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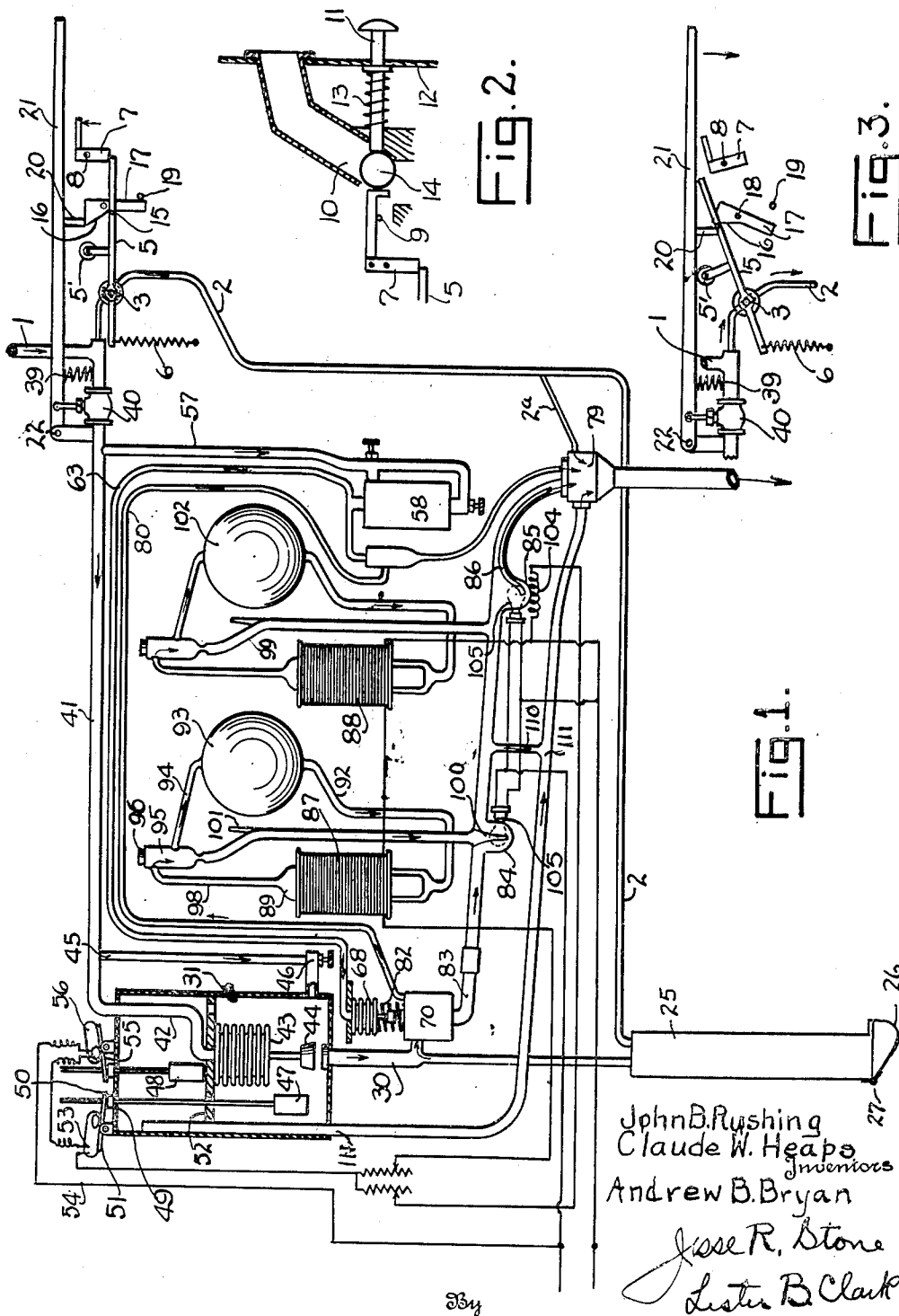
C. W. HEAPS ET AL

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DEVICE FOR MAKING URINE ANALYSIS

