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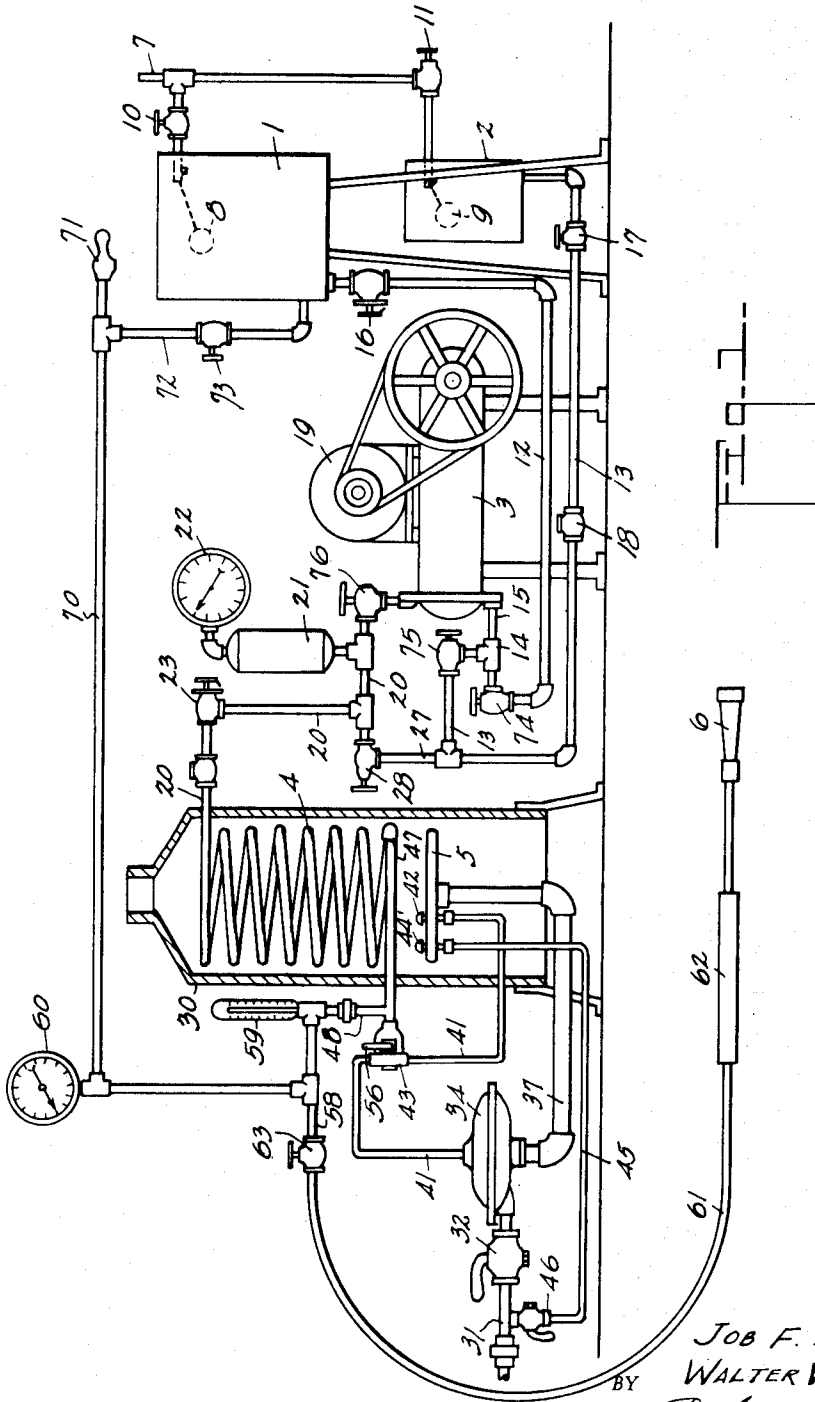
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2,295,228

