

Aug. 20, 1968

S. A. HENDERSON

3,397,648

SUCTION PUMP

Original Filed Oct. 18, 1965

3 Sheets-Sheet 1

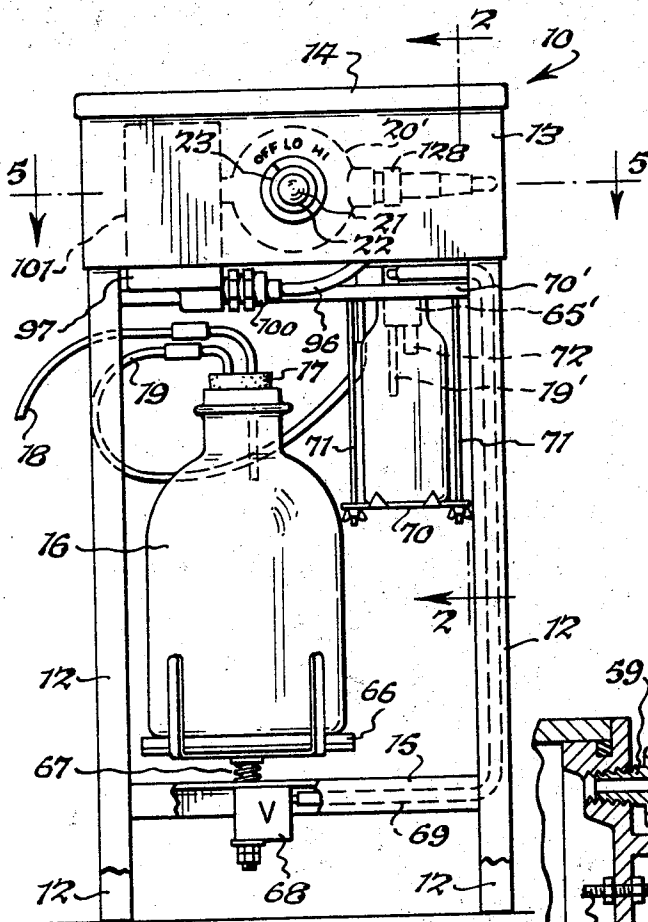


Fig. 1.

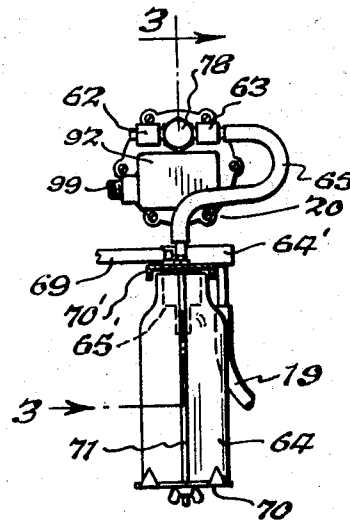
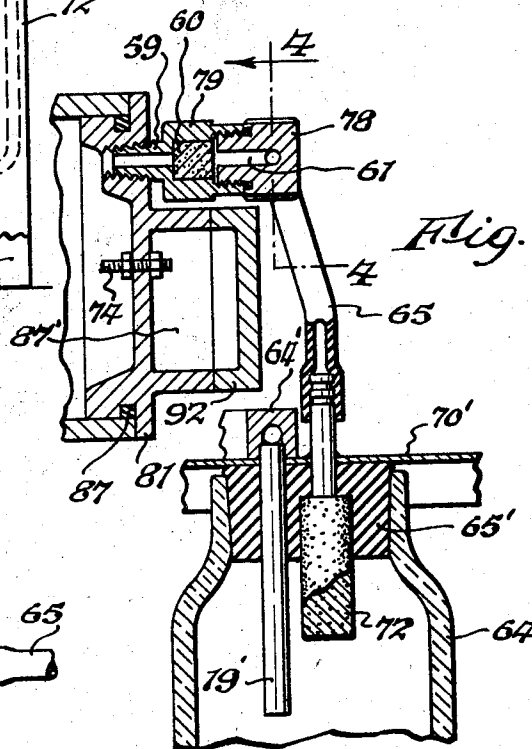


Fig. 2.



