

May 6, 1958

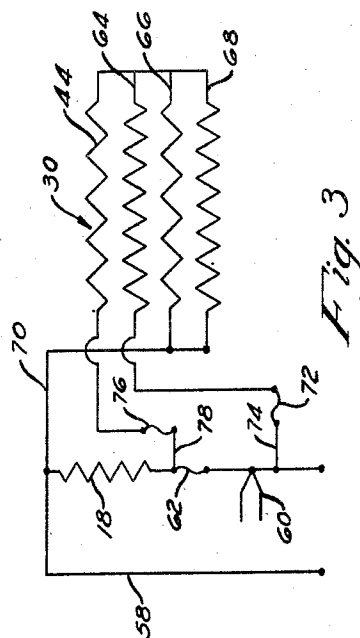
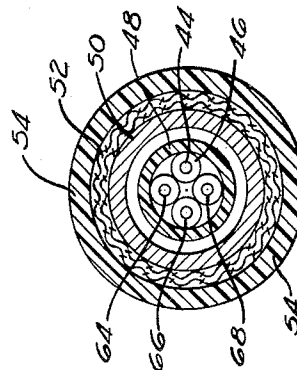
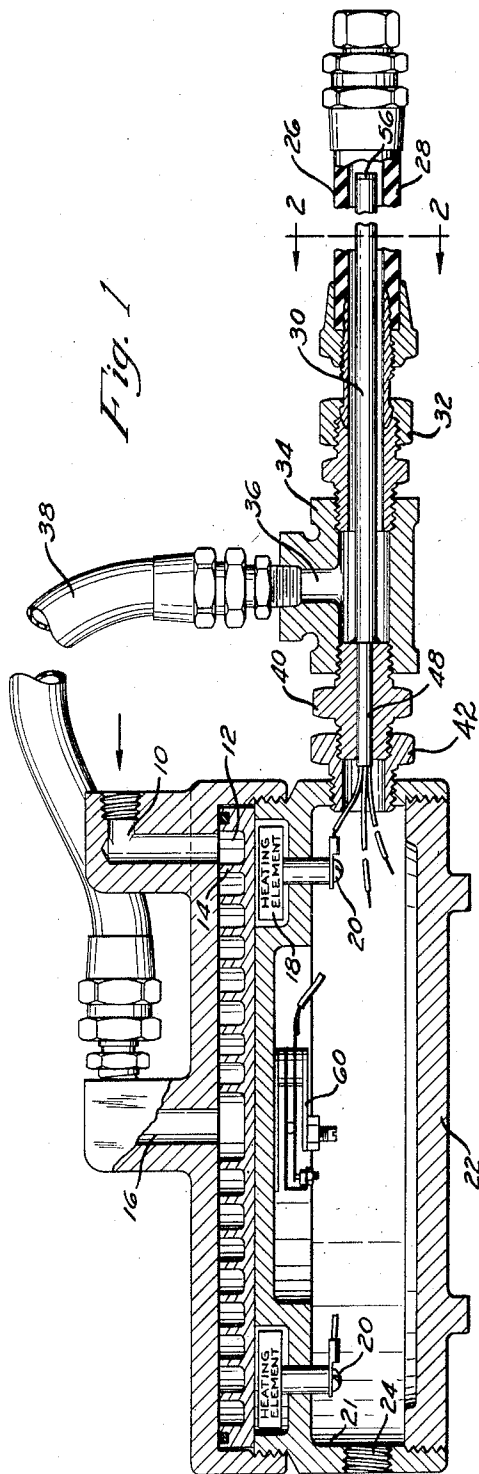
G. S. LEVEY

