

Oct. 24, 1944.

J. N. VERMILYA

2,360,915

PROCESS AND APPARATUS FOR DRYING

Filed March 27, 1942

4 Sheets-Sheet 1

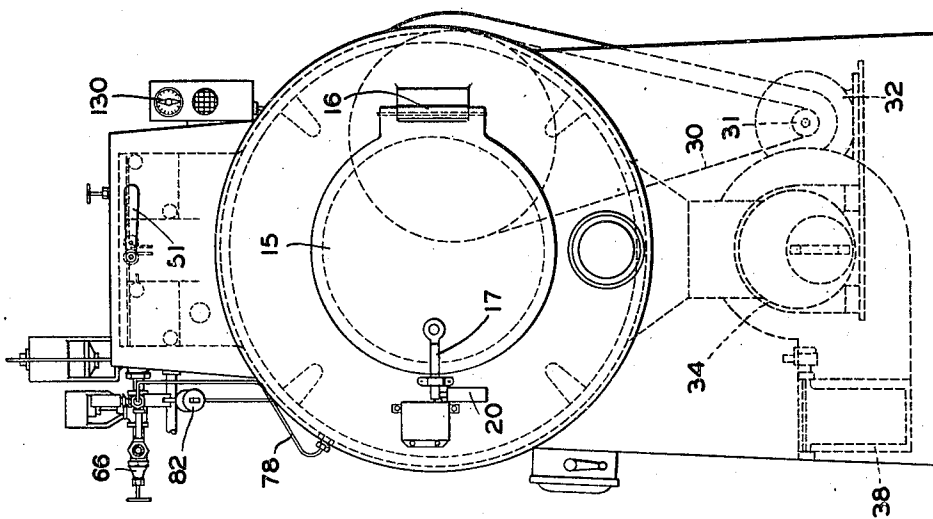


FIG. 1

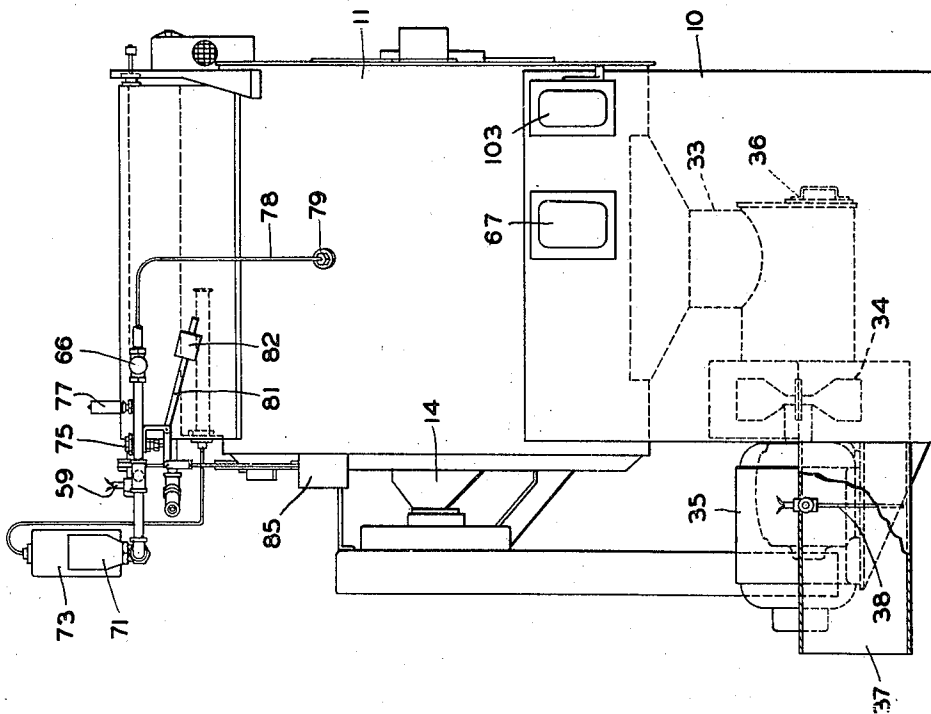


