This invention relates to a dry-cleaning plant for textile goods, that may be both of the single type (with one cleaning machine only), and of the multiple type (with a plurality of cleaning machines), and is inclusive of a drying air or gas heater, that is operated with water superheated by the accumulation of heat.

In modern dry cleaning plants, the textile goods are submitted to four basic processing steps, i.e. a proper washing step, that consists in having the goods thoroughly soaked in an organic solvent (ethylene perchlorate or like), a centrifugating step, for removing the last part of solvent from the textile goods; a drying step for removing by means of circulated air the last residues of solvent left in the textile goods after the centrifugating step, and a deodorizing step, to deprive said textile goods of the solvent odor by means of fresh air. The most modern dry cleaning plants are inclusive of a plurality of cleaning machines, and of a first piping system, through which the drying air is fed, and that is common to all cleaning machines, as well as of a further, also common piping system, through which the deodorizing fresh air is fed, being the arrangement such that all different operations are automatically performed ("slot machine" operation), with the steps of different cleaning machines properly co-ordinated with each other.

In all dry-cleaning plants, the use of a reliably, cheaply and efficiently operating air heater is of the utmost importance, above all when such piece of equipment is arranged centrally within a common ventilating piping system of a multiple plant, inclusive of a plurality of cleaning machines.

In the already known systems, the air heater consists of a tube nest (fitted in the air duct, orthogonally to air path), to which the stream raised in a donkey boiler is fed, or with electric heating resistances fitted inside thereof. The use of a boiler for raising steam designed to be fed to the tubes, or of electric resistances (even if immersed in an oil bath as sometimes occurs), is associated with heavy drawbacks, i.e. with a high energy consumption, a great inertia of heating system, that is utterly unbearable in machines of plants wherein the different operational steps must follow one another in a pre-established sequence; a very long time required for the drying, due to low air temperature; a not negligible initial loss of time for bringing the heater at its operating temperature, a heavy prime cost, owing to the necessity of a boiler and of the plurality of heating resistances in the tubes, and so on.

The main purpose of this invention is the provision of a single, or multiple dry-cleaning plant, inclusive of an air heater that is free from the above-stated drawbacks. The invention is characterized by an air heater consisting of a row of horizontal, large bottom collecting pipes, to which water is fed at the same pressure of water network system (i.e. without the intervention of any valve), and with electric heating resistances fitted in their inside; of a number of vertical pipes, arranged in rows, and of a row of horizontally fitted, large top collecting pipes, being each tube nest connected at either ends with a top header and a bottom header, and being the pressure of heated water inside of heater always kept at a value equal to that of water mains.

According to one feature of the invention, the outer larger than that of inner tubes, which are e.g. smooth; tubes in each vertical nest have a heat radiating surface thus, the water will tend to flow upwardly from bottom headers to top headers, through the inner tubes, flowing then downward through the outer, fanned tubes. Owing to such strong circulation of the fluid, a large accumulation of heat, and a uniform distribution thereof inside of heater are attained.

Briefly resuming, the advantages that can be obtained by this invention are as follows:

- A sufficient amount of heat is transmitted to air directly at the start of drying operation, with a consequent material decrease in the time as required by said operation.
- The power input needed for attaining the required temperature is reduced to about the half (a saving is thus obtained in the prime cost of electric installation, and in the power consumption).
- In respect to a dry-cleaning plant inclusive of a conventional steam heating plant, the cost of a boiler and the operating expenses thereof are saved; directly acting, superheated water is available, and a higher safety standard is attained.

The invention will now be disclosed with reference to accompanying drawings, wherein:

FIG. 1 is a diagrammatic perspective view of novel heater; and
FIG. 2 is a diagrammatic plan view of the ventilating piping system in a dry-cleaning plant.

Referring now to FIG. 1, the heater according to this invention consists of a number of nests I, II, III of tubes I arranged in parallel and close relation with each other, and that in operation are vertically located, i.e. in an orthogonal relation to the path of ventilating air to be heated. Each tube nest opens into a bottom header 2 (for the nest I), 22 (for the nest II) and 222 (for the nest III), being a heating electrical resistance (obviously insulated from the water) fitted within each bottom header. Moreover, each tube nest has its outlet in top headers 3, 33, 333. Thus, there are on the whole three tube nests I, II and III, respectively connected at either ends with three bottom headers 2, 22, 222, and with three top headers 3, 33, 333. Obviously more than three tube nests can be utilized.

As previously stated, the electric resistances for the heating of water are fitted within the bottom headers 2, 22, 222, to which water is fed which, after having been heated therein, rises through the tube nests I, II, III up to the headers 3, 33, 333.

