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(54) A process and an apparatus for rinsing and/or drying articles that have been subjected to a washing process

(57) A process and an apparatus for rinsing and/or drying articles that have been subjected to a washing process. The articles are rinsed in an enclosure from which air and dust have been removed, by filling the tank (1) with a rinsing liquid and expelling the air from the tank (1).

The rinsing liquid is then slowly drained while a flow of hot vapor is admitted into the tank (1) and condensates over the surfaces of the articles progressively emerging from the descending liquid.

A vacuum is then created within the tank (1) causing the boiling of the liquid film covering the articles until they are completely dry.

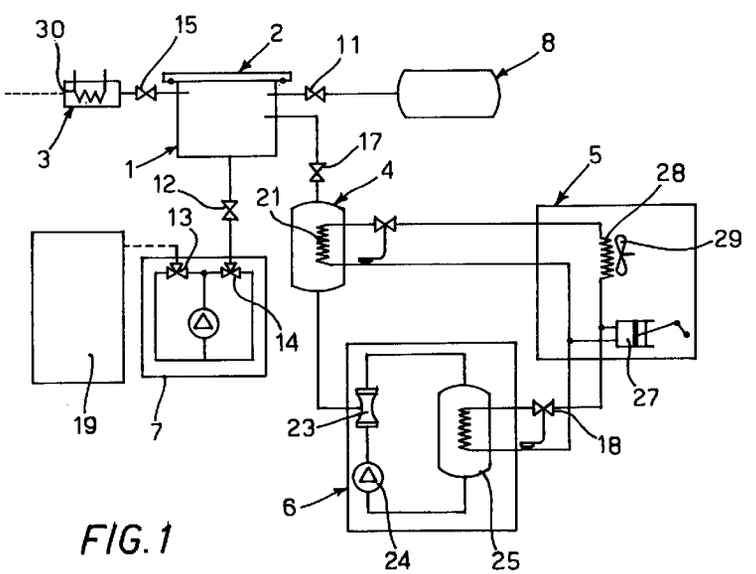

FIG. 1

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Description

The present invention generally refers to the rinsing and drying of articles that have been subjected to a washing process.

As it is known, a number of articles and workpieces are to be subjected to washing (for removing residuals, oils, fats, etc.) in order to obtain a cleaned surface in view of their intended use.

After the washing, such articles or workpieces are to be subjected to a neutralization through one or more rinsings to eliminate the traces of detergents. Finally, to prevent wet or damp areas from remaining on the surfaces of the rinsed articles, which could start chemical attacks (such as oxidations), or leave stains or circles (due to deposits of a hard water or to other reasons), the articles must be dried using particular techniques.

At present the above final operations of rinsing and drying are carried out in the atmospheric environment, that is in presence of the air components (oxygen, moist, several vapors, etc.), as well as in presence of the dusts always present in the air.

In spite of using proper ruses and the utmost care, even with long treatment times, a satisfactory result is not always ensured.

The object of the present invention is to obtain quickly and reliably dried articles that have been submitted to washing and rinsing processes, having a surfaces stainless and devoid of stains.

The above objects are achieved through a process as claimed in claim 1 and an apparatus as claimed in claim 5.

For a better understanding of the invention, preferred but non limiting embodiments of the apparatus and the process will be disclosed hereinbelow with reference to the attached drawings, in which:

Fig. 1 is a schematic diagram illustrating the general construction of an apparatus according to the invention; and

Fig. 2 is a schematic view of an alternate embodiment of the tank.

With reference to Fig. 1, an apparatus according to the invention comprises at least a rinsing tank 1 adapted to contain the articles to be subjected to the washing and/or rinsing and/or drying tratments, which is designed to withstand the stresses due to pressures both higher and lower than the atmospheric pressure as well as to resist to oxidative agents.

The tank 1 can be hermetically closed by means of a cover 2 that is manually or automatically operated. Prefereably the apparatus comprises two of such tanks so that in one of them a lot of articles can be rinsed while in the other another lot of articles is being dried.

Through a valve 15 the tank 1 communicates with a vapor generator 3 having a capacity adequate to the plant requirements. The heating source 30 of the vapor generator can be one of the conventional sources, such as an electric heater, a heat exchanger, a furnace burning a liquid, solid or gasous fuel, a heat pump, a sun-powered heater, a gas compressor, etc.

To the tank 1 it is further connected a vapor cooling and condensing device 4. The condenser 4 comprises a container housing a coil 21 and can be selectively communicated with the tank 1 through a valve 17.

A pumping assembly 7 comprising a pump and two valves 13 and 14, is connected to the bottom of the tank 1 through a valve 12. This pumping assembly is used for pumping the rinsing liquid into the tank 1 and for its extraction. Valve 13 communicates the assembly with a reservoir of rinsing liquid 19.