Filed Aug. 1, 1933

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

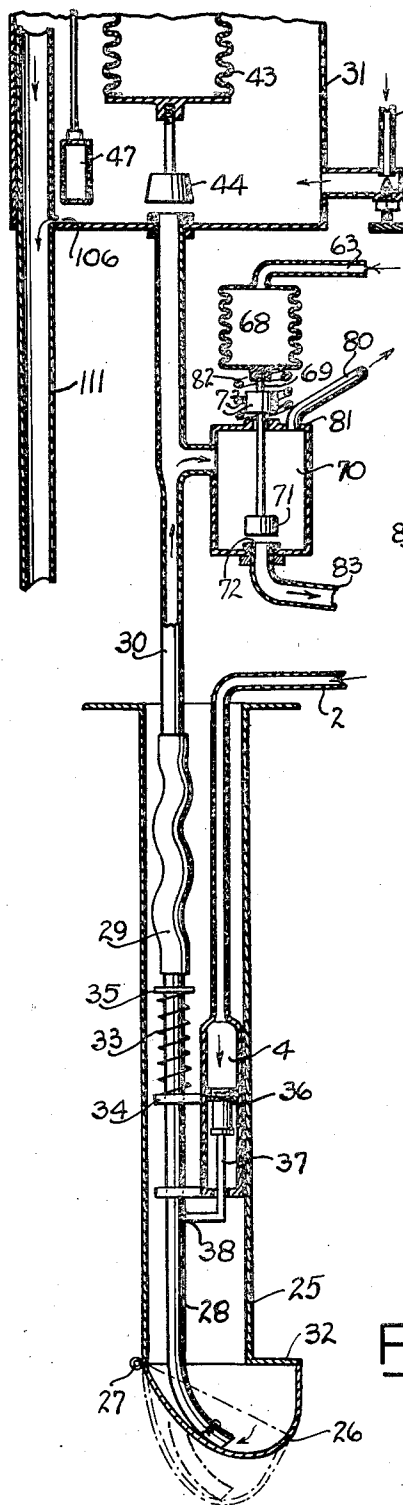


Fig. 4.

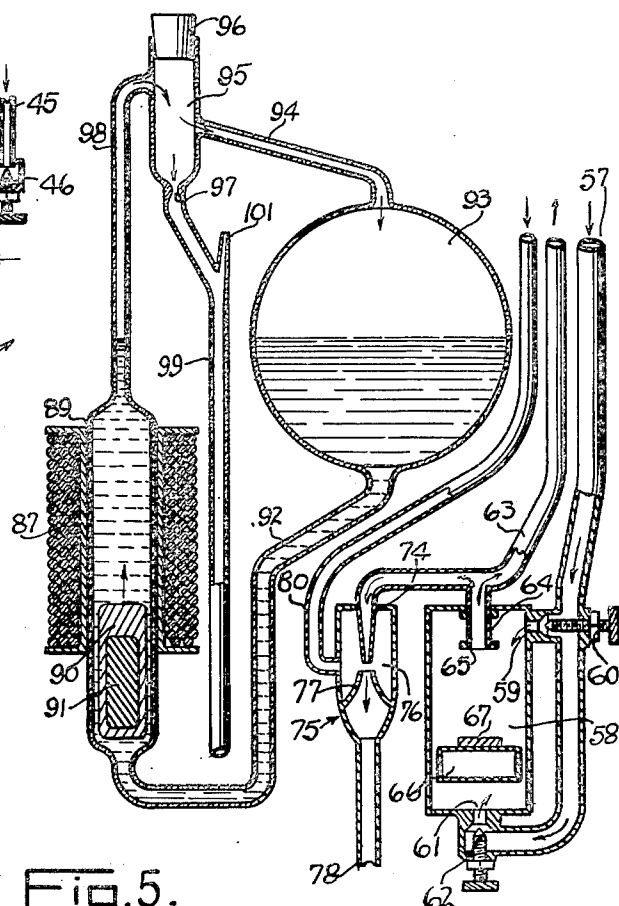


Fig. 5.

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DEVICE FOR MAKING URINE ANALYSIS

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13 Claims. (Cl. 23—253)

Our invention relates to an apparatus for automatically making tests to determine the presence of albumen or sugar in urine.

We desire to provide a machine wherewith one desiring a test of this character can make the said test himself with the assistance of the apparatus which we have provided.