2,833,909

HOSE-TYPE PAINT HEATER

Filed May 29, 1956

2 Sheets-Sheet 1



INVENTOR.
GUSTAVE S. LEVEY

BY
RICHEY, WATTS, EDGERTON & MCNENNY

H. E. Whitaker
ATTORNEYS

May 6, 1958

G. S. LEVEY

2,833,909

HOSE-TYPE PAINT HEATER

Filed May 29, 1956

2 Sheets-Sheet 2

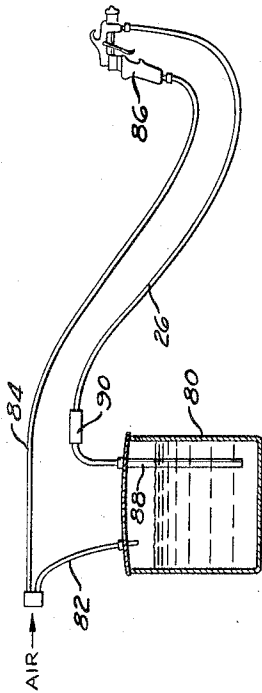


Fig. 6

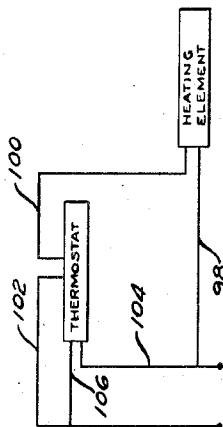


Fig. 5

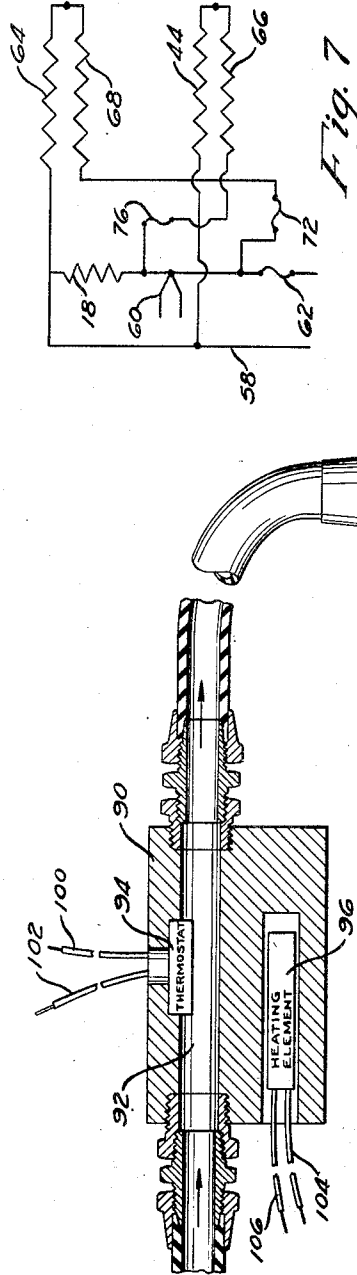


Fig. 4

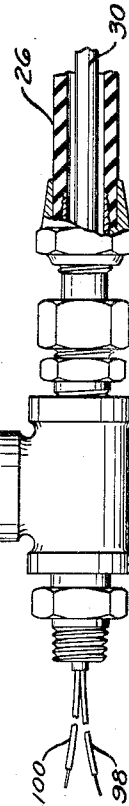


Fig. 7

INVENTOR.
GUSTAVE S. LEVEY

BY
RICHEY, WATTS, EDGERTON & MCNENNY

H. Whitaker
ATTORNEYS

1

2,833,909

HOSE-TYPE PAINT HEATER

Gustave S. Levey, Houston, Tex.

Application May 29, 1956, Serial No. 588,002

23 Claims. (Cl. 219—39)

This invention relates to heat exchangers and more particularly to heat exchangers wherein electrical energy is utilized to heat fluids or to melt solids which may be highly combustible in the heated condition.

One of the important objects of this invention is to provide a heat exchanger assembly capable of heating combustible fluids at high temperatures and high pressures without danger of ignition and explosion.

Another object of this invention is to provide a heat exchanger in the form of a flexible conduit wherein the point of discharge may be freely shifted while the heat is being added continuously as the material passes through the heat exchanger to the point of discharge.

A still further object of this invention is to provide a hose type heat exchanger primarily adapted for heating paint and other flammables wherein viscosity control is obtained by increasing the temperature, the heating being accomplished in the ordinary flexible conduit used in connection with the fluid discharge device.

A still further object of this invention is to provide a paint heater in which the heating element is isolated from the paint, being used in such a manner that communication therebetween cannot result in the heating element being disposed along the path of travel of the paint in order that the paint may be heated as it is used, maintained at the maximum desirable temperature at the point of use.

