The present invention relates to an improved apparatus for drying, and more specifically, to improvements in the field of coin-operated automatic dry cleaning machines.

In a typical coin-operated dry cleaning assembly, the articles to be cleaned are tumbled with a liquid dry cleaning solvent such as perchloroethylene in a washing zone, excess solvent is drained, and then a current of hot air is passed through the articles to vent off solvent. In such systems, solvent recovery is effected by condensing the solvent, filtering, and returning the solvent to the washing zone. Another object of the invention is to provide a dry control system for a dry cleaner which provides for continuous operation of the solvent venting system in the event of a malfunction in the automatic control, thereby substantially eliminating the possibility of reforming solvent-laden clothes in the event of such malfunction.

Still another object of the invention is to provide control circuitry for a drier assembly which compensates by means of overriding circuit elements to eliminate solvent from the articles whenever the load is heavier than normal, upon the existence of any malfunction which might tend to terminals venting of the solvent present.

Another object is to provide an improved dry cleaning method.

Other objects and features of the present invention will become apparent to those skilled in the art from the following description of the attached drawings which illustrate a preferred embodiment.

In the drawings:

FIGURE 1 is a somewhat schematic view of the complete dry cleaning assembly;

FIGURE 2 is a timing chart illustrating the intervals involved in sequence during the operation of the dry cleaning assembly;

FIGURE 3 is a somewhat schematic wiring diagram of the dry control apparatus of the dry cleaning machine;

FIGURE 4 is a plan view of the water separator and float switch assembly employed in the dry control apparatus; and

FIGURE 5 is a cross-sectional view taken substantially along the line V—V of FIGURE 4.

As shown on the drawings:

In FIGURE 1, reference numeral 10 diagrammatically indicates generally a casing for receiving the articles to be cleaned and containing a rotatable, perforate drum 11 mounted for rotation on a shaft 12 driven by the motor drive means illustratively shown by numeral 13. An access door 14 is provided for permit introduction of the articles to be cleaned into the interior of the drum 11. The housing 10 is provided with a conically shaped bottom portion 16 which acts as a sump to collect liquid dry cleaning solvent and discharges it through a line 17 connected thereto.

Dry cleaning solvent is fed to the housing 10 by means of a line 18 so that it is injected onto the contents of the drum 11 during the wash cycle. A heater 19 is also located within the housing 10 and serves to heat air entering the drum 11 for drying purposes during the drying cycle.

Solvent vapors are vented from the housing 10 by means of a conduit 21 located at the rear of the housing 10 and feeding a condenser assembly generally indicated at 22 in the drawings. Solvent laden air vented from the housing 10 passes through a lint filter 20 and a condenser 23, normally of the tube and fin type, by the action of a blower generally indicated at numeral 24 in the drawings. The air is then directed through a conduit 26 past the heater 19 back into the housing 10, while the condensed solvent is withdrawn through a line 27 for purposes which will hereinafter be explained more fully.

The unit shown in FIGURE 1 includes a solvent reservoir 28 containing a body of solvent generally indicated at 29. A refrigeration coil 31 is immersed in the solvent body 29 and is cooled by means of a refrigeration unit indicated at 32 in the drawings. Coil 31 and refrigeration unit 32 are coupled as a hermetic assembly. The liquid is in an opening in the top 28a of reservoir 28. A submerged pump 33 driven by a motor 34 delivers the cooled solvent from the reservoir 28 through a conduit 36 to a filter 37 where impurities are removed from the solvent before its return to the system. The discharge from the filter 37 is conveyed directly into the inlet line 18 feeding the housing 10 by opening a valve 39 connecting the two lines. A portion of the dis-
The present invention is particularly concerned with a charging device which is actuated by the operation of the condenser mechanism to thereby determine the length of the drying cycle. To that end, the liquid condenser is recovered from the condenser 22 and flowing through line 27 passes through a water separator 47 and then through a drying control mechanism generally indicated by numeral 48 in FIGURE 1. These two assemblies are best illustrated in FIGURES 4 and 5 of the drawings. As seen in these figures, the condenser in the line 27 is passed to a cylindrical water separator 47 having a threaded bottom portion closed by means of a cap 51 and sealing gasket 52. The cap 51 may be removed to clean the water separator 47. A pair of substantially flat surfaced defining baffles 53 and 54 of different lengths extend chordally across the cylindrical lining 47. The discharge from the condenser appearing in line 27 will consist of a mixture of condensed water and condensed solvent. As the condensate builds up in the separator 47, the baffles 53 and 54 separate the water from the solvent. Since the water is lighter than the solvent, it flows to the top and is trapped in a chamber 86 between the baffles 53 and 54. During maximum discharge from the condenser, the water level will be at a line indicated at 87 in the drawings, and excess water can be continuously withdrawn by an overflow conduit 58 provided for that purpose. An air vent 59 is also provided in the water separator 47 to prevent excessive pressure from building up. It will be noted from an inspection of FIGURES 4 and 5 that the body portion of water separator 47 and the body portion of the condensate collector 48 are interconnected by a vertical mounting wall 60 permitting upright installation and that the internal chambers of these body portions are slightly tapered for easier molding as well as to accommodate free movement of the somewhat frusto conical float 69.