It is an object of the invention to provide such a device in which the control of the various elements employed in making the test is obtained through the flow of liquid under pressure, such as may be found, for example, in the usual municipal water system.

We further aim to provide an apparatus in which the parts making up the complete device are of simple construction, not easily gotten out of order in the operation of the device. We contemplate the production of an apparatus which may be easily operated by the ordinary layman, and which will clearly disclose the information desired without the necessity of a technical knowledge or operation in the performance of the test on the part of the operator.

The invention lies in the particular structure, arrangement, and cooperation of the parts making up the complete device, a clear understanding of which will be obtained from the description and the drawings herewith in which:

Fig. 1 is an assembly view in front elevation of our device, certain parts being in section for greater clearness.

Fig. 2 is a broken sectional detail illustrating one type of coin-control which may be employed.

Fig. 3 is a detail of the control mechanism similar to that shown in Fig. 1, but with the parts in different positions.

Fig. 4 is a vertical sectional detail, somewhat enlarged, of the parts shown in Fig. 1.

Figs. 5 and 6 are central vertical sections through portions of the operating mechanisms which are employed.

In carrying out our invention it is a general purpose of the device to deliver into small receptacles or bulbs a sample of the liquid which is to be tested together with the necessary re-agents by which the presence of albumen or sugar may be shown, and to then clear the receptacle employed in the test of the material therein.

In carrying out this invention, we provide a system of tubes and conduits which are connected up for the automatic carrying out of our inventive idea. Referring particularly to Fig. 1, the device is shown as adapted for connection to a system of water under pressure. This is done through the pipe 1 shown at the upper right-hand portion of Fig. 1. This pipe is connected with an outlet conduit 2 in which is placed a valve 3. The conduit 2 is adapted to discharge water from the main into a cylinder 4 shown in Fig. 4.

Ordinarily the valve 3 is held in closed position by a lever 5 secured to said valve and extending beyond the valve for connection with a spring 6 which tends to hold the lever arm 5 upwardly against a stop-arm 7, the valve then being in closed position.

The stop-arm 7 is part of a bell crank lever pivoted at 8 to the supporting frame and having one arm thereof resting upon a pin 9 with the end of said arm adjacent to a passage 10 through which a coin may be dropped. Opposite the end of the lever arm is a push pin 11 extending through the wall 12 of the frame or cabinet in which the device is mounted. A spring 13 normally holds the push pin outwardly away from the passage 10. If the pin is pushed inwardly it cannot quite contact with the end of the lever 7. When the coin shown at 14 is dropped into the passage or chute 10 it will fit between the end of the push pin and the lever and enable the operator to exert a push or thrust upon the bell crank lever tipping it into the position shown in Fig. 3, and releasing the end of the lever 5 allowing it to be drawn upwardly into the Fig. 3 position.

There is a laterally projecting pin 15 on the lever 5 which bears against a cammed surface 16 upon a dog 17 pivoted upon a pin 18 in the frame. There is a lower stop pin 19 which limits the swinging of the dog 17 in one direction on its pivot. The upper end of the dog 17 furnishes a stop for a pin 20 projecting downwardly from an operating lever 21. With the dog in its erect position the pin 20 will contact with the dog and prevent the lever from being operated. However, when the lever arm 5 moves upwardly the pin 15 will contact with the cammed surface 16 and push this dog aside into the position shown in Fig. 3, thus releasing the pin 20 upon the lever 21 and allowing said lever to be moved manually downward upon its pivot 22.

After the coin has been inserted and the stop member 7 has been moved to release the lever 5, the water may flow through the tube 2 to the cylinder 4, seen in Fig. 4. The effect of this flow of water will be to open up the lower end of a housing 25. As will be noted, the lower end of said housing is formed into a cup-shaped member 26 hinged to the housing at 27. Said cup 26 is connected on its inner side to the lower curved end of a small pipe 28 which extends vertically upwardly in the housing 25, and is connected in said housing by a flexible hose, or connecting member 29, to the tube 30 extending upwardly from said housing and connected at its upper end within the lower wall of the reservoir 31 to provide an outlet therefor. The pipe 28 is held in an upper position with the cup 26 closed against the lower wall 32 upon the housing by means of a spring 33 bearing at its lower end against a

plate 34 in the housing and at its upper end against a washer 35 fixed upon the pipe 28.