The primary problem in heating a combustible fluid is to do so safely without danger of igniting the material being heated under any condition of operation or structure of the heating system. This problem is magnified when it is desirable to accomplish the heating as the fluid passes through a flexible conduit which is adapted to the discharge device. The heating element must be then constructed with the flexibility of the conduit and have the bursting strength of a solid conduit.

The preferred embodiment herein disclosed, utilizes construction which overcomes the above mentioned problems by providing the strength and flexibility characteristics which has not heretofore been available. Heaters for raising the temperature of the paint ordinarily use a heat exchange medium such as water, oil or air in order to operate safely. Heat exchangers utilizing electrical energy have also been devised, elaborate explosion-proof design and equipment being required when handling flammable products.

The present invention contemplates the direct heating of a fluid by use of a flexible heating element immersed in the fluid that passes through a flexible conduit. The heating element is in the form of a plurality of resistance wires insulated from each other and disposed within a high pressure flexible tube. The tube is surrounded by a metal braid which is covered by a special solvent-resisting and temperature-resisting material. The end of the metal hose is welded into a fitting in such a manner that the material being heated cannot enter the region of the resistance wire. The heating cable, therefore, is

2

impervious to material therearound and has adequate strength to stand many times the normal pressure applied to the surface thereof.

Accordingly, it is an object of this invention to provide a fluid heating structure having strength and safety characteristics which render the heat exchanger explosion-proof under all conditions of operation.

Other objects of the invention will appear from the following descriptions taken in connection with the drawings.

In the drawings:

Fig. 1 is a sectional view of the paint heater assembly;

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1;

Fig. 3 is a circuit diagram for the heater shown in Fig. 1;

Fig. 4 is a sectional view of the flexible heater and control therefor;

Fig. 5 is a circuit diagram for the heater system;

Fig. 6 is a diagrammatical view of a painting system utilizing a flexible heat exchanger for heating the paint as it is conducted to the paint discharge device and,

Fig. 7 is an alternate circuit diagram for the heater system.

Referring first to Fig. 1, an electrical heat exchanger is shown therein having a fluid inlet 10 which communicates with a heating chamber 12 having a spiral baffle 14 which forms a tortuous passageway for the flow of fluid from the inlet 10 to the outlet 16. A heating element 18 which is supplied with electrical energy provides the heat which is added to the fluid in the chamber 12 as it passes through the heat exchanger. The electrical connections 20 are made within a housing 21 which is closed by a cover 22 which is threaded in the conventional manner in the construction of explosion-proof equipment. A threaded opening 24 in the housing 21 is provided for a conduit connection as required for the entry of electrical wiring into the housing 21. A thermostat 60 is enclosed within the housing 21 in contact with the chamber 12.

A flexible heat exchanger 26 includes a flexible hose 28 having high bursting strength characteristics which encloses a flexible heating element 30 which extends throughout the length of the hose and has flexibility characteristics similar to that of the hose. The hose 28 is connected by a hose coupling 32 to a T 34. The side outlet 36 of the T 34 receives one end of a flexible hose 38 which is connected at its other end to the outlet 16 of the heat exchanger. The T 34 is connected to the housing 21 by a bushing 40 which is threaded into a second bushing 42 that is in turn threaded into the housing 21. The flow of the fluid through the first heat exchanger follows therefor, the hose 38 into a T 34 and through the hose 28 to the end of the heat exchanger 26. The end of the hose 28 may be affixed to any discharge device such as a paint gun or any piece of equipment to which it is desired to supply a heated fluid.

The flexible heating element 30 is a composite structure wherein heater wires 44 are enclosed in fiberglass or similar insulation 46 which prevents short circuiting of the wires throughout their length. The insulated wires 44 are enclosed in an insulating sleeve 48 which maintains its physical characteristics under high temperatures. The heater wire assembly is then inserted within a steel tube 50 which may be in the form of a spiral wound tubing which has been found to be more flexible than ordinary straight steel tubing. The tubing 50 is enclosed within a metallic loom 52 which adds to the strength of the tubing 50 and prevents rupture of the tubing under high pressures. The loom 52 is enclosed within a covering 54 which may be applied

3

by extrusion or wrapping in close contact with the loom 52. The material of the covering 54 is resistant to the corrosive action of solvents, acids or other deteriorating characteristics of the fluids which pass through the hose 28. A material which has been found to be particularly suited for this purpose is known in the trade as Teflon. The Teflon coating 54 is impervious to the substances passing through the hose 28 and has a low friction coefficient which reduces the pressure losses in the heat exchanger.