When the rinsing fluid is a pollutant or otherwise harmful, the apparatus is preferably equipped with a storage tank 8 communicating with the tank 1 through a valve 11 and a conduit length opening in the the upper portion of the tank sidewall.

The apparatus of the invention further comprises auxiliary components such as a cooling device 5 and a pump-ejector assembly 6.

The cooling device 5 is of conventional design and comprises a cylinder-piston assembly 27, a refrigerating coil 28 and a fan 29 and communicates through a valve 21 with the cooling and condensing device 4.

The pump-ejector assembly 6 includes an ejector 23, a pump 24 and a (second) condenser 25. The ejector 23 communicates with the cooling and condensing device 4, whereas a valve 18 is interposed between the second condenser 25 and the cooling device 5.

The pump-ejector assembly 6 is used, when required, for extracting from the tank 1 the condensed fluids and possible gases that are not condensable when the tank is under vacuum conditions. The assembly 6 is preferably provided for ensuring the expulsion of air that might have passed through the seals.

Although not shown in the drawings, the apparatus of the invention comprises additional automation devices such as valves, solenoid valves, automatic hydraulic cylinders, etc. All the valves and the devices of the apparatus are controlled and operated by a central control unit, preferably provided with a PLC or a programmed microprocessor.

When the apparatus of the invention is arranged in an automated washing plant, its working is properly coordinated with the working of the main plant.

According to an alternate embodiment, as schematically shown in Fig. 2, a plate 22 is provided within the tank 1A, this plate being cooled by a coil 26 at programmed times, thus acting as a condenser. Both the additional plate 22 and the main condenser 4 can be used for enhancing the drying stage. When using pollutant fluids, the cooling is preferably carried out within the tank 1 in order to strongly reduce the level of harmful vapors and to generate a gas trap for retaining the vapors within the tank during the loading and unloading of the articles.

The process of the invention will now be illustrated with reference to the above disclosed apparatus.

The operating cycle is started by introducing the articles into the empty tank 1 after removing or opening the cover 2. The articles can be positioned in the rinsing tank 1 either manually or automatically and the tank contains supporting means or devices (not shown) accomodating the shape and types of the articles to be rinsed.

After the articles have been properly arranged in the rinsing tank, the cover 2 is tightly sealed and the tank is filled with a rinsing liquid (or a vapor) from the pump assembly 7 and the valve 11 is opened so that the air is expelled from the tank 1 and forced into the air storage tank 8 (if present).

After the tank 1 has been filled with the rinsing liquid and all the air has been expelled or transferred into the air storage tank 8, the valve 11 is closed.

After the tank 1 has been loaded as desired with the rinsing fluid, the articles are subjected to a conventional rinsing cycle as desired or requested.

Then the rinsing liquid is slowly drained from the tank through the pump assembly 7 and returned to the reservoir 19. The drainage is slowly accomplished in such a manner that the descending liquid surface "washes" the articles located in the tank 1.

During the progressive drainage of the rinsing liquid from the tank 1, valve 15 is opened for admitting into the tank 1 a vapor under pressure from the generator 3, the vapor occupying the vacant space left by the rinsing liquid being drained. The temperature of the vapor from generator 3 is higher than that of the rinsing liquid, and preferably the vapor is similar to the rinsing liquid. In all cases the vapor is not of a type capable of reacting with the rinsing liquid or causing other negative phoenomena.

This vapor flows through the portions of the articles emerging from the surface of the liquid being drained and transfers thermal energy to the articles. Since the emerging portions of the articles are initially at the same temperature of the rinsing liquid (i.e. colder than the incoming vapor), the vapor condensates over the emerging portions of the articles and the droplets run down the article surfaces with an additional rinsing or microwashing of said surfaces.

This process takes place in a continuous manner on the surfaces that progressively emerge from the liquid.

After the liquid has been completely drained from the tank 1, the incoming hot vapor raises the temperature of the article surfaces so that their temperature tends to equal that of the incoming vapor.

The valve 15 is then closed thus stopping the admission of the vapor, and by opening tha valve 17 the tank 1, now emptied of any liquid, is communicated with the cooling and condensing device (condenser) 4, schematically represented in Fig. 1 by a tank housing a coil 21 in which a refrigerator flows. The vapor from the tank 1 progressively expands in the condenser 4 and the condensated vapor is collected within the tank, thus creating a vacuum within the tank 1. Since the articles are at a suitable temperature and are covered by a liquid film, the vacuum causes the boiling of the liquid film. The thermal content of the articles can be enough to continue the boiling process until the complete vaporization of the liquid covering the articles, also thanks to the degree of the vacuum produced.

