Oct. 16, 1951 J. C. HOLMES 2,571,575

STEAM CLEANER

Filed July 3, 1947 5 Sheets-Sheet 1

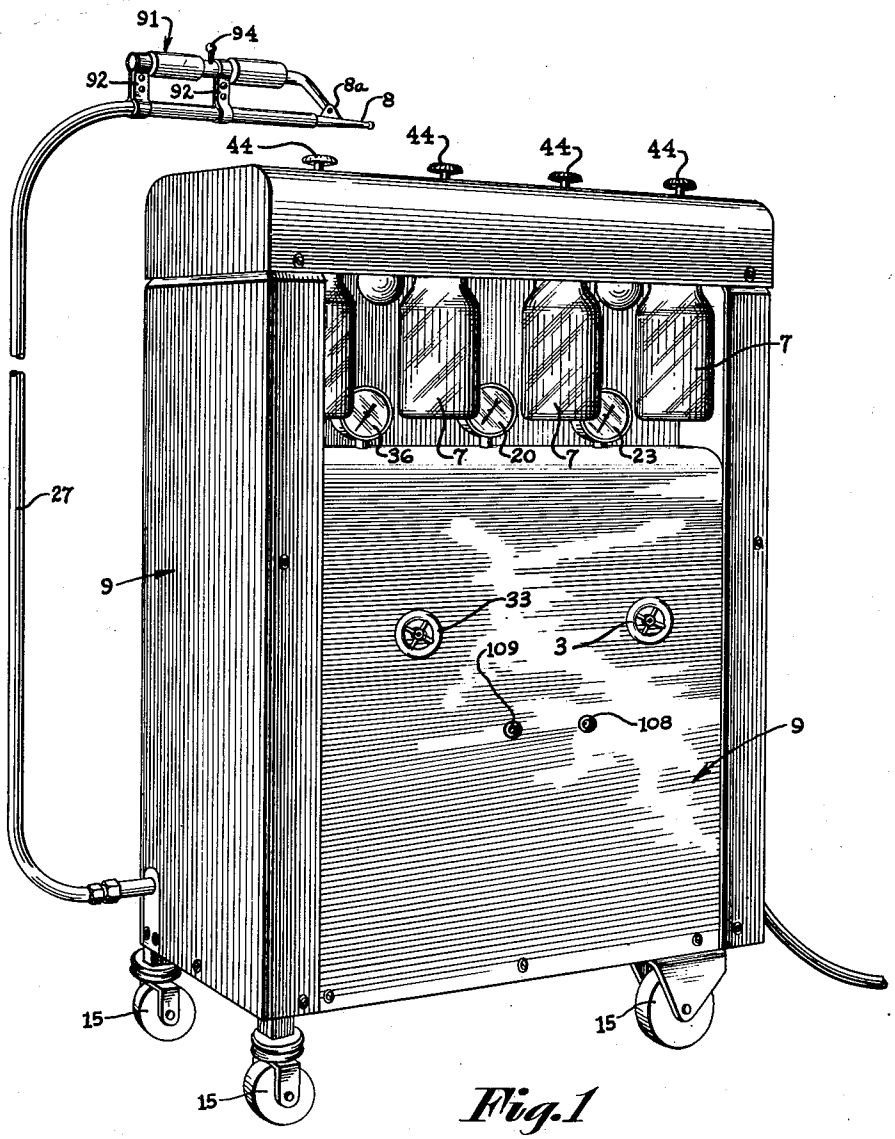

Fig. 1

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STEAM CLEANER

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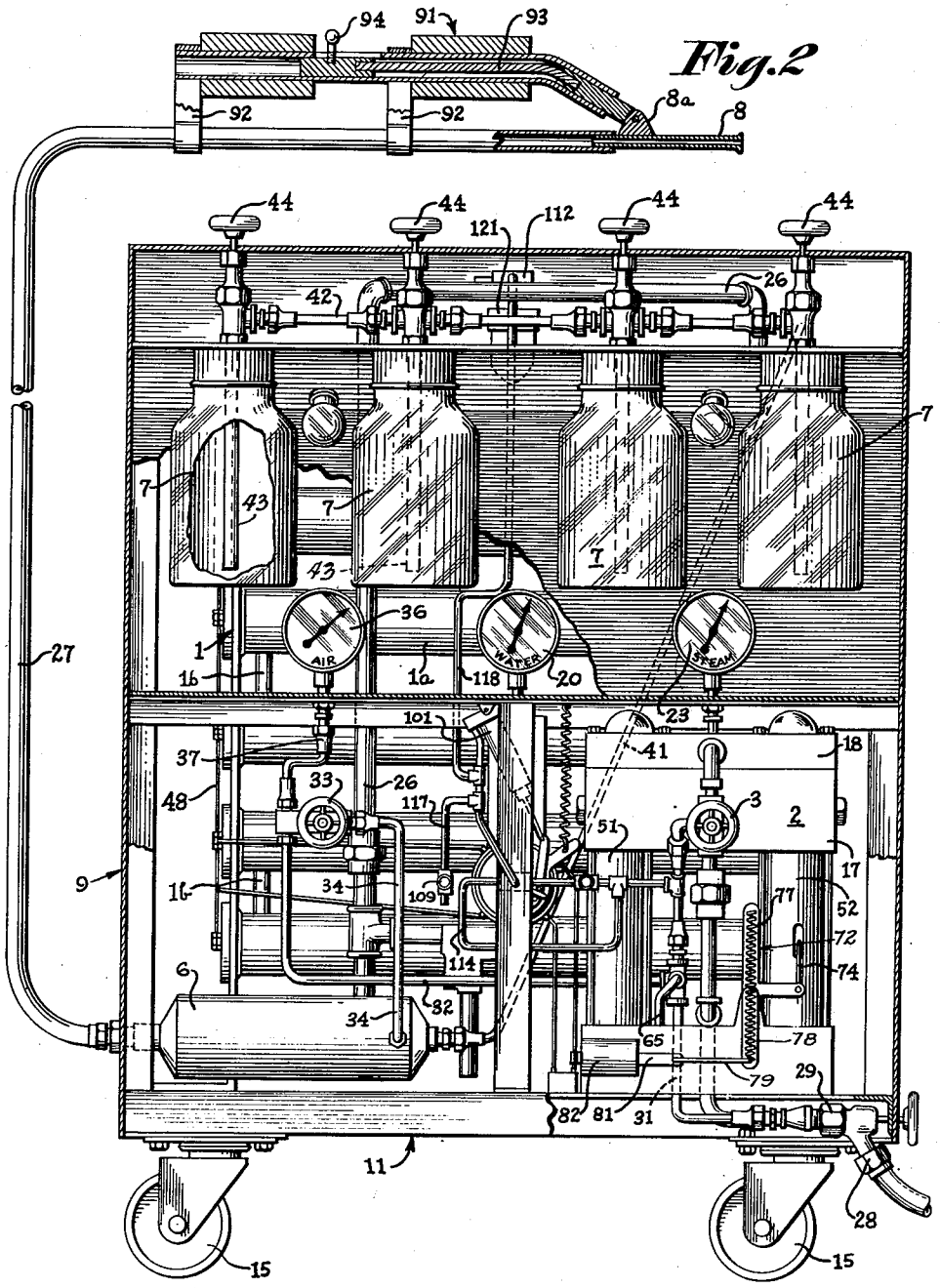
Fig. 2



