June 18, 1968 J. F. OLES 3,388,567

DRY CLEANING APPARATUS

Original Filed Dec. 24, 1963 6 Sheets-Sheet 1

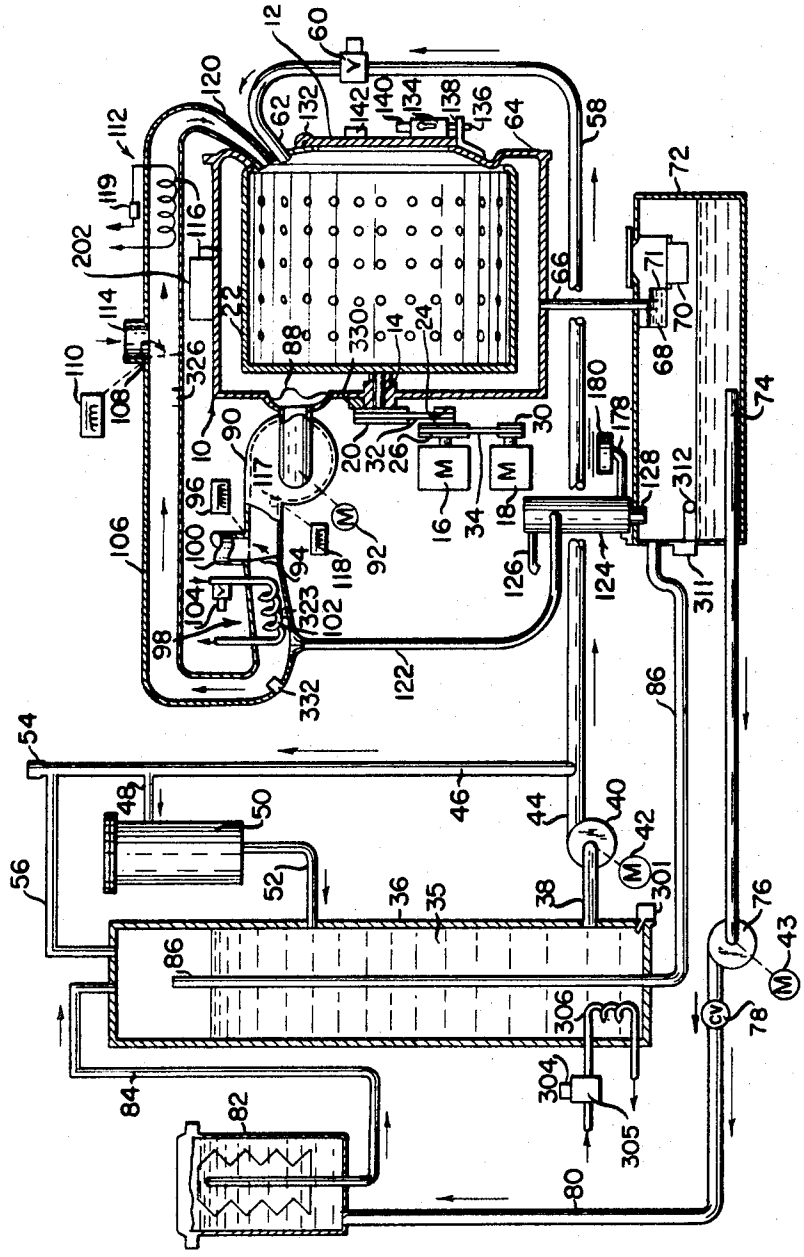

FIG. 1