CLEANING MACHINE

Filed Jan. 4, 1939

3 Sheets-Sheet 1



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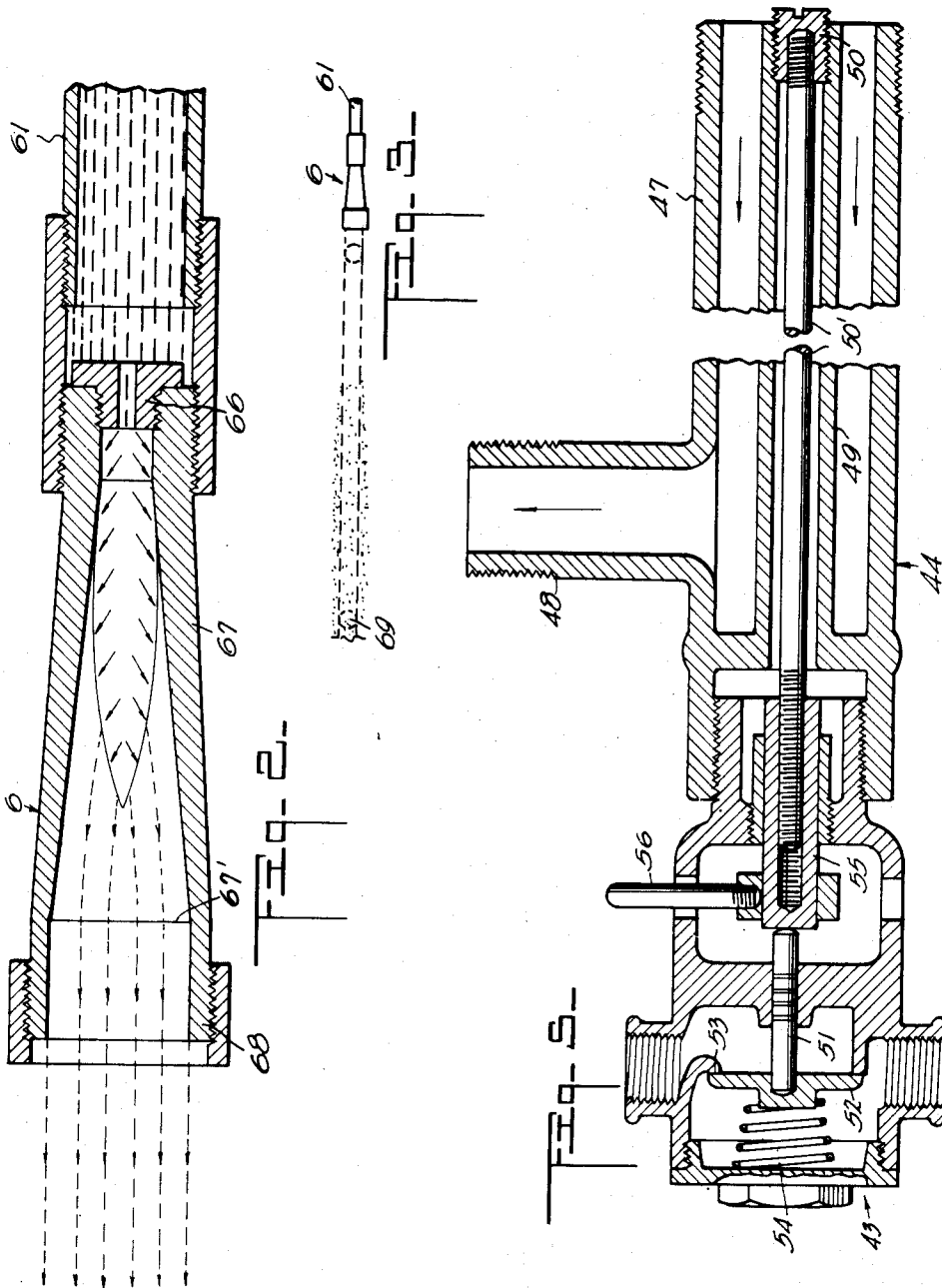
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3 Sheets-Sheet 2