Within the cylinder 4, the water from the tube 2 may act upon a piston 36, having on its lower side a stem 37, which is connected at 38 to the pipe 28. Thus, water pressure in the cylinder 4 will force the piston 36 downwardly carrying with it the pipe 28 to force the cup 26 at the lower end of the housing into open position as shown in dotted lines in Fig. 1. The sample of urine may then be introduced into the cup 26 and the next operation in the handling of the test may be made.

This operation consists in pulling down upon the lever 21 which has been released as previously noted. There is a spring 39 which ordinarily holds the lever 21 in elevated position. When the lever 21 is pulled down the pressure on the wheel 5' depresses the lever 5 until its end is again engaged under the stop arm 7. The valve 3 is thus closed. The water pressure in the chamber 4 is now slowly decreased by leakage through the capillary tube 28, so that after a sufficiently long time the spring 33 causes the tube 28 to move upwardly, thus closing the cup 26. This closure is effected after the urine has been sucked out of the cup. By moving the lever arm 21 downwardly, a valve 40 in the water line is opened to allow the flow of fluid into the pipe 41 which leads by one branch 42 to a syphon element 43. Said element is within a container or reservoir 31 previously noted.

Within said reservoir is a valve member 44 secured upon a stem projecting downwardly from the syphon element 43. Thus, when the water under pressure flows into said element, the valve 44 will be moved downwardly to close the outlet through the tube 30. The receptacle may then start to fill up with water through the branch line 45 of the pipe 41 which is connected to the lower end of said reservoir. There is a needle valve at 46 through which the flow may be restricted to the desired amount so that the reservoir will fill up at the speed desired.

Within the reservoir are two floats 47 and 48. The float 47 projects through a guide opening in a partition 52 in the reservoir, and has a flange 49 thereon which is adapted to engage an arm upon a mercury switch 51 pivoted to rock upon the upper wall of the reservoir. As will be noted, this switch is normally in open position, but when the float raises the stem it will move the mercury switch to close the contact between the two terminals 53 in an electric circuit 54. There is an overflow pipe 111 extending from a point adjacent the upper end of said reservoir downwardly and connected with the drain 79.

When the water rises above the partition 52, the float 48 will be then raised to move the arm 55 of the mercury switch 56, the normal position of which is to close the circuit 54 at that point. When said float rises the switch will be moved to open position thus breaking the circuit 54.

The opening of the valve 40 through the operation of the lever 21 will also allow the flow of water downwardly through the tube 57 so that it may enter the cylinder 58.

With reference particularly to Fig. 6, it will be seen that the water may enter the cylinder 58 through an upper inlet opening 59 which is controlled by a needle valve 60. It may also enter through a lower opening 61 controlled by a needle valve 62. A tube 63 has a branch 64 extending through the upper wall of the cylinder

58 and has a lower flattened seat 65 thereon within the cylinder. There is a freely moving valve member 66 in the cylinder which acts as a piston therein and has on its upper surface a flattened plate 67 which is adapted to act as a valve closing the outlet 65 from the cylinder. The valve 66 is not light enough to actually float in water, but is of such specific gravity as to be carried upwardly by a flow of fluid in said cylinder. When the flow is stopped after one operation the valve will drop back to bottom. The two inlets 59 and 61 to the cylinder may be adjusted so as to control the speed with which the valve may be moved upwardly to close the outlet 65. As soon as the cylinder has been filled with liquid it will find an outlet through the tube 63 which as seen in Fig. 1 is connected at its other end to the syphon 68. Said element is mounted in the frame of the device and has on its lower side a valve stem 69 which projects downwardly into a container 70. At the lower end of the stem 69 within the container is a valve member 71 which is adapted when moved downwardly to close an outlet opening 72 in said container 70.

Also, when the valve is in closed position, a stop member 73 on the valve stem above the container will contact with the upper surface of the container and close the opening about the stem 69.