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STEAM CLEANER

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Fig. 3

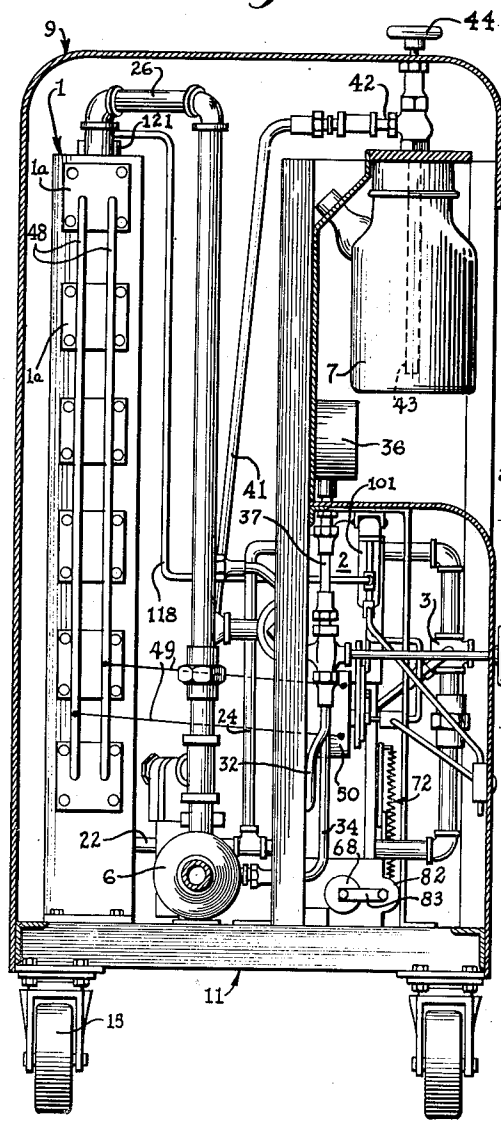
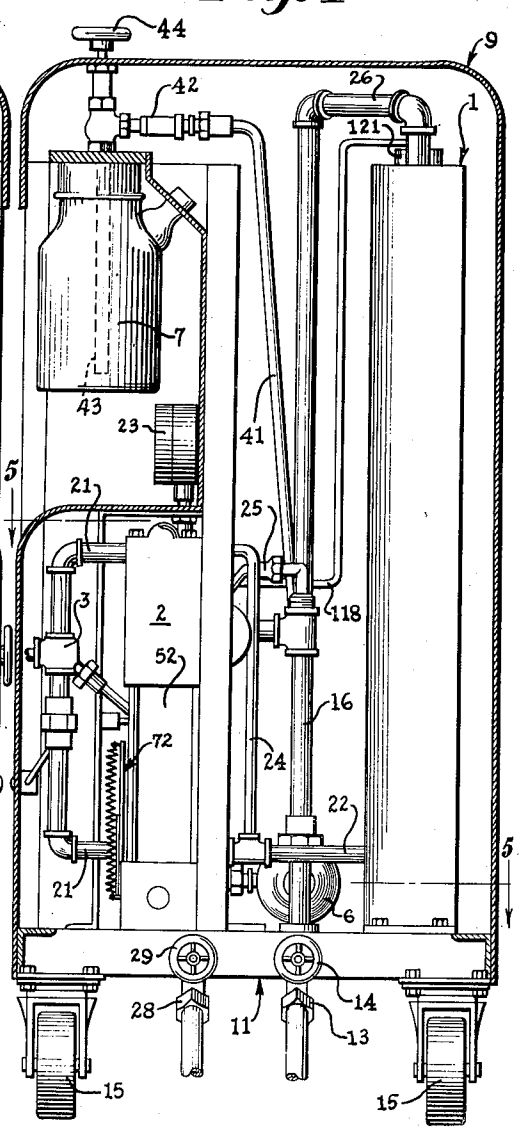


Fig. 4



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STEAM CLEANER

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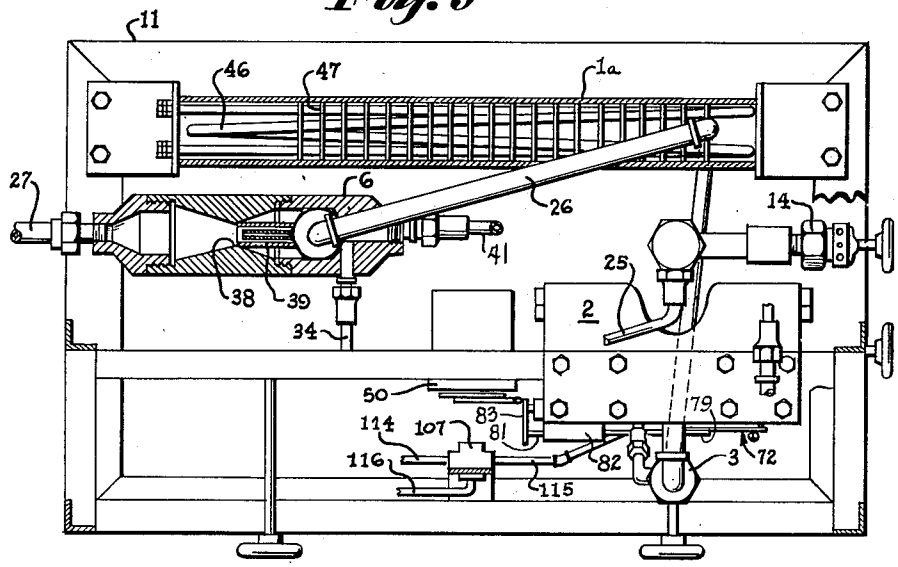
Fig. 5