In case the articles are not completely dry at the end of the above vacuum forming stage, due to an insufficient amount of thermal energy stored by them, another drying cycle is carried out. Hot vapor is again admitted into the tank 1, then this additional admission is stopped and vacuum is again generated in the tank 1, so that the liquid film over the articles completely condensates and the article surfaces become completely dried. If necessary two or more drying steps are carried out until the article surfaces are completely dried.

When the articles are only to be dried, instead of being subjected to a full rinsing and drying treatment, the above sequence of operations is corrispondently shortened. More particularly, the articles are arranged within the tank 1 and the cover 2 is airtigh closed. Then the tank 1 is communicated with the storage tank 8 by opening the valve 11 so that the air within the tank 1 can migrate into tank 8, and the valve 15 towards the vapor generator 3 is opened. Then the valve 11 in the conduit communicating the tank 1 with the tank 8 is closed, while maintaning open the valve 15 that allows the admission into the tank 1 of vapor that heats the articles.

Once a desired level of heating (i.e. thermal energy stored by the articles) has been reached, the admission of vapor is stopped and the tank 1 is communicated with the condenser 4, and in case with the ejector 6. This way an adequate vacuum level is generated in the tank 1 for boiling the liquid film covering the articles as a result of the condensation on their surfaces.

After a certain time interval, the whole liquid film covering the articles has been evaporated, that is if the thermal energy stored by the articles is large enough. In case the film is not completely evaporated, because of the small level of the thermal energy stored in the articles, the cycle is repeated.

It is pointed out that in the initial stage of heating the articles, the vapor condensates over the articles since it is warmer than the articles, thus forming a liquid film that achieves a rinsing by dripping along theirs surfaces, and although modest this rinsing is very effective, particularly at the interface liquid-vapor.

In the above described process the vacuum within the tank 1 has been generated by the communication with the condenser 4. On the other hand, such vacuum could be generated by cooling a surface 22 located within the tank 1, as shown in Fig. 2. This approach can be either an alternative to the condenser or an addition to the condenser.

The invention accomplishes the following advantages over the prior art apparatuses and processes.

- The time interval between two subsequent cycles are reduced.
- The articles are dried in an environment that is extremely clean and not oxidative.
- The drying temperature is kept low.
- The articles are cleaned at a very high degree (such as that required for example in ball bearings, lenses of optical devices, in mechanical components using very thin capillary tubes, etc.).

The process is ecological in that she emission of pollutants into the environment is null or negligible, as a function of the type of fluid that is used.

The apparatus works with any type of fluid or other substance that is evaporable at a pressure lower or higher than the atmospheric pressure.

When the articles do not require a particularly accurate washing, the process of the invention can replace the whole washing cycle, while maintaining unaltered the working principle.

Claims

1. A process for rinsing articles that have been subjected to a washing treatment, characterized in that it comprises the steps of:

   a) positioning the articles to be treated within a tank (1) and hermetically closing said tank (1);
   b) filling said tank (1) with a rinsing liquid, while at the same time expelling the air present in the tank (1);
   c) slowly draining the rinsing liquid from said tank (1) while at the same time admitting into said tank (1) a flow of hot vapor so that the vapor condensates over the surfaces of the articles progressively emerging from the descending rinsing liquid, whereby an additional washing is obtained by the dripping of the liquid film covering said articles;
   d) maintaing the flow of hot vapor after the complete drainage of the rinsing liquid and until said articles store a given amount of thermal energy;
   e) stopping the flow of hot vapor and creating a vacuum within said tank (1) for causing boiling of the liquid film covering the articles until they are completely dry;
   f) opening said tank (1) and removing said rinsed and dried articles.

2. A process as claimed in claim 1, characterized in that said vacuum is generated by communicating said tank (1) with a cooling and condensing device (4).

3. A process as claimed in claim 1, characterized in that said vacuum is generated by cooling a surface (22) located within the tank (1A).

4. A process as claimed in the preceding claims, characterized in that said articles in the rinsing tank (1) are initially cooled by the rinsing liquid so that when said rinsing liquid is slowly drained their emerging portions act as condensation bodies for the incoming hot vapor and are covered by a liquid film that drips down the article surfaces achieving a microwashing of said surfaces.

5. An apparatus for rinsing articles that have been subjected to a washing treatment, characterized in that it comprises

   - at least a rinsing tank (1) that can be hermetically closed by means of a cover (2) for containing said articles;
   - a vapor generator (3) connected to said tank (1) through a valve (15);
   - a vapor cooling and condensing device (4) connected to said tank (1) through a valve (17);
   - a pumping assembly (7) connected to the tank (1) through a valve (12) for pumping the rinsing liquid into said tank (1) and for extracting said rinsing liquid therefrom.

