

[54] SURGEON HAND AND ARM SCRUBBING APPARATUS

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[52] U.S. Cl. .... **134/95; 134/113; 134/199; 128/66**

[51] Int. Cl.<sup>2</sup> ..... **B08B 3/02**

[58] Field of Search ..... 134/191, 195, 199, 113, 134/95, 34, 36, 58 R, 57 D; 15/21 D, 21 R, 320; 298/1; 308/DIG. 1; 277/DIG. 5; 128/66; 34/202; 239/602

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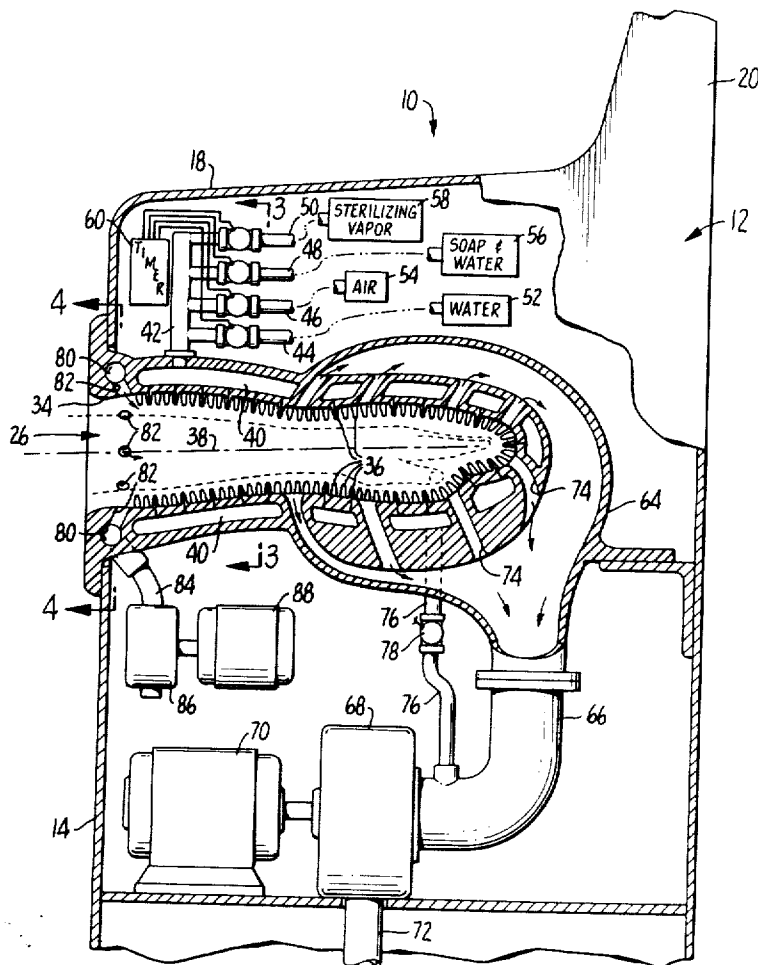
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[57] **ABSTRACT**

A pair of cavities are provided in a housing for receiving hands and forearms, a plurality of nozzles within each of the cavities eject streams of fluids inwardly at predetermined rates and pressures in order to exert a net force on the inserted hands and forearms sufficient to support their weight within each cavity so that they do not touch the interior surface of the cavity and thereby remain uncontaminated after the washing procedure.

**11 Claims, 11 Drawing Figures**



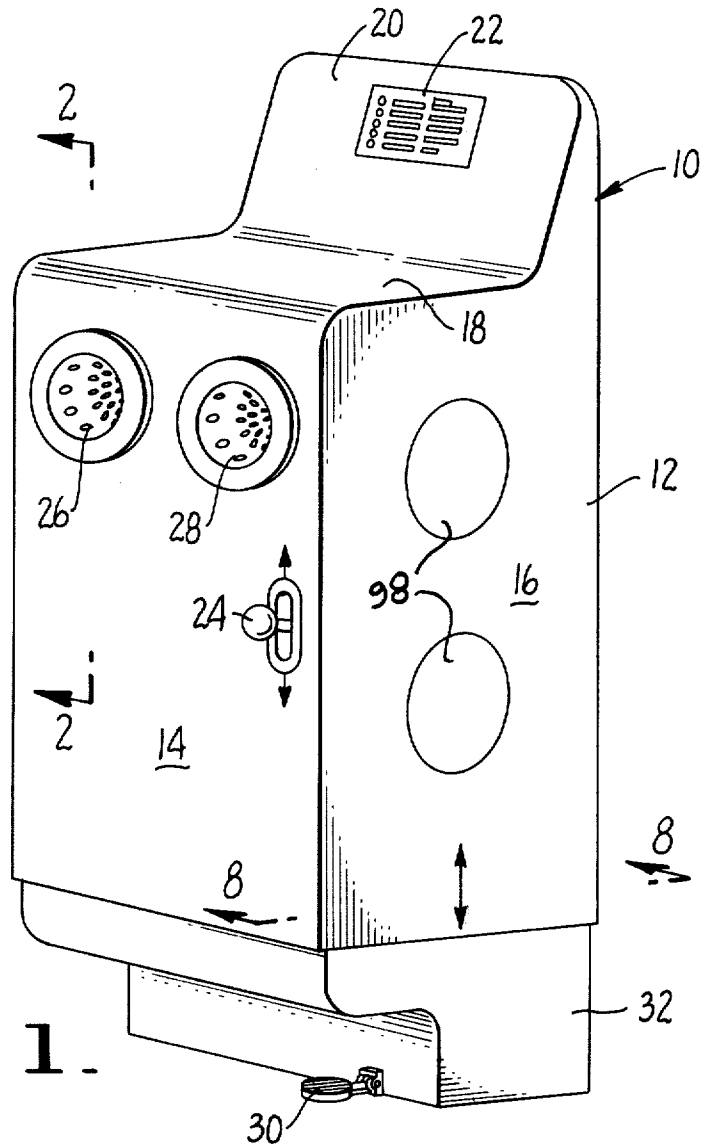


FIG. 1.