Aug. 20, 1968

S. A. HENDERSON

3,397,648

SUCTION PUMP

Original Filed Oct. 18, 1965

3 Sheets-Sheet 2

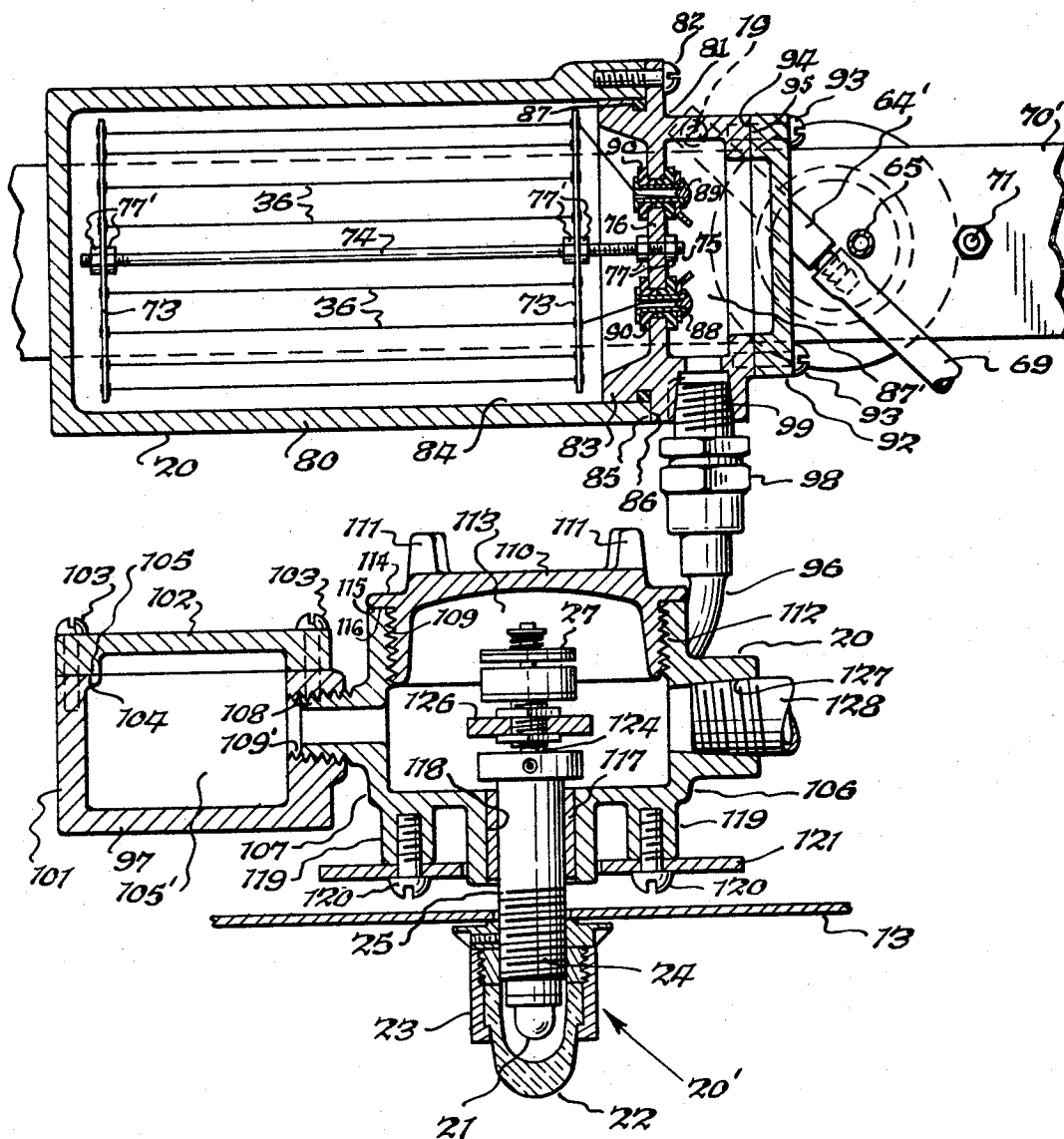


Fig. 5.

INVENTOR

Stanford A. Henderson

BY

Beau, Brooke, Buckley & Beau  
ATTORNEYS.

