This invention relates to a method and apparatus for recovering and purifying solvents of the cleaning type, and it more particularly relates to such a method and apparatus which are conveniently associated with cleaning apparatus.

Certain dry cleaning solvents such as fluorinated hydrocarbons have quite advantageous cleaning properties, but they are relatively expensive. This makes it uneconomical to tolerate the normal losses occurring in dry cleaning from various losses and solvent contamination. Such fluorinated hydrocarbon solvents are trichloromonofluoromethane, trichlorotrifluoroethane and tetrachlorodifluoromethane.

An object of this invention is to provide a means for minimizing solvent losses in a dry cleaning machine.

Another object is to provide a simple and economical means for recovering cleaning solvent from the vapor space of a dry cleaning machine.

Still another object is to provide a simple and economical method of purifying contaminated solvents; and

A further object is to provide a simple and economical means of simultaneously recovering and purifying solvent in a dry cleaning machine.

In accordance with this invention, solvent is recovered from the vapor space of a dry cleaning machine by abstracting and cooling the machine's air and vapor mixture to condense part of its solvent content and collect and reuse accordingly distilled solvent. The condensed air and vapor is then heated to regenerate its solvent absorbing ability and conserved by returning it to the drying chamber of the cleaning machine where it is used to facilitate drying. The aforementioned vapor absorbing and cooling operations also minimize pressure build-up within the vapor space of the machine.

These vapor condensing and heating steps can be remarkably economically performed by the heat absorbing and emitting sections of a heat pump. Solvent condensing and evaporating chambers enclose these sections and are connected in a closed circuit in series with each other and with the vapor space of the dry cleaning machine. This permits an air and vapor mixture to be continuously withdrawn and part of the vapor condensed from the mixture. The uncondensed mixture is heated and returned to the vapor space to restore its solvent absorbing ability which permits it to help dry clean items. The condensate may be used to replenish a clean rinse solvent storage tank; and, therefore, simultaneously purify the solvent as it is being recovered.

In a continuously operating machine where cleaned items are continuously discharged through an exit from the vapor space, the heated air and vapor mixture may be directed into the exit in counter-current flow to the exiting items to minimize the amount of vapor flowing out of the exit with them as the vapor is reintroduced into the system. In a machine of intermittent type of operation, a part of the solvent used for washing can be sprayed into the solvent heating or evaporating chamber and then condensed to purify enough clean solvent to make up what is used during each cycle of operation. Both ends of a heat pump cycle can also be remarkably effectively and economically employed in such a system as well as in an independent solvent purifying system.

Novel features and advantages of the present invention will become apparent to one skilled in the art from a reading of the following description in conjunction with the accompanying drawings wherein similar reference characters refer to similar parts and in which:

FIG. 1 is a schematic diagram of a solvent purifying embodiment of this invention;

FIG. 2 is a schematic diagram of a continuously operating dry cleaning machine which incorporates aspects of this invention;

FIG. 3 is a schematic diagram of another type of continuously operating machine utilizing additional aspects of this invention; and

FIG. 4 is a schematic diagram of an intermittently operating closed type of dry cleaning machine utilizing still another aspect of this invention.

In FIG. 1 is shown a system 10 for purifying dirty solvent contained in a tank 12 and accumulating it in a clean solvent tank 14. The solvent being purified may be of any type used in dry cleaning; and, for example, may be one of the more expensive solvents such as trichlorotrifluoromethane.

As shown in FIG. 1, a pump 16 draws dirty solvent from tank 12 through filter 18 and discharges it into solvent heating and evaporating chamber 20 by spraying it through perforated pipe 22. Solvent evaporating chamber 20 contains the heat emitting element 24 of a heat pump system 26 which includes a refrigerant compressor 28 and a heat absorbing element 30. These elements together with an expansion valve 32 and a filter 34 are connected in a closed heat pumping system by a piping 36. Heat emitting section 24 is, for example, the refrigerant condensing coil of heat pumping system 26; and heat emitting section 30 is, for example, the refrigerant evaporating coil.

