unscrewing the thumb screw 45 far enough to release it from the corresponding threaded hole 44 in the metal plate 43 and moving the block 46 up or down to adjust the loop 51 to the desired level. Following this the thumb screw 45 is screwed into one of the series of holes 43 at the selected level to retain the loop 51 at this level.

The operation then opens the hose clamp 27 to allow the irrigating solution to drip by gravity from the reservoir bottle 23 at any desired rate—usually from 30 to 60 drops per minute. The irrigating solution removed from the reservoir bottle 23 is replaced by air admitted by the air vent stopper 25 for the reservoir bottle, and the irrigating solution passes from the conventional dropper 28 into the upper end of the branch tube 34, which upper end is open to the atmosphere.

The solution dripping into the open upper end of the branch tube 34 at the rate determined by the hose clamp 27 flows to the bottom of this tube, across the connecting tube 36, into the other branch tube 35 and fills all three of these tubes, the solution level in both vertical branches 34 and 35 formed by this U-tube rising equally. When this level rises to the zero mark on the scale 42, the solution flows through the flexible tubing 41 into the bladder. When the bladder is filled to capacity, or to the optional intravesical pressure as determined by the elevation of the siphon loop 51, the pressure of the accumulating solution in the branch tube 34 forces the solution to rise in the end 52 of the length of flexible tubing 50 leading to the siphon loop 51. When this column of solution reaches the top of the siphon loop 51, it spills over the loop emptying into the end 53 of the flexible tubing leading to the waste bottle 19. At the point of spill-over, siphon action is initiated and negative pressure is established in the end 52 of the flexible tubing 50 which will either lift the column of solution in the vertical branch tube 35, or will draw the solution from the bladder. Since it is easier to siphon liquid from a reservoir closer to the force of negative pressure (as the solution in the bladder) than to lift a column of liquid against gravity (as the column of solution in the vertical branch tube 35), the bladder is emptied first, while the solution in the vertical branch tube 35 acts as an air lock. Only after the bladder is completely empty will the column of solution in the vertical branch tube 35 be lifted and the air lock broken, terminating siphon action and completing the irrigation-drainage cycle.

The cycle then automatically repeats itself so that alternate filling and emptying of the bladder is automatic, and requires no attention except to fill the reservoir bottle 23 with the solution and to empty the waste bottle 19. To check the circuit for obstruction, the operator observes the presence or absence of up and down excursions of the solution column in the vertical branch tube 34. These excursions indicate respiratory movements as transmitted by the bladder and if absent indicate obstruction within the lumen of the catheter or tubing.

The fact that, during siphoning, the column of solution in the vertical branch tube 35 acts as an air lock until the bladder is completely emptied and that air cannot enter the siphon circuit until the negative pressure of the siphon circuit has raised the solution from the branch tube 35 until air is allowed to enter from the connecting tube 36 is one of the important features that give the irrigator of the present invention its stability and superiority over similar apparatus used for this work.

The apparatus now in common use for bladder irrigation attempts to control the siphon break by retarding the air inflow to the siphon. While this method will operate satisfactorily when properly adjusted and under ordinary conditions, it is apt to be erratic in operation, particularly when set up by one who is not thoroughly familiar with the apparatus. The sensitivity to adjustment is mainly caused by the small differential pressures between the incoming air and the siphon demand supplied by the bladder solution.

If this demand is not as required, then the incoming air will meet this demand causing the siphon to break and ending further drainage from the bladder.

This variation may be created by several conditions, such as obstruction in the bladder tubing, using a catheter or tubing with too small a lumen, by heavy viscous material being drained from the bladder, by small air bubbles in the bladder tubing, or it may be caused by the patient's voluntarily altering the bladder pressure.

These conditions which are met in irrigating work will not affect the operation of the present apparatus unless carried to an extreme, because in order to break the siphon the condition tending to cause this break must resist a negative pressure equal to the weight of solution in the column below the plane of the bladder.