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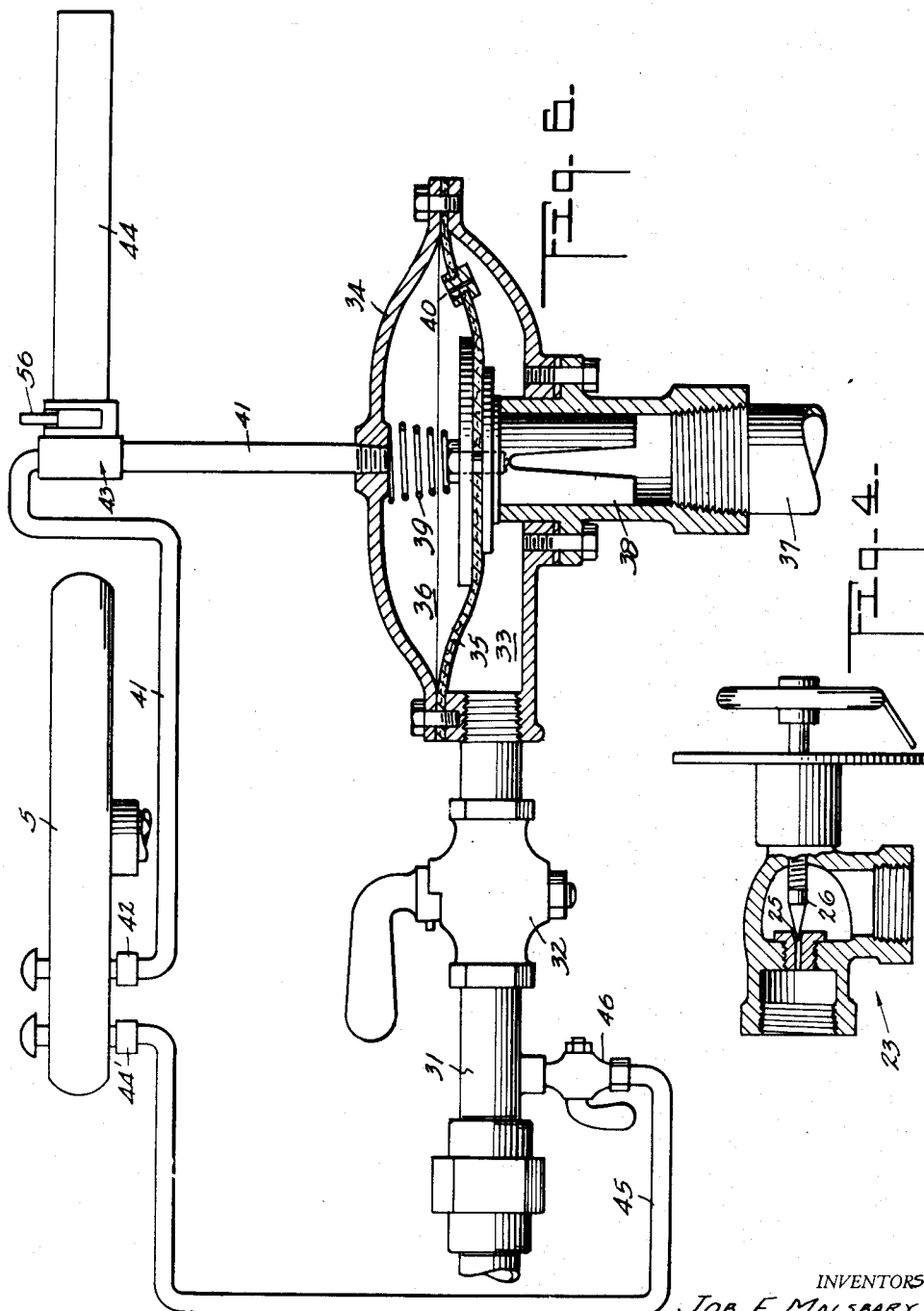
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CLEANING MACHINE

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3 Sheets-Sheet 3



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CLEANING MACHINE

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5 Claims. (Cl. 299—87)

The present invention relates to improvements in cleansing machines of the type which use a spray of liquid or cleansing fluid, usually at relatively high temperatures, for cleaning an object, such as the frame of an automobile or the like, by the combined action of the impact and the cleaning and dissolving effect of the liquid or fluid. It may also be used for chemical spraying of trees or the like, and many other applications such as paint removing, disinfecting or heat treating of liquids.