An air venting cock 4 is fitted on each top header, while no cock or valve is provided in the water feed pipe, since a continuous communication of said pipe with all bottom headers must be positively ensured. Hence, as it can be obviously understood, a pressure equal to that of water mains is maintained within the heater.

Any possible overpressure built-up within the heater will be directly released through the pipe C, whereby all dangers that may spring from an increase in the pressure are positively prevented. At any rate, further safety devices are provided, i.e. a thermostat 15, a pressure controller or thrust meter 16, and a valve 17 which is designed to enter into action in the case of failure of all other devices.

Both thermostat and pressure regulator are to be adjusted in such a manner that the pressure of water inside of heater is not caused by the temperature to exceed that one prevailing in the water mains (i.e. that one existing in the zone where the equipment inclusive of said heater is installed). At any rate, the required superheating of water, such as to ensure the needed heat accumulation, will always be attained.
In the case in question, the best utilization of specific heat of water (which is greater than that of all other substances) is attained. In fact, the most possible amount of heat can be accumulated, or retained in the water, according to higher heat quantity required, and to the compression thereof inside the device according to the invention. The accumulation of heat is made in the course of washing and centrifugating of textile goods, whereby when the drying step is started, the rated amount of heat has been already accumulated in the heater, and is then transferred to air, which is thus brought at once to the required temperature.

As previously stated, the constructional features of the object of the invention undoubtedly are the most suitable for the attainment of the advantages stated above, even because the circulated air will be in a position to act, after having been uniformly heated throughout, the textile goods that are to be dried.

Such uniformity is due to the fact that the pipes pertaining to each nest 1, 11, 111 are different from each other, and can be easily extracted from the FIG. 1, wherein a heater is shown; in more detail: pipes having a larger radiating surface (i.e. finned) 1A are present all along the outer contour of each nest, while smooth pipes 1L (i.e. having a smaller radiating surface) are fitted inside of each nest.

Such difference furthers the circulation of water inside heater, since same water, under the heating action of electric resistances 62, 61 and 60 that are fitted respectively inside of heaters, 2, 22 and 222, is caused to rise up to headers 3, 33 and 333 through the smooth pipes 1L, that run hotter, flowing then down through the ribbed pipes 1A, that are less hot, owing to their larger radiating surfaces.

The circulation of water is obviously a factor in keeping the temperature at a uniform level in all points of heater.

The lower consumption of power and all other advantages are an attribute of the inherent character of the invention, and of the well-chosen point of application of the device; the same means—i.e. the water present in the heater—will tend to maintain its temperature, whereby the thermostat is called into action very much less often than in other plants equipped with heaters of different types.

The ventilating air (see FIG. 2), as sucked by the fan 41 through its strainer 10, from the case of dry-cleaning equipment wherein the centrifuge basket, filled with centrifugated textile goods, is fitted, is delivered through the duct 42, to cooling units 43, where the solvent vapors are condensed, and collected in a water-solvent separator (not shown).

Then the air is fed through the duct 44, to heater 45, and is caused to pass across it, under the already disclosed ideal heating conditions, whereafter it is sent back to dry-cleaning machine 47, to heat the already centrifugated textile goods that are contained in the slowly and alternately turning basket 48. Obviously, same air is then sucked again by the fan through the duct 49 and its strainer 10, and recycled through the same, already described circuit, for the whole time of drying operation which, as already stated, is much shorter than that required in the prior art equipment, owing to higher efficiency of novel heater.

A prominent feature of the invention consists in the wholly free communication, without the interposition of any cock or valve, between the water present in the heater and the water mains whereby, since a pre-established pressure (equal to that of water mains) is maintained within the heater as fitted to dry-cleaning machine, the possibility is given to increase the water temperature up to 120°-130° C., thus obtaining a better heat accumulation without any danger, since the pressure is kept automatically constant, owing to said free communication with the water mains. A possible failure of thermostat does not result in any danger, since the excess of pressure, due to increase in the temperature, is once released into the water mains.

FIG. 2 shows, for simplicity's sake, how the novel device is fitted in a dry-cleaning plant inclusive of only one dry-cleaning machine. However, as it can be readily appreciated, greater and really essential advantages can be attained in multiple dry-cleaning plants (inclusive of a plurality of independent dry-cleaning machine, with a common ventilating circuit according to Italian Patent No. 649,921, granted to same applicant), which presently are in great favour with buyers.

One of the most essential advantages of the invention will clearly appear from the following description, taking into account that as the daily throughput of a dry-cleaning machine is increased, the shorter the total time required for each operating step, and that—as stated before—a dry-cleaning cycle is inclusive of four steps, i.e.: cleaning, centrifugation, drying, deodoration.

