Oct. 29, 1940. A. A. HUMPHREY ET AL 2,220,043

HEATING DEVICE

Filed Dec. 19, 1938 2 Sheets-Sheet 1

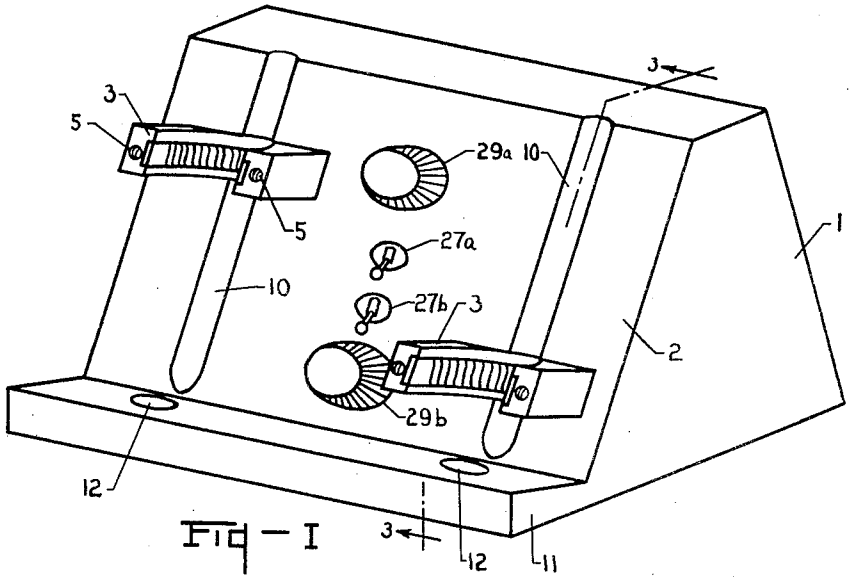


Fig - 1

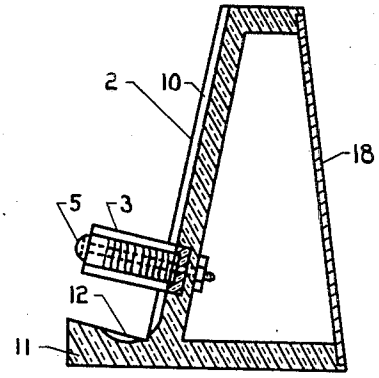


Fig - 3

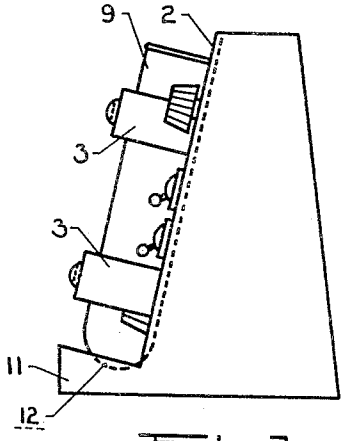


Fig - 2

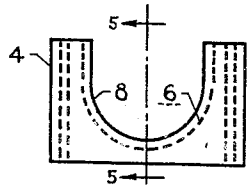


Fig - 4

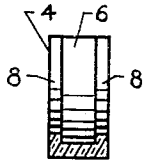


Fig - 5

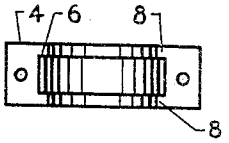


Fig - 6

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HEATING DEVICE

Filed Dec. 19, 1938 2 Sheets-Sheet 2

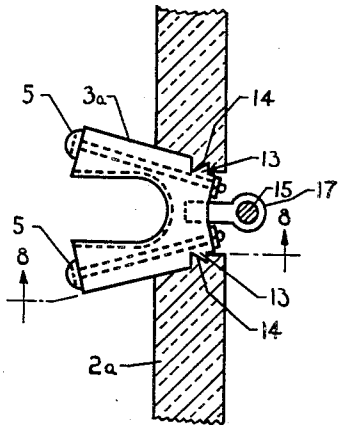


Fig-7

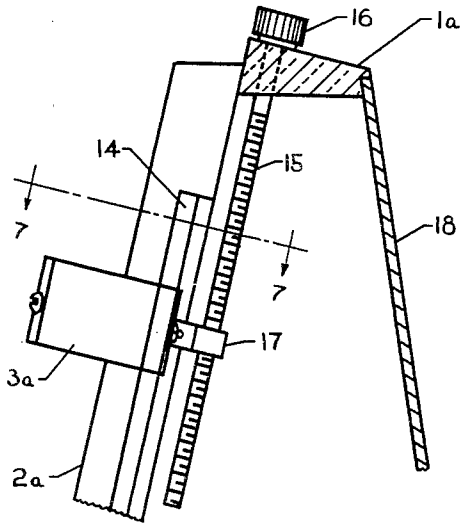


Fig-8

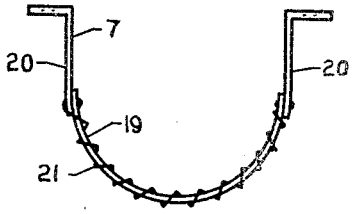


Fig-9

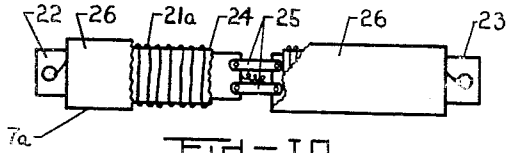


Fig-10

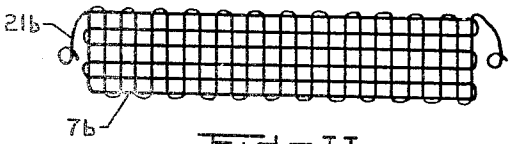


Fig-11

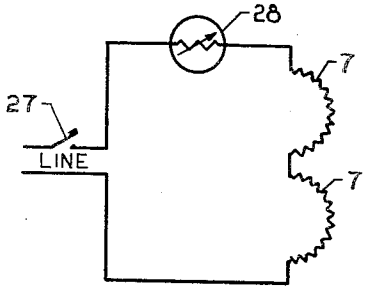


Fig-12

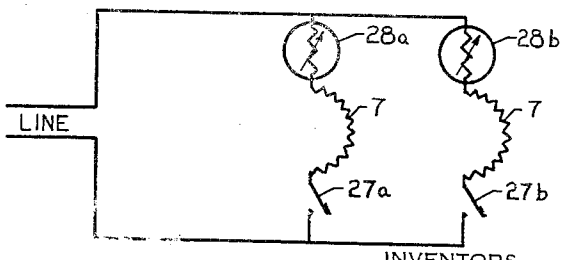


Fig-13

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UNITED STATES PATENT OFFICE

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HEATING DEVICE

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Application December 19, 1938, Serial No. 246,553

6 Claims. (Cl. 219—19)

The present invention relates broadly to heating devices, and in its more specific phases to a heating device particularly adapted for use in urine analysis.

The usual procedure in heating liquids in test tubes involves the holding of the test tube over a suitable flame such as is produced by a lighted Bunsen burner. The rapid application of heat in this manner causes "bumping," as well as violent ebullition during boiling. In testing urine to determine its condition as to sugar and albumin, the normal procedure involves the use of two test tubes, one containing urine, and the other Benedict's solution, and then separately heating same. In testing for sugar the urine is added to boiling Benedict's solution, while in testing for albumin, acetic acid is added to the boiling urine. Where the