It will be noted that the panel **30** is scaled as indicated at **42** in centimeters of water for the purpose of making cystometric determinations. With a convenient height of the panel **30** and the vertical branch tube **34**, readings are usually only possible up to 50 centimeters. Therefore, cystometric determination of hypertonic dysfunction of the bladder will be incomplete, as will determinations of maximum voluntary effort pressures. However, this panel and vertical branch tube could be increased to permit such determinations and the shorter scale is adequate for determining the optional intravesical pressure at which the siphon loop **51** should be set for all types of therapy in bladder dysfunction. For cystometry the symphysis or zero mark on the scale **42** is set at the level of the patient's symphysis pubis, the circuit is filled, air free, with sterile normal saline or sterile water, and a clamp applied to the end of the flexible tubing **41** which connects to the catheter. The column of liquid in the vertical branch tube **34** is then adjusted to zero on the scale **42**, by allowing more liquid to run into the tube if below zero, or allowing some of the liquid to escape from the flexible tube **41** connecting with the catheter if above zero. When the level is so adjusted to zero, the operator clamps the flexible tubing **41** connecting with the catheter. The operator then clamps the end **52** of the flexible tubing **50**, which end connects the vertical branch tube **35** with the siphon loop **51**. The operator then notes and charts the liquid level in the reservoir bottle **23** at this zero reading. He then loosens the clamp from the flexible tubing **41** leading to the catheter and opens the hose clamp **27** to allow the liquid to drip into the system at some 30–60 drops per minute. From here on procedure is the same as for any other type of cystometric determination. Increments of 50 cc. to 100 cc. of liquid are run into the bladder from the reservoir bottle **23**, which is preferably graduated for this purpose, and readings are taken from the scale **42** on the panel **30**. The clamp placed on the end **52** of the flexible tubing **50** between the vertical branch tube **35** and siphon loop **51** should not be removed while cystometric determination is being made.

To clean and sterilize the apparatus, the operator releases the neck of the reservoir bottle **23** from the holding prongs of the bracket **24**, disconnects the lower end of the dropper **28** and lifts the reservoir bottle **23** from the standard. The flexible tubing connections are then removed. The assembly of the panel **30** and U-tube **34, 35, 36** is then disconnected by removing the screws **32** which secure the panel to the telescopic tube **13** of the standard. The waste bottle **19** is removed

and the siphon loop **51** is removed by unscrewing the thumb screw **45**. The leaf spring **38** at the bottom of the panel **30** is then given a half turn to the right or left about its pivot **39** and the stoppers **37** removed from the lower end of the vertical branch tubes **34, 35**. The operator then soaks all flexible tubing, the reservoir bottle **23**, dropper **28** and stoppers in a soap solution and cleanses until all encrustations and discolorations are removed. The vertical branch tubes **34, 35** fixed to the panel **30** are cleaned with a long handled brush which is soaked and inserted through the lower ends of these vertical branch tubes and moved with a piston action. The transverse connecting tube **36** at the bottom of the panel **30** is cleaned by threading a piece of soap-saturated gauze or cotton on an applicator. All soap-cleaned parts are thoroughly rinsed. Following this the apparatus is reassembled and preferably sterilized with cyanide of mercury before reuse.

It will particularly be noted that the construction of the apparatus, particularly the mounting and stoppering of the U-tube assembly **34, 35, 36** carried by the panel **30**, greatly facilitates this cleaning operation.

From the foregoing it will be seen that the present invention provides a simplified but thoroughly efficient tidal irrigator and cystometer which is devoid of complicated connections, reservoirs and valves, its operational principle being based on gravity, siphon action and negative hydrostatic pressure so as to be accurate, sensitive and stable. Further, the unit is so constructed that minimal attention is required in its automatic operation and so that it can be easily cleaned and sterilized.

I claim:

1. A tidal irrigator, comprising a U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of tubing connected with the other branch of said U-tube a substantial distance above the bottom thereof and adapted to be connected with the bladder of the patient, and a second length of tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle.