FIG.-2

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4 Sheets-Sheet 2

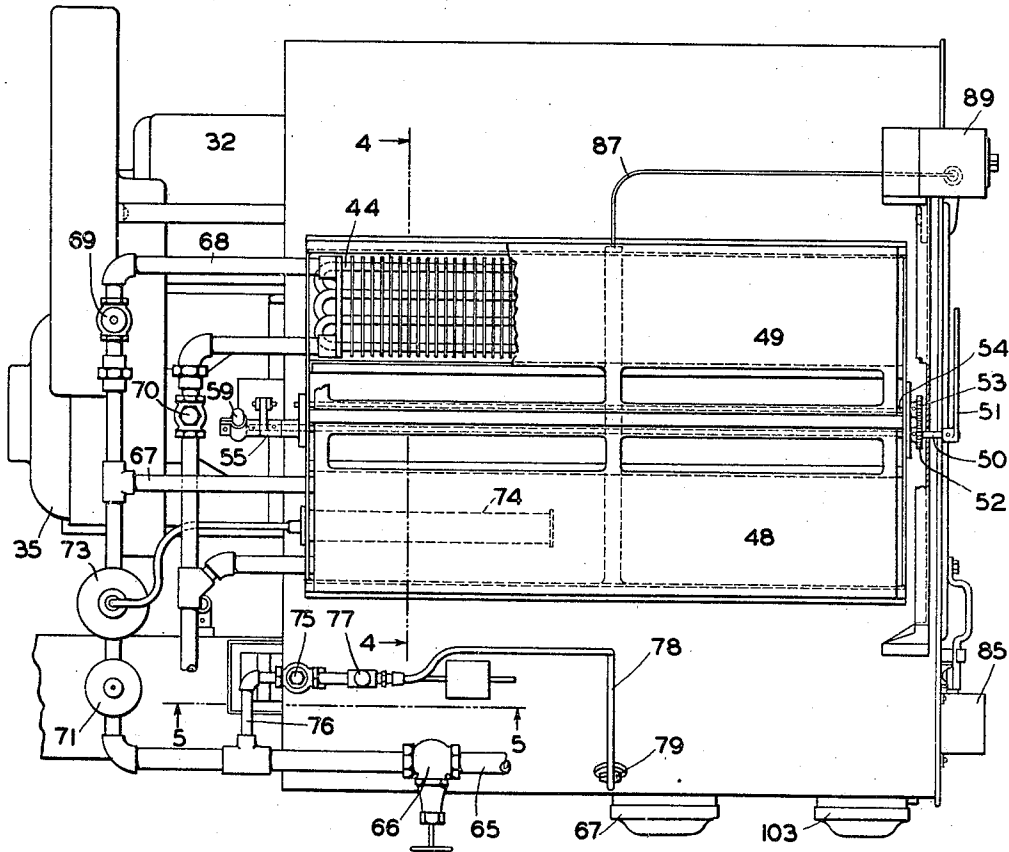


FIG.-3

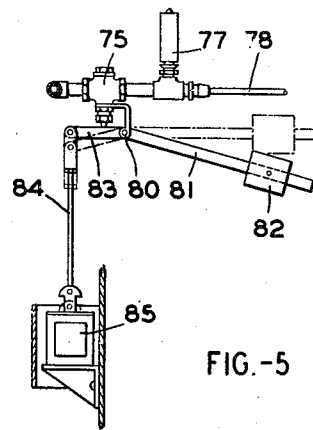
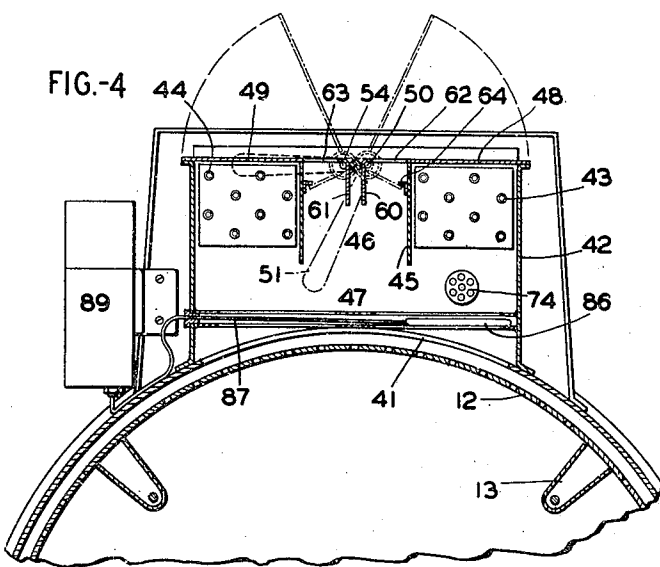