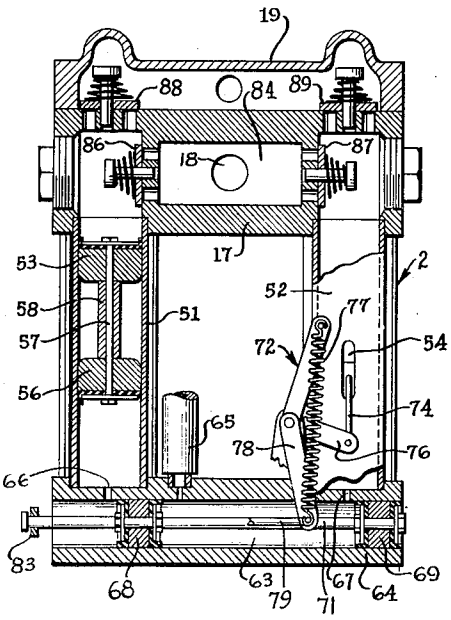


Fig. 6

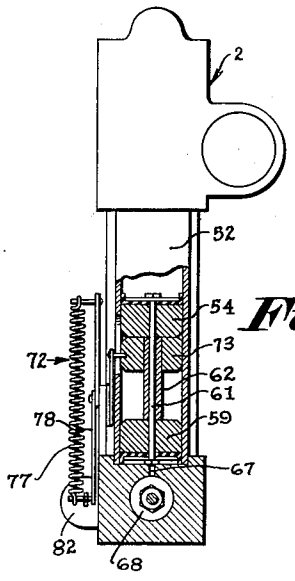


Fig. 7

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STEAM CLEANER

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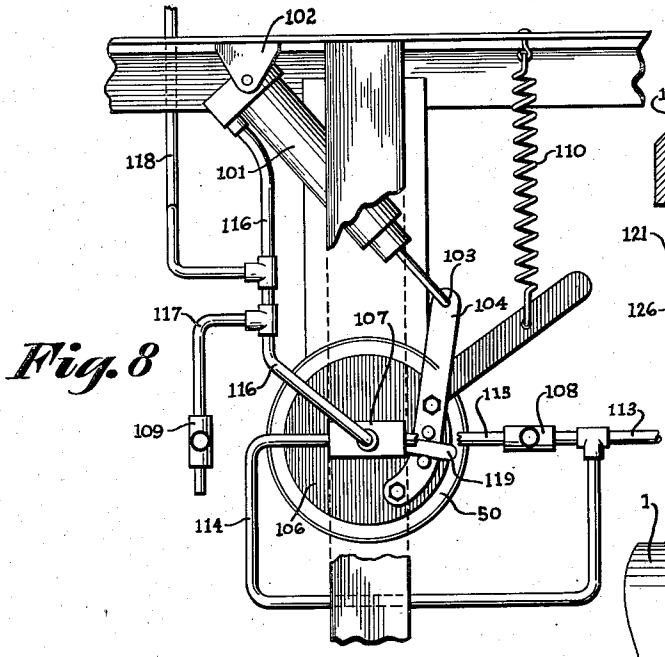

Fig. 8

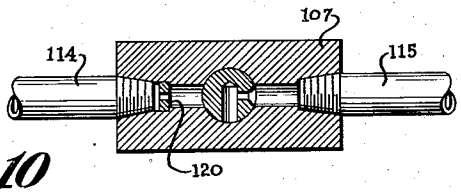

Fig. 10

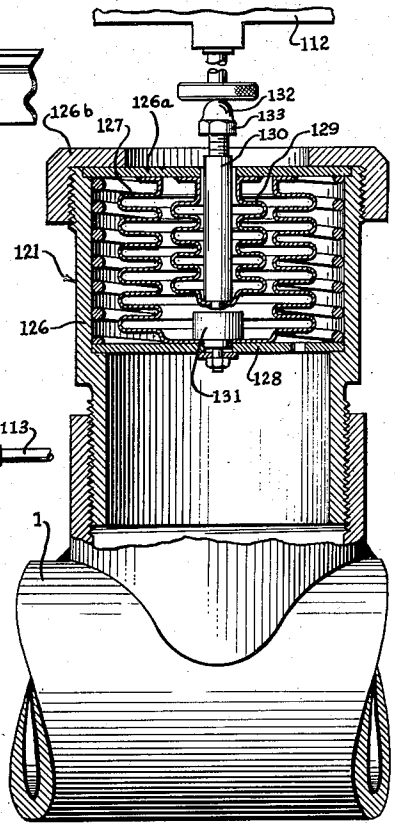

Fig. 11

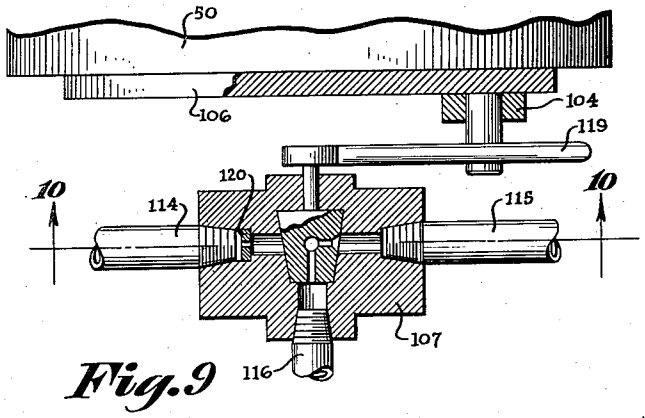

Fig. 9

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Patented Oct. 16, 1951

2,571,575

UNITED STATES PATENT OFFICE

2,571,575

STEAM CLEANER

John C. Holmes, Signal Mountain, Tenn.

Application July 3, 1947, Serial No. 758,966

11 Claims. (Cl. 299—83)

1

This invention relates to cleaning equipment using cleaning fluid discharged from a nozzle at relatively high velocity under controlled temperature and pressure conditions. The invention is primarily adapted to the removal of grease and dirt from the mechanical parts of automotive equipment or for washing the painted surfaces of such equipment. It can also be used for removing paint and may likewise be used for removing sludge, rust and the like from radiators. The cleaning fluid may be air, water, steam or a mixture of any of these three with or without a suitable detergent or cleaning agent.

In an apparatus of this general type prior to my invention, no provision has been made for providing hot air to dry off the parts after they are cleaned. For instance, in steam cleaning automobile motors and chassis to remove the heavy film of grease the entire motor will become enveloped in a cloud of steam. The present invention provides apparatus with which it is possible to immediately blow all of the moisture away from the surface after it is cleaned and also to supply hot, dry air for the purpose of completely drying the surface. Also the apparatus is provided with the necessary controls so that any degree of mixture of air and water may be obtained at the desired temperature so that fluid may be varied progressively from hot, dry air; dry steam; wet steam to hot and warm water mixed with the desired amount of detergent or cleaning agent. Also the pressure can be controlled so that if desired all of these fluids can be supplied at high velocity.

Accordingly, the primary object of the invention is to provide improved cleaning apparatus of the above type in which the mixture of the cleaning fluid can be controlled at will and can be delivered at desired temperature and velocity to meet any desired requirements.

Another object is to provide in such apparatus a boiler which may be used to heat the air, steam or water.

Another object is to provide such apparatus in which the same equipment can be used to clean and dry the object to be cleaned by mere change of the controls.

Another object is to provide such equipment in which the normal operation of equipment will serve to self-clean the boiler and flush out any remaining moisture therein.

Another object is to provide such apparatus in which it is possible to add air pressure to the cleaning fluid stream either before or after it passes through the heating means.

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Another object of invention is to provide steam cleaning apparatus with means for applying the steam at a pressure in excess of the water pressure.

A further object is to provide cleaning apparatus in which the control of the water or steam at the nozzle is controlled on the inlet side to the boiler.