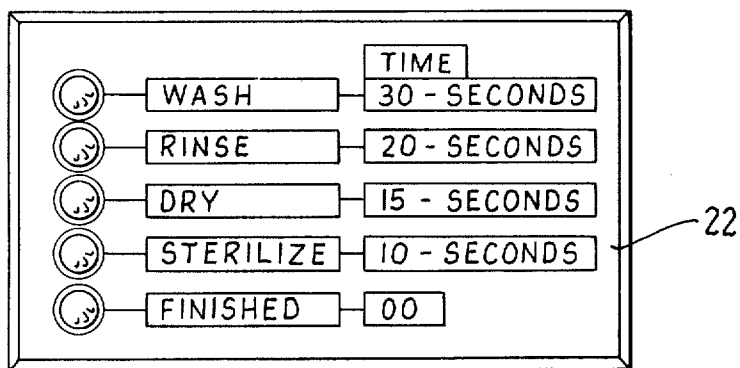


FIG. 7.

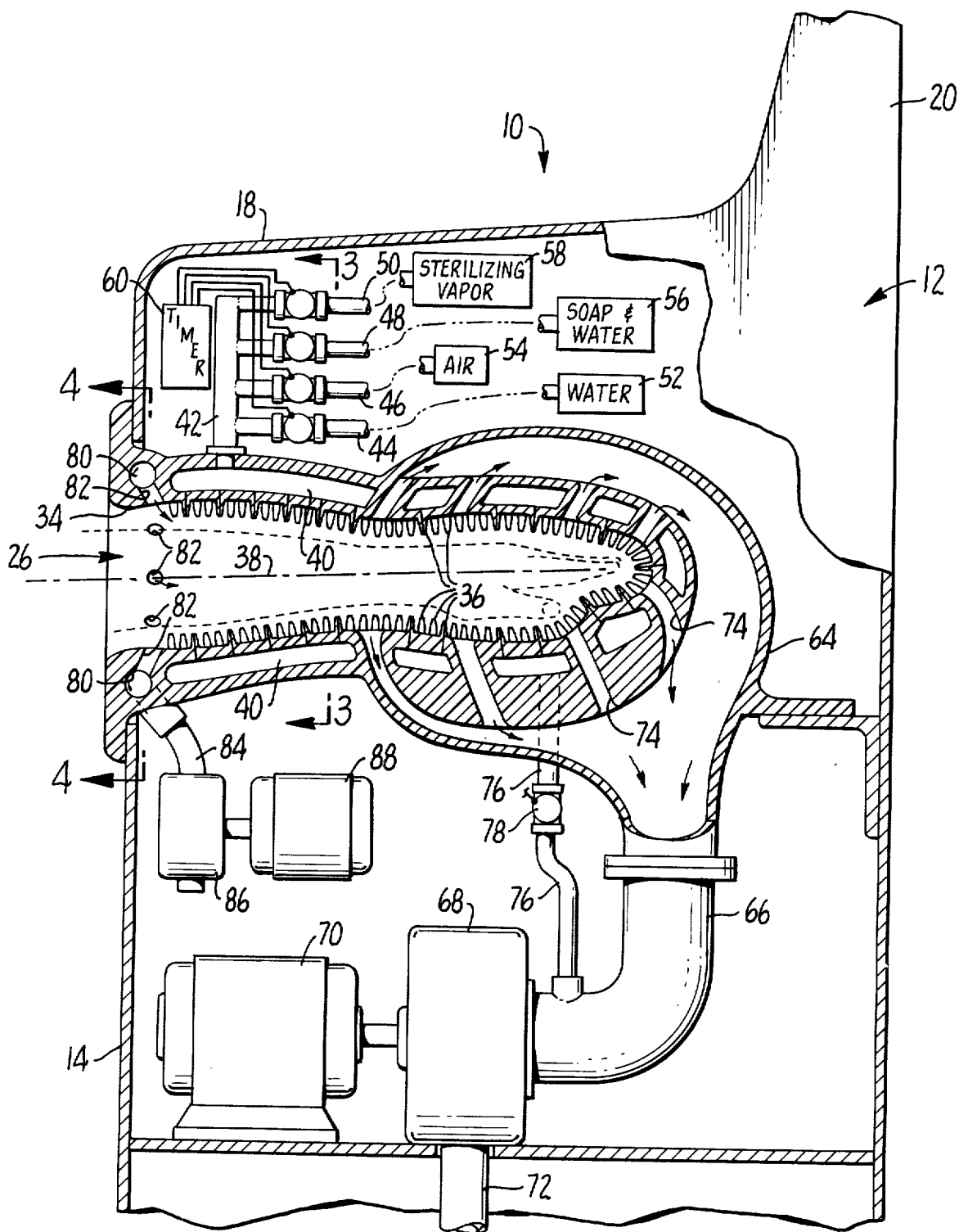


FIG. 2.

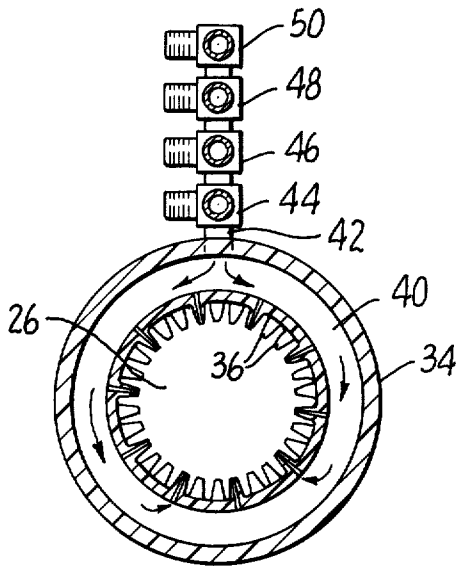


FIG. 3.