Heat absorbing element 30 is enclosed within a solvent condensing chamber 38, and a vapor conduit 40 connects solvent condensing chamber 38 with solvent evaporating chamber 20 to permit the vapor in solvent evaporating chamber 20 to be conducted to solvent condensing chamber 38.

A lower point of solvent evaporating chamber 20 is connected to a contaminated solvent tank 12 by a drain line 42; and, a lower point of solvent condensing chamber 38 is connected to clean solvent storage tank 14 by drain line 44.

Apparatus 10 shown in FIG. 1 operates in a remarkably efficient and economical manner by virtue of its use of both ends of heat pumping system 26. Pump 16 discharges dirty solvent through spray line 22, which may include a set of nozzles (not shown), over heat emitting coils 24 of heat pumping system 26. The heat in coils 24 evaporates a considerable amount of the solvent from which an appreciable amount of foreign matter has already been removed by filter 18. The unevaporated solvent returns to tank 12 through drain line 42, which also returns dissolved liquids, such as oil and other relatively nonvolatile liquids, which do not evaporate in the solvent evaporator, to the contaminated solvent tank for removal by other methods. The evaporated solvent is directed through conduit 40 into solvent condensing chamber 38 where it is cooled and condensed by heat absorbing coils 30. The condensed clean solvent is then directed into clean solvent storage tank 14 through drain line 44.

This system is remarkably efficient because all of the energy made available by heat pumping system 26 is utilized; and the evaporation process occurs at a relatively lower temperature than the normal boiling point of the solution at atmospheric pressure. This minimizes the carry over of droplets of foreign matter in the vapor into the solvent condensate in comparison to evaporation conducted at higher temperatures and higher kinetic energy levels. In addition, system 10 shown in FIG. 1 is remarkably compact and trouble free in operation.

In FIG. 2 is shown a continuously-operating dry clean-
ing system or apparatus 50 including a casing 52 having an entrance tube 54 and an exit tube 56. Dirty items such as a strip of photographic film 58 are introduced into casing 52 through entrance 54 and discharged through exit 56 after being dried cleaned within casing 52. Film 58 is, for example, automatically drawn through casing 52 by a winding roller (not shown) and directed over a series of guide rollers 60 in its passage through casing 52.

Casing 52 is divided by a bulkhead 62 into a washing chamber 64 and a drying chamber 66. The bottom 68 of casing 52 forms a tank for storing a supply of washing solvent 70, which is of a relatively contaminated nature because dirty film 58 is first passed through washing solvent 70 and thereby relieved of most of its foreign matter. A rinse tank 72 is also mounted with the casing 52 with its top disposed above the level of washing solvent 70. Tank 72, therefore, can overflow through upper drain pipe 74 into washing solvent 70 and actually does so in a manner later described in detail.

After film 58 passes through washing solvent 70 and relatively cleaner rinse solvent 76 in tank 72 it passes through connecting tube 78 into drying chamber 66 where practically all of the solvent is evaporated from it to permit clean film 58 to pass out of casing 52 through exit 56. The solvent recovering and purifying portions of apparatus 50 are now described.

The cleaning solvent utilized in this machine may be relatively expensive, and it is therefore desirable to provide simple and economical means of recovering and purifying solvent within casing 52 and preventing it from passing out into the surrounding atmosphere with the cleaned items. To accomplish this, part of the air and solvent vapor mixture within the vapor spaces of casing 52 are abstracted through conduit 80 and circulated through a vapor condensing chamber 82 which includes a heat absorbing element 84 of a heat pumping system 86. A series of baffles 88 lengthen the path of contact of the vapor over heat absorbing coils 84.

Heat pumping system 86 includes a refrigerant compressor 90, a refrigerant heat rejecting section or refrigerant condenser 92 cooled by fan 94. An expansion valve 96 controls the evaporation of refrigerant within the heat absorbing coil 84, and the parts of heat pumping system 86 are connected by piping 98.