A still further object of invention is to provide apparatus of the type described with novel means for supplying the necessary pressure to resist the steam pressure in the boiler.

A further object is to provide a novel pneumatically-operated pump for automatically producing the necessary back-pressure for the boiler of cleaning and washing apparatus of the type described.

A still further object is to provide a novel pneumatic control mechanism for operating the switch controlling the electrical heating units of the boiler and a novel combination thermostat-pressurestat attached to one of the boiler walls which will operate the pneumatic control mechanism to prevent excessive pressures or temperatures in the boiler.

Other and further objects will become readily apparent from the following description when considered in connection with the accompanying drawings, illustrating an embodiment of the invention, and in which:

Fig. 1 is a perspective view of cleaning equipment made in accordance with the present invention.

Fig. 2 is a front elevation with the cover removed.

Fig. 3 is an end elevation of the left hand side of Fig. 2.

Fig. 4 is an elevation of the right hand side of Fig. 2.

Fig. 5 is a partial horizontal section on line 5—5 of Fig. 4.

Fig. 6 is a partial detail sectional elevation of Fig. 2.

Fig. 7 is a partial sectional elevation of Fig. 6.

Fig. 8 is an enlarged partial view of Fig. 2 showing the automatic control for the mixing valve.

Fig. 9 is a cross sectional view of the mixing valve.

Fig. 10 is a cross sectional view on line 10—10 of Fig. 9.

Fig. 11 is an enlarged sectional detail of the thermostat-pressurestat device for automatically releasing the power control device.

Broadly speaking, the novelty of the present

invention resides in the provision of a boiler to which water and/or air may be supplied in the proper ratio to produce a cleaning medium which may be supplied to a mixing chamber where a suitable detergent may be added for facilitating the cleaning with the high velocity jet. As will be apparent from the following description, the mixture in the mixing chamber is delivered through a hose or pipe to the discharge nozzle. One of the advantages of this arrangement is that the ingredients of the cleaning medium become homogeneously mixed before being discharged from the nozzle. Another important feature of the invention is the provision of a suitable booster pump which resists the back pressure of the steam pressure in the boiler and will operate automatically in response to the controls to deliver the cleaning medium at the nozzle at the desired pressure. Suitable control valves are provided so that the cleaning medium discharged from the discharge nozzle may be:

(*a*) Hot water;
(*b*) Steam;
(*c*) Air and steam;
(*d*) Air and hot water; and
(*e*) Hot air

Means also are provided so that the above medium-elements may be delivered at the nozzle either with or without any desired detergent agent.

The form of the invention chosen for the purpose of illustrating the invention, comprises a boiler **1**; main control valve **3** and air control valve **33**; mixing chamber **6**; suitable detergent receptacles **7** and discharge nozzle **8**; and a suitable booster pump **2** for supplying necessary water against pressure, together with the necessary conduits to make this an operative device. All of the mechanism is arranged within a suitable housing **9**, supported by a suitable frame **11**, mounted on suitable casters **15** to facilitate the movement of the apparatus over a floor.

For purpose of clarity, it is believed that it will be best to trace the conduits for the water, air and detergent agents so that the subsequent description will be more easily understood. A suitable water connection **13** is provided which may be connected to any suitable source of water under pressure, such as the usual city water supply, through a flexible hose (not shown). This water supply to the boiler may be controlled by a master water valve **14**. The water connection **13** is connected to the booster pump **2** through suitable conduit pipe **16** to the water inlet manifold **17** at **18**. The water pressure at the inlet **18** will be indicated on the pressure guage **20** which is connected to the pipe **16** by means of the conduit **25** The water outlet manifold **19** of the booster pump **2** is connected through suitable pipe **21** and valve **3** to the bottom of the boiler **1** at the point indicated by the numeral **22**. The pressure in this pipe **21** is indicated on guage **23** which is connected by a suitable conduit **24** to the pipe **21**. After the water is passed into the boiler **1**, it may be converted to steam or merely warmed, depending upon the rate at which the water is supplied to the boiler. Also, as will be explained later, if air is admitted to the inlet of the boiler, some air may be mixed with the water or steam. Alternately, air only may be supplied to the boiler where it may be heated. The outlet from the boiler **1** is connected by a suitable pipe **26** to the mixing chamber **6**. As will be readily apparent, the mixing chamber **6** is connected to the nozzle **8** by means of a flexible hose **27**.

A suitable air connection **28** is provided for connecting the cleaning apparatus to a suitable source of air pressure such as that usually available in a garage. This air inlet **28** is controlled by suitable master valve **29** and is also connected to the three-way main control valve **3** by means of a suitable conduit **31**. This air connection **28** is also connected through the pipes **32**, air valve **33** and pipe **34** to the mixing chamber **6**. The air pressure supplied directly to the mixing chamber **6** will be indicated on the pressure guage **36** which is connected to the pipe **32** by suitable connection **37**. It will be understood that the valve **33** controls the air supplied through the pipe **34** directly to the mixing chamber **6**.

As shown in Figure 5, the mixing chamber **6** is provided with a Venturi throat **38**. The air pipe **34** is connected inside the chamber to a cylindrical tube **39** which terminates at the narrowest part of the Venturi throat. The high velocity air issuing from the tube **39** expands in the throat and tends to create lowered pressure at that point. Water, air or steam or a mixture of all three which enters the mixing chamber through the pipe **26** will have a high velocity as it passes through the Venturi throat. Advantage is taken of the suction of the Venturi throat to draw a detergent into the mixing chamber from which it can be supplied to the nozzle **8**. To this end, a conduit **41** is connected to the back side of the mixing chamber and to the detergent manifold **42**. The manifold **42** has connected thereto suitable branch pipes **43** which extend into the different detergent containers **7**. Communication is provided between the pipes **43** and the manifold **42** through suitable manually operated valves **44**. As will be readily apparent, different kinds of detergents may be put in the different containers **7** and the individual valves **44** may be operated as desired to permit the desired amount or ratio of the different detergents to be drawn into the mixing chamber **6** by the action of the Venturi throat **38**. Since there is a large number of detergents which may be used, if deemed desirable it will be rather apparent that additional containers could be supplied and connected in a manner similar to those shown to provide a larger variation in the detergents for facilitating the cleaning action.

The boiler **1** is of the progressive heating type and includes a series of units **1***a* comprising a series of tubes or pipes lying one above the other. The opposite ends of the pipes or tubes are connected together by suitable conduits **1***b*. The conduits **1***b* are aligned so that the water or steam in the boiler may readily pass from the bottom to the top of the boiler. Although it will be readily understood that other means of heating may be used, in the particular embodiment illustrated in this specification, the individual units **1***a* of the boiler are provided with electrical resistance heating units **46**. These units are of conventional construction of the enclosed heater type in which the heater resistance, per se, is surrounded by suitable insulation and is hermetically sealed inside an outer metallic shield of high heat conductivity. A plurality of heat conducting fins **47** may be arranged transversely of the metallic shield and in thermal contact with the latter. As shown in Figure 3, the individual heater units **46** of the different boiler units **1***a* are connected in parallel to bus bars **48** which may be energized through a suitable electric connection **49** with a

switch 50. The suitable switch 50 serves to break both sides of the circuit so that equipment can be worked upon with complete safety.