Aug. 20, 1968

S. A. HENDERSON

3,397,648

SUCTION PUMP

Original Filed Oct. 18, 1965

3 Sheets-Sheet 3

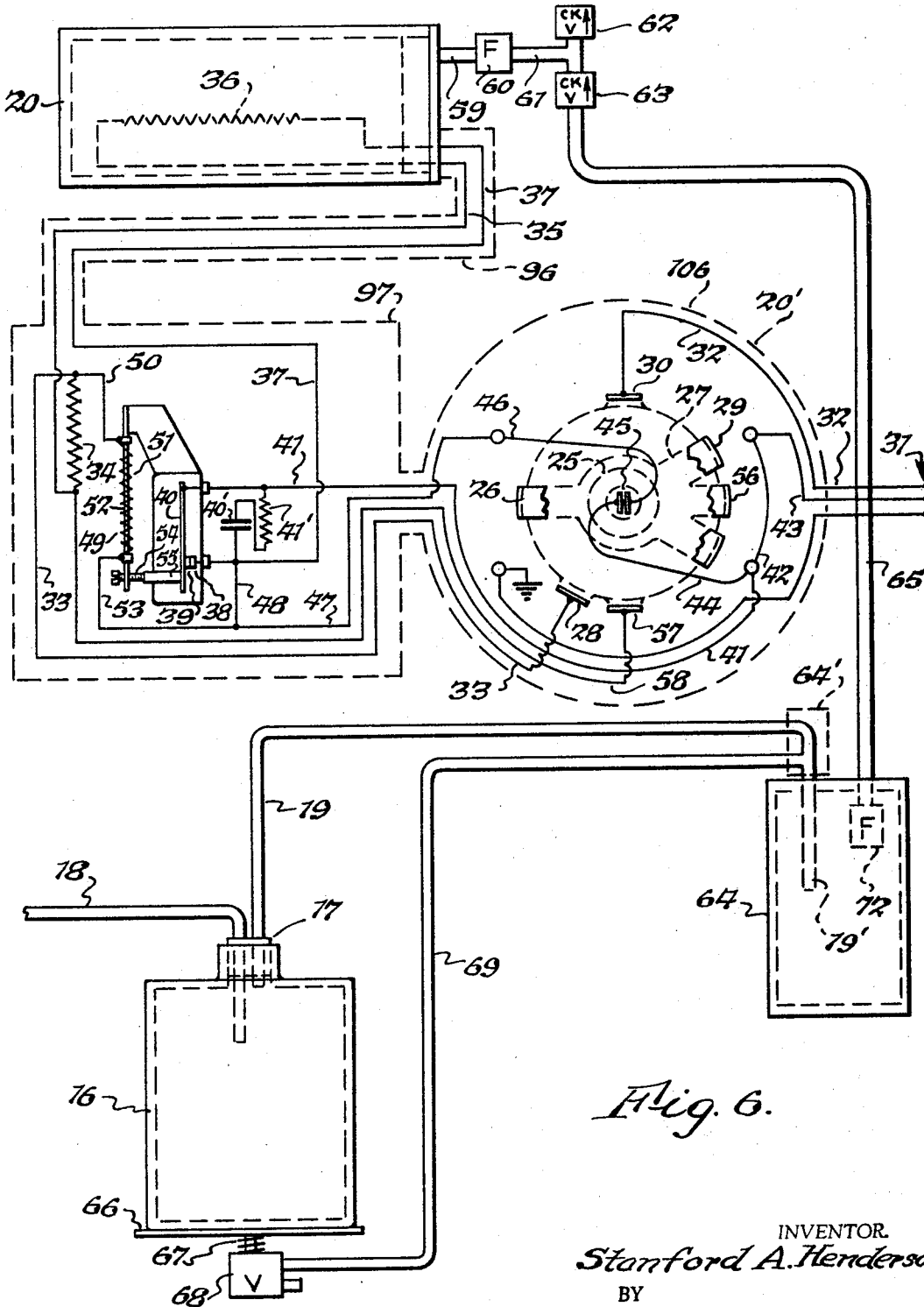


Fig. 6.

INVENTOR.

Stanford A. Henderson

BY

Beau, Brooks, Buckley & Beau  
ATTORNEYS.

1

3,397,648

## SUCTION PUMP

Stanford A. Henderson, Snyder, N.Y., assignor to Gomco Surgical Manufacturing Corporation, Buffalo, N.Y., a corporation of New York

Continuation of application Ser. No. 496,894, Oct. 18, 1965. This application Apr. 17, 1967, Ser. No. 631,567  
9 Claims. (Cl. 103—236)

### ABSTRACT OF THE DISCLOSURE

A suction pump including a pump chamber with a resistance heating element therein and control means for alternately energizing and de-energizing the heating element to cause gases to flow into said chamber through a first conduit having a first check valve and to flow from said chamber through a second conduit having a second check valve, with a porous metal filter in said second conduit and with both said chamber and said control means being within housings which are explosion proof and flame proof, and shielding conduit means for shielding various electrical lead means from the atmosphere.

This application is a continuation of application Ser. No. 496,894, filed Oct. 18, 1965, now abandoned.

The present invention relates to an improved medical suction pump which is especially constructed for removing liquids or gases from patients located in hospital operating rooms or other environments containing explosive mixtures of anesthetics or medicinal compounds.

By way of background, a medical suction pump, such as shown in Patent No. 2,346,841, is used to drain fluids from body cavities. This pump operates by cyclically heating air in a pump chamber. When the air is heated, it expands, and a part of it is forced from the chamber. When the remaining air in the pump chamber cools, a partial vacuum is created, and this partial vacuum is communicated to a catheter which is inserted in an area to be drained. The partial vacuum causes fluids to be drawn into the catheter and to be deposited in a fluid trap. By the alternate heating and cooling of the gases in the pump chamber, a gentle intermittent pumping action is obtained, thus causing excess liquids to be removed from a person's body during the cooling of gas within the pump chamber and permitting fluid to accumulate in the area being drained while the pump chamber is heated. The accumulation of fluids permits the body tissues to be periodically immersed in the liquids which are so necessary to their sustained functioning. It is with an improvement in the foregoing type of medical suction pump that the present invention is concerned.

In the past, suction pumps of the foregoing type were not suitable for use in operating rooms or other environments containing explosive gases. In this respect, while the heated gases being expelled from the pump chamber are normally below the kindling temperature of explosive gases in the operating room, there is always the possibility of an electrical fault causing an arc or raising the temperature of the gases being heated above the kindling point of such explosive gases. The expelling of excessively high temperature gases therefore could create a focal point for explosions. In view of this, other methods and devices were accordingly required for effecting drainage of wounds or body cavities, but such drainage devices could not provide the gentle intermittent drainage with the accompanying periods of non-drainage necessary for maintaining the body cavities immersed in body fluids.