2. A tidal irrigator, comprising a rigid U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of flexible tubing connected with the other branch of said U-tube a substantial distance above the bot-

tom thereof and adapted to be connected with the bladder of the patient, and a second length of flexible tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of flexible tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of flexible tubing, thereafter fills said first length of flexible tubing and the bladder, thereafter fills said one end of said second length of flexible tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of flexible tubing to establish siphonic action and negative pressure in said one end of said second length of flexible tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle.

3. A tidal irrigator, comprising a U-tube having long and short upstanding branches, means for admitting measured amounts of liquid into the longer branch of said U-tube, a generally horizontal length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of of the patient, a second length of tubing connected with the upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle.

4. A tidal irrigator, comprising a standard, a U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of tubing connected with the other branch of said U-tube a substantial distance above the bottom thereof and adapted to be connected with the bladder of the patient, means for supporting said U-tube on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and said other branch of said U-tube to the level of the patient's symphysis pubis, and a second length of tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle.

5. A tidal irrigator, comprising a U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of tubing connected with the other branch of said U-tube a substantial distance above the bottom thereof and adapted to be connected with the bladder of the patient, a second length of tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle, and means for adjusting the elevation of said siphon loop with reference to said U-tube to adjust said intravesical pressure.

6. A tidal irrigator, comprising a standard, a U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of tubing connected with the other branch of said U-tube a substantial distance above the bottom thereof and adapted to be connected with the bladder of the patient, means for supporting said U-tube on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and said other branch of said U-tube to the level of the patient's symphysis pubis, a second length of tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of tubing extending upwardly from

its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle, and means for adjusting the elevation of said siphon loop with reference to said U-tube to adjust said intravesical pressure.

7. A tidal irrigator, comprising a standard, a U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of tubing connected with the other branch of said U-tube a substantial distance above the bottom thereof and adapted to be connected with the bladder of the patient, means for supporting said U-tube on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and said other branch of said U-tube to the level of the patient's symphysis pubis, a second length of tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle, and a vertical scale fixed to said U-tube and having a lower zero point level with said connection between said generally horizontal length of tubing and said other branch of said U-tube to indicate said symphysis level, said scale being graduated to indicate the elevation of said liquid in said one branch of said U-tube.

8. A tidal irrigator, comprising a standard, a U-tube having upstanding branches, means for admitting measured amounts of liquid into one branch of said U-tube, a generally horizontal length of tubing connected with the other branch of said U-tube a substantial distance above the bottom thereof and adapted to be connected with the bladder of the patient, means for supporting said U-tube on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and said other branch of said U-tube to the level of the patient's symphysis pubis, a second length of tubing having one end connected with said other branch of said U-tube a substantial distance above the bottom thereof, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of said U-tube whereby admitting measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said other branch of said U-tube provides an air lock and thereafter lift said column of liquid in said other branch of said U-tube until air is drawn through the lower end of said U-tube to break said siphonic action and complete the cycle, means for adjusting the elevation of said siphon loop with reference to said U-tube to adjust said intravesical pressure, and a vertical scale fixed to said U-tube alongside said one branch of said U-tube and said siphon loop and having a lower zero point level with said connection between said generally horizontal length of tubing and said other branch of said U-tube to indicate said symphysis level, said scale being graduated to indicate the level of said liquid in said one branch of said U-tube and the elevation of said siphon loop.

9. A tidal irrigator, comprising a support, a vertical panel, a rigid U-tube secured to said panel and having long and short upstanding branches, means for admitting measured amounts of liquid into the longer branch of said U-tube, a generally horizontal flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a record length of flexible tubing having one end connected with the upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first

empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure.

10. A tidal irrigator, comprising a support, a vertical panel, a rigid U-tube secured to said panel and having long and short upstanding branches, means for admitting measured amounts of liquid into the longer branch of said U-tube, a generally horizontal flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a second length of flexible tubing having one end connected with the upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure comprising a vertical series of holes provided in said panel, a holder for said siphon loop, and a pin on said holder and insertable into any of said holes to adjust said siphon loop to a corresponding elevation.