When the water flows upwardly in the tube 64 it will also find an outlet to a nozzle 74 forming a portion of an aspirator 75. Said nozzle discharges into a chamber 76 having an upwardly extending partition wall 77 through which the water from the nozzle is projected downwardly to the outlet pipe 78 which leads to the drain 79. This is an ordinary type of aspirator, and causes a reduction of pressure within the chamber 76, and thus exerts a suction upon a lateral suction pipe 80.

Said pipe 80 is connected at its other end at 81 to the container 70 previously described. Thus, when the valve 71 is closed the exerting of suction in the container 70 will tend to draw up liquid from the cup 26 and cause the same to flow into said container.

When the valve 67 in the container 58 has been raised to closed position against the seat 65, the passage of water from the container 58 through the pipe 63 will be stopped and the pressure in the syphon element 68 will be relieved so that the spring 82 will tend to raise the valve 71 from its seat allowing the sample of urine taken into the chamber 70 to be discharged through the outlet pipe 83. Said pipe will conduct the sample in an inclined direction downwardly so as to be received within the bulbs 84 and 85. Any excess of liquid will flow on past the bulb 85 and be discharged into the drain 79 where it will flow to waste. Any small amount later overflowing from bulb 84 may drain through the connecting tube 110 to the conduit 111.

We have provided a siphon tube 86 in the line 83 which extends to a point spaced somewhat from the bottom of the bulb 85 which will carry off all but a small portion of the sample in that bulb, leaving the desired amount in the lower end thereof. It is to be understood that the tube 83 and the bulbs 84 and 85 are of glass as is also a large proportion of the apparatus used in conducting the fluid in our device.

The operation of the switch control mechanism through the floats 47 and 48 in the reservoir 31 is adjusted so that after the sample is delivered into the bulbs 84 and 85 the float 47 will have

closed the switch 53 and allow the energizing of the circuit including the solenoids 87 and 88. Each of these solenoids controls a pumping mechanism which will be understood best from Fig. 5.

Within the winding of wire about the core in this solenoid there is a glass cylinder 89 within which is a plunger 90 having a core 91 of soft iron. As will be noted, the plunger 90 fits rather loosely within the cylinder so that when it is moved up by the solenoid it will cause an upward surge of the liquid above it. This cylinder 89 is connected by a glass tube 92 with a reservoir 93 of the proper reagent to be used in making the test. In the reservoir connected with the solenoid 37 nitric acid will be the liquid employed.

The upper end of the container 93 is connected by means of a tube 94 with the chamber 95, the upper end of which may be closed by a cap or plug 96. The lower end of the chamber 95 is constructed to provide a small capillary opening 97 through which the liquid may pass slowly. The glass cylinder 89 is also connected with the chamber 95 through the tube 98. Below the chamber 95 is a tube 99 leading downwardly to discharge through a small nozzle 100 into the bottom of the bulb 84. There is a small air inlet 101 in the tube 99 to allow the free flow of liquid downwardly into the test bulb. It will be noted, therefore, that when the solenoid 87 is energized the plunger 90 will be raised causing a discharge of the acid into the chamber 95. All but the necessary amount of acid will flow through the tube 94 to the reservoir 93. The remainder in the lower end of the chamber will flow gradually downwardly into the test bulb and will be delivered at a point below the charge of urine in the bulb so that the acid which is heavier will lie in the lower portion of the bulb with a line of demarcation between the acid and the urine which will be plainly discernable. As the acid has time to act upon the urine to make the required test, if albumen is present in the sample, a white line will appear along the interface between the two liquids. If no albumen is present the white line will not appear.

The pump which is operated through the exciting of the solenoid 88 is constructed in the same manner as is the one just described. The reservoir 102 which is employed in this portion of the apparatus contains as a reagent what is known as Benedict's solution, and when this liquid is discharged downwardly into the bulb 85 it will mix with the urine, but as the larger proportion of the charge is Benedict's solution it will remain blue provided there is no sugar in the sample.

Below the bulb 85 is a small resistance coil 104 which will be energized at the same time as are the solenoids, and will heat up the charge within the bulb 85 as is necessary in order to make the test for sugar. When the sample has been heated to boiling point for a period of about one minute, the second switch 56 will be operated by the float 48 to open the circuit and deenergize the solenoids and the heater. If sugar is present in the sample after being thus heated it will turn cloudy and greenish rather than blue.