A vapor conduit 100 connects refrigerant evaporating chamber 82 with casing exit 56, and blower 102 propels vapor from chamber 82 into exit 56. At the same time the solvent condensate at the bottom of chamber 82 is directed into rinse tank 72 through drain line 104 which provides a remarkably convenient manner of continuously purifying the solvent in the system as it is being recovered. The greater surface area of washing solvent 70 in casing 52 provides the primary source of solvent vapor in the vapor spaces of casing 52, which provides a remarkably convenient means of continuously purifying the relatively dirty washing solvent. At the same time a supply of relatively clean rinse solvent 76 is replenished in rinse tank 72.

Before the vapor in conduit 100 is discharged into casing 52, it is raised in temperature by heater 106, which is an electric heater to restore its solvent vapor-absorbing ability. Furthermore, heated vapor is discharged in counter current relationship to the path of cleaned film 58 through exit 56 by directing its flow inwardly through inwardly directed passageway 108 at the bottom of exit tube 56. This heated vapor is capable of absorbing solvent drying from cleaned film 58 through drying chamber 66 and through baffle 110 to pass through drying chamber 66 substantially in the direction of arrows 112. From drying chamber 66 arrows 112 indicate the passage of heated solvent vapor through connecting conduit 78 into washing chamber 64 through which baffle 114 directs it first down and then allows it to pass upwardly through vapor extracting tube 80 into vapor condensing chamber 82. The continuous abstraction of vapor from vapor spaces 64 and 66 into condensing chamber 82 minimizes the vapor pressure in the machine and automatically cleans and recovers solvent vapor in the machine atmosphere. Operation of the heat pump system 86 during shut down periods also insures that the vapor pressure within the machine is therein minimized, which also accordingly minimizes solvent losses.

In FIG. 3 is shown a system 120 which is a modification of system 50 shown in FIG. 2, which also utilizes a heat pumping system 26A similar to that shown in FIG. 1 for evaporating and condensing solvent vapor. Parts shown in FIG. 3 identical or highly similar to those in FIGS. 1 and 2, are designated by similar reference characters and are not herein again described. In this connection the path of items being cleaned are merely indicated by arrows 58A.

However, a pump 122 is utilized for pumping solvent condensed from lower refrigerant condensing chamber 52A into rinse tank 72A, and both heat emitting coils 24A and an electric heater 106A are provided for heating the solvent vapor to be returned through exit 56A into casing 52A. In most instances only the heat emitting element 24A is sufficient to maintain vapor temperatures. However, should additional heat be needed it can be added by electric heater 106A. System 120 in FIG. 3 therefore provides a remarkably compact and efficient manner for utilizing a simple heat pumping system 26A for both recovering and purifying solvent vapor within a dry cleaning machine.

In FIG. 4 is shown a closed intermittently operating dry cleaning machine or system 130, which utilizes many of the aforementioned features and where such features are similar to those previously discussed they are designated by similar numbers followed by the letter "B" and largely not redescribed. In this connection system 130 includes a heat pumping system 26B with inter-connected solvent condensing and solvent evaporating and heating chambers 38B and 203B. In this closed intermittently operated machine, items to be cleaned such as clothing are introduced into casing 52B through an inlet door 132. Wash solvent is stored in a contained solvent container 126B, and relatively cleaner rinse solvent is stored in clean solvent tank 148B. A description of the cycle of operation of apparatus 130 facilitates an understanding of the various parts that it incorporates.

Contaminated solvent is withdrawn from wash tank 126B through filter 118B, valve 134 and pump 136B and discharged into casing 52B for performing the washing portion of the cycle. This contaminated washing solvent is later withdrawn from casing 52B through drain line 136B, detergent decanter 138B and valve 140B back into wash solvent container 126B.