The solvent flows under the baffles 53 into a conduit 61 connecting with the condensate sensing or dry control mechanism 48. The latter includes a casing 62 having a threaded end portion closed by means of a cap 63 and threaded engagement with the casing 62. The bottom of the cap 63 is formed with a metering orifice 64, and the cap presses a sealing gasket 66 against a ceramic filtering element 67 located at the base of the casing 62. Condensate generated by condenser 23 passes from conduit 61 into a chamber 68 within the dry control mechanism 48 and serves to operate a float 69 contained therein. When the rate of flow of condensate entering the chamber 68 is greater than the rate at which the condensate is leaving through the metering orifice 64, the float 69 will rise in the chamber 68. The float 69 is provided with a switch actuating projection 71 which is aligned with an actuating arm 72 of a single-pole, double-throw switch 73 having a first lower position and a second upper position. As long as there is sufficient excess flow within the chamber 68, the switch 73 will be operated to its second upper position and any additional excess condensate is returned to the reservoir by means of conduit 76. When there is insufficient flow within the chamber 68, the float will fall and the switch 73 will return to its first or lower position. The discharge of the metering orifice 64 is also returned to the reservoir 28 by means of a branch conduit 77.

The electrical circuit for controlling operations of the dry cleaning assembly is best illustrated in FIGURES 2 and 3 of the drawings. Referring first to FIGURE 3, numerals 81 and 82 have been applied to the two sides of the line which supplies electrical power to the unit. A door switch 83 is included in the line 81 so that the machine circuitry cannot be energized without the door being closed. The balance of the controlled by a series of cams 88 through 94, inclusive. A manual reset knob 96 is provided in conjunction with the main timer motor 86 for resetting the operation of the timer motor to its zero position as desired.

An auxiliary timer motor 98 is also provided, together with its manual reset means 99. The auxiliary timer motor 98 has a shaft 101 which carries a pair of cams 102 and 103 to operate switches 114 and 116 in timed sequence, as will be explained in a succeeding portion of this specification.

FIGURE 2 illustrates the timing schedule arrangement provided by the various cams operating from the main timer motor 86 and the auxiliary timer motor 98. A total of 60 timer intervals, each one-half minute in duration, is shown for convenience though it should be appreciated that the total elapsed time of this illustrative cycle may exceed thirty minutes.

At the outset of the timing interval, it will be seen from FIGURE 2, which is read from left to right, that Switches 106 and 107, associated with cams 89 and 90, respectively, are closed, thereby applying energizing voltage through parallel circuits to the switches 106 and 107 across the main timer motor 86. At the beginning of the twenty-sixth timer interval, the heating element 19 and the blower 24 are energized, effectively initiating the drying period, by timing cams 92 and 93 through their associated switches 108 and 109 to preheat or warm up the dry cleaning unit during a portion of the extraction period. At the beginning of the twenty-eighth timer interval, solvent is conveyed from the reservoir 28 by energizing pump 33 through the operation of cam 94 and its associated switch 111, thereby delivering solvent through the conduit 36 into the filter 37, to conduit 38, past valve 42 and into the condenser 23 to precool the condenser. At the end of twenty-ninth timer interval, the extraction period ends, and the drying period continues.