The principal object of the invention is to provide a machine of the character described which is particularly effective in accomplishing the desired results.

A further object of our invention is to provide a machine of the character described in which a wide range of different kinds of spray may be produced at the option of the operator, from an almost solid spray of liquid to a spray of superheated steam, or to produce a flow of fluids through the coil either in a solid column of liquid or a mixture of fluid and a small amount of steam bubbles or a small amount of liquid and a great amount of steam bubbles, or a flow containing all superheated steam.

A still further object of the invention is to correlate heat and pressure in such a manner that both are subject to independent control by the operator and may be changed by the operator almost instantaneously to bring about the result desired.

It is still further proposed to provide a machine of the character described in which the operator is given instantaneous control over a wide range of pressures up to a desired maximum, and in which a source of pressure is utilized which furnishes excess pressure far above the maximum pressure desired, and which, if unrestricted, would furnish a flow of liquid through the heater in excess of the heating capacity of the latter for producing desired results.

It is further proposed to provide means utilizing part of the excess pressure and volume for effecting thorough agitation and mixing of the liquid to be used in the machine, the mixing taking place in the pump before the liquid enters the heater.

It is further proposed to provide automatic heat control means immediately responsive to changes in temperature and adjusting means for the same whereby the temperature may be changed over a wide scale, corresponding to the wide range of possible changes in pressure or volume.

It is also proposed to provide means whereby,

particularly when high pressures and relatively low temperatures are used, a hot stream will be carried further with less loss of temperature than has been possible heretofore.

And finally it is proposed to provide control means for the spray as it is ejected from the machine to insure a concentrated spray which will have substantially the same characteristics three to eight feet distant from the spray nozzle as at the nozzle, depending on the size of the machine and the volume of the liquid.

Further objects and advantages of our invention will appear as the specification proceeds.

The preferred form of our invention is illustrated in the accompanying drawings in which:

Figure 1 shows a partly diagrammatic assembly view of our apparatus in elevation;

Figure 2, a longitudinal section through a preferred form of spray nozzle forming part of our invention;

Figure 3, a diagrammatic view illustrating the character of the jet issuing from the nozzle;

Figure 4, an axial section through a pressure control valve used in connection with our invention;

Figure 5, a sectional detail view of a thermostat arrangement used in the apparatus; and

Figure 6, a part-sectional view in elevation of a gas valve arrangement.

While we have shown only the preferred form of our invention, we wish to have it understood that various changes or modifications may be made within the scope of the claims hereto attached without departing from the spirit of the invention.

In its principal features our apparatus, as illustrated in Figure 1, comprises two containers 1 and 2, a high pressure pump 3 for pumping liquids from the containers through a coil 4, heating means 5 for the coil 4, an outlet nozzle 6 for the coil and suitable control means which will be discussed in their special relationships as the specification proceeds.

The container 1 is intended to accommodate a soap solution or other chemical or cleansing agent, and it receives its water supply from the pipe 7, a float control 8 insuring a constant level shut-off of the liquid in the container. The container 2 is intended to accommodate water and is also fed from the pipe 7 and provided with a suitable float control 9 for maintaining a desired water level. Valves 10 and 11 are provided for shutting off the supply going to the container.

Both containers are provided with outlet pipes 12 and 13 which join, as at 14, into a single pipe

15, the relative proportions being subject to control by means of valves 16 and 17. The container 1 is disposed at higher elevation than container 2 so that the soap mixture is added to the water under pressure. A check valve 18 prevents the mixture from flowing backward into the water container when the liquids are recirculated and a pressure exists within the pump passages and chambers.

The pipe 15 connects to the intake side of the high pressure pump 3 which may be operated by the motor 19 and which discharges through the pipes 20 into the coil 4. The intake valves of the pump are shown at 74 and 75 and the delivery valve at 76. One of the pipes 20 is provided with a compression chamber 21 for absorbing fluctuations and surges due to pump action and a pressure gauge 22 is provided. The capacity of the pump should be sufficient to maintain the reading of the pressure gauge at about 300 pounds during operation. It can be increased or decreased by adjusting valve 28.