Usually, the longest time is taken by the drying step, whereby all makers of dry-cleaning equipment have devoted much effort in finding a solution that would allow to cut as much as possible from such time, consistently with a proper drying. Obviously, such time depends on the capacity both of fan and of heater.

When recourse is made to steam heating, no difficulties are encountered in designing a powerful heater, whilst in the case of an all-electric machine, a heater of such kind would result in a very high power consumption, and in addition, the electric equipment of dry-cleaning machine is made much more complex and expensive.

The following example will assist in a better understanding of the invention.

The conventional coin-operated machine, having a capacity of 5 kgs. of textile goods is taken as a reference.

Let us assume that the drying can be obtained in a max. time of ten minutes.

According to practical experiences, 2,600 calories, delivered by the recirculated air, are required for a proper drying of 5 kgs. of garments within 10 minutes. Since 864 cal./h. can be generated by one kw.— or 864/6=144 cal. in ten minutes—a heated having an input of at least 18 kw. must be provided to obtain 2,600 cal. in ten minutes. Such rating is very heavy, and may become unpracticable when five or six dry-cleaning machines are to be installed in a self-service plant.

The ideal solution consists therefore in having the time taken by the other operations of machine (cleaning, centrifugation, deodoration) utilized to accumulate heat in a heater like that according to the invention, that is able to deliver the accumulated heat at the right moment, thereby obtaining the material advantage of a large reduction in the installed power rating, and in addition, the electric equipment of dry-cleaning machine is made much more complex and expensive.

The most suitable means for the accumulation of heat is the water, since it possesses a very high specific heat, equal to 1.

The heater according to the invention, when considered in its whole, i.e. the water present therein and the metal by which it is made, has a thermal capacity equivalent to that of 40 litres of water which, when heated to a temperature of 120° C., are able to accumulate 4,800 calories within them.

Such accumulation is performed at the beginning of the working day, and an installed rating of 7 kw. is sufficient therefor.

At the start of the drying step, the water temperature is equal to that from 120° C., down to 80° C., thus giving off 1600 cal. (40 litres per 40° C.) in the course of ten minutes, then in the same interval of time, 144×7 cal., i.e., further 1008 cal. are produced by the 7 kw. of installed rating (obviously, the means by which the heat is transferred from the water to the air of the ventilating circuit is represented by the sucking fan).

Now, by adding the 1600 calories of accumulated heat, to 1008 cal. produced by the heater, 2600 cal. are ob-
tained, i.e., the amount of heat required for the drying of garments in the prescribed ten minutes.

Thus, a remarkable advantage is obtained with the device according to the invention, since it allows to attain the required purpose with an electric heater having a capacity of 7 kw. only, in place of the 18 kw. heretofore required (with a decrease of more than 60%).

While a certain, specific form of the invention has been herein shown and described, various obvious changes may be made therein, without departing from the spirit of the invention, as defined in the appended claims.

What I claim is:

1. A dry-cleaning plant, comprising at least one cleaning machine wherein the garments to be cleaned are soaked in an organic solvent, and wherein same garments are then dried in a current of hot air, obtained in a closed circuit that is fitted with a heating device, said heating device comprising a plurality of horizontally fitted bottom headers, to which water is directly fed from the water mains, without the interposition of any pressure regulating means, electric heating resistances fitted in said headers; a plurality of vertical tube nests, a plurality of horizontally fitted top headers, being all said tubes of each vertical nest being connected at their ends with said bottom header and said top header respectively, whereby the superheated water contained in the whole heater is kept at a pressure always equal to that of water mains.

2. A dry-cleaning plant according to claim 1, characterized in that the heat radiating surfaces of pipes located on the outer contour of each pipe nest, are greater than those of pipes fitted inside of each nest.

3. A dry-cleaning plant according to claim 1, characterized in that the water fed from mains, is superheated in the bottom headers, and rises therefrom, through the inner tubes, having a smaller radiating surface, up to top headers, flowing then again down to bottom headers through the outer tubes having a greater heat radiating surface.

4. A dry-cleaning plant according to claim 2, characterized in that the outer tubes in each nest are ribbed or finned, while the inner tubes are smooth.

5. A dry-cleaning plant according to claim 1, characterized in that the upper headers are fitted with a thermostat, a pressure regulator, a valve and an air vent.

6. A dry-cleaning plant according to claim 1, characterized in that the fluid that is circulated in the heater can be heated up to 130° C., and that the accumulated heat is uniformly distributed therein.

7. A dry-cleaning plant according to claim 1, inclusive of a dry-cleaning machine, and a heater fitted in the ventilating circuit of same machine.

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