At the beginning of the thirty-fourth timer interval, cam 91 serves to close the first by-pass switch 112 and cam 90 is timed to open the second by-pass switch 107. At the beginning of the thirty-fifth timer interval, cam 89 operates to open switch 106. The movement of switches 112, 107 and 106, at this time, provides a checking interval to detect whether or not float 69 is in its upper position. Normally, in drying regular fabrics there should be sufficient amounts of condensate at this point of the cycle in the chamber 68 to raise the float 69 to where it operates the single-pole, double-throw switch 73 into its upper position as seen in FIGURE 3. Line voltage is thereby supplied to the timer motor 86 through the switch 73 and the now closed first by pass switch 112, connected in parallel shunting relationship around switch 106 to continue operation of the timer motor 86. The switch 106 remains open for one timer interval, and at the end of the thirty-fifth timer interval, the cam 89 operates to reclose switch 106.

Also, at the beginning of the thirty-fifth timer interval, the cam 88 operates to close its associated auxiliary timer motor switch 113 and thereby apply line voltage across the auxiliary timer motor 98.

Switch 73 is responsive to condensate flow which generally decreases as the over-all condition of cleanliness of the articles in drum 11 increases. In a broader form of this invention switch 73 could also be in the form of a thermal responsive element sensitive to the temperature of the fabrics or temperatures of exhaust air from drum 11.
and movable from its upper to its lower position during the drying cycle since the temperature of fabrics or exhaustion increases upon attainment of the over-all condition of dryness.

At the beginning of the thirty-seventh timer interval, the cam 91 operates to open the first by pass switch 112 and the cam 90 operates to close the second by pass switch 107. This switching arrangement provides a second checking interval to detect whether the float 69 is in its lower position when cam 89 operates to open main motor switch 106 at the end of the fifty-fifth timer interval.

At the beginning of the thirty-ninth timer interval, the auxiliary timer motor 98 moves the cam 102 to a position in which it closes its auxiliary motor by pass switch 114 to provide a by pass or shunt circuit around auxiliary timer motor switch 113. This allows continued energization of auxiliary timer motor 98 after switch 113 is subsequently opened by cam 88 at the beginning of the forty-fifth timer interval.

At the beginning of the fifty-fifth interval, the cam 89 operates to open the main timer motor switch 106. It is at this time that the variation of load size affects the operation of the main timer mechanism 86. With a reasonably light load or moderate load, the articles will be sufficiently dry at this time, and insufficient condensate will flow into chamber 68 to keep the heater in its upper position. The float will fall and the switch 73 will have returned to its first or lower position. Line voltage will thereupon be continued to the timer motor 86 through the lower contact of switch 73 (which is now in the position shown in FIGURE 3) and through the second by pass switch 107 which remains closed. At the beginning of the fifty-sixth timer interval, the cam 89 operates to close the main timer motor switch 106 again and the timer 86 continues to be energized. It is at this time that the heated portion of the dry period ends and the deodorizing period begins. At the same time, the heater 19 is de-energized as is the pump 33 which recirculates the condensate. Blower 24, however, remains energized through closed switch 109 to vent to the atmosphere, by means not shown, the last traces of solvent vapor from the articles during the deodorizing period. The machine cycles is then completed at the end of the sixtieth timer interval at which time cam 90 operates to open the second by pass switch 107, cam 89 operates to open the main motor switch 106 and the blower 24 is de-energized by cam 93 opening blower switch 109.

However, if the articles are still insufficiently dry at the beginning of the fifty-fifth timer interval or if a malfunction occurs such as the float 69 or switch 73 sticking in their upper positions or the orifice 64 in the control chamber 68 plugged with foreign matter, the circuit operates as follows:

In the case of insufficiently dry articles, the main timer motor 86 will remain de-energized because the rate of flow of condensate is sufficient to keep float 69 in its upper position which in turn keeps switch 73 in its second or upper position. Therefore, since the first by pass switch 112 is open, the operation of the main timer motor 86 will be interrupted and the drying operation will be extended until float 69 falls and thereby re-applies line voltage through the lower contact of switch 73 and the second by pass switch 107 to the main timer motor 86 so that the machine cycle is thereafter completed in exactly the same way as it would have been for lighter loads.