The pressure and volume provided by the pump is intended to be far in excess of the highest pressure required by the coil under working conditions. The object of the high excess pressure is to insure sufficient volume to flow through the coil at all working pressures and under all working conditions and to give the operator absolute control over the pressure and volume desired even though leaks may develop or part of the surplus pressure be used up in recirculating the liquid within the pump. It is apparent that any other source of high pressure might be substituted for the pump.

The flow of the liquid through the pipes 20 is controlled by the valve 23, which is illustrated in Figure 4 and which includes the orifice 25 of fixed size adapted to step down the pressure of the pump to a desired maximum volume and pressure for the coil 4 and a needle valve 26 for stepping down the volume and pressure within the coil to any desired point below the maximum.

The pressure to be built up in the coil depends, of course, partly on the size of the outlet orifice in the nozzle 6 to be described later, but for a given outlet orifice, the valve 23 might be arranged or adjusted, for instance, so that the fixed orifice 25 reduces the pressure transmitted to the coil to approximately 200 pounds, while the needle valve 26 might reduce the pressure to any degree desired, probably down to about 75 pounds, which might possibly be considered the minimum of pressure necessary for useful results in a machine of this type.

Since the pump provides a pressure of about 300 pounds, which under any circumstances of adjustment exceeds the pressure and volume required in the coil, a by-pass pipe 27 is provided to connect the pipes 13 and 20 and to provide a circulatory path 20—27—13—15, permitting a portion of the mixture ejected from the pump to re-enter at the intake and to thereby cause additional agitation and more perfect mixing of the solution. The effective by-pass area may be controlled by a valve 28.

The coil 4 is suitably mounted in the housing 30 and a heater 5 is mounted underneath the coil, the latter being arranged so that the liquid flows downward in the coil toward the heater and is thus progressively subjected to increasing heat as it advances. The heater is here illustrated as a gas burner, but it is apparent that an oil burner or any other suitable means of heat might

be substituted. The details of the heater unit are illustrated in Figures 5 and 6.

The gas enters at 31 and passes through a manually operated valve 32 into the lower compartment 33 of a valve housing 34 which has a diaphragm 35 separating the upper compartment 36 from the lower compartment 33. From the latter compartment the gas enters the pipe 37 leading to the burner 5, subject to the control of a valve 38 operated by the diaphragm 35, which latter is urged toward valve closing position by a spring 39 and by whatever gas pressure prevails in the upper compartment 36, while the main gas pressure in the lower compartment urges the valve toward valve opening position. An orifice 40 is provided in the diaphragm and tends to equalize the pressure between the two compartments. It is sufficiently small, however, to make time a factor in the equalizing process.

The upper compartment is connected, through pipe 41, with a by-pass burner 42, and this pipe 41 has a valve 43 operated by the thermostat 44 connected with the discharge end of the coil 4. It is apparent that when the valve 43 is wide open, gas will flow freely from the upper compartment 36 of the diaphragm housing to the by-pass burner, relieving the pressure on the upper side of the diaphragm and permitting the pressure in the lower compartment to lift the valve 38 so as to permit of free flow of gas to the main burner. The exchange of gas between the compartments is not sufficiently fast to balance the pressures. When the valve 43 closes or moves toward closing position, the flow of gas through pipe 41 to the by-pass burner lessens or ceases altogether with the result that the pressures on opposite sides of the diaphragm approach or reach a state of balance which permits the spring 39 to move the diaphragm and the valve 38 toward or into closing position so that feed of gas to the main burner is lessened or checked.

A conventional pilot burner 44' may be connected to the main gas supply 31 ahead of the valve 32, through pipe 45 having a pilot valve 46.

The thermostat control 44 for the valve 43 is illustrated in detail in Figure 5 and comprises a pipe 47 threadedly connected to the lower end of the coil so as to form a continuation thereof, and formed, on the outside of the housing 30, with a discharge pipe 48. The pipe 47 is formed with an internal tube 49 made of metal which expands and contracts in response to temperature changes. To the inner end of this tube is secured, as at 50, a rod 50' of non-expandable material, such as Invar steel which rod extends through the tube to within operative proximity of a push pin 51 which is active on a valve disc 52 for lifting the same off its seat 53 over the opposition of the spring 54. The valve disc 52 and the seat form the valve 43. The operative length of the rod 50' may be adjusted by deepening or lessening the engagement therewith of a threaded extension sleeve 55 which operation may be performed through the handle 56.

