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APPARATUS FOR COOLING AND CONDENSING GASES

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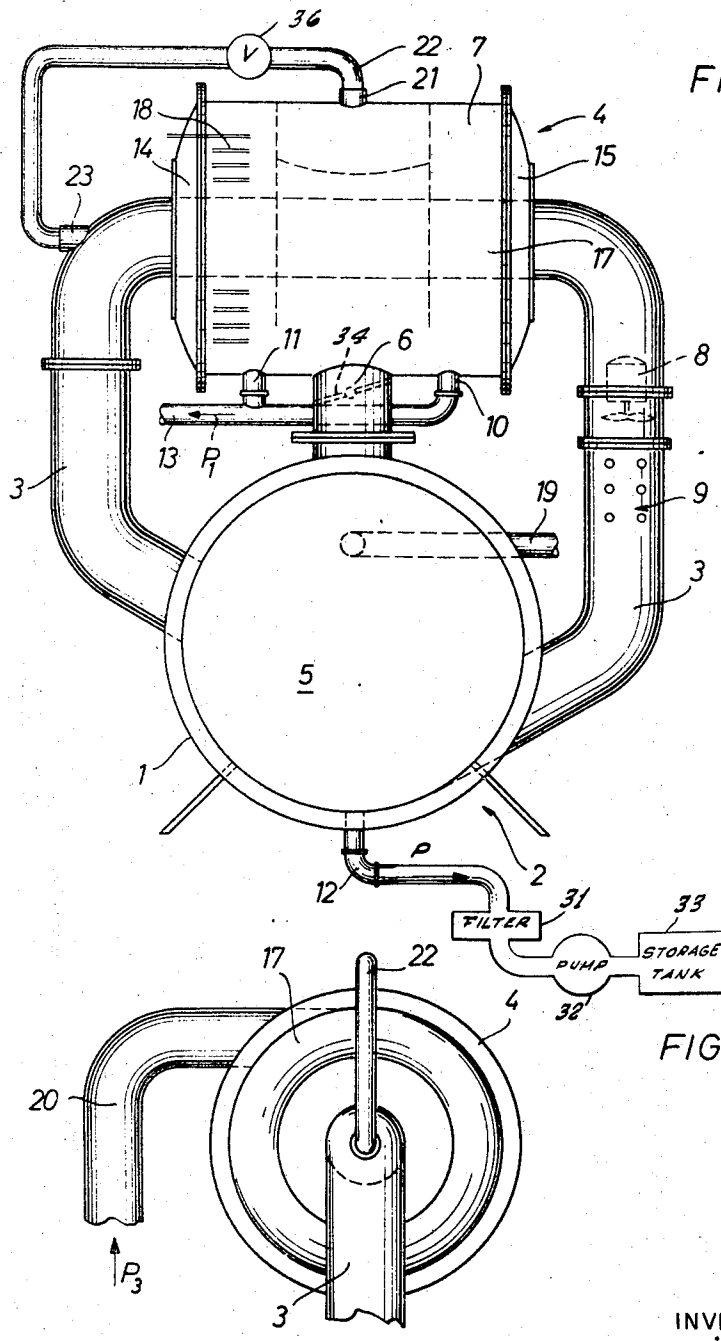

FIG. 1

FIG. 2

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APPARATUS FOR COOLING AND CONDENSING GASES

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ABSTRACT OF THE DISCLOSURE

An apparatus for condensing gases evolved in dry-cleaning or washing machines using a liquid cleaning agent comprising an air-circulating conduit extending from the working chamber of the machine through a condenser and back to the chamber in gas tight relationship, an additional conduit providing communication between the working chamber and the interior of the condenser, and a conduit for discharging the condensed liquid cleaning agent from the condenser.

This invention relates to an apparatus for condensing gases, which are evolved in dry-cleaning or washing machines, which use a liquid cleaning agent containing monofluorotrichloromethane ($CFCl_3$) and/or difluorodichloromethane (CF_2Cl_2) and/or 1,2,2-trifluorotrichloroethane ($CFCl_2$—CF_2Cl).