As previously mentioned, the auxiliary timer motor 98 is initially energized at the beginning of the thirty-seventh timer interval. The auxiliary timer motor 98 is preset to operate for thirty minutes or sixty intervals of the timer chart in FIGURE 2. If at the end of the thirty-minute period of the auxiliary timer motor operation the float 69 is still in the upper position where it holds switch 73 in its second or upper position, cam 103 will be operated by the auxiliary timer motor 98 to close its associated switch 116 which closes after thirty minutes of actual timed operation of auxiliary timer motor 98 have elapsed (and therefore not shown in FIGURE 2). However, since the first by pass switch 112 is open, the circuit is not completed to the main timer motor 86, through switches 116 and 112 and the machine continues to dry until the switch 73 falls to its lower position thereby energizing timer motor 86 through the second by pass switch 107 and the lower contact of float switch 73. This action provides an infinite drying interval so that hard-to-dry articles such as sleeping bags, rugs, blankets and other bulky articles, can be completely dried to a desired dryness before the machine will terminate this drying operation.

After the main timer motor 86 has been energized, the drying operation is normally effectively terminated by timer motor 86 continuing to the end of its programmed machine cycle. However, if a malfunction occurs to cause the float 69 to stick in the upper position or to cause the switch 73 to stick in its upper position, the machine will continue to operate until an attendant services the machine.

If a malfunction should occur such as to cause the float 69 or switch 73 to stick in their lower positions or if the condenser 22 fails to produce condensate because of failure of blower 24 or pump 33, or if the water separator 47 or float chamber 68 should plug above the float 69 with foreign articles preventing passage of solvent into chamber 68, the following conditions will occur:

At the beginning of the thirty-fourth timer interval, the first by pass switch 112 closes, and the second by pass switch 107 opens. At the beginning of the thirty-fifth timer interval, cam 89 operates to open main timer motor switch 106 and cam 103 operates to close the auxiliary timer motor switch 113 which energizes the auxiliary timer motor 98. Because of the malfunction, a circuit is not made from line 81 through switch 73, switch 112, and through the timer motor 86 as is normally the case. Therefore, the operation of the main timer motor 86 is interrupted and the drying interval is dependent on the thirty-minute operation interval of the auxiliary timer motor 98 which is energized at the beginning of the thirty-fifth timer interval of main timer motor 86. One-half minute before the end of the thirty-minute operation interval of the auxiliary timer motor 98, cam 103 operates to close the auxiliary timer motor switch 116 which provides voltage across timer motor 86 through switches 112 and 116. The main timer motor 86 then operates cam 89 to close the main timer motor switch 106. At the end of the thirty-minute time period of the auxiliary timer motor 98, cam 103 operating to open the auxiliary timer motor switch 116, de-energizes the auxiliary timer motor 98.

Under these conditions, the timer chart of FIGURE 2 is interrupted at the thirty-fifth interval of the main timer motor 86 and actually expanded in length by a thirty-minute interval which is the duration of energization of auxiliary timer motor 98.

After the lapsing of this thirty-minute interval and at the beginning of the thirty-seventh timer interval of main timer motor 86, cam 91 operates to open the first by pass switch 112 and cam 90 operates to close the second by pass switch 107. As can be noted in FIGURE 3, the main timer motor 86 is now energized through the second by pass switch 107 and the lower contact of switch 73 as well as through main timer motor switch 106. At the beginning of the fifty-fifth timer interval, cam 89 operates to open main timer motor switch 106. However, the main timer motor 86 continues to be energized through the second by pass switch 107 and the lower contact of switch 73.

At the beginning of the fifty-sixth timer interval, cam 89 operates to reclose main timer motor switch 106 and permit the timer motor 86 to complete the normal machine cycle.
While we have illustrated a preferred embodiment of the invention in the accompanying drawings, it should be evident that various modifications can be made to the described apparatus without departing from the scope of the present invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a drying apparatus including drying means for effecting the drying of articles placed in said drying apparatus, dry control circuitry including means for energizing said drying means during a drying operation,
   first sequential control means in said circuitry for controlling said drying means throughout a first fixed time interval,
   switch means in said circuitry responsive to a condition of dryness of said articles and operable to terminate said drying operation subsequent to said first fixed time interval, and
   second sequential control means in said circuitry to override said switch means and limit the duration of said drying operation in case of a malfunction of said switch means.