As will be apparent from the foregoing description, water enters the boiler a short distance from one end of the lowermost tube and travels the distance of the tube and then passes through the connecting conduit 1b into the next tube or unit 1a above. The water then travels the length of the second tube in the opposite direction from that of the lower tube and then passes through the next conduit 1b into the next tube above and so on back and forth until it reaches the uppermost horizontal tube. Steam or hot water discharges from the opposite end of the last tube in which it enters. By this method the water increases in temperature until it reaches the uppermost tube due to its contact with each of the individual electrical heating elements. Steam is generated in the tubes provided the amount of water flowing is in proper proportion to the heat transfer. When valve 3 is turned to the "Steam" position, a small opening is provided so that a very small amount of water will flow through the boiler. When valve 3 is turned to the "Hot water" position, a larger opening is provided so that the full supply of water may be allowed to flow through the boiler. The amount of water passing the heating elements will lower the temperature below that of steam and will flow through the discharge nozzle as hot water. When valve 3 is moved to the position midway between "Hot air" and "Hot water," air and water may enter the boiler.

From the description so far, it will be seen that a mixture of air and water may be supplied through the boiler 1 to the mixing chamber 6 where suitable detergents may be added and from where it may be discharged from the nozzle 8 at very high velocity. It will also be seen from the foregoing that it will be possible by the operation of the air control valve 33 to add additional air directly to the mixing chamber 6 without having it pass through the boiler 1. The subsequent description will show that the rate at which the water is supplied to the boiler 1 will determine the characteristics of the cleaning medium delivered from the boiler, that is, whether it is dry steam, wet steam or hot water. The desired pressure or temperature of the fluid delivered from the boiler can be regulated by manipulating the air control valve 33.

As previously mentioned, since the boiler 1 is of the type to which water is continuously supplied during operation, it is necessary to provide a booster pump to resist the pressure of the steam. Obviously, where the water pressure is high enough to overcome the normal pressure of the steam, it will not be necessary for the booster pump to operate. The arrangement provided herein is such that the pump automatically operates at the proper rate to maintain the proper pressure. The operation of the pump is controlled by the main control valve 3 by controlling the water input to the boiler. Referring to Figure 6, the booster pump 2 comprises two cylinders 51 and 52 having floating pump pistons 53 and 54 respectively, which operate alternately to reduce the pulses in the output. The pump piston 53 is connected in fixed spaced relation to the pneumatic motor piston 56 by means of the rod 57 and a spacer sleeve 58. Likewise the pump piston 54 in cylinder 52 is connected in fixed spaced relation to pneumatic motor piston 59 by means of the rod 61 and spacer sleeve 62.

The lower end of the two cylinders 51 and 52 are in communication with a bore 63 of the valve case 64 through bores 66 and 67, respectively. The bore 63 is provided with an air inlet 65 which is suitably connected to the air connection 28. Suitable valves 68 and 69 control the passage of the air from inlet 65 to the lower end of the cylinders 51 and 52, respectively. The valves 68 and 69 are fixed in spaced relation on an operating rod 71 which in turn is operated by a snap action mechanism 72. In order to operate the snap action mechanism 72, a piston block 73 is adapted to slide on the spacer sleeve 62 between the pump piston 54 and the pneumatic motor piston 59. When the two pistons in the cylinder 52 are in their lowermost position under the pressure from the water source as will be more fully explained later, the pump piston 54 will engage piston block 73 and move the latter downwardly to its lowermost position. When the pneumatic motor piston 59 is moved upwardly under the influence of air pressure, the piston 59 will engage the under-side of the piston block 73 and move the latter to its uppermost position. The piston block 73 is pivotally connected through a suitable link 74 to a bell crank 76 which is a part of the snap action mechanism 72 previously mentioned. A suitable spring 77 is attached to the upper end of the bell crank mechanism 76 and has its other end connected to a lever 78 pivoted coaxially with the bell crank 76. The lower end of lever 78 is connected through a suitable linkage 79 to a plunger 81 which reciprocates in a guide block 82. The other end of the plunger 81 is connected by a suitable strap 83 to the valve rod 71 for operating the latter. It will be understood from this description that when the piston block 73 is moved to its uppermost position the upper end of the bell crank mechanism 76 will be displaced to the left as viewed in Figure 2 so that the spring 77 will cause the lower end of the lever 78 to snap to the left also. This, of course, will cause the two valves 68 and 69 to move to the left. Likewise when the piston block 73 is in its lowermost position, the upper end of the bell crank mechanism 76 will move over center to the right end through the spring 77 causing the lever 78 to move to the right, moving the pneumatic motor valves 68 and 69 with it.

As will be apparent from Figure 6, the water inlet 18 is in communication with a bore 84, the opposite ends of which are provided with suitable disc valves 86 and 87. These valves are biased with suitable springs to permit the water to flow from the bore 18 under the pressure of the water source to the cylinders 51 and 52. Suitable disc valves 88 and 89 suitably biased are provided to permit the water to flow under the action of the pump pistons 53 and 54 respectively into the pump outlet manifold 19.

As will be seen from the above description, the booster pump 2 comprises two cylinders, each of which has two floating pistons connected together, one of the pistons constituting a part of a reciprocating pneumatic pump while the other direct connected piston constitutes a part of the water pump. The valve mechanism for controlling the air to both cylinders is controlled by the movement of one of these dual pistons. The operation of the pump is as follows:

The water from the water inlet 18 enters the bore 84 of the pump inlet manifold 17, passes through the valve 87 into the cylinder 52 above the pump piston 54. The pressure of the water