During the wash and rinse cycles, part of the contaminated solvent in tank 126B is purified by pumping it by pump 168B through valve 140B and spray line 228B over heat emitting coils 24B in solvent evaporating chamber 203B. The unevaporated solvent in chamber 203B is returned to wash solvent container 126B through drain line 242B and valve 142B. The solvent remaining in chamber 203B is conducted through conduit 40B into solvent condensing chamber 38B, in which part of it is cooled by heat absorbing coils 30B and directed through drain line 44B into clean rinse tank 148B. Sufficient solvent is purified during the wash and rinse cycles to make up a quantity of solvent sufficient for rinse purposes.

Purification of part of the solvent vapor in casing 52B is accomplished during an additional heat being drawn off through orifice or inlet tube 148B at the top of inverted U-shaped tube 144B into chamber 38B when its lower end 146B is immersed in solvent within casing 52B. Part of the solvent is therein condensed, and this purified condensate is returned to rinse the tank 148B. This constitutes a relatively small quantity of purified liquid, and
its condensation serves primarily to avoid pressure build up in enclosure 52B. During the drying portion of the cycle, the uncondensed vapor and air mixture is conducted into solvent evaporating and heating chamber 20B by blowers 102B through vapor conduit 40B, where it is heated and returned through vapor conduit 100B into emptying 52B. The complete cycle of operation of intermittently operated closed machine is now described in detail.

Operation of FIG. 4

Apparatus 130 shown in FIG. 4 operates in accordance with the following cycle which is coordinatized by a motor-operated timer of the type which is for example used for controlling the cycle of an automatic clothes washing machine. Apparatus 130 also, for example, incorporates other unillustrated parts of a conventional dry cleaning machine, such as a tumbling drum. The first timed operation is that of main pump 135 which fills machine emptying 52B if vapor-tight inlet door 132 is closed. Pump 135 draws its supply from tank 12B through filter 18B and automatic valve 134 which in addition to the other automatic valves in this apparatus is, for example, solenoid-operated. At the same time a predetermined quantity of detergent solution is admitted to cleaning machine chamber 52B from detergent container 150 through detergent metering valve 152. Pump 16B starts approximately at the same time as main pump 135 and begins circulating cleaning fluid solvent through valve 140 and pipe 154 into solvent evaporating chamber 20B. At the same time drain valve 142 from chamber 20B opens to return unwetted dirty solvent to tank 12B through drain pipe 42B. Before heating element 24B comes up to operating temperature, practically all of the solvent circulated by purifying pump 16B is accordingly returned to washing solvent container 12B. Heat pumping system 26B then starts to operate after a short delay to bring heat emitting coils 24B up to operating temperature which then start to evaporate a fraction of the solvent liquid sprayed over them through pipe 22B. The evolved vapor passes through conduit 40B over heat absorbing coils 30B which extract the latent heat of condensation causing the vapor to condense or liquify. Orifice tube 146 at the top of inverted U-shaped tube 144 relieves pressure from chamber 30B into machine chamber 52B to prevent pressure build-up within chambers 20B and 30B. The purified solvent is directed to and stored in rinse tank 14B through vapor condensing chamber drain pipe 44B and pure solvent return valve 156 which is maintained open as long as purifying pump 16B is at rated speed.

As the level of solvent washing liquid rises in machine chamber 52B the entrance to the lower leg 146 of inverted U-shaped tube 144 is blocked which causes vapor within chamber 52B to be conducted through inlet tube 14B in the top of U-shaped tube 144 down into solvent condensing chamber 30B where it is condensed to liquid in a similar manner to that previously described. When the solvent level in chamber 52B rises to the washing level, main pump 135 stops and its suction valve 134 closes. However, purifying pump 16B may run for example during the entire wash, extraction rinse and subsequent extraction processes to permit enough solvent to be purified to replenish the amount of rinse solvent abstracted from rinse tank 14B during a cycle of operation. At the end of the washing cycle drain valve 140B opens to return used solvent to tank 12B while detergent is drawn off by detergent operator 138. Drain valve 140 remains open during the extraction and spin dry cycles following the wash cycle.