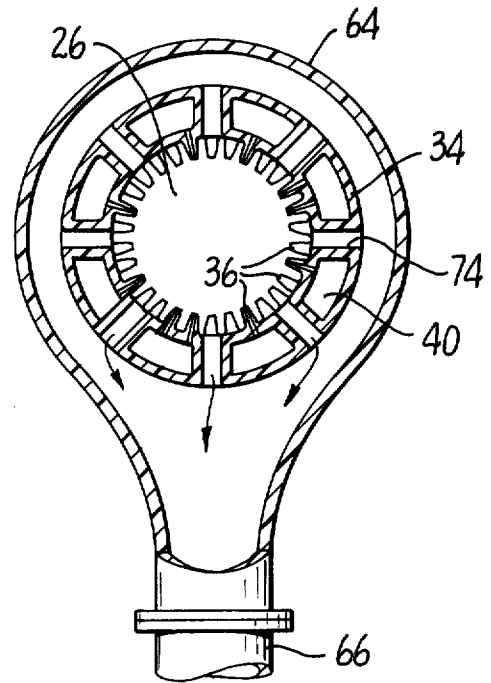


FIG. 5.

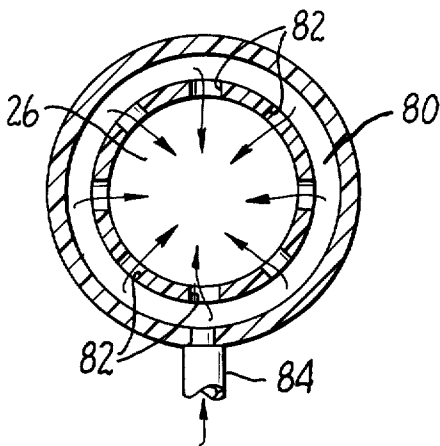


FIG. 4.

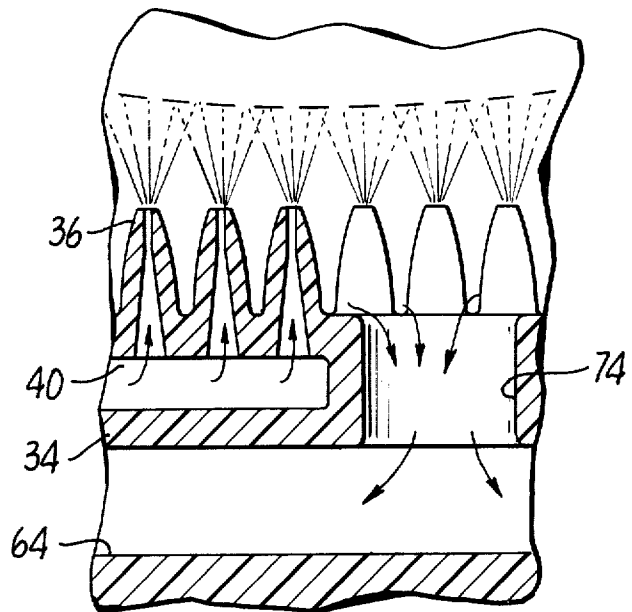


FIG. 6.