6. An apparatus as claimed in claim 5, characterized in that it further comprises a storage tank (8) communicating with said tank (1) through a valve (11) for storing the air expelled from the tank (1) when the rinsing fluid is polluting or harmful.

7. An apparatus as claimed in claim 5 or 6, characterized in that it further comprises a cooling device (5) including a cylinder-piston assembly (27), a refrigerating coil (28) and a fan (29) and communicating through a valve (21) with said cooling and condensing device (4).

8. An apparatus as claimed in claims 5 to 7, characterized in that it further comprises a pump-ejector assembly (6) for extracting from the tank (1) condensed fluids and gases that have not condensated when the tank is in a vacuum condition, said pump-ejector assembly (6) including an ejector (23), a pump (24) and a second condenser (25), with said ejector (23) communicating with said cooling and condensing device (4), and a valve (18) being located between the second condenser (25) and the cooling device (5).

9. An apparatus as claimed in claims 5 to 8, characterized in that a plate (22) that can be cooled by a coil (26) is provided within the tank (1A).

10. An apparatus as claimed in claims 5 to 9, characterized in that it comprises two tanks.

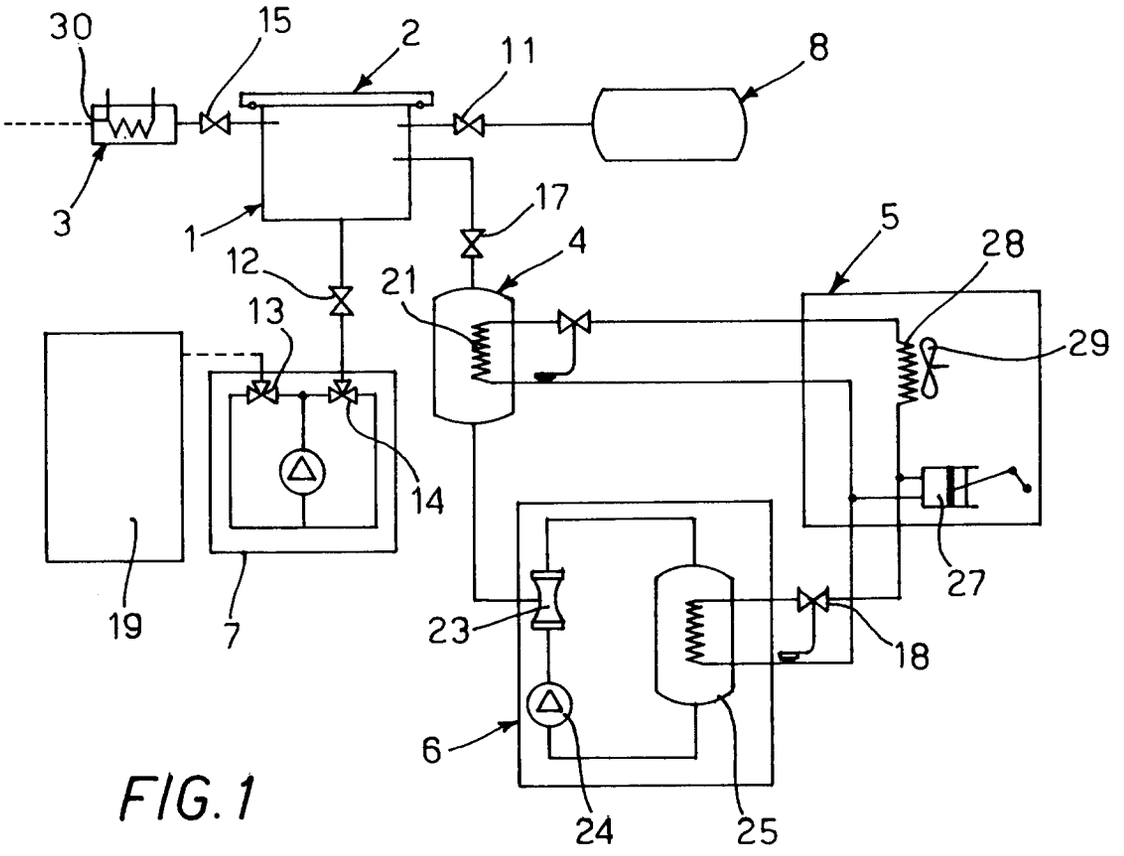

FIG. 1

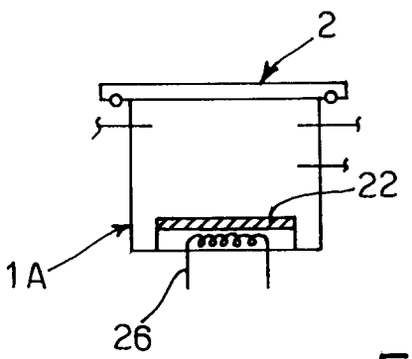

FIG. 2