However, drain valve 140B closes after the first extraction cycle, and rinse tank valve 158 then opens to admit cleaning solvent to main pump 135, which is then started and run until in chamber 52B is at operating level with clean rinse solvent after which main pump 135 is again stopped.
of air and vapor circulated may also be adjusted to provide optimum operating conditions. When for example heat absorbing chamber 38B is operated with the surface of heat absorbing element 30B at 35° F, the mixture of air and vapor traversing chamber 38B is reduced to approximately 60° F, and heat chamber 20B may correspondingly be operated at 110° F to warm the air and vapor going through it to 80° F. During the drying cycle, the air and vapor mixture in chamber 52B may begin at a wet bulb temperature which remains substantially constant at 23° F, which is governed by the conditions in chambers 20B and 30B. However, the wet bulb temperature decreases during the drying cycle while the relative and absolute humidity increase, which is caused by the evaporation of solvent from the clothing. The relative humidity of the air passing through the machine accordingly increases in a range of 100% to 50% and perhaps lower. Actually the relative humidity of the atmosphere within chamber 52B approaches 100% at the start of the drying cycle and gradually decreases to approximately 50%. Even so, rapid drying will be accomplished with air leaving chamber 52B at approximately 50% relative humidity.

The apparatus and method of the invention therefore provide the following advantages. The solvent is substantially fully recovered as well as purified, and any pressure build-up in the machine is prevented. The purification can be accomplished either directly from condensation of vapor in the space or by auxiliary evaporation and condensation by contact with heat emitting and absorbing sections of a heat pump. During the drying cycle, solvent may be condensed from the air and vapor mixture at a temperature of approximately 60° F at a relative humidity of 100%. By contact with the heat emitting element of the heat pump the mixture is raised to a temperature of 60° F at 25% relative humidity which permits it once more to absorb solvent from clothing being dried. Operation under these conditions permits an eight pound load of clothing to be dried in approximately three minutes with the recovery of approximately five pounds of clean solvent. The abstracting and condensation of solvent from the vapor space of the machine also prevents any pressure buildup within the entire cleaning cycle. An auxiliary purification cycle may evolve and condense vapor at approximately five and one-half pounds per minute which is sufficient to replenish the solvent supply necessary for rinsing.

In a continuous flow type of cleaning machine, such as is described in FIGS. 2 and 3, and plastic parts conducted through the machine by a conveyor of any type or photographic film or magnetic tape reeled through it, the solvent purification is performed concurrently with washing and rinsing, which makes it unnecessary to resort to any auxiliary solvent purifying processes. Furthermore, as described in FIGS. 2 and 3, the counter current reinstitution of heated solvent vapor into the vapor space prevents any appreciable amount of solvent vapor from flowing out of the machine with the cleaned items. In addition, since the evaporation of solvent occurs at temperatures well below the maxima at boiling point at atmospheric pressures, the formation and transfer of any minute contaminated liquid droplets is minimized to the point of almost absolute prevention. Operation of the vapor abstracting and condensing cycle during shut down can also prevent build-up of vapor pressure and leakage during that period. The utilization of both ends of the heat pumping cycle makes optimum use of all available energy which minimizes the power consumption and size and space requirements for the apparatus. This system is also uniquely well adapted for automatic control because of its inherent balance of heat absorbed and discarded.

What is claimed is:

1. A method of removing foreign matter from a solvent fluid which comprises the steps of directing said fluid in heat exchange relationship with the heat emitting section of a heat pumping system to evaporate a portion of said fluid, collecting the unevaporated portion of said fluid, directing said evaporated portion of said fluid in heat exchange relationship with the heat absorbing section of said heat pumping system for condensing it, and collecting the condensate which constitutes purified solvent.

2. A method as set forth in claim 1 wherein collected unevaporated fluid solvent is returned to supply of fluid solvent to be purified.