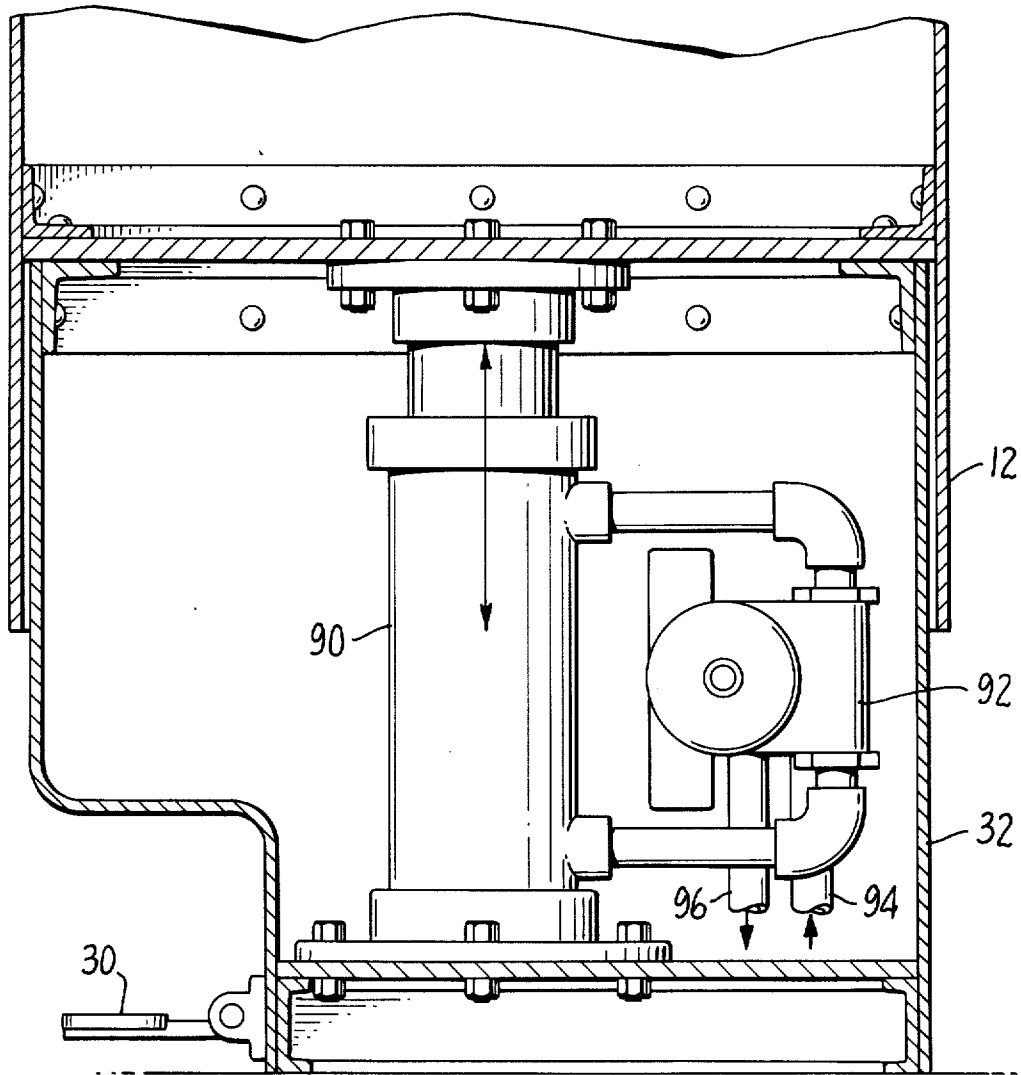


FIG. 8.

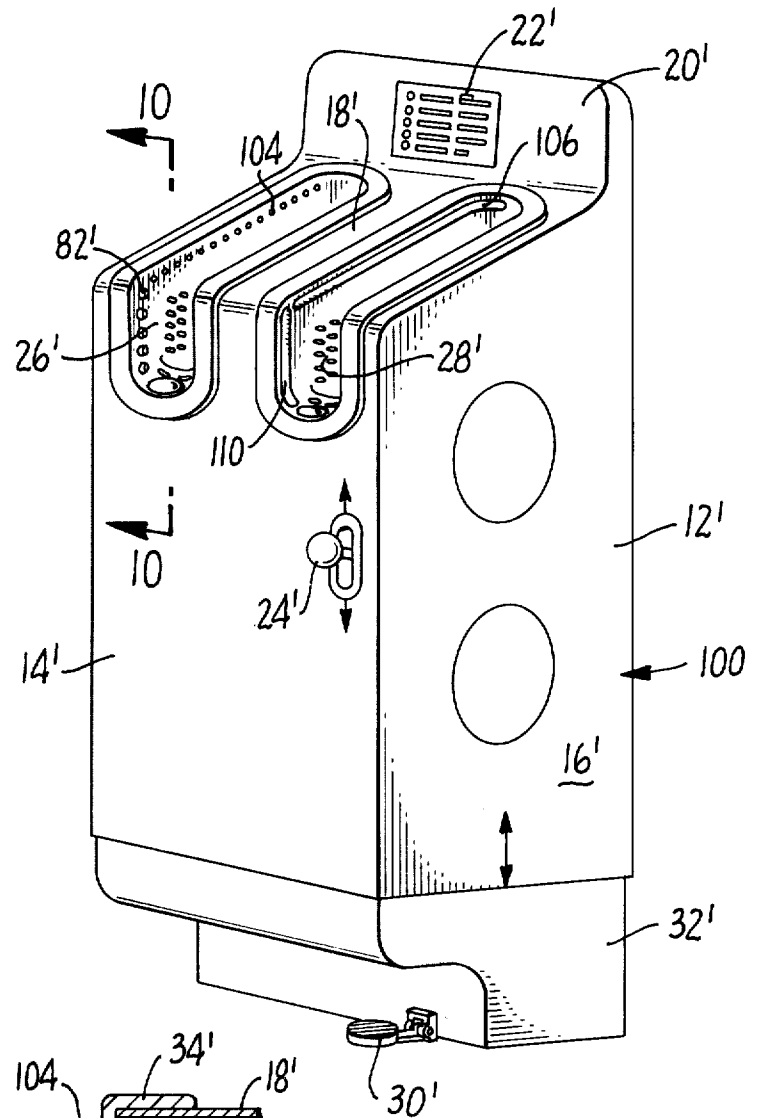


FIG. 9.

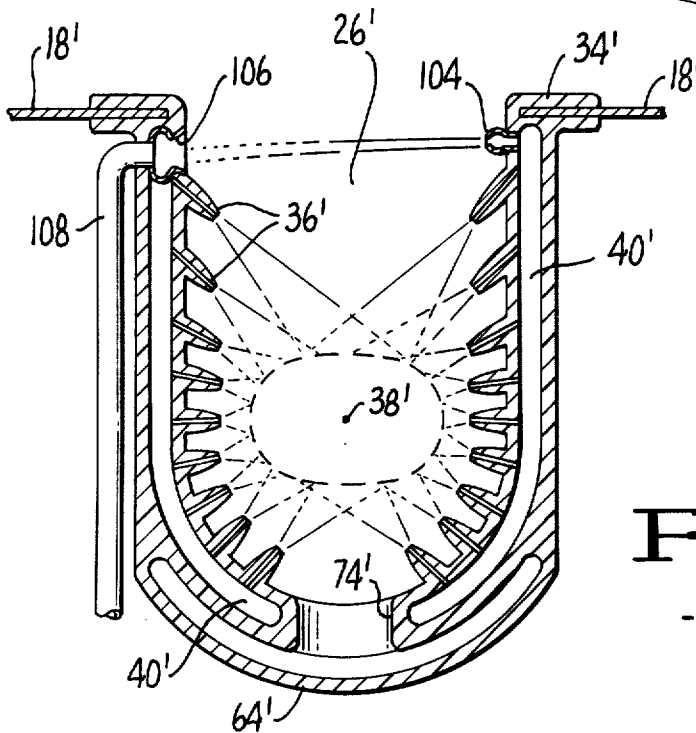


FIG. 11.