It is accordingly one object of the present invention to provide an improved suction pump of the foregoing type

2

which can be utilized in operating rooms and other explosive environments without danger of explosion.

Another object of the present invention is to provide a suction pump in which the pump chamber is constructed to withstand internal explosions produced as a result of the igniting of explosive gases within the pump chamber. A related object of the present invention is to provide an improved suction pump in which all components of the apparatus which could possibly ignite explosive mixtures of gases are placed within housings having an extremely long flame path leading to outside areas so that any gases ignited within such housing are cooled before possibly coming into contact with gases outside of the housing to thereby prevent the exploding of such outside gases.

A further object of the present invention is to provide an improved suction pump in which the mixtures of gases expelled from the pump chamber must pass through a filtered path which not only prevents incandescent material from flowing beyond the apparatus but also provides a sufficiently long path of travel for such gases through relatively low temperature metals to cause previously heated gases within the pump chamber to be cooled before being expelled to the atmosphere, thereby further reducing any possibility of igniting explosive mixtures of gases in the area in which the suction pump is operating. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

The improved suction pump of the present invention includes a pump chamber, heating means operatively associated with the pump chamber, control means for alternately energizing and deenergizing the heating means to thereby alternately heat and cool gases in the pump chamber, first conduit means for conducting gases into the pump chamber during the cooling of the gases, second conduit means for conducting gases out of the pump chamber during the heating of said gases, and means for effectively dissipating heat from the heated gases being conducted through the second conduit means to thereby prevent such gases from kindling explosive mixtures outside of said second conduit means.

The preferred means for dissipating heat is a porous metal filter which by contact with the hot gases removes heat therefrom. In addition, the porous metal filter prevents incandescent materials from passing beyond the filter. The improved suction pump also includes a first housing for the control means which is constructed to prevent any flame or excessive heat from passing beyond the confines thereof. In addition, the improved suction pump includes a second housing for the switch which couples the control means to a source of electric current, the second housing being constructed to prevent the arcing resulting from switch action from passing beyond the confines thereof. The first and second housings and the pump chamber are fabricated from metal which is sufficiently strong to withstand the force of internal explosions which may be experienced as a result of explosive mixtures of gases being ignited therein. The present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawings wherein:

FIGURE 1 is a fragmentary side elevational view of the improved suction pump of the present invention;

FIGURE 2 is a side elevational view of the pump chamber coupled to the overflow jar;

FIGURE 3 is a view taken substantially along line 3—3 of FIGURE 2;

FIGURE 4 is a view taken substantially along line 4—4 of FIGURE 3;

FIGURE 5 is a view taken substantially along lines 5—5 of FIGURE 1 and showing the relationship between

the pump chamber and the switch housing and the control housing; and

FIGURE 6 is a schematic view showing the electrical and pneumatic circuitry of the suction pump.

The improved suction pump 10 includes a stand 11 having four legs 12 which may have casters (not shown) secured to the lower ends thereof to enhance mobility of the pump. The top of suction pump 10 is in the form of a cabinet 13 having a top 14 thereon which is generally of square shape, the four legs 12 essentially being in line with the corners of cabinet 13 and top 14. Top 14 may be utilized for supporting medical instruments and preparations, and thus serves a conventional function of a table top as well as a protection for the components of the pump within cabinet 13. A shelf 15 which is of generally square shape has its four corners suitably secured to legs 12 to thereby stabilize the legs as well as providing additional shelf surface.

By way of general functional description, fluid trap 16, which is essentially a glass bottle having a two-holed stopper 17 therein, is periodically partially evacuated of air and the partial vacuum thus created is communicated to conduit 18, which passes through stopper 17 and has its free end mounting a catheter (not shown) which is inserted into an area to be drained. Also passing through stopper 17 is a conduit 19 which is in communication with the pump chamber 20 (FIG. 5) which produces intermittent evacuation of gases in fluid trap 16 to thereby effect drainage through conduit 18, as will become more readily apparent hereafter.

A three-position electrical switch 20' is mounted on bracket 121 (FIG. 5) and extends through the wall of cabinet 13. The portion outside of cabinet 13 includes a pilot light 21 housed within transparent envelope 22 which is sealed within knob 23. As can be seen from FIGURE 5, a relatively long threaded connection 24 exists between shaft 25 and knob 23. This connection effects the dissipation of any heated gases passing therebetween and in essence, provides a relatively long flame path which prevents any heat generated within envelope 22 from igniting gases outside of said envelope. At this point, it is to be noted that envelope 22 is of sufficient thickness so that it will not shatter in the event that an explosion should occur within its confines.