3. A method for recovering fluid solvent vapor from the air and vapor mixture in the vapor space of a dry cleaning machine which comprises the steps of abstracting a portion of said mixture, cooling said abstracted portion by directing it in heat exchange relationship with the heat absorbing section of a heat pumping system to condense part of the fluid solvent vapor in said mixture, collecting said condensed fluid solvent, heating the uncondensed portion of said mixture to restore its solvent absorbing ability, reintroducing said heated mixture back into said vapor space of said dry cleaning machine, and the material being treated in said dry cleaning machine being fed into an entrance and substantially continuously out of an exit from said vapor space, and said heated solvent mixture being directed into said exit in a countercurrent relationship to said material coming out of its to prevent the flow of solvent vapor out of said exit.

4. A method for recovering fluid solvent vapor from the air and vapor mixture in the vapor space of a dry cleaning machine which comprises the steps of abstracting a portion of said mixture, cooling said abstracted portion to condense part of the fluid solvent vapor in said mixture, collecting said condensed fluid solvent, heating the uncondensed portion of said mixture to restore its solvent absorbing ability, reintroducing said heated mixture back into said vapor space of said dry cleaning machine, the material being treated in said dry cleaning machine being fed into an entrance and substantially continuously out of an exit from said vapor space, and said heated solvent mixture being directed into said exit in a countercurrent relationship to said material coming out of its to prevent the flow of solvent vapor out of said exit.

5. A method for recovering fluid solvent vapor from the air and vapor mixture in the vapor space of a dry cleaning machine which comprises the steps of abstracting a portion of said mixture, cooling said abstracted portion to condense part of the fluid solvent vapor in said mixture, collecting said condensed fluid solvent, heating the uncondensed portion of said mixture to restore its solvent absorbing ability, reintroducing said heated mixture back into said vapor space of said dry cleaning machine, said dry cleaning machine including a rinse tank holding clean solvent and a wash tank holding relatively dirty solvent, the condensed fluid being returned to said rinse tank to replenish the supply of clean solvent in it, and said rinse tank overflowing into said wash tank to purify the solvent in it.

6. A method as set forth in claim wherein said dry cleaning machine is of the substantially continuously operating type, and said rinse tank overflowing into said wash tank to provide a means for continuously purifying the solvent in said machine.

7. A method as set forth in claim wherein said dry cleaning machine is intermittently operated, a heat pump including heat absorbing and heat emitting sections being associated with said dry cleaning machine, said heat absorbing section being used for cooling said mixture, dirty solvent being sprayed over the heat emitting section of said heat pump, and the heat emitting section also being condensed by said heat absorbing section for supplementing the replenishment of the supply of clean solvent for said machine.

8. A method as set forth in claim wherein said dirty solvent is evaporated by said heat emitting section during any part of the drying process except the drying process.

9. An apparatus for purifying dirty solvent fluid comprising a heat pumping system including heat emitting
and heat absorbing elements, heat emitting and heat absorbing chambers respectively enclosing said elements, a pumping system connected for spraying dirty solvent into said heat emitting chamber in heat exchange relationship with said heat emitting element whereby a portion of said solvent is evaporated, a dirty solvent drain from said heat emitting chamber for removing the unevaporated solvent, a vapor conduit connecting said chambers for conducting vapor into said heat absorbing chamber into heat exchange relationship with said heat absorbing element for condensing said solvent vapor, and a clean solvent drain from said heat absorbing chamber for removing said purified solvent from it.

10. An apparatus as set forth in claim 9 wherein said dirty solvent drain from said heat emitting chamber is connected to the dirty solvent storage tank from which said pumping system draws its supply.

11. An apparatus as set forth in claim 9 wherein said clean solvent drain pipe from said heat absorbing chamber is connected to a clean solvent storage tank.

12. An apparatus for recovering and purifying solvent being used in the operating chamber of a dry cleaning machine which encloses a vapor space containing a mixture of air and solvent vapor, said apparatus comprising a heat absorbing chamber having an entrance and an exit mounted adjacent said vapor space, an abstracting conduit connecting said vapor space with the entrance to heat absorbing chamber for conducting said mixture into said heat absorbing chamber whereby a portion of said vapor is condensed, a drain pipe from said heat absorbing chamber for removing the purified condensate formed therein, a passageway connecting said exit from said heat absorbing chamber to said vapor space, a heater in heat exchange relationship with said passageway for heating said mixture passing through it to restore its solvent absorbing ability before it is reintroduced into said vapor space, means for forcing said vapor from said vapor space through said heat absorbing chamber and said heater back into said vapor space through said passageway and said heat absorbing chamber and said heater being respectively provided by the heat absorbing and heat emitting element of a heat pumping system.