In known dry-cleaning machines, solvents are used which include perchloroethylene, ethylene trichloride and substances covered by the generic term naphtha. Solvents containing trifluorotrichloroethane ($CFCl_2$—CF_3Cl) have also been used. Where such solvents are employed, an off-take pipe for the fumes is required so that considerable amounts of solvent are lost. Special public regulations must be complied with when such plants are established in populated areas in order to avoid danger to the inhabitants of the area. The compliance with these public regulations adds substantially to the prime cost of the plant. The fumes which are evolved are also obnoxious and to some extent unhealthy to the operators. Many of the above-mentioned disadvantages can be eliminated when monofluorotrichloromethane is employed, particularly when this solvent is recycled.

On the other hand, monofluorotrichloromethane has a boiling point of +23.77° C. at 760 mm. mercury so that refrigerants having a much lower boiling point must be used for cooling and condensing this solvent. The solvent could also be used with water but this would greatly prolong the batch time so that the process would become uneconomical. A second closed cycle may be associated with the dry-cleaning machine and may contain difluorodichloromethane having a boiling point of −29.80° C. at 760 mm. mercury, or difluoromonochloromethane (CHF_2Cl) having a boiling point of −40.80° C., which is used as a refrigerant in such a manner that the $CFCl_3$ vapor (gas) evolved in the cleaning drum is fed to an evaporator, which is cooled with CF_2Cl_2 or, e.g., CHF_2Cl_3 and in which the heat exchange results in a condensation of the solvent $CFCl_3$

One of the objects of the invention is to provide an economically operating apparatus for condensing gases of the liquid cleaning agent, particularly monofluorotrichloromethane. This is accomplished in accordance with the invention by the provision of an air-circulating conduit which extends from the working chamber of the cleaning machine and gas-tightly through a condenser and discharges back into the working chamber of the cleaning machine, and by the provision of an additional conduit, which extends from the working chamber of the cleaning machine and communicates with the interior of the condenser. The arrangement according to the invention ensures that the solvent vapors evolved as a result of the temperature rise of the liquid cleaning agent during the cleaning operation carried out in the drum are fed directly to the condenser. The vapors which are evolved after the draining of the liquid cleaning agent and after the centrifuging of the cleaned material are also fed directly to the condenser. The condensation of the vapor in the condenser results in a reduction of the amount of vapor and of the pressure in the cleaning machine. The cleaned material is free of solvent when the pressure has been reduced to the atmospheric pressure. By condensing of the vapors of the liquid cleaning agent in the condenser an underpressure is created in the condenser with relation to the other parts of the cleaning machine. By this means the gas-air-mixture is fed to the condenser on a purely physical basis until the gas has been completely condensed and is therefore available for the next cleaning operation.

According to a further inventive step the air or the air-gas-mixture present in the air-circulating conduit can, after draining of the liquid cleaning agent, be forced by a blower through said air-circulating conduit and the working chamber of the cleaning machine, and a conduit for discharging liquid agent can extend from the interior of the condenser. Further, a heating element can be incorporated in the conduit, if desired. This measure enables an effective air supply to the contents of the machine after the draining of the cleaning machine. If the machine is heated, a particularly rapid formation of vapor will result and the vapor will flow directly into the condenser, where the vapor condenses.

To obtain a closed cycle, another development of the invention provides that the conduit for discharging condensed cleaning agents from the condenser opens into a storage container for liquid cleaning agent.

To prevent a flow of uncondensed gases from the condenser into the interior of the machine, a further embodiment of the invention comprises a check valve which is incorporated in the conduit leading from the working chamber of the machine into the interior of the condenser. This check valve can preferably consist of a flap valve or the like which, according to a further feature of the invention, is automatically closed when the working chamber of the machine is opened.