The thermostat operates as follows: The liquid passing through pipe 47 toward the outlet pipe 48 travels around the tube 49 and causes the latter to expand and contract in response to temperature changes. As the tube expands, the Invar steel rod, which does not expand accordingly, retracts and allows spring 54 to move the valve disc toward its seat. As the tube 49 contracts, the

Invar steel rod moves toward the valve and lifts the same off its seat.

It will be seen therefore, that a rise in the temperature of the liquid beyond a desired degree causes the valve to move toward closing position, reducing the gas flowing through pipe 41 to the by-pass burner 42 and thereby reduces the main gas feed to the main gas burner. A fall in temperature of the liquid below the desired degree will cause the valve 43 to open, thereby increasing the flow through pipe 41 and effecting a corresponding increase in the flow of gas through the main valve 38.

To adjust the thermostat to different temperatures, it is only necessary to turn the handle 56 one way or the other whereby the overall length of the Invar steel rod 50' with cap 55 is changed and the desired valve operation effected at higher or lower temperatures.

The outlet pipe 48 of the thermostat connects with a pipe 58 which latter is provided with a thermometer 59 and a pressure gauge 60 and connects with a hose 61 having the nozzle 6 at the end thereof. A suitable handhold 62 is provided near the nozzle and a conventional shut-off valve 63 may be provided in the pipe 58.

The nozzle 6, which is illustrated in Figures 2 and 3, is an important part of our invention, since in its specific construction, it bears a definite relation to the remainder of the apparatus and is intended not only to build up the desired degree of pressure in the coil, but also to insure a steady, concentrated stream of great velocity, which, at least for a distance of some three to eight feet, depending on the size of the machine, is substantially as solid and concentrated as it was on leaving the nozzle, and which carries heat much farther from the nozzle than any machine lacking this feature.

It should be remembered that while our apparatus is capable of producing sprays of widely varying characteristics, from a substantially solid stream to a fine spray of super-heated steam, it is primarily intended for heavy duty cleaning in which a so-called wet spray or stream is desired with a minimum of steam vapor. For this purpose it is desirable in our apparatus to coordinate pressure and temperature in the coil so as to maintain a solid body of liquid therein.

As shown in Figure 2, our nozzle 6 has three different phases, which may be described as the orifice 66, the expansion chamber 67 and the guide chamber 68. The orifice 66, which is preferably made in the form of a replaceable and exchangeable unit, as shown in the drawings, should have an opening related to the opening 25 in valve 23, which, when wide open, allows the desired pressure to be built up in the coil. Both openings should bear a relation to the pressures employed to allow a solid body of liquid to be maintained at the desired temperatures.

By way of example, to give a clear picture of the proportions employed, we might state that the opening of the orifice 66 is one-eighth of an inch in diameter, corresponding to a cross-sectional area of .0122 sq. in. From the orifice the nozzle expands in a taper, to form the expansion chamber 67, and, after it has reached a diameter of about five-eighths of an inch which gives it an area of .306 sq. in., it continues at that diameter in cylindrical form to the end of the nozzle. The latter end is about twenty-five times larger in area than the orifice opening 66.

The above areas and ratio of areas are found to be practical and give good results commercially

for respective sized machines, and will accommodate a wide variation of pressures and temperatures in each machine.

As a solid body of liquid, under a gauge pressure, of say two hundred pounds and at a temperature of say, 300° F., is forced through the orifice opening and is ejected therefrom, it first forms a cone as indicated in the drawing, and then expands against the tapered wall of the nozzle until it reaches the joint 67', between the expansion chamber and the guide chamber. During the expansion it loses its compression, and pressure gauges attached to the expansion chamber show that the pressure gradually changes from two hundred pounds prevailing at the orifice 66 to zero, so that, at the joint 67', all expansive force originally in the liquid is expended. At the same time the temperature has dropped to the boiling point at atmospheric pressure.