The contacts on the rear of switch 20' are shown in the off position in FIGURE 6. If it is desired to effect a relatively slow pumping action, shaft 25 is rotated in a counterclockwise direction in FIGURE 6 (clockwise in FIG. 1) to rotate switch plate 27 which is attached to shaft 25 and thus cause contact 26 of switch plate 27 to snap into engagement with terminal 28 and simultaneously cause contact 29 of switch plate 27 to move into engagement with terminal 30. This will cause a circuit to be completed from a suitable source of electric current 31 through lead 32, terminal 30, contact 29, plate 27, contact 26, terminal 28, lead 33, voltage drop resistor 34, lead 35, resistance heating filament 36 within pump chamber 20, lead 37, contact 38, contact 39 (which is in engagement with contact 38 when filament 36 is being heated), switch armature 40, lead 41, lead 42, and lead 43 back to the current source 31 to thereby complete a circuit through filament 36 in pump chamber 20. In addition, a circuit is completed from lead 37 through leads 48 and 47, lead 46, terminals 45 of pilot light 21, and leads 44, 42 and 43 back to current source 31. Thus, lamp 21 will ignite when current is not passing through heating elements 36 thereby indicating that the gases within pump chamber 20 are not being heated, or are cooling. When contacts 38 and 39 are closed, lamp 21 is shunted out of the circuit.

The foregoing heating of filament 36 is effected by thermostatic switch 49 in the following manner: As can be seen from FIGURE 6, current flows from lead 33, through lead 50, heating element 51 encircling bimetal 52, screw 54, conductor 55 in engagement with screw 54, closed con-

tacts 38 and 39, leads 48, 47, 46, lamp terminals 45, and leads 43 and 42 to current source 31. It can thus be seen that when contacts 38 and 39 are closed, current will be supplied to both resistance heating element 36 in pump chamber 20 and to resistance heater 51 encircling bimetal 52. As the bimetal 52 heats up it will warp and cause armature 40 to move and thus cause contacts 38 and 39 to separate, thereby disrupting flow of current to both filament 36 in pump chamber 20 and to heating element 51. The gases are thus heated in pump chamber 20 and when filament 36 cools, the gases also will cool. In addition, as resistance heating element 51 cools bimetal 52 will again move back to a position where it causes contacts 38 and 39 to close to thereby again initiate heating of filaments 36 and 51. It can thus be seen that filament 36 is energized intermittently to thereby effect cyclic heating of the gases in pump chamber 20. Lamp 21 will ignite only when the filament 36 is not heating, as noted above.

In the event that it is desired to effect rapid cyclic heating of pump chamber 20, switch 20' is manipulated to cause contact 56 to move into engagement with terminal 30 and cause contact 26 to move into engagement with terminal 57. This has the effect of removing circuit resistor 34 from the circuit to thereby permit filament 36 to heat up more rapidly. Otherwise, the circuitry is not changed. In other words, current can now flow from source 31 through lead 32, terminal 30, contact 56, plate 27, contact 26, terminal 57, and lead 58 to lead 35 whereas previously the current had to flow through resistor 34 prior to flowing into lead 35. The switching circuit and the lamp 21 both operate in the same manner when rapid pump cycling is being effected as when the slow cycling, described in detail above, is being effected, and therefore a further detailed explanation is deemed unnecessary. It is to be noted that capacitor 40' and resistor 41' are coupled in series across leads 37 and 41 for the purpose of suppressing arcing across switch contacts 38 and 39.

It is the above described alternate heating and cooling of filament 36 which produces the pumping action. More specifically, whenever the gases within chamber 20 are heated (FIGS. 3 and 6), they will expand and will be forced through conduit 59, porous bronze filter 60, conduit 61 and check valve 62 to the atmosphere. At this time check valve 63 will be closed because it can only pass gases in the direction of the arrow shown in FIGURE 6. Whenever filament 36 cools, the gases within chamber 20 will also cool and thus create a partial vacuum. This vacuum will thus draw liquids through from a catheter (not shown) into fluid trap 16 by drawing gases through conduit 19, overflow jar 64, conduit 65, check valve 63, conduit 61, filter 60 and conduit 59. At this time, check valve 62 will be closed because it can only pass gases in the direction of the arrow shown in FIGURE 6. The liquids drawn into fluid trap 16 will gradually build up therein and fluid trap 16 should be emptied before it is full to insure continued operation of the pump. If for any reason the fluid trap 16 is not emptied, it will cause overflow jar 64 to be vented to the atmosphere to thereby terminate the suction at the catheter. More specifically, fluid trap 16 is mounted on platform 66 (FIG. 1) which in turn is held in an upper position by spring 67 interposed between it and shelf 15. A simple slide valve 68 is provided with the slide member thereof normally closing the end of conduit 69 when the jar is below a certain weight, thereby permitting suction to be transmitted to conduit 18 from overflow jar 64. However, when fluid trap 16 fills to a predetermined amount, the weight thereof will cause slide valve 68 to open to thereby vent conduit 69 to the atmosphere. As can be seen from FIGURES 2, 5 and 6, conduit 69 is in communication with overflow jar 64 through fitting 64' and thus if there is a suction in conduit 65, said suction will be satisfied with air flowing through conduit 69 into overflow jar 64 and will not create a suction in conduit 19 which is also in communication with fitting 64', which is essentially a T having outlets in communication with conduits 19 and 69

and also having an outlet 19' extending through stopper 65'. As can be seen from FIGURE 1, overflow jar 64 is mounted on bracket 70 attached to plate 70' in cabinet 13 by elongated screws 71. Plate 70' has its opposite ends attached to the cabinet sides and also supports pump chamber 20. As can be seen from FIGURES 3 and 6, a porous filter 72 is mounted on the end of conduit 65 within overflow jar 64 to filter impurities from the air passing into conduit 65 and therefore protect check valve 63 against the deposit of impurities thereon.