sugar determination is carried on by the present-day conventional drop method, this presents the disadvantage of requiring the technician to use both hands, one to hold in proper location in the heating flame the test tube containing Benedict's solution, and the other hand to manipulate a dropper. At the same time, he must watch to see that the test tube is held in proper position and location in the heating flame, while dropping the urine into the test tube and observing the reaction taking place. In view of these and other difficulties, the present invention has been devised for use in the making of rapid and simple chemical determinations which require the application of heat to a test tube, or other elongated article, and particularly in connection with tests such as are made in the detection of sugar and albumin in urine.

Another object of the invention is to provide an apparatus with a pair of substantially U-shaped electric heaters suitably mounted for use in making simultaneous tests of urine for albumin and sugar.

Another object of the invention is to provide a heating apparatus with an inclined face so as to support the test tube to be heated and make it easily handable.

A further object of the invention is to provide substantially U-shaped heaters with an open front so that the test tube may be laid therein, and at the same time be visible its full length.

A further object is to provide an apparatus adapted to apply heat to liquid in a test tube in gradual manner so as to eliminate "bumping" and violent ebullition of gas.

A further object is to provide means for adjusting the location of the U-shaped heaters so as to vary the point of application of heat to a suitable article such as a test tube containing a material to be heated.

A still further object is to provide a mechanism having at least two U-shaped heating elements and means for connecting one or more at a time to a suitable source of electricity.