FIG.-5

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4 Sheets-Sheet 3

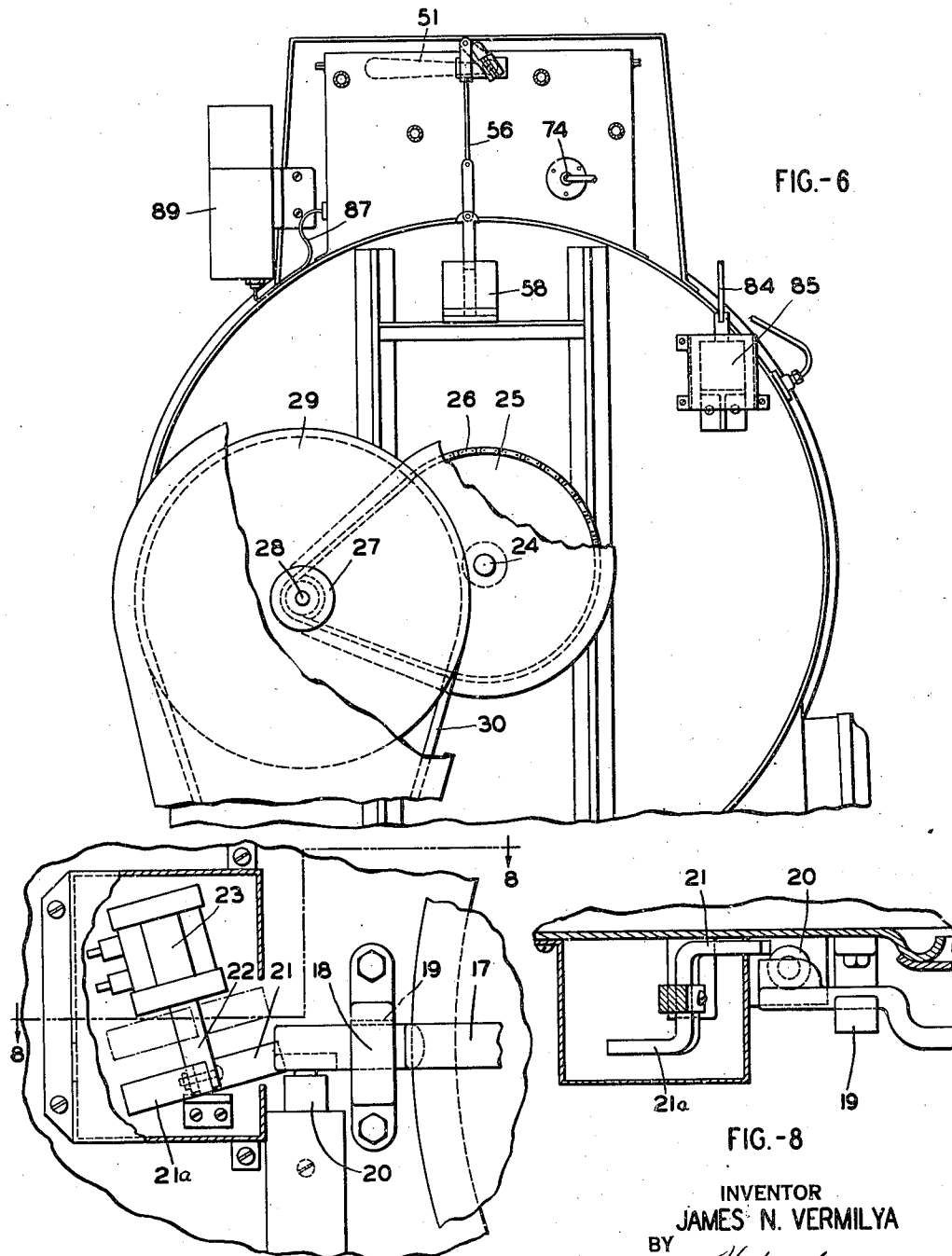


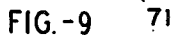
FIG.-6

FIG.-8

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,360,915

PROCESS AND APPARATUS FOR DRYING

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Application March 27, 1942, Serial No. 436,486

9 Claims. (Cl. 34—31)

This invention relates to process and apparatus for drying any materials previously treated, as for cleaning, with a volatile solvent, and more particularly, any inflammable volatile solvent such as that solvent known in the industry as 140-F solvent, although the invention is not limited thereto.

Dry cleaning of any materials, such as wearing apparel, fabrics, or other substances, with inflammable volatile solvents is always attended by the danger incident to flame, combustion, or explosion. After the material has been agitated sufficiently in a bath of the detergent, the latter is drained off, following which, not only for the purpose of drying and deodorizing the material but also for the purpose of recovering the solvent itself, the damp material is dried, usually by agitation in a stream of more or less heated air. Some attempts have been made to avoid the dangers referred to by limiting the temperature of the heated drying air to something less than the flash point of the particular inflammable solvent employed, which, in the case of 140-F solvent, is 140° Fahrenheit.

By extensive research and investigation based largely upon known properties of these substances, I have determined that in this process of drying, safety, from the standpoint of avoidance of flame, fire or explosion, is not so much a matter of the temperature alone as it is of the degree of dilution of the detergent with air. In other words, if the apparatus is so designed, and the process is so carried out, that the vapors of the volatile detergent are always diluted with a sufficient quantity of air during the drying process, the temperature may be carried considerably higher than the flash point of the particular detergent without any danger or possibility of combustion in any way, such as by the production or propagation of flame or the occurrence of fire or an explosion.

Accordingly, one object of the present invention is to provide improved dry cleaning apparatus, and a process employing the same, in which the temperature of the current of heated air moved across the damp material, for drying purposes, may be carried considerably above the flash point of the volatile detergent without liability of flame, fire or explosion, thereby materially reducing the time for drying and the cost of the drying operation and increasing the capacity of the apparatus.

Another object of the invention is to provide process and apparatus of the character described, including a heat exchanger for heating the drying air, which exchanger is sensitive to the rate of

flow of the moving stream of gas, or, in other words, to the cubic volume per second flowing through or from the drying chamber, thereby to insure dilution of the volatile detergent with sufficient air to avoid any possibility of flame production or propagation.

Another object of the invention is to provide process and apparatus of the character described which insures that the drying operation will be carried out at a relatively high temperature with a large quantity of air, and hence in reduced time, and in which continuance of the supply of heat to the drying air depends upon the maintenance of such large air supply.

A further object of the invention is to provide improved process and apparatus of the character described in which the maintenance of a heating effect upon the drying air is dependent upon the maintenance of a predetermined rate of flow for the air current, thus insuring dilution of the volatile detergent with sufficient air to avoid any possibility of flame production or propagation.

A further object of the invention is to provide apparatus of the kind described including a door closed chamber in which the work to be dried is agitated while subjected to a current of heated air, the door to said chamber having a lock or latch sensitive to the temperature of the air current, and more particularly, an arrangement of the kind described in which the door cannot be opened except when the temperature of the air current is below a predetermined minimum, such as the flash point of the particular detergent employed.