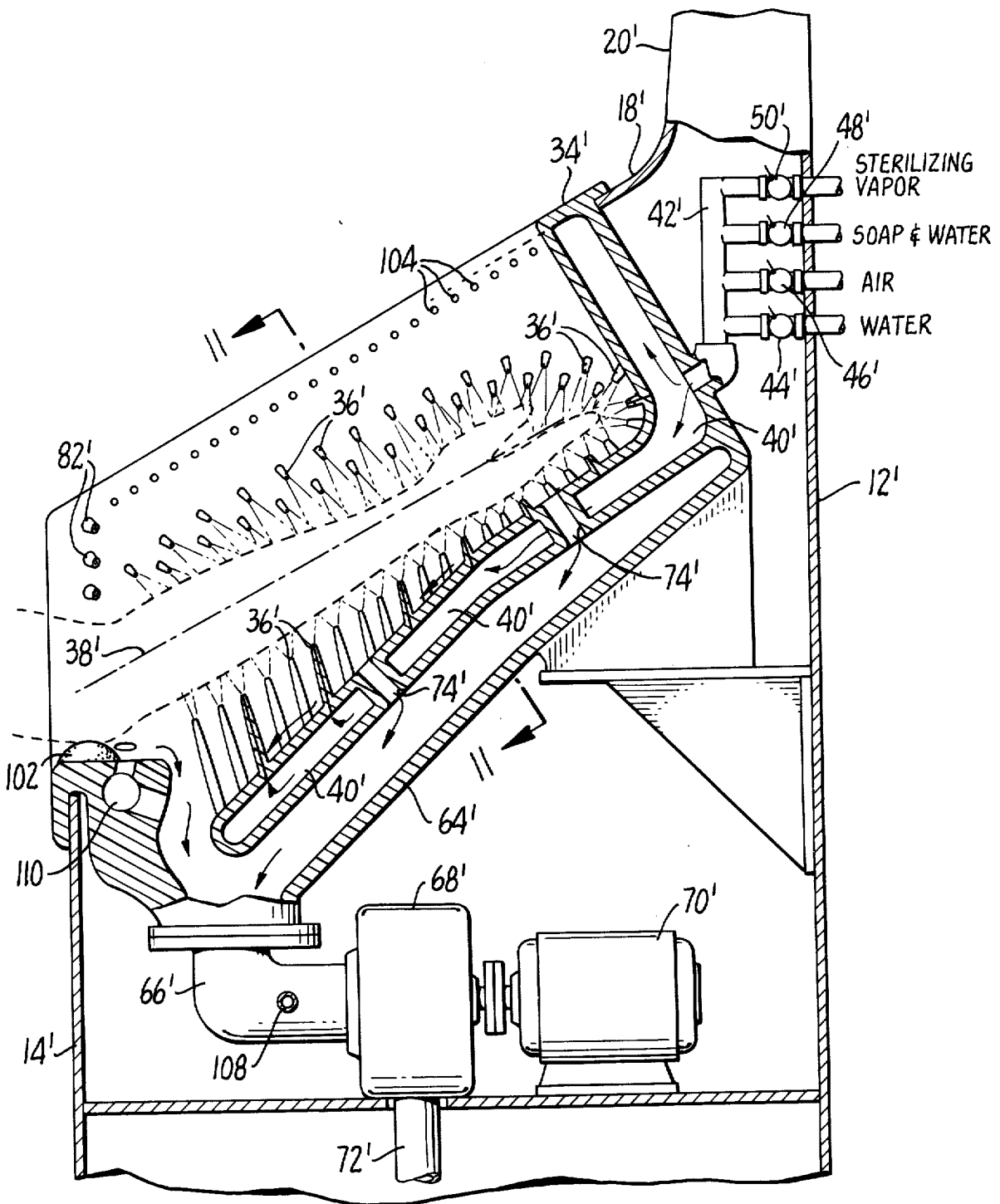


FIG. 10.

## SURGEON HAND AND ARM SCRUBBING APPARATUS

### BACKGROUND OF THE INVENTION

The present invention relates to a cleaning device and more particularly to a device for cleansing the hands and forearms of a surgeon, doctor, nurse or other medical personnel.

Various hand scrubbing devices have been proposed which utilize rotating brushes and streams of water. It has been recently recognized that such prior art scrubbing brush devices are objectionable to doctors and particularly surgeons who fear that because of machine malfunction they may be inserting their hands into a grinder rather than a scrubber. Thus, it has been more recently proposed to only utilize streams of water and sterilized air in such devices to wash and disinfect the inserted hands and forearms. One problem with some prior art devices of this type is that it is necessary to provide a tight seal around the inserted forearms to prevent water from being sprayed out of the machine, such as described in U.S. Pat. No. 3,699,984. Such devices are again not preferred by surgeons who want the freedom to remove their hands at any time should a malfunction occur, such as excessively high water temperature, for example.

Still another objection to many such prior art devices is that the user has no way of telling how long each step of the operation should take or how much more time is involved.

In all such devices, it is desirable to minimize the amount of microabrasion to the skin of the forearms and hands. It is also desirable that the hands and forearms not be contaminated by contact with the device itself. Since a certain amount of time is required to complete the washing cycle, and since this procedure is typically repeated many times during the normal working day of a surgeon, for example, the strain required of the user to support the weight of his own hands and forearms within the machine at an inclined angle during many such procedures is undesirable.

### SUMMARY OF THE INVENTION

The above and other disadvantages are overcome by the present invention of a hand spray cleaning apparatus comprising a housing having at least one cavity therein, each cavity having a longitudinal axis of symmetry and being suitable for receiving at least a separate hand. A plurality of nozzles within each cavity are directed towards the axis of symmetry. Means are provided for pumping fluid through the nozzles at a predetermined rate and pressure so as to exert a net force on the inserted hand which is sufficient to support its weight within each cavity. Thus the user experiences no strain in supporting his hands within the cavity during repeated washing operations. The means for pumping fluid through the nozzles includes means for pumping, in sequence, a soap and water solution, water alone, heated air, a sterilizing vapor, and warm air in timed stages which are visually displayed at the top of the housing.