A still further object is to provide easily replaceable heating elements for the U-shaped heaters.

Still further objects and advantages of the invention will appear as the description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims, the annexed drawings and the following description setting forth in detail certain means for carrying out the invention, such disclosed means illustrating, however, but several of various ways in which the principle of the invention may be used.

In said annexed drawings:

Figure 1 is a perspective view of one form of the present invention.

Figure 2 is an end view of the apparatus as seen from the right side of Figure 1, and with a test tube in place.

Figure 3 is a section view of the apparatus as taken along the line 3—3 of Figure 1.

Figure 4 is a front view of one of the U-shaped heaters with the heating element omitted.

Figure 5 is a section view of the U-shaped heater as viewed along the line 5—5 of Figure 4.

Figure 6 is a top view of the U-shaped heater shown in Figure 4.

Figure 7 is a section view showing an adjustable location U-shaped heater in place as viewed along the line 7—7 of Figure 8.

Figure 8 is a partially sectioned view of an adjustable location U-shaped heater in place as viewed along the line 8—8 of Figure 7.

Figures 9, 10 and 11 show three types of heating elements adapted for use in the U-shaped heaters.

Figure 12 shows a wiring diagram with two of the heating elements in series.

Figure 13 shows a wiring diagram with two of the heating elements in parallel.

Referring more particularly to the drawings, the frame 1 of the apparatus may be made of metal, wood, glass, porcelain covered metal, heat resisting material, ceramic material, or the like. In preferred construction the front panel 2 of the frame 1 is inclined from vertical as shown to provide support for a test tube, or the like, to

which heat is to be applied. The amount of this rearwardly directed incline may vary over a considerable range, but preferably between 5 and 30 degrees from perpendicular to the base of the frame. Mounted on the front panel 2 are two U-shaped heaters 3. These heaters open outward so that each may have a test tube placed therein and lay against the front panel 2 in a substantially vertical plane. The body 4 of the U-shaped heaters 3 may be formed as an integral part of the frame 1, or they may be made as separate elements attachable with bolts 5 or the like, as shown in Figure 3. The U-shaped heaters are preferably provided with a groove 6 (Figs. 5 and 6) adapted to receive a suitable heating element 7, the top face of which will lie below or approximately flush with the surface of the ribs 8 which form the sides of groove 6. This type of construction protects the heating element from excessive wear due to contact with a test tube 9 containing a suitable material to be heated.

Various means may be used to hold the test tube in substantially upright position for heating, and one of the simplest involves the placing of grooves 10 in the face of the front panel, as shown in Figure 1. The U-shaped heaters 3 are preferably installed so that the curved face of ribs 8 coincide with the bottom of grooves 10 as shown in Figure 3. The bottom of frame 1 at its front edge is preferably provided with a shelf member 11 having depressions 12 adapted to receive the lower end of a test tube 9 when in proper position, as shown in Figure 2. The use of these depressions 12, together with grooves 10 and U-shaped heaters 3, form a combination which holds the inclined test tube in place and guards against displacement during use of the mechanism.

The bolts 5 act to electrically connect the ends of heating element 7 to a suitable electric circuit at the back of front panel 2, such circuit for instance being of the general type shown in Figures 12 and 13. Where the U-shaped heaters 3 are removable, then the bolts 5 will also act to hold the same in place on the face of front panel 2.

Where the apparatus is to be used for the rapid carrying out of simple chemical determinations which require heat on a test tube, it is sometimes desirable to have the U-shaped heaters 3 set at different elevations above the shelf member 11. For instance, in carrying out albumin and sugar tests on urine, it is desirable practice to apply the heat in the albumin test to the upper end of the body of specimen in the test tube, since this retards convection currents in the body of boiling urine and permits the albuminous cloud forming at the top of the test tube, upon addition of acetic acid, to contrast with the clear solution below, so that it can be readily seen. On the other hand, in conducting the sugar test on urine, the heat is preferably applied to the body of specimen near the bottom of the test tube, since this causes convection currents with efficient mixing of urine and reagent so that change of color from blue to red may be readily observed. To take care of simultaneously conducting the albumin and sugar tests, the U-shaped heaters 3 are preferably placed in the approximate locations shown in Figure 1. The use of this apparatus thus simplifies the carrying out of these tests, while reducing the time required by making simultaneous tests for both albumin and sugar possible, and at the same time by gradually applying heat to the test tubes containing the specimens being tested, bumping and violent ebullition are avoided.