A further object of the invention is to provide apparatus of the kind described in which, in case of failure of current supply either to the fan motor alone, or to the machine as a whole, any one or more of several protective measures take place, such as

- (a) The door remains locked;
- (b) The air current-controlling dampers move to cold air position;
- (c) The heat exchanger for the air supply is rendered ineffective.

A further object is to provide improved means for flooding the working chamber with steam, as a final emergency safeguard, in case of complete current failure.

Further objects of the invention in part are obvious and in part will appear more in detail hereinafter.

In the drawings, which represent one suitable embodiment of the invention, Fig. 1 is a front elevation; Fig. 2 is a side elevation from the left

in Fig. 1; Fig. 3 is a plan view on a larger scale, parts being broken away to expose interior parts; Fig. 4 is a detail sectional elevation on the line 4—4, Fig. 3, through the upper portion of the machine; Fig. 5 is a detail sectional elevation on the line 5—5, Fig. 3; Fig. 6 is a fragmental rear elevation of the machine; Fig. 7 is an enlarged detail view of the door locking mechanism; Fig. 8 is a detail sectional view on the line 8—8, Fig. 7; and Fig. 9 is a schematic diagram, showing the control circuits.

The machine shown in the drawings comprises a suitable frame or housing 10, a portion of which, marked 11, is of generally cylindrical form with its axis horizontal. It serves as a casing to enclose a foraminous work containing cylinder or drum 12 provided with the usual baffles 13 and supported at its rear end for rotation in a bearing 14, Fig. 2.

Access to the chamber within the drum is through an opening at its end opposite to the bearing 14 by way of an opening in the frame casing 11 closed by a door 15 hinged at one side, at 16, on a vertical axis. Pivotaly attached to the door is a resilient lever 17 (Figs. 1, 7 and 8) forming a latch or lock. When the door is closed, this yieldable latch is pushed back and swung down behind a keeper 18 fastened to the casing wall and then allowed to spring forwardly beneath a shoulder or abutment 19 thereof. In the fully latched position, shown in Figs. 7 and 8, a lateral extension on the door latch depresses and holds closed a normally open switch 20, later to be referred to. Also, cooperating with the latch lever 17 is an arm 21 fastened to the armature 22 of a solenoid 23 to be later referred to. When solenoid 23 is deenergized its armature, and the arm 21 secured thereto, are in their lowermost positions, shown in full lines in Figs. 7 and 8. If the door is open while arm 21 is in such lowermost position, it is impossible to operate handle 17 to latch the door, because the arm 21 obstructs downward movement of lever 17 to a position where it can move forward beneath the shoulder 19. Again, if the door is closed and latched, while arm 21 is in such lowermost position, as illustrated in Figs. 7 and 8, the door cannot be unlatched, because, as shown in Fig. 8, arm 21 then lies horizontally behind the lateral extension of handle 17, and the latter cannot be pushed back to free it from its position beneath the abutment 19. But whenever solenoid 23 is energized, and the arm 21 is in its uppermost position, shown in dot-dash lines, Fig. 7, the door handle may be freely moved either into or out of latching position, as will be readily understood.

For driving the foraminous goods containing drum 12 any suitable means may be employed. It may be rotated continuously in one direction, or it may be reversible after the manner of a drum type washing machine. The drawings show an arrangement in which the shaft 24 is provided with a sprocket wheel 25 connected by a chain 26 with a sprocket 27 on a stub shaft 28 having a pulley 29 connected by a belt 30 to a pulley 31 on the shaft of motor 32.

The work to be treated in this machine, such as wearing apparel or other fabrics dry cleaned with a volatile detergent, such as 140-F solvent, of course have been subjected to a bath thereof in any suitable dry cleaning washing machine, the detergent has been drained from the work, and the work in a moist condition has been introduced into the foraminous drum of the present machine. While under agitation in said drum, by

rotation thereof, it is subjected to the effect of a current of heated air introduced to the chamber in the cylindrical casing 11 through an inlet at the top and leaving it by way of an outlet at the bottom. The outlet communicates with a conduit 33 leading to a suction fan 34 driven by an electric motor 35.

In the conduit 33 is a removable clean-out door 36, and the fan 34 discharges to atmosphere by way of a pipe 37 in which is a weighted hinged vane 38, the shaft 39 of which, on the outside of the casing, actuates a suitable switch 40, to be later referred to. In the arrangement shown, this is a standard mercoild switch mounted upon the shaft to move with it.

The inlet opening at the top of the casing is indicated at 41, Fig. 4. Above it is a box-like casing or housing 42 enclosing two banks of steam coils 43, 44, forming parts of a heat exchanger, said banks of coils being separated from each other by depending walls 45 which between them form an entrance passage 46 to a chamber 47 communicating with the inlet 41. Admission of air from atmosphere to the two banks of steam coils is controlled by two dampers marked respectively 48, 49. These are relatively long rectangular dampers, as shown in the plan view, Fig. 3. Damper 48 is carried by a shaft 50 having an operating handle 51 at one end. Said shaft is also provided with a pinion 52 meshing with a pinion 53 on a shaft 54 supporting the other damper, so that movement of the handle 51, by the operator, in one direction or the other, simultaneously moves both dampers. At its opposite end shaft 50 is provided (see Figs. 3 and 9) with an arm 55 connected by a link 56 to the armature 57 of an electromagnet 58 later to be referred to. And it also operates a switch 59, which here is again a standard form of mercoild switch fastened to the shaft and rotatable with it, like the switch 40 before referred to.