In one preferred embodiment a pair of cavities for separately receiving each hand and forearm are provided. The fluid pumping means includes means for evacuating the air and water from each of the cavities. The nozzles and connecting passages to the fluid pumping means are integrally incorporated in a resilient, wa-

terproof material which lines each of the cavities. The vertical position of the housing relative to the user of the apparatus may be adjusted by an actuator. The housing has exterior front, side and top walls with the cavities being open through at least the front wall of the housing.

In one such preferred embodiment, the cavities are additionally open through the top wall and means are provided for spraying a substantially continuous sheet of liquid across each top wall cavity opening so as to provide a barrier to the fluid sprayed against the inserted hand and forearm. Means are also provided for discharging a substantially continuous sheet of gas, such as air, across the front wall cavity openings through which the forearms and hands are inserted so as to provide a similar fluid barrier across the front wall cavity openings around the inserted forearms and hands. Both the water sheet seal and the air sheet seal, in addition to preventing the fluid pumped through the nozzles in the cavities from being sprayed outside of the machine also prevents contamination from the outside air.

It is therefore an object of the present invention to provide a hand and forearm scrubbing apparatus in which the hands and forearms are inserted into open cavities in a housing and are supported by fluid streams pumped through nozzles within the cavities.

It is another object of the invention to provide a hand and forearm scrubbing apparatus in which only a fluid seal is maintained around the forearms when they are inserted within the cavities so as to allow the easy removal of the forearms and hands from the apparatus at any time during the operation.

It is still another object of the invention to provide a hand and forearm scrubbing apparatus in which a timed sequence of washing operations are visually displayed to the user.

The foregoing and other objectives, features and advantages of the invention will be more readily understood upon consideration of the following detailed description of certain preferred embodiments of the invention, taken in conjunction with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the exterior of a first embodiment of the invention;

FIG. 2 is an enlarged vertical view in section taken generally along the lines 2—2 of FIG. 1;

FIG. 3 is an enlarged vertical view in section taken generally along the lines 3—3 of FIG. 2;

FIG. 4 is an enlarged vertical view in section taken generally along the lines 4—4 in FIG. 2;

FIG. 5 is an enlarged vertical view in section taken generally along the lines 5—5 in FIG. 2;

FIG. 6 is an enlarged vertical view in section of a portion of the cavity lining as displayed in FIG. 2;

FIG. 7 is an enlarged vertical view of the visual display in the embodiment of FIG. 1;

FIG. 8 is an enlarged vertical view in section taken generally along the lines 8—8 of FIG. 1;

FIG. 9 is a perspective view of a second embodiment of the invention;

FIG. 10 is an enlarged vertical view in section taken generally along the lines 10—10 of FIG. 9; and

FIG. 11 is an enlarged vertical view in section taken generally along the lines 11—11 of FIG. 10.



### DETAILED DESCRIPTION OF CERTAIN PREFERRED EMBODIMENTS

Referring now more particularly to FIG. 1, there is shown a hand and forearm scrubbing unit 10 which includes an upper housing 12 and a lower housing 32. The upper housing 12 has a front wall 14, a pair of side walls 16 and a back wall (not shown). The upper housing 12 also has a top wall 18 and a panel display board 20. A lighted display 22 is on the display board 20. An "up-down" switch 24, whose purpose will be explained in greater detail hereinafter, is mounted in the front wall 14.

A pair of cavity openings 26 and 28 are provided in the left and right sides, respectively, of the front wall 14 as viewed in FIG. 1. The lower housing 32 is provided with a foot switch 30 for controlling the operation of the device 10.

Referring now more particularly to FIG. 2, the details of the cavity 26 are illustrated. It will be understood that the details of the cavity 28 are substantially a mirror image of the details of the cavity 26 so as to accommodate the right hand instead of the left hand. The cavity 26 is provided with a liner 34 of resilient material whose inner surface is roughly in the shape of a left handed mitten to receive the left hand and forearm of the user of the machine. The interior surface of the liner 34 is provided with a plurality of nozzles 36 which are integrally incorporated into the lining material. The nozzles 36 are generally directed towards a central axis, indicated by the dashed line 38, which corresponds roughly to an axis of symmetry for the cavity liner 34.

The nozzles 36 are hollow and contain passages which communicate with a hollow manifold 40 within the cavity liner 34. The manifold 40 is, in turn, connected to a valve manifold 42 which is connected to a plurality of electrical solenoid operated valves 44, 46, 48 and 50. The valve 44 is connected between the manifold 42 and a source of water under pressure 52. The valve 46 is connected between the manifold 42 and a source of pressurized air 54. The valve 48 is connected between the manifold 42 and a source of soap and water under pressure 56. The valve 50 is connected between the manifold 42 and a source of sterilizing vapor under pressure 58. The fluid sources 52, 54, 56 and 58 may either be stored internally within the device 10 or they may be external sources connected to the apparatus through piping. An electric timer 60 operates each of the solenoid valves 44, 46, 48 and 50 in a sequence of timed stages as will be explained in greater detail hereinafter. The timer also controls the display panel indicator 22 to energize light behind appropriate signs describing each stage in the timed sequence.

The innermost end of the liner 34, that is the end which corresponds to the portion which would surround the inserted hand, is encompassed by an integrally formed evacuation chamber 64 which is connected to the inlet 66 of a pump 68 driven by an electric motor 70. The outlet of the pump 68 is connected to a wasteline 72. A plurality of passageways 74 are provided in the liner 34 to connect the interior of the cavity 26 with the inlet 66 of the pump 68. The manifold 40 is connected to the inlet 66 of the pump 68 by means of a drain line 76. A solenoid operated drain valve 78 is interposed in the line 76 between the pump inlet 66 and the manifold 40. The pump 66 is of the

centrifugal variety and is capable of drawing off water, air or vapor mixtures.