Referring to Fig. 1 the steel tubing 48 is molded or brazed into the bushing 40 to form a liquid seal and thus prevent entry of fluid into the interior of the heating element 30. The opposite end of the tube 50 is also closed by welding a head 56 thereon. The tube 50 opens into the housing 21 to provide an entrance for the wires 44 thus maintaining the explosion-proof nature of the assembly. The loom 52 and the covering 54 are sealed at the bushing 40 to prevent contact of the fluid contained in the hose 28 with the metal tubing 50. The heating element 30 has high bursting strength characteristics which would prevent the transmission of an explosion in the interior thereof, to the surrounding area. This high strength and safety is obtained while maintaining the desirable flexibility of the hose type heat exchanger 26.

The electrical circuit for the heat exchanger illustrated in Fig. 1 is shown diagrammatically in Fig. 3. The heating element 18 is connected to a power supply through connection 58. A thermostat 60 and a fuse 62 are in series with the heater 18 and function to control the current to the heater as determined by the temperature requirement, the fuse 62 preventing over-temperature of the heat exchanger. The fuse 62 is the fusible link type which opens when a predetermined temperature has been reached and protects the heat exchanger against damage should the thermostat 60 fail to open the circuit under a high temperature condition.

The flexible heating element 30 includes a plurality of resistance heater wires 44, 64, 66 and 68. Heater wire 66 is a relatively low resistance wire, having characteristics of a wide range of resistance which varies with a change in temperature. Iron wire is an example of a material which would provide this function. Wire 64 is a high resistance wire similar to wire 68, and wire 44 is a relatively low resistance wire. It is noted that all of the resistance wires are connected at the extreme end of the heating element 30 and that the wires 66 and 68 are connected to each other and to the power connection 58 by connection 70. The resistance wire 64 is connected through a fuse 72 and connection 74 to the power supply to complete the circuit. Since the high resistance wire 64 is in the circuit the current through the wires 64, 66, and 68 is of a relatively low value, with the result that a low wattage is obtained. The thermostat 60 is not in this circuit and the low wattage circuit therefore is continuously functioning to restore the heat lost from the elongated flexible heat exchanger.

When the thermostat 60 is closed, the circuit is completed through the fuse 62 and the fuse 76 by a connection 78 to the heater wire 44, wires 66, 68, connection 70 and connection 58. Since the resistance of wire 44 is relatively low, a much higher current will result and a relatively high wattage will be produced for transfer to the fluid surrounding the heating element 30. Accordingly, when fluid is flowing through the heat exchanger and the thermostat is closed, the total wattage of the heater 18, 44, 64, 66 and 68 will be effective to continuously raise the temperature of a flowing fluid. Should the flow be interrupted, the temperature of the fluid would immediately rise, the thermostat 60 would open the circuit to the high wattage heaters while the low wattage heaters would remain effective to main-

4

tain the temperature of the fluid in the heat exchanger at a high level.

Since the resistance wire 66 varies with the temperature, the circuit would be self-regulating and should the temperature rise in the heat exchanger, the wattage would be accordingly reduced to the amount required to supply that which is lost to the atmosphere. This arrangement of heaters and controls is contemplated as being the preferred embodiment but other arrangements of circuits and controls may be devised without departing from the scope of this invention.

When it is desired to use the flexible heat exchanger without the pre-heating heat exchanger, the assembly would be used in the manner as indicated in Fig. 6 which for purposes of illustration is shown as an arrangement for painting. A paint tank 80 containing paint therein has pressure applied to the surface of the paint from a source of compressed air through a line 82. Air is also supplied through line 84, to a conventional paint gun 86. The hose 26 having the heating element 30 therein, is connected to the dip pipe 88 in the tank 80 and conducts the paint to the gun 86 while heating the paint as it flows thereto. When the paint reaches the gun, the temperature has been increased to the optimum spraying condition.