Shafts 50 and 54 also carry two smaller dampers 60, 61 extending at right angles to the dampers 48, 49, down into the passage 46.

Fig. 4, in full lines, shows the four dampers in what may be termed the cold air position. In other words, dampers 48, 49 cut off supply of air to the banks of heating coils 43, 44, but atmospheric air can flow through the openings 62, 63 in the damper plates to the passage 46, chamber 47 and thence through inlet 41 to the foraminous drum. The dot-dash lines illustrate the dampers in the hot air position. Here dampers 48, 49 are elevated and the banks of heating coils are open to atmosphere. Dampers 60, 61 engage stops 64 on the walls 45 and close off communication of atmospheric air to the passage 46. Consequently all air supplied to the drying chamber passes over the banks of coils 43, 44.

The heat exchanger, as stated, comprises the two banks of steam coils. The steam for heating them is supplied from a main 65 in which is a main valve 66. Beyond the valve 66 pipe 65 communicates with the two banks of steam coils by way of pipes 67, 68. 69 indicates a manual cut-off valve to one of said banks of coils to render it ineffective under certain special conditions, such as when drying light fabrics such as silks or the like. In that case a check valve 70 in the condensate drain pipe prevents cross communication and supply of steam to coils 44 from coils 43.

71 indicates an automatic steam control valve actuated by a solenoid 72, later to be referred to.

73 indicates another automatic steam control valve of any suitable form adapted to maintain

the temperature of the air current at a predetermined value. An ordinary Powers regulating valve, obtainable on the open market, is suitable for the purpose. It includes a bulb or control device, indicated at 74, which is located in the chamber 47 directly beneath one of the banks of steam coils, to-wit, the bank 43, so that it is always in the hottest spot in the air channel, regardless of whether either or both of the coils 43, 44 is employed. 75, Fig. 5, indicates still another steam valve in a branch 76 from the main conduit 65 but beyond the main valve 66.

This valve controls the flow of steam both to an audible alarm, such as a whistle 77, and also to a pipe 78 which enters the working chamber at 79. The steam valve 75 is sensitive to the effect of a two-armed lever pivoted at 80, one arm 81 thereof carrying a weight 82 and the other arm 83 thereof being connected by a link 84 to a solenoid 85 to be later referred to.

The door lock or latch 17 before referred to is here made sensitive to the temperature within the working chamber, or more accurately, in the communicating passage between the heat exchanger and said chamber. In that passage, at the hottest point, close to the bulb 74, I locate a bulb 86 communicating by a pipe 87 with an expansible device, such as a Sylphon bellows 88. Expansion and contraction thereof, in accordance with variations in temperature in the air supply passage, is utilized to actuate any suitable snap action switch mechanism, such as that generally indicated at 89, Fig. 9. The switch shown comprises a fixed contact 90 and a movable contact 91 mounted on an arm of a lever 92 pivoted at 93. The expansible Sylphon bellows 88 operates against a loaded spring 94 and actuates a lever 95 pivoted at 96. The free end of said lever is connected by a tension spring 97 (acting as a link) to a lever 98 also pivoted at 93. Pivotally mounted in arms of lever 98 is a snap lever 99, the free end of which works between abutment shoulders 100, 101 and is connected by a tension spring 102 to another arm of the lever 92.

Assuming the parts in the positions shown in Fig. 9, as the temperature at the bulb 86 rises, bellows 88 expands, turning lever 95 about its pivot and through the spring 97 turning lever 98 about its pivot 93 until finally the lower end of lever 99 crosses the line of pull of spring 102, causing lever 99 to snap to the left, or counter-clockwise in Fig. 9, over to abutment 100, thereby applying the force of spring 102 to lever 92, turning it clockwise and suddenly elevating the movable contact 91 and opening the switch. Reduction of temperature causes the parts to operate in reverse direction. When the switch is closed electromagnet 23 is energized, and when the switch is open it is deenergized. Arm 21 of the armature of solenoid 23 preferably is balanced by a corresponding arm 21a on the other side of the armature, solely for the purpose of avoiding lateral binding action as the armature moves back and forth.

The machine described is operated as follows:

Let us assume that the main steam valve 66 is closed, that the dampers 48, 49 occupy their full line position, Fig. 4, to which they are normally biased by their own weight, that all electrical circuits are deenergized, that the machine is cold and empty, with the door open.

Let it further be assumed that the machine is designed to operate on a load of definite quantity, say not more than about twenty pounds, of extracted garments containing the usual quan-

tity of residual inflammable volatile detergent. Assuming that quantity, the machine has been designed with a suction fan 34 having capacity great enough so that when the hot air dampers 48, 49 are open sufficient hot air, at the maximum temperature determined by bulb 74, and considering the rate of evaporation or vaporization of the solvent at that temperature, will be supplied to insure the impossibility of producing or propagating flame. That is nothing more than a matter of size and speed of fan rotor and cross sectional area of the passages through which the stream of air or air and vapor passes.

Directions to the operator, inscribed on a plate affixed to the machine, warn him not to open the main steam valve until after the electrical circuits have been energized by closing the main switch, and also not to open the main switch before first closing the main steam valve. This is to avoid accidentally and unnecessarily flooding the machine with steam by way of valve 75, as will later appear.