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DRY CLEANING APPARATUS

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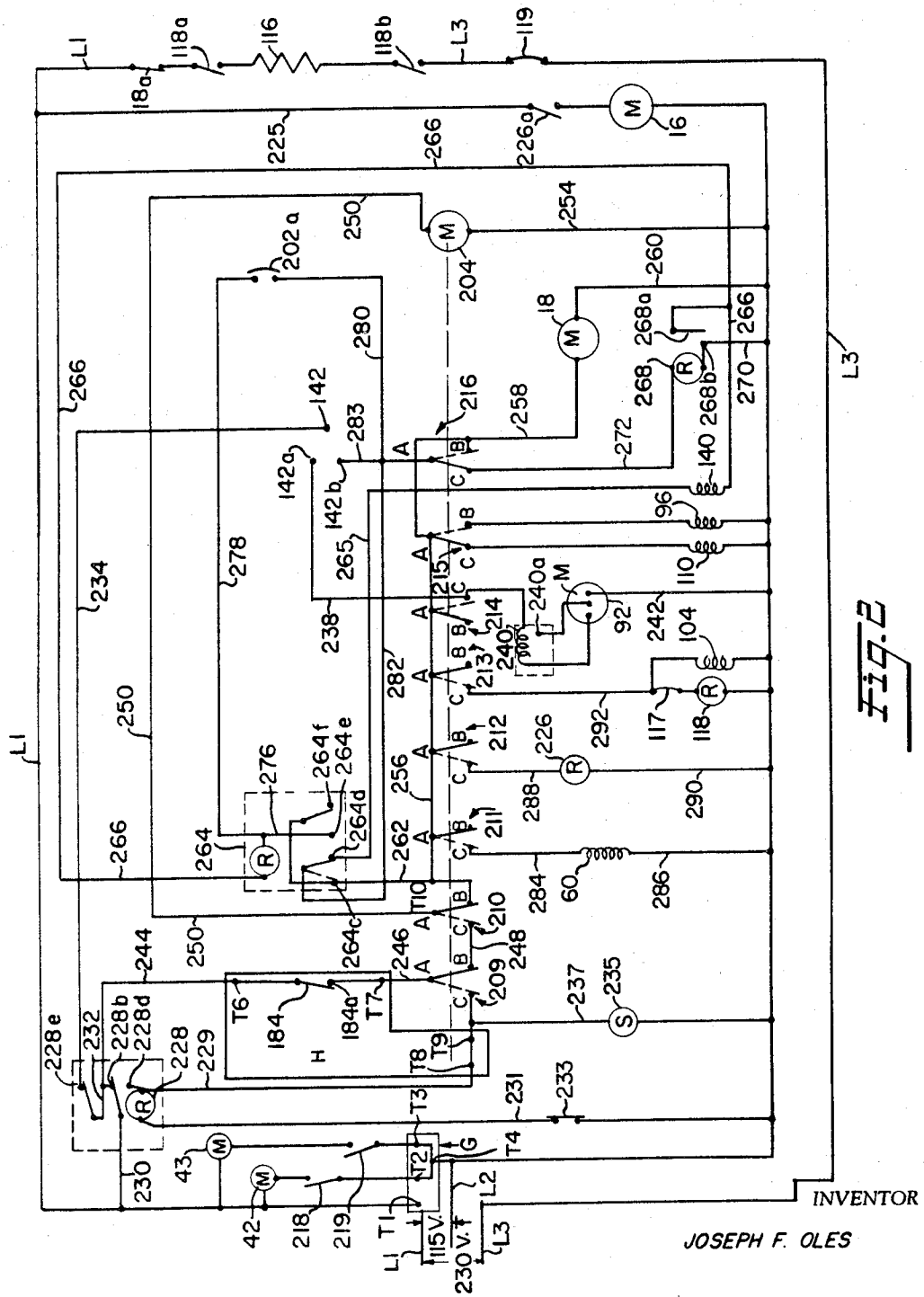