In a further development of the invention, the interior of the condenser is connected by a pressure-equalizing conduit to the suction side of the air-circulating conduit, a shut-off valve being preferably incorporated in the pressure-equalizing conduit.

Further, a still or distilling unit can succeed the storage tank and a vapor conduit can lead from said still into the condenser, the latter in this case being used not only for condensing the gases coming from the working chamber but also the gases of the distilling circuit for cleaning the liquid cleaning agent.

The invention will now be explained more fully with reference to an embodiment which is shown by way of example in the drawing, in which

FIG. 1 is a diagrammatic general view of the apparatus according to the invention and

FIG. 2 a side elevation showing a portion of FIG. 1.

In the drawing, a cleaning or washing machine **2** comprises a housing **1**. A conduit **3** extends from the housing **1** through a condenser **4** and back into the housing **1** of the washing or cleaning machine **2**. An additional conduit **6** extends from the interior **5** of the washing or cleaning machine and communicates with the interior of the condenser **4**. Air may be introduced into the conduit **3** and is forced by a blower **8** through the conduit **3** and

the interior 5 of the machine 2 when the liquid cleaning agent has been drained through a drain conduit 12 at the lowermost point of the machine 2 and has been supplied in the direction of the arrow P through a strainer 31 and a pump 32 to a storage tank 33. The strainer, pump and storage tank are connected in series. To accelerate the evaporation of the residual solvent contained in the cleaned material, a heating element 9 is incorporated in the condiut 3. The heating element 9 may comprise an electric resistor or may be gas-fired.

Outlets 10, 11 for the distillate extend from the condenser 4 into a conduit 13, which leads to the solvent tank.

The conduit 6 which leads from the interior 5 of the machine 2 into the interior 7 of the condenser 4 may incorporate a flap 34 which acts as a check valve and is shut automatically as soon as the working chamber 5 of the machine 2 is opened. In this condition, the flap prevents a flow of uncondensed gas from the condenser 4 back into the interior 5 of the machine 2.

As is shown in FIG. 1, the condenser 4 is sealed by two covers 14, 15, through which the conduit 3 extends in sealed relation. The condenser 4 constitutes thus a double-walled container, which has an annular space defined on one side by the shell of the condenser and on the other side by the conduit 3. The annular space contains evaporator tubes 18, which may be supplied with a refrigerant consisting of difluorodichloromethane (CF_2Cl_2) or difluorochloromethane (CHF_2Cl).

The process of cooling and condensing the solvent is carried out as follows:

The liquid cleaning agent, which contains, e.g., monofluorotrichloromethane, is supplied from a filter through a conduit 19 into the machine 2, which consists, e.g., of a drum-type machine. As the drum revolves, the liquid cleaning agent is heated to a temperature of and above +23.77° C. by the friction at the drum shell and the material to be cleaned and by the constant circulation of the liquid cleaning agent through connecting conduits, the filter and a pump. At the said temperature, the monofluorotrichloromethane boils under a pressure of about 1.083 kg./cm.^{2}. This superatmospheric pressure, which reaches 4.171 kg./cm.^{2} at a temperature of +70° C., is undesired in the cleaning or washing process. For this reason, gas is forced through conduit 6 into the interior 7 of the condenser 4, where the gas condenses on the refrigerant conduits 18. The resulting distillate is recycled to the liquid cleaning agent tank through the outlets 10 and 11 and the condiut 13 so that the cleaning agent cycle is closed.

When the liquid cleaning agent has been removed from the machine 2 through conduit 12 into the tank, which contains monofluorotrichloromethane, the cleaned material remains in the machine 2. The circulating blower 8 is now started and the air from the blower is heated in a heating element 9 to a temperature of about +50° C. In this way the residual solvent, such as monofluorotrichloromethane, which is still contained in the cleaned material, is evaporated and introduced through conduit 6 into the condenser 4, where the gas is condensed. The distillate returns through outlets 10 and 11 and conduit 13 to the tank so that this cycle is closed, too.