A control for this type of operation is indicated in Fig. 4 wherein a perforate body 90 has a passageway 92 formed therein through which the paint from the tank 80 passes before it reaches the hose 26. A thermostat 94 senses the temperature of the small quantity of paint contained within the passageway 92 and is closed when the paint therein is cooled. A heating element 96 supplies heat to the body 90 which in turn heats the small quantity of fluid in the passageway 92 when the flow thereof is interrupted. When the paint flow is stopped, by operation of the gun 86 the temperature of the paint in the passageway 92 rises rapidly and the thermostat 94 opens for the purpose of de-energizing the circuits in the heating element 30 and preventing overheating of the paint within the hose 26. When flow through the passageway 92 is begun by opening the gun 86, cold paint strikes the thermostat 94 and immediately closes the circuit to the heating element 30 which is immediately effective to heat the paint as it flows through the hose 26.

The circuit diagram for this type of control is illustrated in Fig. 5 wherein one side of the heating element is connected to a power supply through connection 98. The other side of the heating element 30 is connected to the thermostat through an electrical connection 100 and then to the power supply through a connection 102. The heating element 96 is energized continuously by being connected to the power supply through connections 104 and 106. If it is desired to have both high wattage and low wattage in the heating element 30, the thermostat device illustrated in Fig. 4 would serve the function of the thermostat 60 illustrated in Fig. 3 with the low wattage circuit being continuously energized while the thermostatic device would control the high wattage circuit.

An alternate circuit arrangement to that illustrated in Fig. 3 is shown in Fig. 7 wherein a parallel-type connection is made between the heater circuits which function to provide low heat and high heat conditions. The heater wires 64 and 68 are joined at their extreme ends and are connected to the power supply through fuses 62 and 72 without thermostatic regulation. Since the resistance of wire 64 has a high value the current through this section is low and the heat output is consequently of a low value. This heater circuit is energized continuously to provide the low wattage required to overcome the heat loss from the outer surface of the hose 26 and thus maintain the temperature of the contents of the hose 26 at the desired level.

The heater wires 44 and 66 are joined at their extreme ends and are connected to the power supply through fuses

5

62, 76 and thermostat 60. Since the resistance of wires 44 and 66 are low the current therethrough is high and the wattage output is high thus providing heat necessary to raise the temperature of fluid flowing through the hose 26 to the desired value.

It is noted that the resistance of wire 66 varies with the temperature and self-regulation occurs in this circuit by reducing the wattage of the output with an increase of temperature. Accordingly, the heater wires may be operated in either parallel or series arrangements to accomplish the function of low and high heat outputs as determined by the operating conditions of the heat exchanger.

It is noted that the hose type heat exchanger will function as a unit in itself without a controller for regulating the temperature. As an example, in heating a wax for coating purposes wherein the ultimate temperature of the material is not critical. Also, the hose type heat exchanger could function to maintain the temperature of a material previously heated in a heating tank throughout the system connected thereto. In this manner materials which are solid at room temperatures could be supplied through a single line by pumping to an atomizer or other discharge apparatus capable of atomization of the material without benefit of air as would be accomplished in the case of hydraulic atomization of paints, oils and waxes.

Since the elongated flexible heat exchanger is of small diameter and hoses of this type are manufactured having strength to withstand very high pressures, this heat exchanger is adaptable to operation where the pressure of the fluid being heated is very high. Also a flexible heat exchanger is particularly useful in cooperating with other heat exchangers in maintaining the temperature to the point of use by overcoming the heat loss ordinarily experienced as the fluid is conducted away from the primary heat exchanger.

It is to be understood that the specific nature of the present disclosure is not intended to be restrictive or confining and that various rearrangements of parts and modifications of design may be resorted to without departing from the scope or spirit of the invention as herein claimed.

What I claim and desire to be secured by Letters Patent is:

1. A flexible heating element for heating fluid passing through a flexible conduit comprising an insulated electrical heating wire in a circuit, a flexible metallic fluid tight conduit enclosing the insulated wire and the circuit, and a solvent and temperature resisting coating surrounding said flexible conduit.

2. A flexible heating element for heating fluid passing through a flexible conduit comprising an insulated electrical heating wire in a circuit, a flexible metallic fluid tight conduit enclosing the insulated wire, reinforcing braid surrounding said conduit, and a solvent and temperature resisting coating surrounding said braid.

3. A flexible heating element for heating fluid passing through a flexible conduit comprising an electrical heating wire in a circuit, insulation means surrounding said wire, a flexible metallic fluid tight conduit enclosing the insulated wire, reinforcing braid surrounding said conduit, and a solvent and temperature resisting coating surrounding said braid.