Behind each of the bulbs 84 and 85 we contemplate placing electric lights 105, so that the action of the reagents upon the sample can be clearly seen. During the period that the lever arm 21 is being held downwardly no further action in the apparatus will take place, and the observer will be able to watch the samples and study them carefully to see what action takes place. He may then release the lever 21 which will be raised up-

wardly by the spring 39 and the dog 17 will swing in beneath the pin 20 and hold the arm from downward movement until another coin is inserted to release the lever 5.

When the arm 21 is moved upwardly the valve 40 will be closed again. This will shut off the pressure in the syphon element 43, allowing the valve 44 to be raised from its seat through the contraction of the bellows-shaped walls of the element. When the valve has been raised from its seat the water in the reservoir 31 will discharge downwardly through the tubes connected therewith and will pass into the chamber 70 and downwardly through the tubes 83 and the bulbs 84 and 85, and will flush the liquid therein from the tubes and bulbs and leave them clean. The water will also discharge downwardly through the tubes 30 and 28 and clean the cup 26. The device will then remain in this position until it is again operated.

In the lower part of the reservoir 31 is provided a leak opening 106 which allows the reservoir to be entirely drained of water before the next test is made. This leak is so small, however, that it will not interfere with the operation of the device as previously set out.

It will be seen that with the apparatus arranged and adjusted as above described, it will be possible for anyone desiring a test of this character to easily make the test himself at a very nominal charge. As the parts are regulated as to size and are capable of accurate adjustment, it will be impossible for the operator to make any errors in the conduct of the test, and the results will be accurate and reliable.

It will be apparent that the apparatus which has been disclosed may be arranged compactly within a small cabinet so that it will not take up any large space and may be arranged conveniently for use by the public.

What we claim as new is:

1. A device of the character described including a sample receiving receptacle, two test bulbs, water conducting pipes connected with a source of water under pressure, means actuated by the flow of water in said pipes to deliver samples of urine from said receptacle to said bulbs, separate means to deliver reagents to each of said bulbs, means to heat one of said bulbs, and automatically operated means to flush water from said pipes through said receptacle and through said bulbs to clear the same of said samples.

2. A device of the character described including, a series of water-conducting pipes connected with a source of water under pressure, a urine-receiving receptacle, an albumen-testing bulb, a sugar-testing bulb, means to deliver a sample of urine to each of said bulbs, actuated by the flow of water in said pipes, means to deliver nitric acid to said albumen-testing bulb, similar means to deliver Benedict's solution to said sugar-testing bulb, means to heat the latter bulb, and means connected with said pipes to flush said bulbs and receptacle clear of urine.

3. A device of the character described including, a series of water-conducting pipes connected with a source of water under pressure, a urine-receiving receptacle, an albumen-testing bulb, a sugar-testing bulb, means to deliver a sample of urine to each of said bulbs actuated by the flow of water in said pipes, electrically operated means to deliver nitric acid to said albumen-testing bulb, similar means to deliver Benedict's solution to said sugar-testing bulb,

means to heat the latter bulb, and means connected with said pipes to flush said bulbs and receptacle clear of urine.

4. A device of the character described including, a series of water-conducting pipes connected with a source of water under pressure, a urine-receiving receptacle, an albumen-testing bulb, a sugar-testing bulb, means to deliver a sample of urine from said receptacle to each of said bulbs, including an aspirator actuated by the flow of water in said pipes, electrically operated means controlled by water from said pipes to deliver nitric acid to said albumen-testing bulb, similar means to deliver Benedict's solution to said sugar-testing bulb, means to heat the latter bulb, and means connected with said pipes to flush said bulbs and receptacle clear of urine.

5. A device of the character described including a plurality of pipes connected with a source of fluid under pressure, a urine receptacle, a plurality of sample-receiving bulbs, a fluid-conducting passage from said receptacle to said bulbs, a chamber in said passage having an inlet and an outlet, means to close said outlet actuated by water pressure in said pipes, means to discharge urine from said receptacle to said chamber, means to release said water pressure and open said closing means and discharge samples of the said urine from said chamber to said bulbs, separate means to deliver a predetermined amount of reagents to said bulbs, means to heat one of said bulbs, and means to flush said bulbs.