on piston 54 causes the piston 54 to move downwardly until it contacts the piston block 73 moving it down to its lowermost position. As explained above, the movement of the piston block 73 operates the slide valves 68 and 69 and the downward movement of the block 73 through the bell crank toggle mechanism 76, 77 and 78 moves the valves 68 and 69 to the right as viewed in Figure 6, whereby valve 69 will uncover port 67 allowing air to enter through bore 63 to the lower part of cylinder 52 against the bottom of pneumatic motor piston 59. At the same time valve 68 has also moved to the right, uncovering port 66 in the bottom of cylinder 51, allowing the air under piston 56 to escape through the other end of bore 63 to exhaust. The air pressure in the bottom of cylinder 52 under piston 59 forces the latter upwardly until piston 59 contacts block 73 moving the latter to its uppermost position. This action reverses the valve action, moving it to the left causing valves 68 and 69 to move to their other extreme position, exhausting air under piston 59 through port 67 and at the same time allowing air to enter cylinder 51 through port 66. The construction arrangement is such so that the pump operates only when the water admitted to the inlet manifold of the pump 2 is sufficient to move the pump pistons downwardly. In this respect the automatic operation of the pump is operated by adjustment of the valve 3. If, for instance, valve 3 is closed, no water can pass into the boiler and air pressure on the pistons 56 and 59, whichever one is on the upward stroke, due to the position of valves 68 and 69, remain stalled and no movement of the pistons takes place until water is allowed to flow through valve 3. If valve 3 is open all the way, as is the case when it is desired to deliver hot water, the pump remains stationary, due to the fact that there will not be sufficient resistance to check the flow of water to develop sufficient pressure on the pistons 53 and 54 to operate the latter. Consequently, the water will flow through the water inlet and outlet manifolds of the pump 2 into the boiler, mixing chamber hose and nozzle without any added pressure being developed by the pump. In some cases where air pressure does not exceed water pressure to any great extent, it may be desirable to install a piston block in cylinder 51 similar to the piston block 73 in the cylinder 52 and to connect such additional block to the bell crank mechanism in such a manner as to take advantage of the water pressure on piston 53, pushing it to its lowermost position while air is applied to piston 59, moving the latter to its uppermost position. In so doing, the pump would operate whenever water was passing through valve 3 whether it is in steam or "Hot water" position. The pump will then operate at any time that the water pressure on either of the pump pistons 53, 54 is sufficient to move the latter far enough to operate the valves 68, 69.

It will be obvious that the electrical control switch 50 may be manually operated. However, in order to prevent damage to the boiler and the electrical resistance units by reason of possible overheating through neglect or carelessness of the operator, means is provided for automatically opening the switch in response to excessive temperature or pressure in the boiler. To this end, a pneumatic cylinder 101 is suitably pivoted to the frame at 102 and the piston rod is connected at 103 to a suitable arm 104 which in turn is secured to a disk or wheel 106 on the shaft which operates the switch 50. As will be apparent from the previous description, a source of air pressure must be available to operate the steam cleaner and this same source is used to operate the pneumatic cylinder. The admission of the air to the cylinder 101 is controlled by suitable three-way air valve 107 and push button air valve 108. As will be clearer from the following description, the air valve 108 admits air to the pneumatic cylinder 101 to operate the switch and the air exhaust valve 109 may be manually operated to exhaust the air from the pneumatic cylinder to permit a suitable spring 110 to return the switch 50 to the "Off" position. An additional air exhaust valve 112, supplemental to air valve 109, is responsive to the excessive pressure or temperature in the boiler, is provided for automatically releasing the air from the piston 101 to provide a safety control for the boiler.

The three-way air valve 107 is connected through suitable pipe 113 to the source of air pressure used for the operation of the cleaning mechanism of this invention. The pipe 113 is divided into two branches, 114 and 115. The branch 114 is connected directly to one side of the valve 107 while branch 115 through the air control valve 108 is connected to the opposite side of the valve 107. A suitable pipe or conduit 116 connects the valve 107 to the base of the pneumatic cylinder 101. Conduit 117 is connected to the conduit 116 between the cylinder 101 and the valve 107 and through the air control valve 109 provides means for bleeding the air from the cylinder 101. As previously mentioned, the valve 109 is adapted to be manually operated. A second branch conduit 118 also connected to the conduit 116 communicates with the air release valve 112 which is operated by a combination thermostat-pressurestat 121 in response to excessive temperature or pressure in the boiler to exhaust the air from the cylinder 101. When valve 108 is depressed, air can flow from conduit 113 through conduit 115 through the valve 107 to the base of the cylinder 101. A suitable mechanical connection is provided between the arm 104 and the valve operating arm 119 of the valve 107 so that when air is admitted to the base of the cylinder 101, causing the arm 104 to rotate in a clockwise direction, the valve arm 119 will be rotated with it so that communication between the conduit 115 and the valve 107 is cut off. As will be readily apparent from Figure 8 the air from conduit 113 can flow directly into the opposite side of the valve 107 through the conduit 114. It should be noted here that a suitable reducer disk 120 having a very small opening therein is provided in the conduit 104 to reduce the air flow into the valve 107. This restriction becomes very important as will be understood later in connection with the release of the air from the cylinder 101 for returning the switch 50 to its "Off" position. When the piston in cylinder 101 has been moved through its full stroke under the influence of air pressure, the valve 107 will have moved to such a position that communication with conduit 115 is completely closed. It will be readily apparent that by reason of the reducer disk 120 that the piston in the cylinder 101 will have very slow movement. When the piston has traveled to its outward limit, the switch 50, through suitable snap action mechanism (not shown) will have moved to the "On" position and will be held in this position as long as air pressure remains on the piston in cylinder 101. In this position the valve 107 will be in such a position that the conduit 114 is directly in communication with the

conduit 116. If the operator wishes to cut off the electric current to the heater, he merely has to depress the air control valve 109. This exhausts the air in cylinder 101 to the atmosphere. Due to the fact that the opening in the valve 109 is larger than the opening in the reducer disk 120 in the conduit 114, the pressure in the cylinder 101 will be greatly reduced so that the spring 110 will rotate the disk 106 to return the piston to its innermost position. It will be readily understood that at the same time this movement of the lever 104 to the "Off" position turns the valve operating arm 119 of the valve 107 to its original position so that air is cut off from the conduit 116. Of course, the hydraulic piston mechanism can again be operated by depressing the air control valve 108. If, for any reason, the air supply fails or drops in pressure sufficiently to preclude the proper operation of the cleaner, the spring 110 will pull the lever 104 to the "Off" position. The operator will then have to again depress the air valve 108 in order to close the electrical switch 50.

In order to avoid extreme temperatures of the heating elements where the operator is heating air for drying off work and operates the machine for a long period of time, which may damage the elements or shorten the life of the discharge hose, a combination thermostat and pressurestat 121 is installed in any suitable position in the wall of the boiler. This device is adapted to operate on a temperature of approximately 500 degrees or a pressure of approximately 150 pounds per square inch. Of course, if desired the device could be designed or adjusted to operate on other desirable temperatures and pressures. This unit comprises a housing 126 which may be screwed into the side of the boiler or may be secured thereto by welding. In the form illustrated the housing 126 is cylindrical and threadedly engages an internally threaded cylinder welded to a wall of the boiler 1. Inside of this housing 126 is an outer bellows 127, one end of which is suitably sealed to a disk 126a held by a cap 126b on the outer end of housing 126. The inner end of the outer bellows 127 is suitably sealed to a disk 128 which seats on a ledge in housing 126. This disk is provided with a suitable aperture as shown so that the relative movement of disks 126a and 128 will not be retarded by any fluid which might be trapped therebetween. A second inner bellows 129 is provided with its outer end sealed to the disk 126a and its inner end sealed to an actuating stem 130. It will be readily understood that, if desired, the two bellows could be made in one unit with the bellows 129 inside of the outer bellows 127. The intervening space between the walls of the inner and outer bellows is filled with a fluid having a suitable thermal expansion characteristic. The inner end of an actuating stem 130 is adapted to rest normally against a boss 131 carried by the disk 128 and the other end protrudes through a central aperture in the disk 126a. An extension 132 is adjustably threaded on the outer end of the stem 130 and may be locked in position by a suitable lock nut 133. The purpose of the adjustable extension 132 is to provide means for adjusting the effective length of the stem 130 for varying the temperature or pressure at which the device opens the air valve 112 to release air from cylinder 101. The end of the stem is arranged adjacent the air valve 112 so that if the stem 130 is moved outwardly of the housing 126, it will operate the valve 112 to exhaust any air in the cylinder 101.