To cover a larger range in the point of application of heat to the contents of a test tube or the like, adjustable U-shaped heaters 3*a* (Figs. 7 and 8) may be used. These heaters are preferably provided with ribs 13 adapted to slidably fit ways 14 in front panel 2*a*. To provide for the movement of the adjustable U-shaped heater 3*a* up and down the ways 14, a suitable threaded rod 15 with knob 16 (Fig. 8) is mounted on frame 1*a*. Each of the adjustable U-shaped heaters 3*a* are preferably provided at the rear thereof with a threaded projecting member 17 adapted to threadedly engage threaded rod 15 in manner such that by rotating knob 16, adjustable U-shaped heater 3*a* will be moved up or down, depending upon the direction of rotation. Where it is desired to remove one of the adjustable U-shaped heaters 3*a*, the threaded rod 15 may be turned out of threaded projecting member 17 and by eliminating the upper end of ways 14, as shown in Figure 8, the U-shaped member may be slid past the upper end of the ways and then lifted out. To provide a neat appearing assembly and for the making of electrical connections, et cetera, behind the front panel 2 or 2*a*, a removable back cover plate 18 may be used. Such plate may be fastened in place in conventional manner, for instance, by the use of screws (not shown).

The heating elements may be constructed in various forms, three of which are illustrated in Figures 9 to 11 inclusive. Referring more particularly to Figure 9, a semi-circular strip 19 of mica or similar heat resisting electric insulating material may be used as the bottom portion of the unit. At the upper edges of the semi-circle are provided two angular metal strips 20 which may be made of Monel metal, stainless steel, nickel or chrome plated copper, or the like. These angular metal members 20 are preferably riveted to the semi-circular insulating member 19. A suitable amount of bare or asbestos covered electric resistance wire or ribbon 21 is wound around the semi-circular strip 19 and the ends thereof fastened to the angular metal strips 20 in any conventional manner, for instance, by means of the rivets used for fastening the angular metal strips 20 to the semi-circular strip 19. Suitable openings are made in the upper end of each of the angular metal members 20 so as to allow bolts 5 to pass therethrough and electrically connect the unit through said bolts to the electric wiring at the back of front panel 2. A modified construction of the heating element is shown in Figure 10. Here Monel metal strips, or the like, 22 and 23 are covered with insulation 24 and an electric resistance wire 21*a* in desired size and amount wound over this insulation, the ends of the resistance wire being joined to or contacting the metal strips 22 and 23 so as to join the electric circuit through bolts 5. The metal strips 22 and 23 are preferably joined together by means of links 25, formed from material which is a non-conductor of electricity. The thus constructed heating unit may be bent to shape and directly mounted in groove 6 of U-shaped heater 3, but in preferred form it is first covered with insulation 26. The strips 22 and 23 instead of being of metal may be made of electric insulating material with the resistance wire 21*a* wound thereon as described. Figure 10 is to be considered as a diagrammatic showing of either of these constructions. Figure 11 shows in diagrammatic manner a still further modification wherein an

electrically insulated resistance element 21*b* is woven so as to have the resistance wire begin at one end of the woven strip and end at the other. This permits connections to be made at both ends through bolts 5 to the electric circuit.

Figure 12 shows a typical wiring diagram where two of the heating elements 7 are connected in series and a switch 27 used to connect same to a suitable source of electricity. If desired, a rheostat 28 may be connected in the line to vary the flow of electricity through heating elements 7. Where it is desired to operate the heating elements individually, they may be connected into the electric circuit as shown in Figure 13. Here the electric heating elements 7 are each provided with switches 27*a* and 27*b*, respectively. When it is desired to vary the flow of electricity through the individual heating elements, they may be provided with rheostats 28*a* and 28*b*, respectively, and preferably controlled through knobs 29*a* and 29*b* as shown in Figure 1.

Other modes of applying the principles of our invention may be employed instead of those explained, change being made as regards the article herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

We therefore particularly point out and distinctly claim as our invention:

1. In a heater for use in urine analysis apparatus or the like, the combination of a substantially U-shaped member having an electrically insulated inner face, upwardly projecting ribs on the side edges of said inner face, said ribs forming a continuous circumferential groove therebetween on the inner face of said U-shaped member, a strip-shaped electric resistance heating element on the inner face of said U-shaped member and lying in said groove with its upper face substantially flush with the upper edge of said ribs, and means connected to the ends of said strip-shaped electric resistance heating element for holding same in said groove.