4. A paint heater comprising preheating means for the paint, a flexible conduit connected to said preheating means, an electrical circuit including a flexible heating element disposed within said flexible conduit, said electrical circuit being sealed and insulated from the contents of said conduit.

5. A paint heater comprising preheating means for the paint, a flexible conduit connected to said preheating means, a flexible heating element disposed within said flexible conduit, and an explosion-proof chamber associated with said preheating means, said heating element

6

terminating within said explosion-proof chamber and being sealed from the contents of said conduit.

6. A paint heater comprising preheating means for the paint, a flexible conduit connected to said preheating means, a flexible heating element disposed within said flexible conduit, an explosion-proof chamber associated with said preheating means, said heating element terminating within said explosion-proof chamber and being sealed from the contents of said conduit, and control means in said chamber for regulating the heat supplied to the paint.

7. A paint heater comprising means connecting a paint supply means to a paint discharge apparatus including a flexible hose, an electrical heating circuit including a flexible heating element within said hose having a resistance wire totally enclosed in a pressure and fluid resisting cover, the outside of said cover presenting a heat transfer surface to the paint as it flows through said hose, and an electrical circuit for supplying electrical energy to said heating circuit.

8. Painting apparatus comprising means for supplying paint under pressure, a paint discharge apparatus, heater means connecting said paint supply means to said discharge apparatus comprising a flexible hose, an electrical heating circuit including a flexible heating element within said hose having a resistance wire totally enclosed in a pressure and fluid resisting cover, the outside of said cover presenting a heat transfer surface to the paint as it flows through said hose, and an electrical circuit for supplying electrical energy to said heating circuit.

9. A paint heater comprising means for supplying paint under pressure, a paint discharge apparatus heater means connecting said paint supply means to said discharge apparatus, comprising a flexible hose, an electrical circuit including a flexible heating element within said hose having a resistance wire totally enclosed in a pressure and fluid resisting cover, the outside of said cover presenting a heat transfer surface to the paint as it flows through said hose, an electrical circuit for supplying electrical energy to said heating circuit, and control means in said circuit for regulating the amount of heat transferred to the paint.

10. A paint heater comprising a supply of paint under pressure, heater means connected to said paint supply, a second heater means for conducting the paint from the first heater means to a discharge apparatus, said second heater means comprising a flexible hose, and a flexible heating element in an electrical circuit within said hose, said heating element and the electrical circuit being totally enclosed in a pressure and fluid resisting cover, the outside of said cover presenting a heat transfer surface to the paint as it flows through said hose.

11. A paint heater comprising means for supplying paint under pressure, heater means connected to said paint supply means, a second heater means for conducting the paint from the first heater means to a discharge apparatus, said second heater means comprising a flexible hose, a flexible heating element in an electrical circuit within said hose, said heating element and the electrical circuit being totally enclosed in a pressure and fluid resisting cover, the outside of said cover presenting a heat transfer surface to the paint as its flows through said hose.

12. A paint heater comprising a supply of paint under pressure, heater means connected to said paint supply, a second heater means for conducting the paint from the first heater means to a discharge apparatus, said second heater means comprising a flexible hose, a flexible heating element in an electrical circuit within said hose, said heating element and the electrical circuit being totally enclosed in a pressure and fluid resisting cover, the outside of said cover presenting a heat transfer surface to the paint as it flows through said hose, and current regulating means operated by the temperature of the paint

for controlling the current to said first and second heater means.

13. An immersion heater for use in a flexible hose comprising a plurality of heater wires having lengths substantially that of the hose, two of said wires being connected in parallel, one of said two wires having the characteristic of increasing resistance as the temperature of the wire increases, the other of said wires being connected in series with said two wires to complete the circuit, and electrical supply means for energizing said heater wires whereby the quantity of heat dissipated by said heater wires decreases as the temperature of the substance heated increases.

14. An immersion heater for use in a flexible hose comprising a plurality of heater wires having lengths substantially that of the hose, two of said wires being connected in parallel, one of said two wires having the characteristics of increasing resistance as the temperature of the wire increases, the other of said wires being connected in series with said two wires to complete the circuit, electrical supply means for energizing said heater wires whereby the quantities of heat dissipated by said heater wires decreases as the temperatures of the wires increase, and a covering resistant to corrosion by acids and paint solvents for said heater wires.