11. A tidal irrigator, comprising a support, a vertical panel, a rigid U-tube secured to said panel and having long and short upstanding branches, means for admitting measured amounts of liquid into the longer branch of said U-tube, a generally horizontal flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a second length of flexible tubing having one end connected with the upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure, comprising a vertical series of threaded holes provided in said panel at the upper end thereof, a holder for said siphon loop, and a screw threaded in an opening extending through said holder and adapted to be screwed into any of said holes to adjust said siphon loop to a corresponding level.

12. A tidal irrigator, comprising a support, a vertical panel, a rigid transparent U-tube secured to said panel and having long and short upstanding branches, means for admitting measured amounts of liquid into the longer branch of said U-tube, a generally horizontal flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a second length of flexible tubing having one end connected with the upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure, said panel being provided with a vertical scale having a zero point level with said connection between the generally horizontal length of tubing and said shorter branch of said U-tube to indicate said symphysis level, and said scale being graduated to indicate the elevation of said liquid in said longer branch of said U-tube and the elevation of said siphon loop.

13. A tidal irrigator, comprising a support, a vertical panel, a rigid U-tube secured to said panel

and having long and short upstanding branches open at their upper and lower ends and a horizontal tube connecting said branches adjacent the lower ends thereof, a stopper in the lower end of each of said branches, means for admitting measured amounts of liquid into the open upper end of the longer branch of said U-tube, a generally horizontal flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a second length of flexible tubing having one end connected in sealed relation to the open upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure.

14. A tidal irrigator, comprising a support, a vertical panel, a rigid U-tube secured to said panel and having long and short upstanding branches open at their upper and lower ends and a horizontal tube connecting said branches adjacent the lower ends thereof, a stopper in the lower end of each of said branches, a latch carried by said panel and engageable with said stoppers to retain them in said branches, means for admitting measured amounts of liquid into the open upper end of the longer branch of said U-tube, a generally horizontal flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a second length of flexible tubing having one end connected in sealed relation to the open upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure.

15. A tidal irrigator, comprising a support, a vertical panel, a rigid U-tube secured to said panel and having long and short upstanding branches open at their upper and lower ends and a horizontal tube connecting said branches adjacent the lower ends thereof, a stopper in the lower end of each of said branches, a spring leaf pivoted at its center on said panel to swing about a vertical axis between said stoppers and arranged with its ends to engage the undersides of said stoppers and retain them in said branches, means for admitting measured amounts of liquid into the open upper end of the longer branch of said U-tube, a generally horizontally flexible length of tubing connected with the upper end of the shorter branch of said U-tube and adapted to be connected with the bladder of the patient, means supporting said panel on said standard for adjustment in a vertical direction to permit of adjusting the connection between said generally horizontal length of tubing and the shorter branch of said U-tube to the level of the patient's symphysis pubis, a second length of flexible tubing having one end connected in sealed relation to the open upper end of said shorter branch of said U-tube, said second length of tubing extending upwardly from its connection with said U-tube and being formed to provide an elevated siphon loop and its other end extending downwardly below the bottom of the U-tube whereby admitting said measured amounts of liquid first fills said U-tube to the level of said first length of tubing, thereafter fills said first length of tubing and the bladder, thereafter fills said one end of said second length of tubing to said siphon loop to provide an intravesical pressure determined by the elevation of said siphon loop, and thereafter spills over said siphon loop into said other end of said second length of tubing to establish siphonic action and negative pressure in said one end of said second length of tubing thereby to first empty the patient's bladder while the column of liquid in said shorter branch of said U-tube provides an air lock and thereafter lift said column of liquid in said shorter branch of said U-tube to break said siphonic action and complete the cycle, and means carried by said panel for adjusting the elevation of said siphon loop to adjust said intravesical pressure.

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No references cited.