FIG. 2

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DRY CLEANING APPARATUS

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Fig. 3

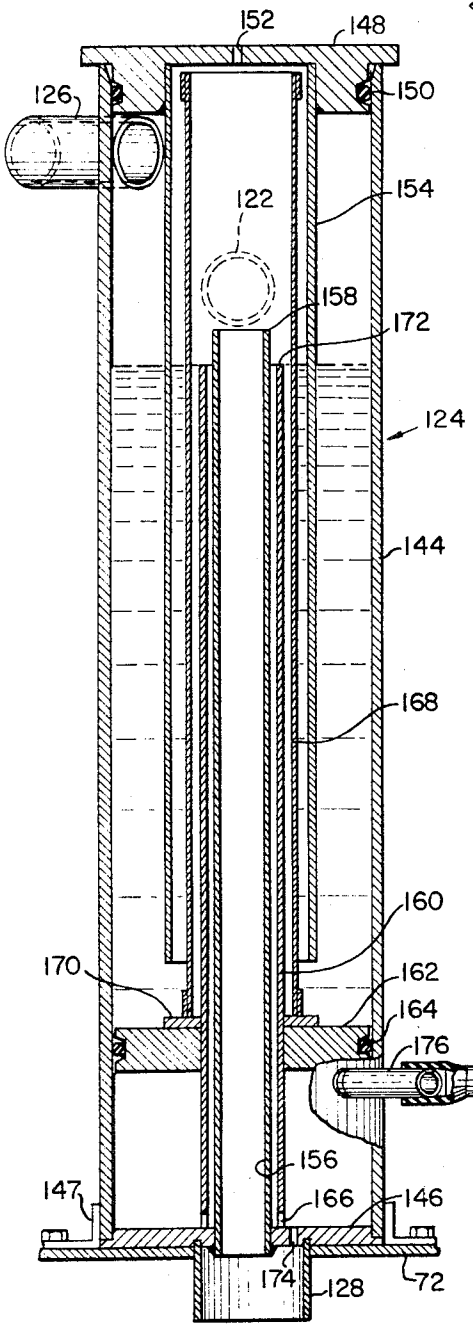
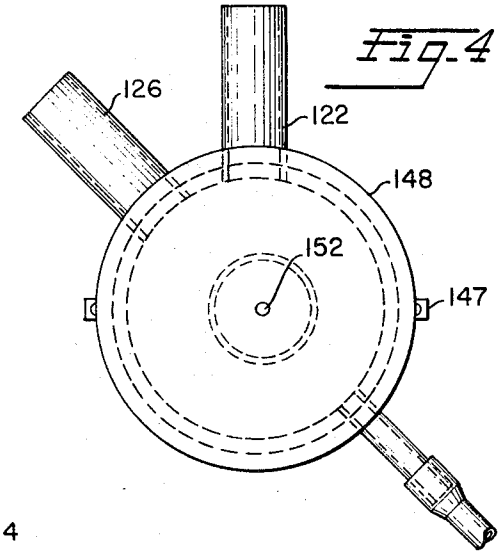
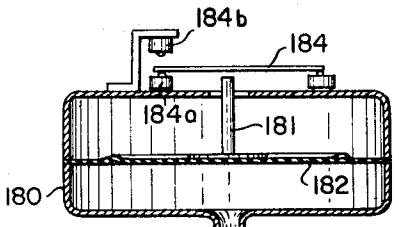


Fig. 4





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Original Filed Dec. 24, 1963 6 Sheets-Sheet 4