Because of the thermal expansion characteristics of the fluid between the two bellows, an excessive temperature rise in the boiler 2 will cause the fluid to expand the inner bellows 129 and move the stem 130 outwardly, thereby actuating the valve 112. If, on the other hand, the temperature does not become excessive but the pressure in the boiler becomes too high the outer bellows 127 will be compressed and the stem 130 will be forced outwardly to actuate the valve 112 permitting air to escape from the cylinder 101. The adjustable extension 132 makes it possible to set it for various temperatures or pressures.

Supposing the operator has been heating air for a considerable period of time, and the heating elements and boilers are at a very high temperature but not high enough to release the switch, he may turn the main valve to hot water. This action will cause steam to generate quickly; much faster than the discharge nozzle will allow it to escape, and this pressure rise would cut off the switch immediately and no harm would be done. The operator could not turn on the current even if he wanted to until the pressure was reduced to normal. This same thing could happen if the discharge hose became clogged up. In case the operator should turn on the current without having water or air flowing through the boiler, the sudden temperature rise would cause the release of air pressure in the cylinder 101 and cut off the electric current.

If the operator wishes to clean the grease and dirt from an automobile motor or chassis, the operator starts the operation of the cleaning equipment with the electrical control switch 50 in the "Off" position. The main valve 3 is turned to the "Hot water" position and is allowed to remain until the water flows in a steady stream from the discharge nozzle 8. This to insure the boiler is filled with water. Then the main valve 3 is turned to the "Off" position and the control switch 50 is turned on. Within a brief interval steam will be discharged from the discharge nozzle 8 and the pressure in the boiler 1 will begin to rise as indicated on the steam guage 23. The main valve 3 is then turned to the "Steam" position, which is about ninety degrees in an anti-clock-wise direction from the "Off" position. When this vlave is in this position, a small amount of water is allowed to enter the boiler and is converted to steam. The steam pressure will gradually increase and remain fairly constant, fluctuating slightly due to the moisture content of the steam. This moisture is desirable and may be adjusted by moving the main valve 3 slightly to the right or left of the "Steam" position. By opening the valve farther to the approximate 180 degree position, the amount of water entering the boiler will be sufficient to prevent the generation of steam and the water will merely be warmed or heated. The control can be varied to vary the temperature of the water. Farther opening of the main valve 3 to the 270 degree position shuts off all the water allowing air only to enter the boiler, displacing all the water and thereby producing hot air. Any solution or combination of cleaning solutions or detergents may be added to the steam, water, or air being discharged from the nozzle 8 by adjusting one or more of the valves 44 to produce the quantity suitable for the best results. It will be understood that when any one of the valves 44 are opened the suction created in the Venturi throat 38 of the mixing chamber 6 will draw the cleaning solution or detergent from the glass containers 7 through the pipe 41.

After the motor or other object has been cleaned with steam and the desired cleaning solution, the valves **44** will be closed and the main valve **3** will be turned to the "Hot water" position. This will have the effect of tremendous steam pressure discharging from the nozzle **8** due to the over-supply of water coming into contact with the heating elements and in so doing it flushes out the detergents and flushes out any foreign ingredients from the boiler and discharge hose. This condition is of short duration and is then followed by clear hot water. After the article has been washed with steam and the cleaning solution and rinsed with hot water, the article may be immediately dried with hot air by turning the main valve **3** to "Hot air" position. Hot water is then driven from the boiler through the discharge nozzle **8** and is displaced by a stream of hot air which is heated as it passes through the boiler **1**. This is a particularly advantageous feature of this invention where it is desired to steam clean automobile motors and immediately dry all of the ignition wires, coils, etc.

When it is desired to wash the painted surfaces of an object such as an automobile body and wheels, a procedure similar to that described above is followed except that when using steam it may be desired to cool the steam somewhat in order not to damage the painted surface. This may be done by opening the air valve **33** and adjusting to the desired temperature. This allows cool air to by-pass the boiler **1** directly into the mixing chamber **6** to thereby increase the effectiveness of the washing procedure both by providing greater pressure and by more thorough mixing of the cleaning solution with the moisture. It is possible for the operator to have at will almost any combination he desires to meet the conditions encountered. The device may also be used for flushing out radiators and motor blocks of automobiles. In such case the special cleaning agents or detergents to be used would be those particularly effective in dissolving or loosening the rust scale inside radiators and motor.

Although the present invention has been specifically described with reference to a specific embodiment, it will be readily apparent that the exact arrangement shown is not absolutely essential so long as the basic elements are used in combination with the necessary controls. However, there are certain specific features of the present equipment which contributes to the overall efficiency of the equipment. For instance, it will be noted that all the ingredients are mixed in the mixing chamber **6** and are then delivered to the high velocity nozzle **8** through the flexible hose **7**. The flexible hose **7** facilitates the further mixing of the ingredients and since its inside diameter is greater than the orifice in the nozzle **8**, high velocity discharge is produced at the end of the nozzle. This system is distinguished from some of the prior devices in which the ingredients are mixed at the point of discharge from the nozzle. Another novel feature of this invention is the provision of the special handle **91** which is attached to the hose **27** by separable brackets **92**. The handle **91** is provided with a special Bowden wire control **93** which is connected to a boss **8a** on the nozzle **8**. The Bowden wire is provided with a small button **94** by which the operator can change the direction of the nozzle by pulling back and forth.

Another feature of the present invention is the special booster pump **2** which operates only when it is necessary to supply desired increase in pressure in response to the control valves. It provides a very simple and efficient construction and since it only operates when it is needed it is not necessary to run continuously as is true in other equipment now on the market.

From the foregoing explanation it will be apparent that the pump provides a back-pressure for the boiler dependent upon the pressure of the water source or the source of compressed air, whichever is the greater. In other words if the water pressure was sufficient the pump would never have to operate.

The novel combination thermostat-pressurestat **121** is so arranged that a double safety feature is provided not only for the boiler itself but for the heating units. The device will be operated either by excessive pressure or temperature.

Although the invention has been described in considerable detail, it will be apparent to those skilled in the art that many variations are possible without departing from the inventive concept. It is therefore desired that the invention not be limited except insofar as is made necessary by the prior art and by the appended claims.