A hollow, annular passageway 80 within the liner 34 surrounds the entrance to the cavity 26. The passageway 80 is provided with a plurality of inwardly turned ports 82 which connect with the interior of the cavity 26 and are inclined towards its innermost end. The passageway 80 is connected by means of a pipe 84 with a warm air blower 86. The blower 86 is driven by an electric motor 88.

Referring now more particularly to FIG. 8, the mechanism for raising and lowering the upper housing 12 is illustrated. The upper housing 12 is supported on the top of a hydraulic ram 90 which is supplied with hydraulic fluid under pressure through a four-way solenoid operated valve 92 connected to a pair of inlet and outlet pipes 94 and 96, respectively, which are connected to either an internal or external source (not shown) of hydraulic fluid under pressure. The solenoid valve 92 is operated by the up and down switch 24 mounted on the front wall 14 of the upper housing 12. The upper housing 12 may be raised or lowered approximately eight inches with respect to the lower housing 32 in order to adjust for the particular height of the user of the machine. The sidewalls 16 are provided with external vents 98.

The foot switch 30 activates the timer 60 to begin the timed sequence of washing and drying stages. As shown in FIG. 7, as each timed stage takes place an indicator light adjacent a descriptive sign on the display panel 22 is lit. The time required to complete that cycle is also indicated on the panel by an adjacent sign.

In operation, the user adjusts the height of the console 12 by means of the up and down switch 24 so that his forearms and hands will be in a comfortable position within the cavities 26 and 28. The washing cycle is then activated by pressing down on the foot switch 30. The beginning of the cycle is with the washing stage. After the sign on the display panel 22 indicates that the wash stage has begun, the user puts his hands and forearms within the cavities 26 and 28. The pressing of the foot switch 30 activates the timer 60 to energize the solenoid valve 48 so that the soap solution from the source 56 travels through the manifold 40 to be ejected from the nozzles 36 under pressure. The timer also activates the pump 68 to evacuate the soap and water mixture as it is sprayed into the cavities 26 and 28. The vacuum pump 68 is on throughout the whole sequence of the washing operation which takes approximately 75 seconds.

The duration of the soap and water washing stage is approximately thirty seconds. When this is completed, the valve 48 is shut off by the timer 60 and the valve 44 is energized to spray water through the nozzle 36 on the hands and forearms in the cavities 26 and 28. The rinse water used is filtered and heated to approximately 70°F. The rinse water not only rinses the forearms and hands but the whole washing system as well. At the completion of the rinsing cycle, which takes approximately 20 seconds, the valve 44 is closed and the valve 46 is opened to supply compressed air to the manifold 40 and the nozzles 36. The drain valve 78 in the drain line 76 is also momentarily opened at this point to quickly evacuate water from the manifold 40. The warm air blower 86 is also energized by the timer 60 at this time to supply a stream of warm air around the

openings to the cavities 26 and 28. This cycle is the drying cycle and takes approximately 15 seconds.

At the completion of the drying cycle the warm air from the blower 86 continues to be supplied but the valve 46 is closed and the valve 50 is opened to admit a sterilizing vapor to the cavities 26 and 28 which covers the forearms and hands. The vapor cycle takes approximately 5 seconds and the warm air continues thereafter until the finish light is turned off. At the completion of the cycle, as indicated on the display panel 22 by the "finished" light, the forearms and hands have been washed, rinsed, sterilized and dried and may be removed from the enclosure.

At no time during the washing operation have the forearms and hands been touched by anything other than water, soap, air and sterilizing vapor. All of these various fluids are admitted to the cavities 26 and 28 at individually predetermined flowrates and pressures which are sufficient to support the weight of the hands and forearms within the cavities 26 and 28 so that the user of the machine is not put under the strain of supporting his arms during this procedure. The cavity lining 34 and the exterior chamber 64 are made of materials which are sufficiently resilient so that they do not sag downward at any time.

Referring now more particularly to FIGS. 9, 10 and 11, a modified embodiment 100 of the hand and forearm scrubbing device according to the invention is illustrated. With this embodiment it is possible for the user to view the entire operation within the scrubbing cavity as it takes place. Since the basic apparatus is substantially identical to the embodiment of FIG. 1, the same reference numerals primed have been applied to the corresponding parts. Thus, the upper housing 12' is provided with a front wall 14', sidewalls 16' and a top wall 18'. The timed sequence of stages is visually displayed on the light panel 22' mounted on the display panel 20'. The upper housing 12' is raised and lowered with respect to the lower housing 32' by means of the hydraulic ram servo 90 under the control of an up and down switch 24'. The cycle is begun by depressing the foot switch 30'.

In this embodiment the cavities 26' and 28' are not only open to the front wall 14' but are also open to the top wall 18' so that the user can watch the entire sequence of the operation. Thus the cavity liner 34' has a cross-sectional shape in the form of a U as illustrated in FIGS. 9 and 11. The interior surface of the liner 34' is provided with a plurality of integrally formed nozzles 36' generally directed towards a central, symmetrical axis 38' which is inclined at approximately 30° to the horizontal. A hollow passageway 40' within the liner 34' supplies fluid communication between the passages within the nozzles 36' and the valve manifold 42'. The valve manifold 42' is connected through the plurality of solenoid operated valves 44', 46', 48' and 50' with the same, corresponding sources 52', 54', 56' and 58' of water, air, soap and water, and sterilizing vapor, respectively, as discussed above in relation to the embodiment of FIG. 1.