A load of material to be dried, such as garments or fabric damp with a residual portion of the volatile inflammable solvent used to clean them, such as 140-F solvent, is placed in the machine. The door 15 is closed, but it cannot immediately be fully latched or locked, because solenoid 23 is deenergized and its arm 21 lies in the path of downward movement of latch lever 17 which prevents its engagement under the abutment 19 of the keeper.

Accordingly, the main switch 103 (Fig. 9) is closed. This has the effect of energizing circuits as follows:

(a) From the several lead wires L₁, L₂, L₃ by way of wires 104, 105, 106 to magnetic switch 107, which is open.

(b) From lead wire L₁ by way of wires 108, 109 to solenoid 85 and by wires 110, 111, back to lead wire L₃. Energization of solenoid 85 pulls down the lever arm 83, permits valve 75 to close by the effect of its own spring, and elevates arm 81 and the weight 82 thereon, so that upon deenergization of said solenoid the weight 82 can become effective to open valve 75.

(c) By way of wires 108, 112 to snap action switch 89 to the point 113, thence by way of wire 114 to solenoid 23, and by way of wire 115 and wire 111 to L₃, and also from the point 113 by way of wire 116 and signal lamp 117 to wire 111 and L₃. Snap switches, such as that shown at 89, are usually adjustable to operate at any desired critical temperature. But in this particular case the switch is set at the factory to operate at the critical temperature for the particular volatile detergent being used, to-wit, the flash point of the detergent. Assuming that to be 140-F solvent, switch 89 would be set for 140° Fahrenheit. At first, in starting the machine it is cold, and the switch is so arranged that so long as the temperature at the controlling bulb 86 is below 140° F. the switch remains closed. Therefore, solenoid 23 immediately is energized, and its armature 22 rises, moving arm 21 to the dot-dash position, Fig. 7. This makes it possible to immediately push back the door lock lever 17 and then move it down into the keeper where it is permitted to again move forwardly beneath the keeper abutment 19, latching the door closed. As the lever 17 is moved downwardly to its final locked position, it closes switch 20, thus closing a circuit 118, Fig. 9, from L₁ to L₃, including the coil 119 of a solenoid, the movable armature 120 of which closes

magnetic switch 107, completing circuits by way of the branch wires shown in Fig. 9 to the two motors 32, 35, the first for producing rotation of the foraminous drum 12 and the second for driving the suction fan 34.

The machine is now in operation with the drum rotating and the fan operating to move through the working chamber a stream of atmospheric air coming by way of passage 46. No heated air is yet being supplied. It is therefore necessary to produce a heating effect.

First the main steam valve 66 is opened. Then the operator grasps the handle 51 and moves it from its uppermost to its lowermost position in Fig. 4, moving dampers 48, 49 and 60, 61 to their dot-dash positions, cutting off the flow of air to the intermediate passage 46 and establishing the flow of air from atmosphere to each of the banks of steam coils 43, 44. Fairly promptly, the air current reaches full volume and velocity. One of its effects is to move the vane 38 from the full line to the dot-dash line position, Fig. 9, closing switch 40. Adjustment of the dampers 48, 49 to their open position also has closed switch 59. Consequently a circuit has been completed as follows: From L₁ by wire 108 to wire 121, switch 59, wire 122, solenoid 58, wire 123, solenoid 72, wire 124, switch 40, wire 125, and wires 115 and 111 to L₂. Energization of solenoid 58 maintains the four dampers in the position to which they have been adjusted manually, and the operator can now remove his hand from handle 51 and the hot air dampers will remain open until solenoid 58 is deenergized. At the same time energization of solenoid 72 opens valve 71, permitting steam flow through said valve by way of the powers or other regulating valve 73 to the branch pipes 67, 68 communicating with the banks of steam coils. If silks or other delicate fabrics are being dried valve 69 has been permitted to remain closed and no steam is supplied to the bank of coils 44, but we will assume that both coils are in operation. As a consequence, steam flow to the coils continues and the air stream is heated and its temperature rises to the limit imposed upon it by the temperature regulator 73, 74, which in the assumed instance is 210°. As soon as the temperature exceeds that for which switch 89 has been set (140° F. in the instance before referred to) the said switch opens, solenoid 23 is deenergized, and its armature and arm 21 drop to the position shown in full lines, Figs. 7 and 8, with said arm lying horizontally behind the lateral extension of door handle 17 and obstructing movement of said handle to unlatch and open the door.

As before stated, safeguarding of this apparatus against the possibility of the production or propagation of flame is accomplished by insuring sufficient dilution of the vaporized inflammable detergent with air. This is accomplished by closing the hot air dampers and opening the cold or atmospheric air dampers whenever the rate of flow of the air stream through the apparatus is reduced below that necessary to take care of the normal residual detergent in the standard load of work assumed to be placed in this machine. The dampers are therefore made subject to the rate of flow of the gaseous stream. This may be accomplished in any suitable manner, such as by a movable vane more or less deflected by the gaseous stream in accordance with variations in its rate of flow or any function

generally in step therewith, such as its pressure. The movable vane may be placed anywhere along the stream, such as in the chamber 47 where the air stream enters the working chamber, because while it is true that the stream at this point contains no detergent vapor, its rate of flow and pressure vary in step with the stream of mixed gases at the outlet from the working chamber, where the vane 38 is actually placed in the apparatus shown in the drawings for purposes of illustration. Whether placed where it is, or in chamber 47, it is sensitive to variations in the rate of flow, and other corresponding functions, both of the air stream alone and of the stream of mixed air and vapors of a volatile detergent.