What I claim is:

1. Cleaning or washing apparatus having a series fluid path comprising a boiler, means for connecting a source of water under pressure to a common input orifice for said boiler, independent means for connecting a source of compressed air to said input orifice, a mixing chamber, means for connecting the outlet of said boiler to said mixing chamber, a high velocity discharge nozzle separate from said mixing chamber, conduit means for connecting said mixing chamber with said nozzle said boiler forming a fluid conduit interposed in the fluid path between said common input orifice and said mixing chamber for imparting heat to the water and compressed air coupled therethrough, and valve means intercoupled between the means for coupling the compressed air and water to said common orifice for selectively controlling the flow of air and water therethrough, whereby said valve means may be adjusted to supply either steam, hot water, a mixture of air and steam, a mixture of air and hot water, and hot air only to said discharge nozzle.

2. A washing and cleaning apparatus having a series fluid path comprising a high velocity discharge nozzle, a mixing chamber, a conduit connecting said mixing chamber and said nozzle, a flash boiler, means connecting said mixing chamber and said flash boiler, means for connecting a source of water under pressure to a common input orifice for said boiler, independent means for connecting a source of compressed air to said input orifice, said boiler forming a fluid conduit interposed in the fluid path between said common input orifice and said mixing chamber for imparting heat to the water and compressed air therethrough coupled, and valve means intercoupled between the means for coupling the compressed air and water to said common orifice for selectively controlling the flow of air and water therethrough, whereby said valve means may be adjusted to supply either steam, hot water, a mixture of air and steam, a mixture of air and hot water, and hot air only to said discharge nozzle.

3. Method of controlling the detergent char-

acteristics of a fluid used in an apparatus for cleaning grease, dirt and the like from an article, comprising the step of supplying air and water in selected quantities independently and each under pressure to a common conductor, coupling said air and water from said conductor through a heated conduit, discharging the resultant fluid from said heated conduit to a mixing chamber, maintaining sufficient velocity in said mixing chamber so as to inject by suction an additional detergent agent and delivering said resultant fluid from said mixing chamber through a nozzle in a high velocity stream.

4. In a process for cleaning an article by the detergent action of a high velocity fluid which comprises the step of supplying air and water in selected quantities independently and each under pressure to a common conductor, coupling said air and water from said conductor through a heated conduit, discharging the resultant fluid from said heated conduit to a mixing chamber, delivering said resultant fluid from said mixing chamber through a nozzle in a high velocity directive stream and controlling the detergent and drying action of said cleaning fluid by adjusting the relative amount of water and air supplied to said heated conduit.

5. In combination in a washing and cleaning apparatus, a boiler, means for coupling a source of water under pressure to said boiler, independent means for coupling a source of air under pressure to said boiler, a pump for continuously delivering water to said boiler, valve means between the means coupling water and air to said boiler for selectively controlling the flow of water and air entering said boiler, said pump comprising a cylinder, a piston assembly, including a pump piston in said cylinder and a pneumatic motor piston in said cylinder adapted to operate said pump piston, valve means responsive to movement of said piston assembly for controlling the operation of said pneumatic piston, the pump piston end of said cylinder adapted to be connected to a source of water under pressure, the pneumatic motor end of said cylinder being coupled to a source of air under pressure to operate said pump piston in response to a pre-determined pressure differential between the water pressure on said pump piston and the air pressure on said pneumatic motor piston.

6. A cleaning or washing apparatus of the type described having a series fluid path comprising a boiler, means for connecting a source of water under pressure to a common input orifice for said boiler, independent means for connecting a source of compressed air to said input orifice, a mixing chamber, means for connecting the output of said boiler to said mixing chamber, a high velocity nozzle separate from said mixing chamber, conduit means for connecting said mixing chamber with said nozzle, a pump between said source of water and said common input orifice, said boiler forming a fluid conduit interposed in the fluid path between said common input orifices and said mixing chamber for imparting heat to the water and compressed air coupled therethrough, and a valve means intercoupled between the means coupling water and air to said boiler for effecting the control of air and water to said boiler, whereby said valve means may be adjusted to supply either steam, hot water, a mixture of air and steam, a mixture of air and hot water, and hot air only to said discharge nozzle.

7. A cleaning or washing apparatus of the type described, comprising a boiler, a high velocity discharge nozzle, a mixing chamber, conduit means connecting said mixing chamber and said nozzle, conduit means connecting said mixing chamber and said boiler, means for connecting a source of water under pressure to the inlet of said boiler, independent means for connecting a source of compressed air to the inlet of said boiler, valve means intercoupled between the means coupling water and air to the inlet of said boiler for controlling the amount of water and air entering said boiler, and means controlled by the comparative pressure of the source of water and the source of compressed air for developing a back-pressure to resist the pressure developed in said boiler.

8. A washing and cleaning apparatus of the type described comprising a boiler, means for connecting the input of said boiler to a source of water under pressure, independent means for connecting the input of said boiler to a source of compressed air, valve means intercoupled between said means connecting the input of the boiler to the water and air for controlling the relative amounts of air or water entering said boiler, and pump means intercoupled between said means connecting water and air to said boiler inlet and responsive to the comparative pressure of said source of water and the source of compressed air for maintaining a desired back-pressure from the water supply to said boiler.

9. A washing and cleaning apparatus of the type described comprising a boiler, means for supplying water to the inlet side of said boiler, a source of compressed air connected independently to the inlet side of said boiler, a pump between the source of water and the said inlet side of said boiler, valve means intercoupled between said means supplying water to the boiler inlet and the compressed air connection to said boiler for controlling the relative amounts of air and water entering said boiler, said pump being intercoupled between said means connecting water and air to said boiler inlet and responsive to the comparative pressure of said water source and the pressure of said source of compressed air for developing a pressure to overcome the pressure developed in said boiler.

10. A washing and cleaning apparatus of the type described comprising a boiler, means for coupling a source of water under pressure to said boiler, independent means for coupling a source of air under pressure to said boiler, common valve means intercoupled between said means for coupling water and air to said boiler for controlling the relative amounts of water and air entering said boiler to selectively supply water only, compressed air only, and desired proportions of both water and air to said boiler whereby either hot water, steam, mixtures of either with compressed air, and hot air alone, may be selectively produced at the output of said boiler, and a pump intercoupled between said source of water and said source of compressed air responsive to the comparative pressure of said water source and of said source of compressed air and controlled thereby to supply a back pressure to the input of said boiler, dependent upon the maximum pressure of said source of water or said source of compressed air.

11. A washing and cleaning apparatus of the type described comprising a boiler, means for coupling a source of water under pressure to

said boiler, independent means for coupling a source of compressed air to said boiler, common valve means intercoupled between said means for coupling water and air to said boiler for controlling the amount of air and water entering said boiler, a pump intercoupled between said source of compressed air and said source of water, said pump having a pumping piston and a pneumatic motor piston for operating said pump piston respectively intercoupled with the means coupling the water to said boiler and the means coupling compressed air to said boiler and being responsive to and controlled by the difference between the pressure applied to said pistons to operate said pump piston and supply a back pressure to said boiler.

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