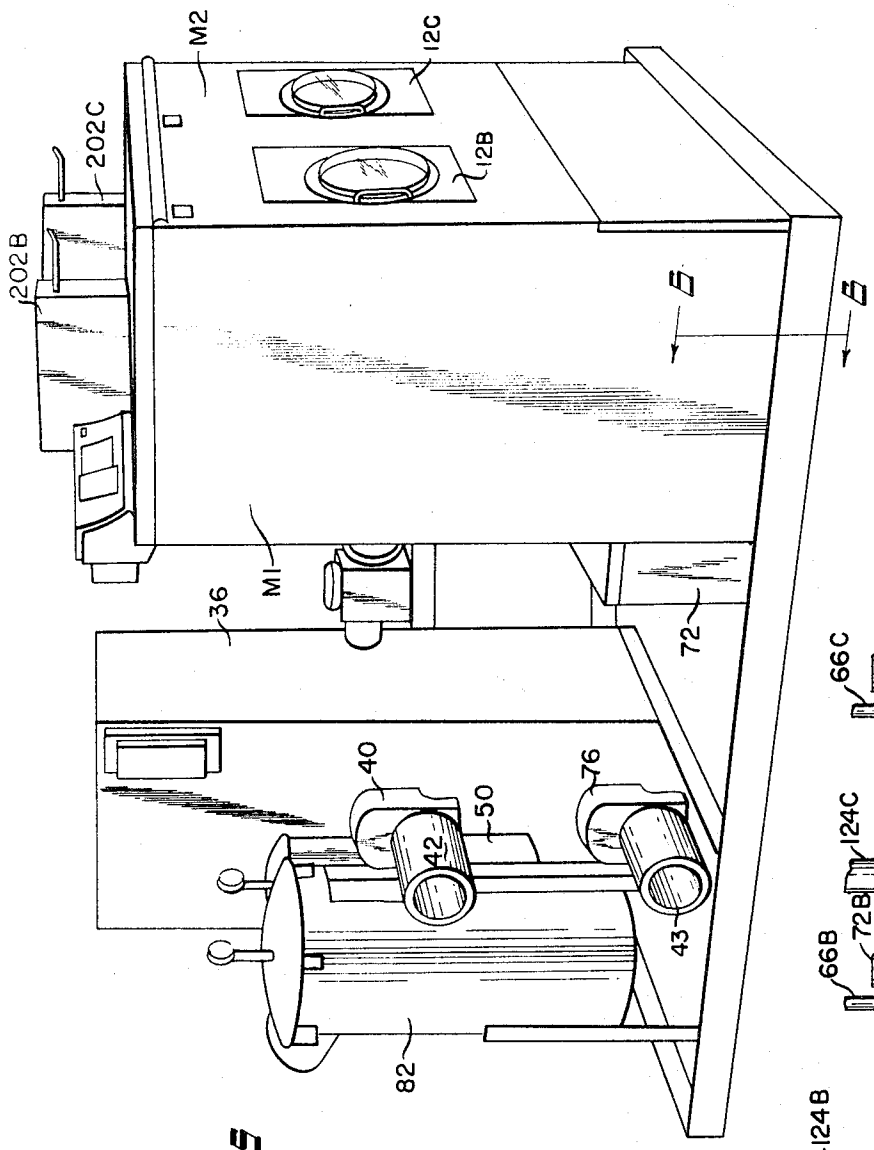

FIG. 3

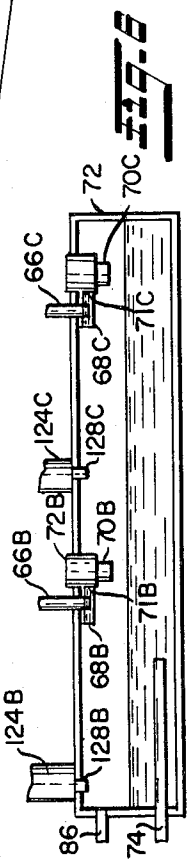

FIG. 8

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DRY CLEANING APPARATUS

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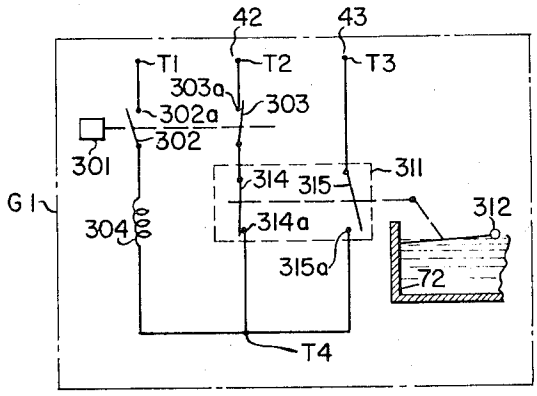