6. A device of the character described including a plurality of pipes connected with a source of fluid under pressure, a urine receptacle, a plurality of sample-receiving bulbs, a fluid-conducting passage from said receptacle to said bulbs, a chamber in said passage having an inlet and an outlet, means to close said outlet actuated by water pressure in said pipes, means responsive to the flow of water in said pipes to discharge urine from said receptacle to said chamber, means to release said water pressure and open said closing means and discharge samples of the said urine from said chamber to said bulbs, separate means to deliver a predetermined amount of reagents to said bulbs, means to heat one of said bulbs, and means to flush said bulbs.

7. A device of the character described including a plurality of pipes connected with a source of fluid under pressure, a urine receptacle, a plurality of sample-receiving bulbs, a fluid-conducting passage from said receptacle to said bulbs, a chamber in said passage having an inlet and an outlet, means to close said outlet actuated by water pressure in said pipes, means to discharge urine from said receptacle to said chamber, means to release said water pressure and open said closing means and discharge samples of the said urine from said chamber to said bulbs, separate means to deliver a predetermined amount of reagents to said bulbs, means to heat one of said bulbs, said delivering means and said heating means being electrically operated, time operated means to deenergize the same, and means to flush said bulbs.

8. In a sample-testing machine, a series of water-conducting pipes to receive water under pressure, valves to control the flow of fluid in said pipes, means normally holding said valves closed, means to release said holding means, a pair of test bulbs, means actuated by the flow of water

in said pipes to deliver a sample of urine to each of said bulbs, separate means operating in response to the pressure of said water to deliver a testing fluid to each of said bulbs, and means to heat one of said bulbs.

9. In a sample-testing machine, a water main, a plurality of water-conducting pipes to receive water under pressure from said main, a manually operated valve and a coin-controlled valve connected in said pipes, means to open said coin-controlled valve, a urine receptacle, two test bulbs, means operated by the opening of said coin-controlled valve to open said receptacle, means operated responsive to the opening of said manually operated valve to deliver urine from said receptacle to said test bulbs, means to deliver testing fluid to said bulbs and means to heat one of said bulbs.

10. In a sample-testing machine, a series of water conducting pipes, valves controlling the flow of liquid therein, a plurality of test bulbs, a urine receptacle, a passage from said receptacle to said bulbs, a chamber in said passage, means actuated by the flow of water in one of said pipes to create a suction in said chamber and move urine from said receptacle to said chamber, means adapted to be closed by the pressure of said liquid in said pipes to control the passage of urine from said chamber to said bulbs, means to deliver testing fluid to said bulbs and means to heat one of said bulbs.

11. Liquid moving and measuring means comprising a liquid container, a cylinder connected to said container and at a lower level than said container to receive liquid by gravity therefrom to normally fill said cylinder, a measuring chamber connected with the upper ends of said cylinder and said container, said chamber having an open constricted outlet, a piston fitting loosely in said cylinder, an iron core in said piston, and a solenoid about said cylinder adapted, when energized, to move a surge of liquid into said chamber, the overflow from said chamber passing into said container.

12. Liquid moving and measuring means comprising a liquid container, a cylinder connected to said container to receive liquid by gravity therefrom to normally fill said cylinder, a measuring chamber connected with the upper ends of said cylinder and said container, a piston fitting loosely in said cylinder, means to operate said piston to give thereto a single upward movement and to cause a surge of liquid from said cylinder to said chamber all but a small measured amount being carried on to said container, and from thence by gravity back to said cylinder.

13. In a sample testing machine, a series of water conducting pipes, valves controlling the flow of liquid therein, a plurality of test bulbs, a receptacle, a passage from said receptacle to said bulbs, means operating in response to the flow of liquid in said pipes to move a sample from said receptacle to said bulbs, means to deliver a reagent to each of said bulbs including an electrically operated plunger, means to heat one of said bulbs, and an electric circuit to energize said heating means and said electrically operated piston, operating in response to water discharged from said pipes, and means to flush said bulbs of liquid.

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