Deenergization of solenoid 58 can be produced in several ways:

The parts are so proportioned, including cross sectional areas of air passages, size and capacity of suction fan, etc., that for the normal load of material which the apparatus is intended to dry, the fan will produce a rate of air flow sufficient to dilute the vapors of the inflammable solvent to such degree that no flame can be produced or propagated therein and the machine thereby may be operated with full safety. If, for any reason, the rate of air flow is reduced, such as by a frictional retarding effect upon the fan, reduction of voltage in the current supply, cutting off of the current supply, or for any other reason, the reduced rate of flow through the outlet conduit 37 reduces the impact or pressure effect upon the vane 38, which is of such weight and so balanced that it will then fall, opening switch 40. This opens the control circuit to solenoids 58 and 72, causing the dampers to move to the cold air position and closes valve 71, cutting off the steam supply. Vane 38 and switch 40 are so mounted upon shaft 39 that vane 38 must be within a few degrees of its extreme upper position for switch 40 to close and a very slight drop of vane 38 opens said switch.

Again, if the operator moves the handle 51 upwardly from its lowermost position, Fig. 4, either partially or wholly closing the dampers, the switch 59 is likewise opened, thus deenergizing the same circuit and producing the same effect upon solenoids 58, 72. Again, the same circuit may be provided with an extra switch, such as a snap switch, which the operator can either open or close as he desires, so that energization or deenergization of the controlling circuit referred to is under the control of the operator. The drawings show for the purpose a timing switch, shown diagrammatically and marked 126. This switch includes a conducting arm 127 movable over a conducting segment 128 and operated by a shaft 129 having an operating pointer 130 travelling over a scale 131. When such a switch is employed the operator sets or adjusts the time switch just before he lowers the handle 51 to open dampers 48, 49, and at the conclusion of the time period for which he has set the switch the machine automatically opens the controlling circuit and produces the flow of cold air through the machine to cool down the work and ultimately resulting in operation of the snap switch 89 to release the door latch and permit the door to be opened and the work to be removed from the machine.

In apparatus constructed according to the present invention, safety, as regards the impossibility of producing a propagating flame, is dependent entirely upon the insurement of dilution of the

inflammable vapors with a sufficient quantity of air, and in case concentration becomes too strong, the supply of heat is turned off and cold or atmospheric air is passed through the machine for the purpose of cooling the work. Further, the door lock or latch is sensitive to or responsive to the temperature of the air current, the arrangement being such that the door can be opened only when the temperature is below a predetermined minimum, such as the flash point of the particular solvent being employed. Again, the machine operates with the air current at a temperature considerably above the flash point of the solvent, even as high as 210° F. in the case of 140-F solvent, so that the drying operation is rapid and efficient. Also, if there is a complete failure of current supply or even if current supply to the fan motor fails, the door to the machine remains locked and it cannot be opened, the air dampers are moved to the cold air position, and the supply of heating steam is cut off.

Finally, as a last safety measure, the machine is provided with means for flooding it with steam in case all current supply is cut off in the absence of the operator, in which case stoppage of the fan, along with the residual heat in the coils, might permit a situation to arise involving possible flame production or propagation. In such a case the circuit to solenoid 85 is opened, said solenoid is deenergized, and weight 82 falls, opening valve 75, supplying steam to the chamber within the machine and preventing the possibility of combustion therein.

It will also be observed that the improved drying method of this invention proceeds in a cycle involving two time periods. The operator predetermines the first time period by his setting of the time switch handle 130, determining the position of the conducting arm 127 on the conducting segment 128 and the time required for said arm to reach the gap in the segment and open the circuit, thus deenergizing coil 58 and releasing the dampers for movement to the cold air position, or if a manual switch is used in place of a time switch, as before described, the operator depends upon his experience and his own judgment as to when to open the switch and terminate the first time period. The work in the working chamber is then subjected to the effect of a stream of cooling air for a second period of time which inevitably must be of minimum duration sufficient to insure positively that the temperature of the air stream, and consequently of the work, has been reduced to a value safely below the flash point of the particular detergent being employed, such as 5° or 10° below that value. Not until the lapse of that minimum period will the snap switch 89 close and both energize the solenoid 23 and release the door lock and also supply current to the signal lamp 117, indicating to the operator that the cooling effect has been completed and that the door now may be safely opened and the machine unloaded. This he promptly accomplishes by unlocking the door, thereby opening switch 20 and deenergizing motors 32 and 35. Any delay by the operator in so doing is immaterial and without harmful effect.