An exterior chamber 64' surrounds the bottom wall of the liner 34' and is connected to the interior of the cavity 26' through a plurality of ports 74' in the liner 34'. The chamber 64' is connected to the inlet 66' of the pump 68' driven by the motor 70'. As in the embodiment of FIG. 1, the fluids pumped through the valve manifold 42' to the liner manifold 40' are ejected

through the nozzles 36' at pressures and flowrates that exert a supporting force within the cavity 26' sufficient to support the weight of the hand and forearm. Less force is required to support the hand and forearm than in the embodiment of FIG. 1 because at the bottom entrance edge of the cavity liner 34' there is an elbow rest 102 which partially supports the weight of the forearm and hand.

In order to prevent water and soap, etc. from being sprayed out of the openings in the cavities 26' and 28', fluid and air barriers are provided for the top and front openings, respectively, of the cavities. Thus, with reference more particularly to FIG. 11, a plurality of nozzles 104 are provided along the outer, upper edge of the cavity liner 34', that is, the upper left edge as viewed in FIG. 9. These nozzles 104 communicate with the interior manifold 40' of the cavity liner 34'. On the inner, upper edge of the cavity liner 34', i.e. the upper right edge as viewed in FIG. 9, is an evacuation vent 106 which runs substantially the length of the cavity liner 34'. The vent 106 is connected by means of a pipe 108 to the inlet 66' of the pump 68'. Thus, whenever fluid is being pumped through the manifold 40' a substantially continuous sheet of water is projected from the exterior side of the top cavity opening over the hand and forearm inserted within the cavity 26' to the evacuation vent 106 on the interior, upper edge of the cavity liner 34'. The purpose of this liquid sheet is to act as a shield over the top of the cavity to prevent contamination of the cavity from the outside environment and to prevent fluid spray within the cavity from leaving the cavity.

A plurality of inwardly directed warm air nozzles 82' are provided along the outer front edge of the opening of the cavity liner 34'. A vacuum vent 110 is oppositely aligned with the plurality of warm air nozzles 82' on the inner front edge of the opening of the cavity liner 34'. The vacuum vent 110 is also connected by means of a pipe (not shown) to the inlet 66' of the vacuum pump 68'. Together the nozzles 82' and the vent 110 provide a curtain of warm air across the opening of the cavity liner 34'. This air curtain also serves to prevent liquid sprayed within the cavity from spraying out the front opening and to prevent contamination of the cavity from the outside environment.

The operation of the embodiment of FIG. 9 is substantially the same as described above with reference to the embodiment of FIG. 1 except that the hands and forearms are first lowered into the cavities 26' and 28' before the switch peddle 30' is depressed. If this sequence is not followed, then splashing will be produced when the hands and forearms are passed through the water curtain ejected by the nozzles 104. As in the embodiment of FIG. 1, the fluid pressure exiting from the nozzles 36' supports the weight of the hands and forearms during the entire process. Nothing other than air, water, a soap and water mixture, and sterilizing vapor contact the hands and forearms at any-time during the washing operation. If it becomes necessary for the user to withdraw his hands during the washing cycle, he may do so immediately by simply raising them through the water curtain and the top openings of the cavities 26' and 28'.

While only four basic stages in the washing cycle have been described above with reference to the embodiments of FIGS. 1 and 9, it will be understood by

those skilled in the art that further stages may be added as required for the particular operation involved.

In the above embodiments a pair of cavities for receiving separate hands and forearms are described but in other, smaller embodiments only the hands are received while in still other less advantageous embodiments a single cavity is provided for both of the hands and/or forearms.

The terms and expressions which have been employed here are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described, or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A hand and forearm spray cleaning apparatus comprising a housing having a pair of cavities therein, each cavity having a longitudinal axis of symmetry and being suitable for receiving a separate hand and forearm, a plurality of nozzles within each cavity which are directed towards the axis of symmetry, and means for pumping fluid through the nozzles at a predetermined rate and pressure so as to exert a net force on the inserted hands and forearms sufficient to support their weight within each cavity.

2. A hand and forearm spray cleaning apparatus as recited in claim 1 wherein the means for pumping fluid further comprises means for pumping a soap and water solution, water alone, heated air, a sterilizing vapor, and warm air in a sequence of timed stages.

3. A hand and forearm spray cleaning apparatus as recited in claim 2 further comprising display means mounted on the housing for visually displaying each stage in the timed sequence of the pumping means.

4. A hand and forearm spray cleaning apparatus as recited in claim 1 wherein the means for pumping fluid further comprises means for evacuating air and water from the cavities.

5. A hand and forearm spray cleaning apparatus as

recited in claim 1 wherein the cavities are lined with a waterproof, resilient material in which at least some of the plurality of nozzles are integrally incorporated, the resilient material including a manifold passage for connecting the incorporated nozzles with the means for pumping the fluid.

6. A hand and forearm spray cleaning apparatus as recited in claim 1 further comprising actuator means for adjusting the vertical position of a portion of the housing.

7. A hand and forearm spray cleaning apparatus as recited in claim 1 wherein the housing has exterior front and top walls, the cavities being open through at least the front wall of the housing.

8. A hand and forearm spray cleaning apparatus as recited in claim 7 wherein the cavities are additionally open through the top wall of the housing.

9. A hand and forearm spray cleaning apparatus as recited in claim 8 further comprising means for spraying a substantially continuous sheet of fluid across the cavity openings in the top wall of the housing to provide a fluid barrier across the top wall cavity openings.

10. A hand and forearm spray cleaning apparatus as recited in claim 7 further comprising means for discharging a substantially continuous sheet of gas across the cavity openings in the front wall of the housing to provide a fluid barrier across the front wall cavity openings.

11. A hand and forearm spray cleaning apparatus comprising a housing having at least one cavity therein, each cavity having a longitudinal axis of symmetry and being suitable for receiving at least a separate hand, a plurality of nozzles within each cavity which are directed toward the axis of symmetry, and means for pumping fluid through the nozzles at a predetermined rate and pressure so as to exert a net force on the inserted hand sufficient to support its weight within each cavity.

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