As is apparent from FIG. 2, cleaning agent vapor, such as monofluorotrichloromethane, which has been evolved in the still 35, is introduced into the condenser 4 by a conduit 20, in which the vapor flows in the direction of arrow P_3. The still is fed from the storage tank, and serves to distill the soiled liquid cleaning agent, as desired. The gas which is supplied to the condenser 4 through conduit 20 is condensed in condenser 4. The distillate is withdrawn through the outlets 10, 11 and passed through conduit 13 to the tank. This is another closed cycle. It is apparent from the above that the distillation of soiled liquid washing agent, such as monofluorotrichloromethane, can be carried out at the same time as the washing of the material to be cleaned and does not result in an increase of the superatmospheric pressure in the machine 2. On the other hand, soiled monofluorotrichloroethane may be distilled independently of the primary cleaning process. The cycle remains the same in this case.

The condenser 4 is provided with a connecting pipe 21 for a conduit 22, which is connected by a connecting pipe 23 to the air-circulating conduit 3, which extends through the condenser 4. The conduit 22 is a manifold for an equalization of pressure. It connects all containers of the plant which contain monofluorotrichloromethane and provides a means for the escape of air from the condenser 4, when the liquid cleaning agent is filled into the working chamber 5. At this time a valve 36 is opened in the conduit 22. The conduit 22 also prevents an undesired superatmospheric pressure in the spaces which contain monofluorotrichloromethane even when the supply of refrigerant to the cooling pipes 18 is discontinued. The vapors are then positively circulated in the equalizing conduits. As the conduit 22 discharges into the suction side of the conduit 3, it further helps to create an underpressure in the condenser 4 which is necessary for the drawing in of the air-gas-mixture into the condenser.

What is claimed is:

1. Apparatus for condensing gases, which are evolved in dry-cleaning or washing machines, which use a liquid cleaning agent containing monofluorotrichloromethane ($CFCl_3$) and/or difluorodichloromethane (CF_2Cl_2) and/or 1,2,2-trifluorotrichloroethane

($CFCl_2$—CF_2Cl)

characterized by the provision of an air-circulating conduit which extends from the working chamber of the cleaning machine and gastightly through a condenser having cooling pipes therein and discharges back into the working chamber of the cleaning machine, and by the provision of an additional conduit, which extends from the working chamber of the cleaning machine and communicates with the interior of the condenser and a conduit for discharging condensed liquid cleaning agent from said condenser.

2. Apparatus according to claim 1, characterized in that the air or the air-gas mixture can, after draining of the liquid cleaning agent, be forced by a blower through said air-circulating conduit and the working chamber of the cleaning machine, and the conduit for discharging liquid cleaning agent extends from the interior of the condenser.

3. Apparatus according to claim 1, characterized in that a heating element is incorporated in the air-circulating conduit.

4. Apparatus according to claim 1, characterized in that the conduit for discharging condensed cleaning agent from the condenser opens into a storage container for liquid cleaning agent.

5. Apparatus according to claim 1, characterized by a check valve, which is incorporated in the conduit leading from the working chamber of the machine into the interior of the condenser.

6. Apparatus according to claim 5, characterized in that the check valve consists of a flap valve or the like.

7. Apparatus according to claim 6, characterized in that the valve is automatically closed when the working chamber of the machine is opened.

8. Apparatus according to claim 1, characterized in that the interior of the condenser is connected by a pressure-equalizing conduit to the suction side of the air-circulating conduit.

9. Apparatus according to claim 8, characterized in that a shut-off valve is incorporated in the pressure-equalizing conduit.

10. Apparatus according to claim 1, characterized in that a still succeeds the storage tank and a vapor conduit leads from said still into the condenser.

11. Apparatus according to claim 1, characterized in that the cooling pipes of the condenser have passing therethrough a refrigerant having a boiling point below 0° C.,

preferably difluorodichloromethane or difluoromonochloromethane.

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