2. In a drying apparatus including drying means for effecting the drying of articles placed in said drying apparatus, dry control circuitry including means for energizing said drying means during a drying operation,
   first sequential control means in said circuitry for controlling said drying means throughout a first fixed time interval,
   switch means in said circuitry responsive to a condition of dryness of said articles for extending said drying operation beyond said first fixed time interval and thereafter terminating said drying operation, a by-pass switch interconnected in said circuitry in parallel with said switch means, and
   second sequential control means in said circuitry for operating said by-pass switch to limit the duration of said drying operation in the event of a malfunction of said switch means.

3. In a drying apparatus including drying means for effecting the evaporation of fluids from articles placed in said apparatus and further including condensing means for condensing vapors resulting from said evaporation during a drying operation, the combination comprising,
   an electrical circuit for said apparatus including means for energizing said drying means,
   sequential control means in said circuit for controlling said drying means throughout a first fixed time interval,
   sensing means responsive to the rate of flow of condensate generated by said condensing means, circuit means including a switch actuated by said sensing means between first and second positions, and means operative between said sequential control means and said switch providing checking intervals for extending said drying operation beyond said first fixed time interval when said switch is in said first position and terminating said drying operation when said switch is in said second position.

4. In a drying apparatus including evaporation means for evaporating fluids from articles placed in said apparatus and condenser means for condensing said evaporated fluids during a programmed drying operation, a dry control system comprising,
   first sequential control means for controlling said evaporation means and said condenser means and for carrying out said programmed drying operation,
   switch means being movable between first and second positions dependent upon the flow of condensate from said condenser means, said switch means in said first position energizing said first sequential control means,
from its first position to its second position to extend said drying operation beyond said fixed time interval, and a second sequential control means operatively connected to said first circuit to override said second switch means and to terminate the drying operation during the extended time interval in the event of a malfunction of said second switch means.

8. In a drying apparatus including electrically energized heating means, electrically energized blower means cooperating with said heating means to evaporate dry cleaning solvent from a load, and a timing mechanism arranged to program said apparatus through a timed sequence of drying,
a condenser receiving fluid evaporated from said load, a water separator receiving the discharge from said condenser and arranged to separate water therefrom,
a dry control mechanism receiving condensed solvent from said water separator, drain means in said mechanism for constantly draining solvent therefrom, a float in said mechanism, a switch associated with said float and actuated thereby from a first to a second position when the level of solvent in said mechanism reaches a predetermined level, and circuit means associated with said timing mechanism to provide checking intervals and being responsive to the position of said switch in said second position to continue energization of said blower means and said heating means beyond their normal programmed energization upon malfunctioning of said float in said dry control mechanism.

9. In a dry cleaning apparatus including an electrically energized heater, a blower, and a solvent condenser including a condensate pump for circulating dry cleaning solvent, a control circuit comprising a main timer motor having timing cams thereon to energize said heater, blower, and condensate pump in timed sequence during an operating cycle,
a first cam operated switch actuated by said main timer motor to periodically deenergize said main timer motor during an operating cycle, a second cam operated switch arranged to apply energizing voltage across said main timer motor in one position of said switch during an interval in which said first cam operated switch would otherwise deenergize said main timer motor, float means responsive to the amount of condensate produced during drying,
a float operated switch in association with said float means and in electrical series relation with said second cam operated switch, a third cam operated switch actuated by said main timer motor and arranged to deenergize said main timer motor except for said interval in which said first cam operated switch would otherwise deenergize said main timer motor, an auxiliary timer motor, a fourth cam operated switch actuated by said main timer motor to energize said auxiliary timer motor during said interval in which said first cam operated switch would otherwise deenergize said main timer motor, and a fifth cam operated switch actuated by said auxiliary timer motor, and in parallel circuit relation to said float operated switch.

10. In a drying apparatus including drying means for effecting the evaporation of fluids from articles placed in said apparatus and further including condensing means for condensing vapors resulting from said evaporation during a drying operation, the combination comprising, an electrical circuit for said apparatus including means for energizing said drying means, first sequential control means in said circuit for controlling said drying means throughout a first fixed time interval, and sensing means responsive to the rate of flow of condensate generated by said condensing means for extending said drying operation beyond said first fixed time interval and thereafter terminating said drying operation, a by-pass switch interconnected in said circuit in parallel with said sensing means, and second sequential control means in said circuit for operating said by-pass switch to limit the duration of said drying operation.

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