As noted above, the heated gases passing from pump chamber 20 must pass through porous bronze filter 60 (FIG. 3). This serves a plurality of functions. First of all, heat is conducted from gases passing through metal filter 60 and coming into contact therewith, to thereby cause only cooled gases to pass into conduit 61 leading to check valve 62. In addition, the gases passing through filter 60 are cooled because of expansion in going from a relatively high to a relatively low pressure area. Thus, the gases which are expelled to the atmosphere of an operating room or other environment which may contain explosive gases are positively cooled below the kindling point of such explosive gases. It is to be especially noted that the gases within the pump chamber are normally not heated above the kindling point of explosive gases in an operating room. It is only when an electrical fault occurs, such as an arc resulting from a wire breaking or from a short circuit or the like that the gases are heated above the kindling point of explosive gases. In addition, porous bronze filter 60 prevents incandescent material from passing into conduit 61. More specifically, as can be seen from FIGURE 5, filament 36 is continuous and is strung between mica discs 73 which are mounted on rod 74 which in turn has the end 75 thereof secured to pump head plate 76 by nuts 77, discs 73 being held in position by nuts 77' on opposite sides thereof. The mica may flake off or oxidation of other matter within chamber 20 may provide incandescent particles which bronze filter 60 intercepts. In addition, filter 60 also prevents dust particles from being deposited on either check valve 62 or 63 thereby insuring long satisfactory service thereof. It can thus be seen that heated gases cannot be intentionally dumped into an explosive environment. These gases are dumped only after they have been sufficiently cooled and incandescent particles have been filtered therefrom. Further, as can be seen from FIGURE 3, bronze filter 60 may be removed for periodic replacement, if required, by merely screwing fitting 78 out of fitting 79 housing the filter, removing filter 60, replacing a new filter within housing 79 and thereafter reassembling fitting 78 into fitting 79.

In addition to preventing the expelling of heated gases into the environment in which pump 10 is operating, various components thereof are individually constructed and integrated with each other so as to prevent any heated gases from passing into the explosive environment from such components. More specifically, as can be seen from FIGURE 5, pump chamber 20 consists of a cylindrical cup-like portion 80 having a cylinder head 81 attached thereto by circumferentially spaced screws 82. The cylinder cover 81 includes an inwardly extending collar 83 having an outer peripheral surface which is adapted to provide a relatively tight fit with the internal surface 84 of cylinder 80. In addition, peripheral surface 85 of cover 81 provides a good snug abutting fit with end surface 86 of cylinder 80. A gasket or O-ring may be located in the annular groove 87 of cover 81. Because of the foregoing surface-to-surface contacts between cylinder 80 and cover 81, an elongated flame path is provided so that in the event there is for any reason any tendency for gases within cylinder 80 to leak through the space between the cover and the cylinder, such gases will be cooled prior to reaching the atmosphere. Furthermore, it is to be especially noted that explosions may occur within cylinder 80 because of electrical faults, such as broken filaments or arcing due to short circuits, which may cause explosive mixtures to

ignite. However, the above described relatively long flame path prevents any heated gases expanded by the sudden explosions from being admitted to the atmosphere through the joint between the cover 81 and cylinder 80.

A portion of the electrical wires conducting electricity to filament 36 are housed within chamber 87' of cover 81. In this respect the terminals of the wires are connected to terminals 88 and 89 which are secured on central plate 76 of the cover 81 by insulators 90 which may be fabricated from nylon or ceramic material, which also tend to provide a seal between chamber 87' and the chamber in which filament 36 is located. The terminal compartment or chamber 87' has a cover 92 thereon which is secured thereto by screws 93. The surface 94 of cover 92 mates with surface 95 of cover 81 to provide a relatively large amount of surface-to-surface contact. Thus, in the event that explosions should occur within chamber 87' there will be very little tendency of such gases to be expelled between the joints at surfaces 94 and 95 because of the relatively long flame path therebetween. All of the foregoing components of pump chamber 20 are preferably fabricated from relatively heavy cast aluminum to thereby render the entire pump chamber sufficiently rugged to withstand the severest of internal explosions which may be encountered in use.