The cylindrical guide chamber at the discharge end of the nozzle concentrates the stream emanating from the expansion chamber so that it issues from the guide chamber in the form of a cylindrical jet and retains this form for a considerable distance. At the same time it issues at an enormous speed due to the expansion of latent heat and excess initial pressure.

Figure 3 shows the stream issuing from the nozzle on a reduced scale. It will be noted that the stream remains substantially constant and of uniform diameter so that a major portion thereof would pass an opening 69 of approximately the same size as the discharge end of the nozzle at a distance of some three to eight feet from the latter. A slight cloud surrounds the stream of water as shown in Figure 3, but this cloud is very light and represents vapors due to contact of the stream of liquid with the cold atmosphere.

While we have principally discussed the pressure capacity of the pump as being in excess of any pressure required in the system, it should be understood that the volume capacity of the pump should also be such that it feeds a quantity of liquid considerably in excess of the heater capacity of the system.

The operation of our apparatus will be readily understood from the foregoing description. The entire apparatus is under perfect control by the operator who may regulate temperature and pressure within the coil by observation of the thermometer 59 and the pressure gauge 60 and by operation of the thermostat adjusting handle 56 and the pressure regulating valve 23. Ample pressure and volume is available since the high pressure pump supplies pressure at 300 pounds or about 100 pounds more than the maximum needed for the coil. This excess in pressure and volume takes care of possible leaks that may develop, pressure losses, recirculation through the by-pass 28, and at the same time, insures smooth and steady flow into or through the coil at any pressure desired.

The independent temperature and pressure controls allow a wide variety of changes to be made, and a number of particularly characteristic adjustments may be outlined as follows:

1. Pressure (at gauge 60) of 200 pounds within the coil and temperature (at thermometer 59) of 220° F.; this is relatively high pressure and low temperature and results in a really wet spray with a minimum of vapor present. The pressure is amply sufficient to keep the liquid in solid mass or shape in the coil and a forceful

stream of liquid issues from the nozzle, with minimum of steam vapor present and slugs of water resembling in size No. 5 buckshot of about one-eighth inch diameter and maintaining its concentrated form for a long distance, say, ten to twenty feet. This adjustment is particularly adapted for the cleaning of tractors having a heavy coating of mud or solid deposit of grease.

2. Pressure of 125 pounds within the coil and temperature of 300° F.; this pressure is still sufficient to maintain a solid body of liquid in the coil, but the spray issuing from the nozzle shows smaller subdivisions of particles, comparable to No. 11 buckshot of about one-sixteenth of an inch in diameter; the spray still be mostly water, but will be accompanied by a certain amount of vapor, more than in No. 1. This spray would be particularly useful for washing an automobile frame having a coating of car grease deposited thereon in a heavy, gummy layer.

3. Pressure of 100 pounds and temperature of 330° F.; this results in a fine liquid spray of particles similar in size to bird shot (one-thirty-second of an inch in diameter). The column of liquid in the coil is still solid and the stream issuing from the nozzle is still more water than vapor, but there will be more vapor than under 1 and 2. This spray would be adapted for the cleaning of an automobile frame having but light grease and ordinary traffic film, neither hard nor difficult to remove.

It will be noted that in the three adjustments discussed thus far, a solid body of liquid is maintained in the coil and this insures a smooth operation, free from jerking, even without soap or chemicals added. An operator holding the handle 62 will feel a steady and smooth flow and can operate the nozzle for a long time without tiring. Where steam is allowed to form in the coil and is passed on to the nozzle along with the liquid, the operation becomes jerky, steam alternating with liquid in crowding through the orifice, and the nozzle becomes difficult and tiresome to operate, although the operation is smoothed to some extent through the presence of soap in the liquid. A spray of this type may be obtained as follows:

4. Pressure of 100 pounds and temperature of 338° F.; At this adjustment the coil will contain steam and water, and as a result, a rather spasmodic intermittent spray of steam and water will sputter out of the nozzle, with a rather jerky, vibrating sensation to the hands of the operator. A spray of this type would be particularly useful for the steaming out of a tank for removal of volatile vapors.