13. An apparatus as set forth in claim 12 wherein said dry cleaning machine is of the continuously operated type having an entrance and an exit through which items are introduced and removed from said operating chamber, and said passageway being directed inwardly into said exit to prevent vapor from flowing out of said vapor space with said cleaned items passing out through said exit.

14. An apparatus as set forth in claim 13 wherein a bulkhead divides said vapor space into a washing vapor space and a drying vapor space, an open solvent surface contiguous to said washing vapor space, said vapor abstracting conduit being connected to said washing vapor space, and a connecting conduit connecting said vapor spaces to each other for permitting relatively dryer vapor from said drying space to enter into said washing vapor space for replacing the vapor abstracted from it.

15. An apparatus as set forth in claim 12 wherein a rinse solvent storage tank is provided for storing purified solvent, and said drain pipe from said heat absorbing chamber discharges into said rinse tank for replenishing its supply.

16. An apparatus as set forth in claim 15 wherein said rinse tank is mounted adjacent a supply of wash solvent, and an overflow means directs clean solvent overflowing from said rinse storage tank into said wash solvent supply for replenishing it.

17. An apparatus as set forth in claim 16 wherein the contacting area between said items and said wash solvent tank is appreciably greater than the contacting area between said items and said rinse solvent tank to cause the solvent vapor evolved from said items into said vapor space to primarily come from said wash solvent tank.

18. An apparatus as set forth in claim 12 wherein said dry cleaning machine is of the intermittently operated type in which solvent is periodically pumped into and drained out of said operating chamber, relatively dirty solvent being stored in a washing solvent tank and pure solvent being stored in a rinsing solvent tank, a pumping system connected said washing solvent tank with said casing of said machine and with said heat emitting chamber, a drain line from said heat emitting chamber into said washing solvent tank for returning unevaporated washing solvent to said wash solvent tank, said heat emitting chamber enclosing a heating element for evaporating a portion of said washing solvent directed into it, a pure solvent drain line from said heat absorbing chamber to said rinsing solvent tank, and control means for directing washing solvent into said heat emitting chamber during phases of operation of said machine other than the drying cycle for replenishing the supply of rinsing solvent as said machine is being operated.

19. An apparatus as set forth in claim 18 wherein a conduit connects said heat absorbing chamber with the operating chamber of said machine for drawing vapor from said operating chamber into said heat absorbing chamber during the drying process for recovering solvent in the drying atmosphere and minimizing any pressure build up within said operating chamber during said drying process.

20. An apparatus as set forth in claim 19 wherein said conduit comprises an inverted U-shaped tube having an open lower end which extends below the level of washing solvent and an orifice at its upper end for allowing vapor from said space to flow into said heat absorbing chamber when its pressure exceeds that in said heat absorbing chamber during washing and rinsing processes.

21. An apparatus as set forth in claim 18 wherein the vapor evaporating and condensing capacities of said heat emitting and heat absorbing chambers is sufficient to replenish the amount of purified solvent utilized in each rinsing operation, and said operating chamber includes a drain into said washing solvent tank to allow the solvent introduced into said operating chamber in said rinsing operation to replenish the amount of washing solvent drawn from said washing solvent tank.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,070,463

December 25, 1962

Donald J. Bardy

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 25, for "machine" read -- machine --;
line 34, for "contact" read -- content --;
column 5, line 73, for "52b" read -- 52B --;
column 6, line 51, after "loss"
insert -- of --;
column 7, line 43, for "buildup" read
-- build-up --;
column 8, line 38, for "its" read -- it --.

Signed and sealed this 18th day of June 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents