Oct. 5, 1971 P. CARPIGIANI 3,610,002

WEARING APPARELS DRY CLEANING MACHINE

Filed Feb. 11, 1970 2 Sheets-Sheet 1

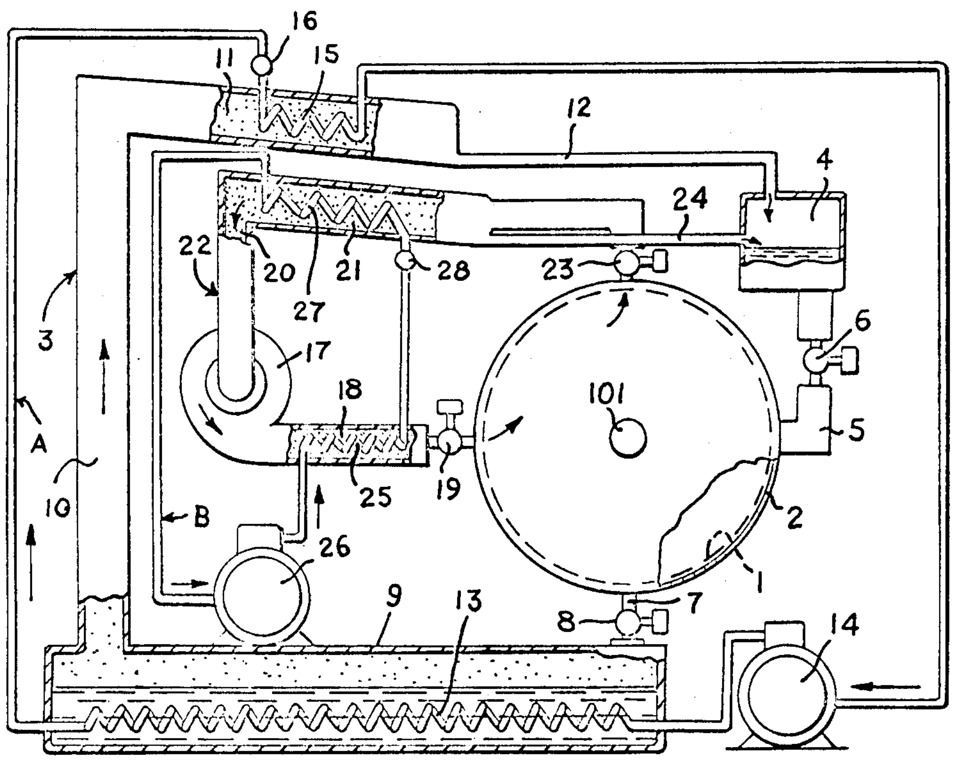

Fig. 1

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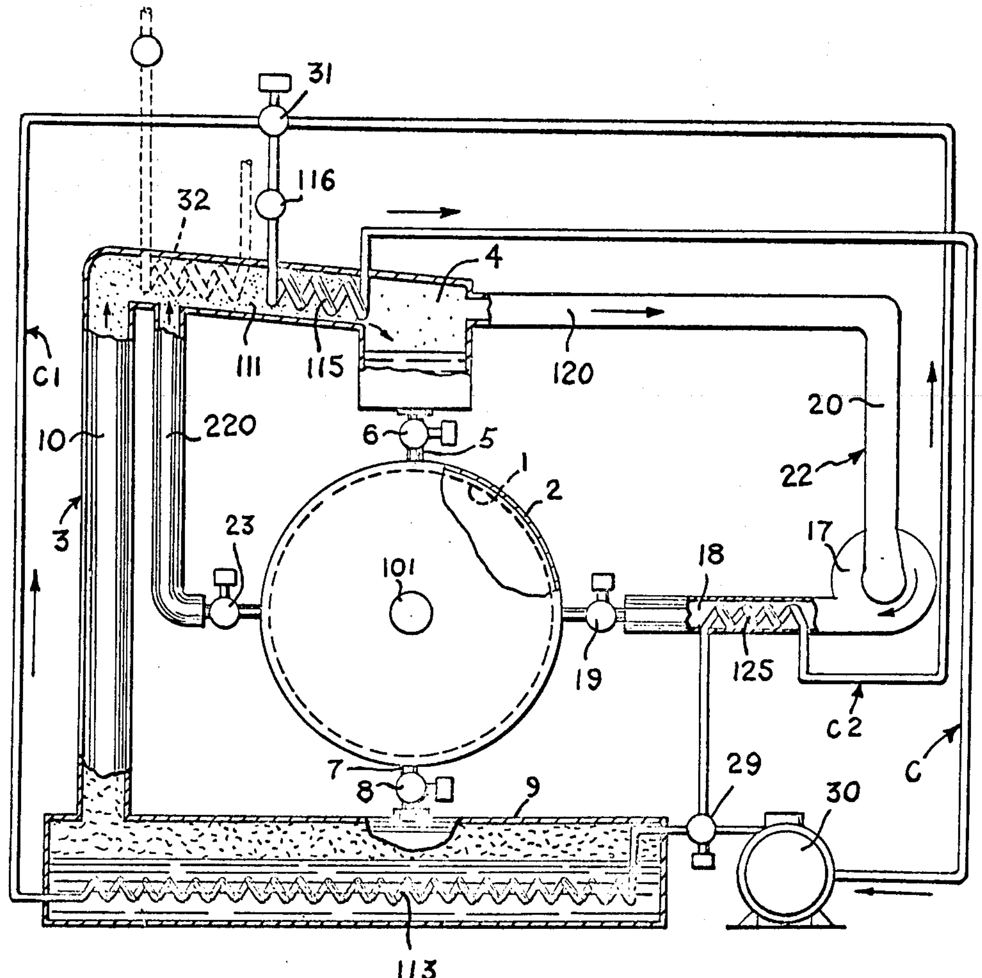
31
116
32
4
111
115
120
C1
10
220
6
5
1
2
20
22
3
23
101
17
18
19
125
C2
C
7
8
9
29
30
113

Fig-2

United States Patent Office 3,610,002
Patented Oct. 5, 1971

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3,610,002
WEARING APPARELS DRY CLEANING MACHINE

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Filed Feb. 11, 1970, Ser. No. 10,453
Claims priority, application Italy, Feb. 13, 1969, 6,805/69
Int. Cl. D06f 43/08; B01d 5/00
U.S. Cl. 68—18 C 5 Claims

ABSTRACT OF THE DISCLOSURE

A dry cleaning machine employing low boiling point solvents comprises a cleaning chamber containing a revolving drum connected through a pair of valved ducts to a clean solvent tank and to a soiled solvent receiver and still; said soiled solvent still being connected with said clean solvent tank by means of ducts; said cleaning chamber being further connected to a valved drying air circuit including an air-inlet duct and an air outlet duct and an a pair of heat pumps, based on the vapor compression refrigerating cycle and each comprising a heat-evolving condenser and a heat-absorbing evaporator; the condenser of one of said heat jumps being fitted in the soiled solvent still while the corresponding evaporator is inserted in the distillation duct leading to the clean solvent tank; while the condenser of the other of said heat pumps is inserted on the delivery duct of a blower blowing air into the cleaning chamber, the corresponding evaporator being inserted in the air outlet duct of said chamber said air outlet duct being connected to a liquid solvent return duct opening in said clean solvent tank.

This invention relates to a machine for the dry cleaning of articles of clothing or wearing apparel by employing solvents having a very low boiling point, such as the class of the chloro-fluorinated hydrocarbons.

More particularly, the invention relates to a dry cleaning machine of the kind comprising a dry cleaning chamber housing a rotatable perforated drum, and a very low-boiling point dry cleaning solvent-feeding and recovering circuit comprising: a feed tank for the clean solvent, communicating with the top of the dry cleaning chamber, a soiled-solvent receiver communicating with the bottom of the dry cleaning chamber and functioning also as a solvent still; a distillation duct leading from said still to said feed tank, heating means in heat-exchange relation with the soiled solvent in said still furnishing the heat for the distillation of the said solvent and cooling means at the head end of the said distillation duct for condensing the distilled solvent vapors evolved from the soiled solvent in said still.

According to prior practice, the cooling means were constituted by the evaporator of a refrigerating machine, while the heating means were constituted by electric heating elements.

By the known machines of this kind the problem arises of the dissipation of a great amount of heat evolved by the heating elements these being additional generated in the condenser in the vapor-compression refrigeration cycle.

Accordingly in the present invention, the problem is solved in a simple and economical manner by using the condenser of a vapor-compression refrigeration cycle as a source of heat for the distillation of the solvent in the soiled solvent receiver and still.

It is therefore the main object of the present invention to provide, in combination with a machine of the kind above-referred to, which employs a vapor-compression refrigeration cycle that functions as a heat pump and comprises a condenser in heat-exchange relation with the soiled solvent collected in a receiver functioning as a still, said still being provided with a distillation duct, while the evaporator of the same cycle is in heat-exchange relation with the vapors at the head end of the solvent distillation duct from which the solvent vapors, condensed by being cooled by the cold generated in said evaporator, are liquefied in a position from which the condensed liquid solvent may flow into the clean solvent tank. Thus a heat pump is employed that is based on a vapor-compression refrigerating cycle, which operates with great efficiency due to the very efficient heat absorption from its condenser.

Due to the necessity of avoiding any possible loss of solvent, the machine according to the invention includes a cycle for recovering the solvent imbibing the cleaned article, said solvent-recovering cycle employing an evaporator of a like vapor-compression refrigerating system including an evaporator, generating the cold for condensing the solvent vapors entrained by the air blown through the dry cleaned articles and a condenser for heating the air to be blown through said articles.

According to one advantageous embodiment of the invention, a single motor-compressor of a vapor-compression refrigerating machine may be used for alternately operating the aforementioned refrigerating cycles. In said cycles, further, a common evaporator may be employed for refrigerating and condensing in liquid form both the solvent vapors distilled from the soiled solvent, as well as those entrained by the warm air blown through the cleaned articles, while each refrigerating cycle has a separate condenser, one in heat-exchange relation with the soiled solvent in the receiver, functioning also as still, and the other in heat-exchange relation with the air in a duct on the pressure side of the blower, valve means being provided for switching off and on either of said vapor-compression refrigerating cycles, by connecting same alternately to the single motor compressor.

Further objects and advantages of the invention will be apparent from the following specification, reference being made to the accompanying drawings, wherein:

FIG. 1 is a flow-sheet diagram of a dry cleaning machine including two independent solvent-recovery circuits, each consisting of a vapor-compression refrigerating cycle provided with its own independent motor-compressor, and

FIG. 2 is a variation of the dry cleaning machine shown in FIG. 1, employing a single motor-compressor acting alternately for operating each of the vapor-compression refrigerating circuits.

The dry cleaning machines according to the invention, as shown in FIGS. 1 and 2 are designed for employing very efficient but expensive solvents having a very low boiling point, such as the chloro-fluorinated hydrocarbons of the kind of those known under the registered trade names Freon or Frigen.

Turning now to the embodiment shown in FIG. 1, the dry cleaning machine comprises a cleaning chamber **2**, which is tightly closed by a door (not shown). In chamber **2** there is provided a perforated drum **1**, designed for containing the articles to be dry cleaned, this being rotatably mounted on shaft **101** and driven by a conventional electric motor and step-down gear (not shown). The solvent is fed from a clean solvent tank **4** through an inlet duct **5** into the drum and discharged through an outlet duct **7** into a soiled-solvent receiver **9**, both ducts being controlled by conventional electromagnetic valves **6** and **8**. The solvent in the receiver **9** is purified by distillation by utilising the same receiver **9** as still and conveying the solvent vapors through duct **10** into a condensation duct or chamber **11** where the vapors are cooled as will be seen hereinafter and from where they flow back into the clean solvent tank **4**.

After the articles in drum 1 are cleaned, they must be dried and this is accomplished.

In the closed circuit 22 in which circulates the air entraining solvent vapors evaporated from the articles in drum 1, and comprising a blower 17 the output side of which is connected to a duct 18 and connected through a conventional electromagnetic-controlled valve 19 with the chamber 2. The suction side of said blower 17 is connected through upright tube 20 with a solvent vapor condensation duct or chamber 21. The liquefied solvent vapors condensed in duct 21 may flow back into the clean-solvent tank 4 through duct 24.

The air containing the solvent vapors evaporated from the articles in chamber 2 is discharged from this chamber 2 into the refrigerated condensation duct 21 through electromagnetic valve 23 positioned on top of chamber 2.

The heat required for both distilling the solvent and condensing the solvent vapors is produced by auxiliary vapor-compression refrigerating circuits which act as heat pumps.

With reference to the embodiment shown in FIG. 1, the auxiliary refrigerating circuit A for distilling the soiled solvent and recovering the same solvent by condensing the distilled solvent vapors, comprises a motor-compressor unit 14, a condenser coil 13, an expansion valve 16 and an evaporator 15. In this circuit the condenser 13 serves as a heating coil for distilling the solvent in the receiver 9, which functions as a still, while the evaporator 15 serves as a cooling means for condensing the solvent vapors flowing through the condensation duct or chamber 11 and returned in liquid form through duct 12 to the solvent tank 4.

The auxiliary refrigerating circuit B for recovering the solvent vapors entrained by the drying air passing through the dry cleaned articles, comprises a second motor-compressor unit 26 provided with a condenser coil 25 inserted in heat-exchange relation in the delivery duct 18 of the blower 17 and serves to heat the air to be blown into chamber 2, an expansion valve 28, and an evaporator 27 in heat exchange relation with the air sucked from chamber 2 by the blower 17 and containing solvent vapors which are condensed and liquefied by flowing into contact with the cold walls of the evaporator 27 and may flow back through descending pipe 24 into the clean solvent tank 4.

The operation of this dry cleaning machine is apparent:

First the clean solvent from tank 4 is caused to flow through valve 6 and duct 5 into drum 1 containing the articles to be cleaned. At the end of the dry cleaning operation, the soiled solvent from the dry cleaning chamber 2 is discharged through duct 7 and valve 8 into the soiled solvent receiver acting as a still 9. At the same time the motor-compressor unit 14 is operated so that the solvent in receiver 9 is distilled by utilizing the heat evolved from the condenser 13 and is again condensed by utilizing the cold generated by the evaporator 15 and flows back through duct 12 into the clean-solvent tank 4.

When the soiled solvent distilling cycle is completed, valves 19 and 23 are opened and at the same time the motor-compressor 14 is stopped and motor-compressor 26 and blower 17 are started. Thus hot air is blown through valve 19 into chamber 2 and solvent vapor-charged air is discharged from the same chamber through valve 23 and this air, by passing through duct 21 comes into contact with the cold evaporator 27 and thus the solvent vapors, by coming into contact with said evaporator, are condensed and flow back through descending duct 24 into tank 4, while the air deprived from solvent vapors is sucked by blower 17, again heated and circulated into and through the articles in drum 1, from which it absorbs the solvent still wetting them.

When the articles in chamber 2 are substantially dry and do not contain appreciable quantities of solvent, valves 19 and 23 are also closed and the chamber may be opened and the cleaned articles extracted from drum 1 and replaced by other articles to be cleaned.

In the second embodiment shown in FIG. 2, a single motor compressor 30 is employed for operating alternately either of said two heat pumps acting on the principle of the vapor-compression refrigeration cycles and serving for the distillation of the soiled solvent, for the condensation of the distilled solvent vapors and for the recovery by condensation of the solvent vapors entrained by the air blown through the cleaned articles for removing the solvent still wetting them.

The cleaning solvent, as in the first embodiment, is stored in tank 4 and is fed into chamber 2 and drum 1 through valve 6 and discharged through valve 8 into the soiled-solvent receiver and still 9 where it is distilled by being heated by the heat generated in condenser 113.

During this cycle, a two-way valve 29 mounted on the delivery side of the motor compressor 30 is switched so as to insert the condenser 113 and the refrigerating circuit C1 is completed by opening two-way valve 31 so that the condensed low-boiling solvent, by passing through expansion valve 116 may expand into the evaporator 115 in heat-exchange relation with the descending condensation duct 111 through which the distilled solvent vapors flow and are liquefied, so that they can flow down into tank 4.