The electrical conduits which are led into compartment 87' are housed within metal conduit 96 (FIGS. 5 and 1) extending between cylinder head 81 and thermostat housing 97. As can be seen from FIGURE 5, a first fitting 98 has a threaded portion 99 which screws into cover 81 and another portion which mounts one end of conduit 96. The other end of conduit 96 is mounted on a portion of fitting 100 (FIG. 1) which has a portion similar to portion 99 threaded into thermostat housing 97. All of the components shown within the broken line box designated 97 in FIGURE 6 are housed within thermostat housing 97. The housing 97 essentially consists of a substantially rectangular box-like portion 101 (FIGS. 1 and 5) having a cover 102 secured thereto by screws 103 at appropriate spaced locations. There is relatively large surface contact between cover 102 and portion 101 at peripheral edge surfaces 104 and 105, respectively. These peripheral edge surfaces, when abutting each other, provide a good tight fit to prevent heat from passing from within compartment 105' out to the environment in which housing 97 is located. In other words, a flame path is provided which dissipates any flame or heat within chamber 105' before it can reach the outside of chamber 105'. Thermostat compartment 97 is fabricated from relatively heavy cast aluminum which can withstand the force of the severest explosions which may occur therein.

A switch housing 106 is provided for housing the switch plate 27 and the various terminals and contacts discussed above and shown in FIGURE 6. This housing includes a central body portion 107 having a threaded nipple 108 formed integrally therewith which threads into a mating tapped aperture 109' of housing 97 and supports the latter. In addition, housing 106 has a tapped portion 109 which receives the mating threads of cover 110 having lugs 111 on the outside thereof for accommodating a suitable spanner wrench. It is to be noted that the length of tapped portion 109 and thread 112 and the length of threads 108 and tapped portion 109' provide extremely long flame paths to prevent heat or arcing in chamber 113 from passing to the outside of housing 107. In addition, a flange 114 is provided on cover 110, said flange having a planar surface 115 which forms a good tight fit with surface 116 of housing 107 to also provide a flame path.

Shaft 25 of switch 20' is received within bushing 117 which in turn is received within bore 118 of housing 107. The fit between this shaft and the bushing and between the bushing and the housing is sufficiently snug to provide an extremely long flame path to prevent heated gases from within chamber 113 from passing beyond the confines of housing 107. Furthermore, housing 107 is made

of cast aluminum which is of sufficient thickness to withstand the force of any explosions which may possibly occur within chamber 113. A plurality of bosses 119 are provided on housing 107 for receiving screws 120 which fasten said housing to plate 121 which in turn is suitably secured to cabinet 13 by connections, not shown.

For further preventing any possibility of heat or gases from passing out of chamber 113 through hollow shaft 25 and the socket in which lamp 21 is inserted, a threaded connection 24 consists of an extremely long thread on shaft 25 and on knob 23 to thereby provide the elongated flame path necessary for achieving this function.

At this point it is to be noted that a flexible coupling 124 is provided between shaft 25 and the remainder of the switch which is mounted on plate 126, which, in turn, is suitably secured by screws (not shown) to housing 107. This flexible coupling insures good switch action, notwithstanding possible misalignment between the axes of shaft 25 and the remainder of the switch. While not specifically shown, the switch contains the necessary detents for holding it in any one of its three positions, low, high, or off.

At this point it is to be noted that an additional tapped bore 127 is provided in housing 107 for receiving fitting 128 which may conduct other electrical wires into chamber 113 from a suitable source of electrical current. Suitable sealing is provided between the electrical wires and nipple 128 to maintain the explosion-proof characteristics of the structure.

It can thus be seen that the above described suction pump is manifestly capable of providing explosion-proof operation in environments having explosive gases, and while a preferred embodiment of the present invention has been disclosed, it will readily be appreciated that it is not limited thereto but may be otherwise embodied within the scope of the following claims.

I claim:

1. A suction pump comprising a pump chamber, heating means operatively associated with said pump chamber, control means for alternately energizing and de-energizing said heating means to thereby alternately heat and cool gases in said pump chamber, first conduit means for conducting gases into said chamber during said cooling, said first conduit means having a first valve means therein for permitting gases to pass into said chamber but preventing gases from passing from said chamber into said first conduit means, and second conduit means for conducting gases out of said pump chamber during said heating, said second conduit means having a second valve means therein for permitting gases to pass from said chamber into said second conduit means but preventing gases from passing into said chamber from said second conduit means, and a porous metal filter means interposed between said pump chamber and said second valve means to conduct heat from said heated gases passing through said porous metal filter and also filter incandescent materials from said gases and also prevent the deposit of solids on said second valve means.

2. A suction pump as set forth in claim 1 including switch means for selectively connecting said control means to a source of electric current, and housing means for said control means and said switch means for preventing flame originated by said switch means and said control means from passing beyond the confines of said housing means.

3. A suction pump as set forth in claim 1 including second filter means in said first conduit means for preventing the deposit of impurities on said first and second valve means.