I have referred to the apparatus of this invention as designed for a normal or standard load of work which, for example, may be not more than about twenty pounds of extracted garments containing the usual quantity of residual inflammable volatile detergent. It should be realized, of course, that the quantity of work con-

stituting a normal or standard load, in practice, is susceptible of relatively wide variation. For example, in the design of the particular machine shown in the drawings and hereinbefore described, practical and economical operation dictated the flow of from thirty to forty cubic feet of air per minute for each pound of goods in the load, and the machine was so designed. That is true notwithstanding the fact that experience shows that even as low as six to eight cubic feet of air per minute for each pound of goods will not produce a concentration of volatile detergent sufficient to propagate the flame. So that the machine has actually been designed with the factor of safety of the order of five and a contemplated load of twenty pounds of garments could be increased even to as much as one hundred pounds without involving reasonable probability of the production of an unsafe concentration in which flame might be produced or propagated. Therefore, references in the description or claims to a standard or normal quantity of work, or a quantity not exceeding a predetermined maximum, must be understood to contemplate rather wide limits of variation.

Further advantages of the invention will be apparent to those skilled in the art.

What I claim is:

1. The method of drying dry cleaned work containing residual volatile inflammable detergent, consisting in placing the work in the chamber of a container, agitating the work therein, heating air to a temperature materially above the flash point of the particular volatile detergent employed, and promptly, before material reduction in the quantity of residual detergent in the work, passing a stream of the so heated air through said chamber and over the work therein in quantity and at a rate sufficiently high to produce and insure such dilution of the vaporized residual detergent with air as to prevent any possibility of combustion of the mixture, and promptly at any time, upon reduction in the rate of flow and quantity of air passing through said chamber below a predetermined safe minimum, passing a stream of cool air through said chamber, thereby to prevent combustion if the air vapor mixture assumes combustion proportions.

2. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for producing flow of a stream of air through said heater to the container inlet and thence through the container to its outlet, said flow producing means and the air passages to and from the same being constructed with such capacity that during normal operation of said flow producing means the air stream is in quantity and flows at a rate sufficient to insure such dilution of the vaporized residual detergent with air as to prevent any possibility of combustion of the mixture, and means operated by the air in said stream when the rate and hence the quantity of air flow is reduced below a safe minimum value for cutting off the flow of hot air from said heater to the container inlet.

3. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above

the flash point of the detergent, means for producing flow of a stream of air through said heater to the container inlet and thence through the container to its outlet, said flow producing means and the air passages to and from the same being constructed with such capacity that during normal operation of said flow producing means the air stream is in quantity and flows at a rate sufficient to insure such dilution of the vaporized residual detergent with air as to prevent any possibility of combustion of the mixture, and means operated by the air in said stream when the rate and hence the quantity of air flow is reduced below a safe minimum value for cutting off the flow of hot air from said heater to the container inlet and for also establishing communication to the air inlet from atmosphere.

4. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for producing flow of a stream of air through said heater to the container inlet and thence through the container to its outlet, said flow producing means and the air passages to and from the same being constructed with such capacity that during normal operation of said flow producing means the air stream is in quantity and flows at a rate sufficient to insure such dilution of the vaporized residual detergent with air as to prevent any possibility of combustion of the mixture, and means operated by the air in said stream when the rate and hence the quantity of air flow is reduced below a safe minimum value for rendering the heater ineffective.

5. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for producing flow of a stream of air through said heater to the container inlet and thence through the container to its outlet, said flow producing means and the air passages to and from the same being constructed with such capacity that during normal operation of said flow producing means the air stream is in quantity and flows at a rate sufficient to insure such dilution of the vaporized residual detergent with air as to prevent any possibility of combustion of the mixture, and means operated by the air in said stream when the rate and hence the quantity of air flow is reduced below a safe minimum value for rendering the heater ineffective and for also establishing communication to the air inlet from atmosphere.

6. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for producing flow of a stream of air through said heater to the container inlet and thence through the container to its outlet, said flow producing means and the air passages to and from the same

being constructed with such capacity that during normal operation of said flow producing means the air stream is in quantity sufficient to insure such dilution of the vaporized residual detergent with air as to prevent any possibility of combustion of the mixture, and means operated by the air in said stream when the rate and hence the quantity of flow is reduced below a safe minimum value for flooding the container chamber with cooling air.

7. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for passing a stream of air from the inlet to the outlet through said container and over the work therein, means providing communication to said inlet from atmosphere either directly or by way of said heater, damper means for alternatively selecting such communication and thereby having hot air and cold air positions and being normally biased toward cold air position, operating means for said damper means, and means controlled by and dependent upon the rate of flow of the air stream for holding the damper means in hot air position.

8. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for passing a stream of air from the inlet to the outlet through said container and over the work therein, means providing communication to said inlet from atmosphere either directly or by way of said heater, damper means for alternatively selecting such communication and thereby having hot air and cold air positions and being normally biased toward cold air position, operating means for said damper means, and means controlled by and dependent upon the rate of flow of the air stream and also controlled by said damper operating means for holding the damper means in hot air position.

9. Apparatus for drying dry cleaned work containing residual volatile inflammable detergent of known flash point, comprising a work container having an inlet and an outlet, means for agitating the work therein, a heater arranged to heat air to a temperature materially above the flash point of the detergent, means for passing a stream of air from the inlet to the outlet through said container and over the work therein, means providing communication to said inlet from atmosphere either directly or by way of said heater, damper means for alternatively selecting such communication and thereby having hot air and cold air positions and being normally biased toward cold air position, operating means for said damper means, means controlled by the air stream for holding the damper means in hot air position, and time controlled means unaffected by the air stream for rendering said holding means ineffective to thereby release said damper means for movement to cold air position.