During the subsequent cycle, in which the solvent still wetting the cleaned articles is removed by a current of warm air, the two-way valve 29 is switched so as to exclude the condenser 113 and include the condenser 125, inserted in the delivery duct connected to the pressure side of the blower 17 (which in the meantime has been started) and forming part of the heat pump circuit C2 including also two-way valve 31, expansion valve 116 and evaporator 115.

The circuit of the air, when the blower is started and the heat pump circuit C2, including condenser 125, is switched on, passes through duct 18 where the air, after the removal of the solvent vapors therefrom, is heated by condenser 125, then passes through drum 1 where it removes the solvent in vapor form from the cleaned articles and subsequently is led through valve 23, duct 220 and chamber 111 into contact with the cold evaporator 115 which promotes the condensation of the vapors which flow in liquid form back to receiver or tank 4, while the air, after removal of the solvent vapors, is sucked through ducts 120 and 20 by the blower 17 and the drying air cycle is started again, until the solvent has been substantially completely removed from the articls in drum 1.

From the foregoing it is apparent that improved very compact dry cleaning machines have been devised which avoid solvent losses, thus permitting using very efficient, even if expensive solvents boiling at very low temperatures, requiring a limited amount of heat for evaporation and a limited amount of cold for liquerfication, both heat and cold being furnished by heat pumps working on the vapor-compression refrigeration cycle. It is conceivable that these dry cleaning machines may also undergo numerous changes while remaining within the limits of the appended claims.

Thus, as shown in FIG. 2, whenever a most effiicent refrigeration of the solvent vapors is needed, a supplementary cooling coil 32 may be employed, through which cold water, when available, might be circulated.

I claim:

1. A dry cleaning machine of the kind employing very low boiling point solvents, such as the chloro-fluorinated hydrocarbons, said dry cleaning machine comprising a dry-cleaning chamber in which a perforated drum, designed for containing the articles to be dry cleaned is rotatably mounted, said dry cleaning chamber being in communication through valved ducts with a clean solvent tank, with a solid solvent receiver functioning as a still, with a hot-air duct connected to the delivery side of a blower and with an outlet duct for the air having traversed

the said dry cleaning chamber and drum, and containing solvent vapors, characterized by including therewith a vaporous compression refrigeration system including plural heat pump circuits having plural heat evolving condensers and at least one heat absorbing evaporator, wherein the first of said heat pump circuits has one of the condensers arranged in heat exchange relation with the soiled solvent still, and the evaporator therefor is arranged in heat exchange relation with the solvent vapors distilled from said still, and further wherein the second heat pump circuit has its condenser arranged in the hot air delivery duct and serves to heat said air, and the evaporator of said second circuit in the flow path of the air flowing out from the dry cleaning chamber thereby serving to condense the vapor entrained by the air discharged from said chamber.

2. A dry cleaning machine according to claim **1**, wherein the said heat pumps are independent from each other.

3. A dry cleaning machine according to claim **1**, wherein both heat pumps are driven by a single motor-compressor through a two-way switch valve.

4. A dry cleaning machine according to claim **3**, wherein a single chamber is provided for condensing the solvent vapors both coming from the soiled solvent still and from the solvent- charged air coming out of the cleaning chamber during the drying of the cleaned articles; a single evaporator mounted in said condensation chamber; valves for connecting said chamber with either of the solvent circuits nad valves for connecting the only evaporator with either of the two condensers forming part of the circuits of the said two heat pumps.

5. A dry cleaning machine employing low boiling point solvents comprising a cleaning chamber containing a revolving drum connected through a pair of valved ducts to a clean solvent tank and to a soiled solvent receiver and still; said soiled solvent still being connected with said clean solvent tank by means of ducts; said cleaning chamber being further connected to a valved drying air circuit including an air-inlet duct and an air outlet duct and a pair of heat pumps, based on the vapor compression refrigerating cycle and each comprising a heat-evolving condenser and a heat-absorbing evaporator; the condenser of one of said heat pumps being fitted in the soiled solvent still while the corresponding evaporator is inserted in the distillation duct leading to the clean solvent tank; while the condenser of the other of said heat pumps is inserted on the delivery duct of a blower blowing air into the cleaning chamber, the corresponding evaporator being inserted in the air outlet duct of said chamber said air outlet duct being connected to a liquid solvent return duct opening in said clean solvent tank.

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