5. Pressure of 75 pounds and temperature of 350° F.; this results in superheated steam adapted for industrial uses, steam cleaning of clothes, dry steam for heating of vulcanizers, house heating, running machinery, etc.

To relieve excess pressure in the coil 4, we provide a pipe connection 70 having a pressure relief valve 71 discharging into the tank 1. The pipe 70 may also be connected to the tank 1 through a pipe 72 leading to the bottom portion of the tank and being controlled by a valve 73. This connection is used when it is desired to agitate the solution or to stir a new mixture.

We claim:

1. A cleaning machine comprising a conduit, means for pumping a liquid therein under high pressure, control means for the conduit to maintain the pressure substantially constant and comprising a compression chamber attached to the

conduit and a manually-controlled valve operable to establish a desired pressure in said conduit, a second conduit including a coil connected to the first conduit and having a restricted discharge orifice, a manually-controlled metering valve between the first conduit and the coil, the normal operating capacity of the metering valve as compared with the outlet orifice and with the pump capacity being such as to maintain a substantially constant pressure in the first conduit essentially higher than the coil pressure, means for heating the coil, an adjustable thermostat control for maintaining the coil temperature constant at a given setting, and a manual control for the thermostat adjusting means for effecting different temperatures, the metering valve and the thermostat adjusting means being operable to produce a wide variety of different discharge sprays under normal operating conditions due to the high pressure head in the first conduit.

2. A cleaning machine comprising a conduit, means for maintaining a liquid therein under high and substantially constant pressure, a second conduit including a coil connected to the first conduit and having a restricted discharge orifice, a manually-controlled metering valve between the first conduit and the coil, the normal operating capacity of the metering valve as compared with the outlet orifice and the capacity of the pressure maintaining means being such as to maintain a substantially constant pressure in the first conduit essentially higher than the coil pressure, means for heating the coil, an adjustable thermostat control for maintaining the coil temperature constant at a given setting and a manual control for the thermostat adjusting means for effecting different temperatures, the metering valve and the thermostat adjusting means being operable to produce a wide variety of different discharge sprays under normal operating conditions due to the high pressure head in the first conduit.

3. In a cleaning machine, a conduit including a compression chamber, a pump for pumping a liquid therein under high pressure, a coil connected to the conduit, a needle valve between the pump and the coil, a restricted outlet orifice for the coil, the needle valve including a coil intake orifice bearing relation to the outlet orifice and to the pump capacity to confine the pressure within the coil to a maximum and a needle for reducing the coil pressure to a desired degree below said maximum pressure, a by-pass for the pump and a valve for the latter operable to co-act with the compression chamber in maintaining a pump pressure active on the coil intake orifice essentially in excess of the maximum coil pressure.

4. A cleaning machine comprising a conduit, means for maintaining a liquid therein under high and substantially constant pressure, a second conduit including a coil connected to the first conduit and having a restricted discharge orifice, a manually-controlled metering valve between the first conduit and the coil, means for heating the coil, an adjustable thermostat control for maintaining the coil temperature constant at a given setting and a manual control for the thermostat-adjusting means for effecting different temperatures, the pressure-maintaining means in the first conduit having a coil feeding capacity in excess of the coil requirements and the heater capacity under normal operating conditions, and the metering valve and

the thermostat adjusting means being operable to produce a wide variety of different discharge sprays under said normal operating conditions due to the high pressure head in the first conduit.

5. A cleaning machine comprising a conduit, means for pumping a liquid thereinto under high pressure, control means for the conduit to maintain the pressure substantially constant and comprising a compression chamber attached to the conduit and a manually-controlled valve operable to establish a desired pressure in said conduit, a second conduit including a coil connected to the first conduit and having a restricted discharge orifice, a manually-controlled metering valve between the first conduit and the coil,

means for heating the coil, an adjustable thermostat control for maintaining the coil temperature constant at a given setting and a manual control for the thermostat adjusting means for effecting different temperatures, the pumping means in the first conduit having a coil feeding capacity in excess of the coil requirements and the heater capacity under normal operating conditions, and the metering valve and the thermostat adjusting means being operable to produce a wide variety of different discharge sprays under said normal operating conditions due to the high pressure head in the first conduit.

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