15. An immersion heater for use in a flexible hose comprising a plurality of heater wires having lengths substantially that of the hose, two of said wires being connected in parallel, one of said two wires having the characteristic of increasing resistance as the temperature of the wire increases, the other of said wires being connected in series with said two wires to complete the circuit, electrical supply means for energizing said heater wires whereby the quantity of heat dissipated by said heater wires decreases as the temperature of the substance heated increases, and temperature and pressure resisting coating surrounding said wires.

16. A heat exchanger comprising an elongated flexible conduit, a flexible electrical heating element in the said conduit and extending throughout the length thereof, an electrical circuit for said heating element, a perforate body of heat conductive material having a passageway for fluid to be heated, said passageway being connected to the inlet of said conduit, a heating element in said body connected to a source of electrical energy, and a thermostatic switch in said body actuated by the temperature of the fluid in the passageway in the body whereby the introduction of cold fluid into said passageway immediately closes the circuit to the heating element in said conduit and the interruption of the flow through the conduit allows the heating element in said body to raise the temperature of the fluid adjacent said thermostatic switch and open the circuit to the heating element in said conduit.

17. A heat exchanger comprising an elongated flexible conduit, a flexible electrical heating element in the said conduit and extending throughout the length thereof, an electrical circuit for said heating element, a perforate body of heat conductive material having a passageway for fluid to be heated, said passageway being connected to the inlet of said conduit, a heating element in said body connected to a source of electrical energy, and a circuit control means in said body actuated by the temperature of the fluid in the passageway in the body whereby the introduction of cold fluid into said passageway immedi-

ately closes the circuit to the heating element in said conduit and the interruption of the flow through the conduit allows the heating element in said body to raise the temperature of the fluid adjacent said thermostatic switch and open the circuit to the heating element in said conduit.

18. A heat exchanger control for an electrical heat exchanger having a heating element comprising an electrical circuit for said heating element, a perforate body of heat conductive material having a passageway for fluid to be heated, said passageway being connected to the inlet of said heat exchanger, a heating element in said body connected to a source of electrical energy, and a circuit control means in said body actuated by the temperature of the fluid in the passageway in the body whereby the introduction of cold fluid into said passageway immediately closes the circuit to the heating element in said conduit and the interruption of the flow through the conduit allows the heating element in said body to raise the temperature of the fluid adjacent said thermostatic switch and open the circuit to the heating element in said conduit.

19. A flexible heating element for heating fluid passing through a flexible conduit comprising an insulated electrical heating wire and a circuit, and a flexible metallic fluid-tight conduit enclosing the insulated wire and said circuit.

20. A flexible heating element for heating fluid passing through a flexible conduit comprising an insulated electrical heating wire and a circuit, a flexible metallic fluid-tight conduit enclosing the insulated wire, and a reinforcing braid surrounding said conduit.

21. A flexible heating element for heating fluid passing through a flexible conduit comprising an insulated electrical heating wire, insulation means surrounding said wire, a flexible metallic fluid-tight conduit enclosing the wire, and reinforcing braid surrounding said conduit.

22. An immersion heater for use in a flexible hose comprising a plurality of heater wires having lengths substantially that of the hose, two of said wires being connected in series, one of said wires having the characteristic of increasing resistance as the temperature of the wire increases, a second pair of wires connected in series, the two pairs of wires being connected in parallel to an electrical supply means for energizing said heater wires whereby the quantity of heat dissipated decreases as the temperature of the substance heated increases.

23. An immersion heater for use in a flexible hose comprising a plurality of heater wires having lengths substantially that of the hose, a pair of said wires having high resistance and forming a circuit of low wattage output, a second pair of wires having low-resistance and forming a high wattage output circuit, an electrical supply means energizing said low wattage circuit continually and said high wattage circuit intermittently as determined by a thermostat control.

References Cited in the file of this patent

UNITED STATES PATENTS

1,759,774	Andriulli	May 20, 1930
1,905,343	Carpenter	Apr. 25, 1933
1,974,302	Finlayson	Sept. 18, 1934
2,243,220	Pitman	May 27, 1941
2,722,595	Kolb	Nov. 1, 1955