4. A suction pump for use in an environment which may be explosive comprising a pump chamber, heating filament means in said pump chamber, a second chamber mounted on said pump chamber, plate means separating said pump chamber and said second chamber, electrical

terminals mounted on said plate means and electrically coupled to said heating filament means, said plate means being entirely confined by said pump chamber and said second chamber to prevent exposure of said electrical terminals to said environment, a control housing, thermostatic control means confined against exposure to said environment within said control housing, first electrical lead means for effecting electrical communication between said thermostatic control means and said electrical terminals to thereby alternately energize and deenergize said filament means to thereby alternately heat and cool gases in said pump chamber, electrical conduit means extending between said control housing and said second chamber for shielding said first electrical lead means from said environment, a switch housing, switch means confined against exposure to said environment in said housing, second electrical lead means for effecting electrical communication between said switch means and said thermostatic control means for energizing said thermostatic control means, means associated with said switch housing and said control housing for shielding said second electrical lead means from said environment, means in said switch housing for permitting a portion of said switch means to extend therethrough while preventing communication between the inside of said switch housing and said environment, first conduit means for conducting gases into said pump chamber, first filter means in said first conduit means for filtering gases passing through said first conduit means, first valve means in said first conduit means for permitting gases to pass into said pump chamber from said first conduit means during said cooling but preventing gases from passing from said pump chamber into said first conduit means during said heating, second conduit means for conducting gases out of said pump chamber, second valve means in said second conduit means for permitting gases to pass into said second conduit means from said pump chamber during said heating but preventing gases from passing into said pump chamber through said second conduit means during said cooling, and porous metal filter means in said second conduit means between said pump chamber and said second valve means to conduct heat from heated gases passing through said second conduit means and also filter heated solids from said gases to prevent deposit of said solids on said second valve means.

5. A suction pump comprising a pump chamber, heating means operatively associated with said pump chamber, control means for alternately energizing and de-energizing said heating means to thereby alternately heat and cool gases in said pump chamber, first conduit means for conducting gases into said chamber during said cooling, said first conduit means having a first valve means therein for permitting gases to pass into said chamber but preventing gases from passing from said chamber into said first conduit means, and second conduit means for conducting gases out of said pump chamber and into the atmosphere during said heating, said second conduit means having a second valve means therein for permitting gases to pass from said chamber into said second conduit means but preventing gases from passing into said chamber from said second conduit means, and filter means for effectively dissipating heat from said gases passing through said second conduit means to said atmosphere, said filter means being interposed between said pump chamber and said second valve means to also trap solid particles and incandescent materials passing toward said second valve means from said pump chamber.

6. A suction pump as set forth in claim 5 including fitting means for permitting insertion and removal of said filter means relative to said second conduit means.

7. A suction pump for use in an environment which may be explosive comprising a pump chamber, heating filament means in said pump chamber, a second chamber mounted on said pump chamber, plate means separating said pump chamber and said second chamber, elec-

trical terminals mounted on said plate means and electrically coupled to said heating filament means, said plate means being entirely confined by said pump chamber and said second chamber to prevent exposure of said electrical terminals to said environment, a control housing, thermostatic control means confined against exposure to said environment within said control housing, first electrical lead means for effecting electrical communication between said thermostatic control means and said electrical terminals to thereby alternately energize and de-energize said filament means to thereby alternately heat and cool gases in said pump chamber, a switch housing, switch means confined against exposure to said environment in said housing, second electrical lead means for effecting electrical communication between said switch means and said thermostatic control means for energizing said thermostatic control means, means in said switch housing for permitting a portion of said switch means to extend therethrough while preventing communication between the inside of said switch housing and said environment, first conduit means for conducting gases into said pump chamber, first valve means in said first conduit means for permitting gases to pass into said pump chamber from said first conduit means during said cooling but preventing gases from passing from said pump chamber into said first conduit means during said heating, second conduit means for conducting gases out of said pump chamber, and second valve means in said second conduit means for permitting gases to pass into said second conduit means from said pump chamber during said heating but preventing gases from passing into said pump cham-

ber through said second conduit means during said cooling.

8. A suction pump as set forth in claim 7 including first electrical conduit means extending between said control housing and said second chamber for shielding said first electrical lead means from said environment, and means associated with said switch housing and said control housing for shielding said second electrical lead means from said environment.

9. A suction pump as set forth in claim 7 including means in said second conduit means for effectively dissipating heat from gases passing through said second conduit means to said environment.

#### References Cited

##### UNITED STATES PATENTS

|           |         |                |           |
|-----------|---------|----------------|-----------|
| 1,271,712 | 7/1918  | Humphrey       | 230—182   |
| 2,354,761 | 8/1944  | Luckenbach     | 230—132   |
| 2,465,685 | 3/1949  | Henderson      | 103—236 X |
| 2,727,678 | 12/1955 | Henderson      | 103—236 X |
| 2,772,831 | 12/1956 | Cotter         | 230—211   |
| 2,917,226 | 12/1959 | Scheiterlein   | 230—211 X |
| 3,116,785 | 1/1964  | Bubniak et al. | 230—132   |
| 3,187,519 | 6/1965  | Matless        | 230—17 X  |

##### FOREIGN PATENTS

17,433 8/1898 Great Britain.

FRED C. MATTERN, Jr., *Primary Examiner*.  
W. J. KRAUSS, *Assistant Examiner*.