2. In a heating apparatus, the combination of a frame having a base, a rearwardly sloping face, and an extending supporting member at the foot of said face, two U-shaped heaters mounted on said face at different elevations and longitudinally spaced out of line with each other, each of said heaters opening outward from said face and being mounted so that a line coinciding with the radius of the U and starting at the bottom thereof will lie in a plane perpendicular to the base of the frame, the body of each of said heaters at least having a surface which is a non-conductor of electricity, the inner face of the U being provided with a groove having rib sides, an electric resistance heating unit separately mounted in the groove of each of said U-shaped heaters, a groove on the front face of said frame at each of said U-shaped heaters coinciding in location with said plane perpendicular to the base of said frame at each heater, the bottom of the groove being approximately at the same level as the upper edge of said ribs of the U-shaped heaters, holding means on the extending supporting member at the foot of the front face of the frame, means for electrically connecting said heating units in operable manner to the back of the front panel of the frame, and means for connecting said last-named means to a suitable source of electricity.

3. A urine analysis apparatus of the character described, which comprises a frame with sloping front face, two grooves running up said face in substantially vertical direction and adapted to have a test tube, in which urine is to be tested, laid in each of said grooves on said face, a substantially U-shaped heater located at each of said grooves and having the bottom of its inner circumference coinciding substantially with the bottom of the corresponding groove, said U-shaped heaters being at different elevations, and a strip-shaped electric heating element on the inner face of each of said U-shaped heaters and depressed so as to lie with its upper face approximately flush with the face of the corresponding groove in the sloping front face of the apparatus.

4. A urine analysis apparatus of the character described, which comprises a frame with a base and a sloping front face, at least one outwardly opening substantially U-shaped heater mounted on said face, said U-shaped heater being adapted to receive therein a test tube containing urine to be tested while permitting said test tube to lie in a plane substantially perpendicular to both said base and sloping front face and with the test tube resting in inclined position over the latter, means cooperating with said U-shaped heater for holding said test tube in said substantially perpendicular plane, said U-shaped heater having a rib at each side edge of its inner circumference with a continuous circumferential groove therebetween, a continuous electric resistance element in said groove with the upper face of said resistance element substantially flush with the top faces of said ribs forming the edges of said groove, and means electrically connecting the ends of said resistance element to a member for connecting same to a suitable source of electricity.

5. A urine analysis apparatus of the character described, which comprises a frame with sloping front face, two slots running up said face in substantially vertical direction and adapted to have a test tube, in which urine is to be tested, laid over each of said slots in said face, a substantially U-shaped heater located over and crosswise of each of said slots, each of said U-shaped heaters having an inwardly directed continuous circumferential groove on its inner face, a strip-shaped electric heating element in the groove on the inner face of each of said U-shaped heaters and depressed so as to lie with its upper face approximately flush with the top of said groove, cooperating means on said face and U-shaped heaters for joining the latter to the former while permitting the U-shaped heaters to be moved along prescribed paths corresponding with the slots on said face, and means for moving said U-shaped heaters along said paths and holding same at various locations thereon ranging from lower or urine sugar analysis position to upper or urine albumin analysis position, whereby the said apparatus may be efficiently used for urine sugar analysis, urine albumin analysis, or both simultaneously.

6. In a heating apparatus, the combination of a frame having a base, a rearwardly sloping face, and an extending supporting member at the foot of said face, two U-shaped heaters mounted on said face at different elevations and longitudinally spaced out of line with each other, each of said heaters opening outward from said face and being mounted so that a line coinciding with the radius of the U and starting at the bottom thereof will lie in a plane perpendicular to the base of the frame and perpendicular to the under face of the heater, the body of each of said heaters at least having a surface which is a non-conductor of electricity, the inner face of the U being provided with a groove having rib sides, an elec-

tric resistance heating unit separately mounted in the groove of each of said U-shaped heaters, a groove on the front face of said frame at each of said U-shaped heaters coinciding in location with said plane perpendicular to the base of said frame at each heater, the bottom of the groove being approximately at the same level as the upper edge of said ribs of the U-shaped heaters, holding means on the extending supporting member at the foot of the front face of the frame, means for electrically connecting said heating units in operable manner to the back of the front panel of the frame, variable resistance means for varying the flow of electricity to the electric resistance heating units of said U-shaped heaters, and means connecting said heating units and variable resistance means to a suitable source of electricity.

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