Fig. 7

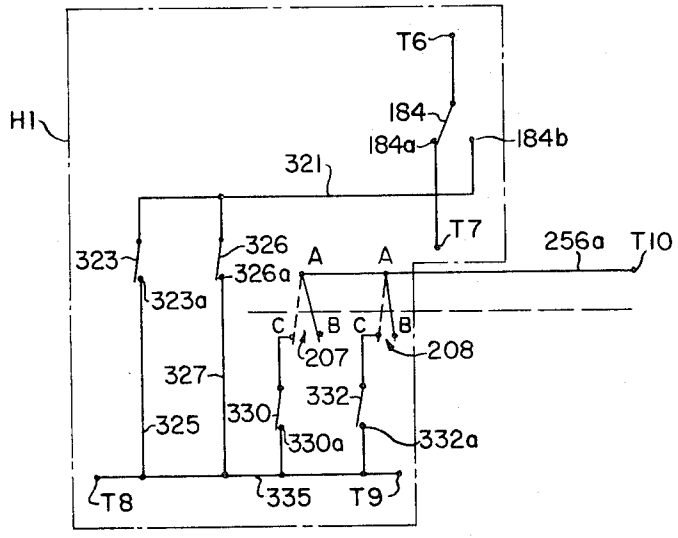

Fig. 8

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DRY CLEANING APPARATUS

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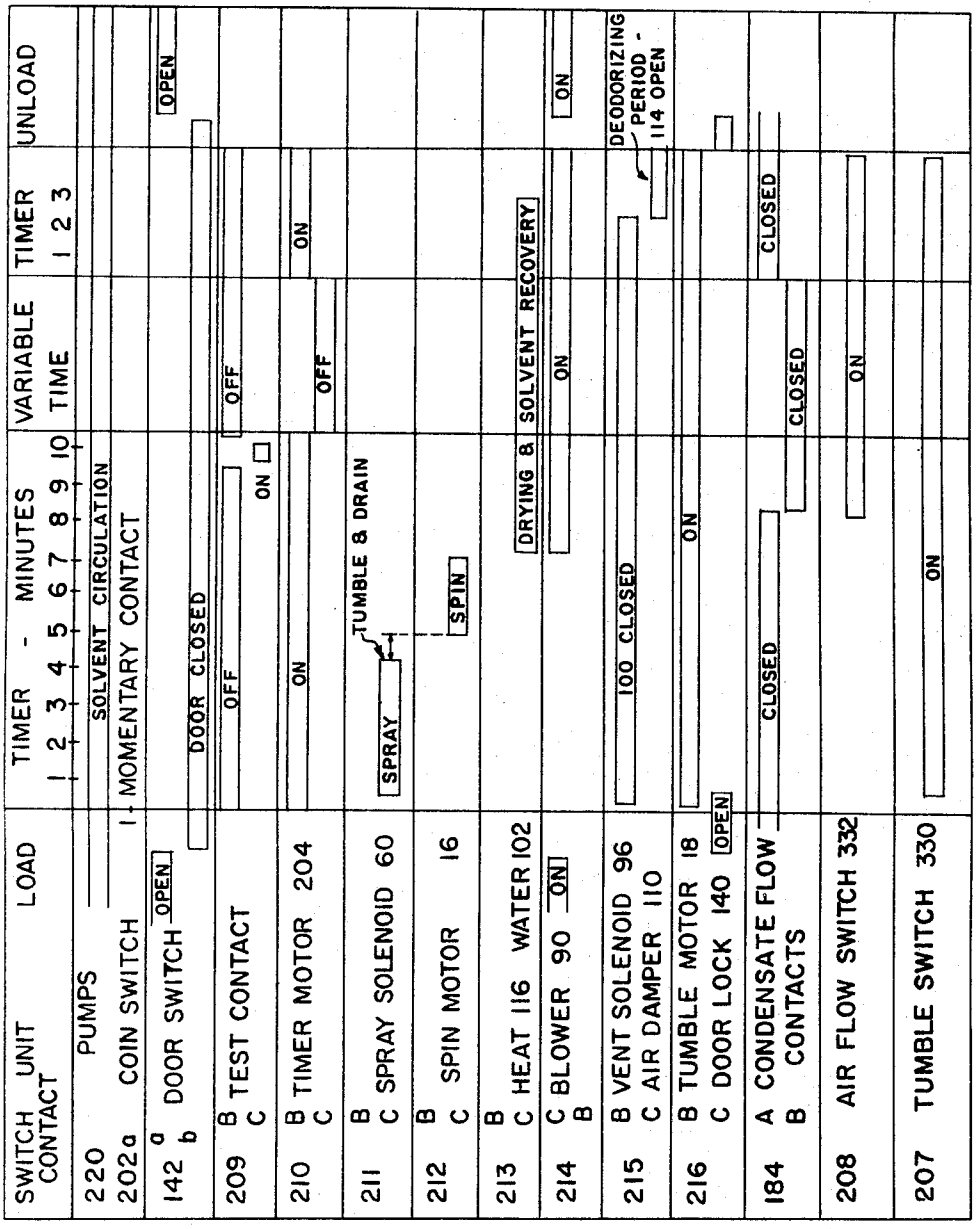

FIG. 9

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United States Patent Office 3,388,567 Patented June 18, 1968

3,388,567

DRY CLEANING APPARATUS

Joseph F. Oles, Richmond Heights, Ohio, assignor to White Consolidated Industries Inc., a corporation of Delaware

Original application Dec. 24, 1963, Ser. No. 333,033, now Patent No. 3,246,493, dated Apr. 19, 1966. Divided and this application Apr. 14, 1966, Ser. No. 562,983
3 Claims. (Cl. 68—18)

ABSTRACT OF THE DISCLOSURE

Automatic safety controls for dry cleaning machines in which cleaning fluid or solvent is circulated through a rotating clothes drum, the safety controls initiating an automatic shutdown and alarm sequence when any of several conditions are detected which indicate failure of the solvent recovery to progress normally or upon failure of the drum to rotate at proper speed.

This application is a division of copending application, Ser. No. 333,033 filed Dec. 24, 1963, now Patent No. 3,246,493, for Dry Cleaning Apparatus.

This invention relates to dry cleaning machines and more particularly to control apparatus for such machines and apparatus for handling the cleaning fluid, commonly called solvent, at the completion of a dry cleaning operation.

In general, automatic dry cleaning machines include tumblers, blowers, solvent condensers, heaters and the like, controlled by a sequence timer the operation of which may be initiated manually or, in commercial machines, by the deposit of a coin.

The sequence timer then operates the apparatus automatically through the complete cycle, a portion of which includes the extraction and recovery of the solvent from the load. As is well known in the art, the solvent recovered from the load contains excessive amounts of water as well as solid impurities.

Thus, to assure efficient operation of the apparatus it is necessary to recover the optimum amount of solvent from the load and to purify the solvent by the removal of water and solid impurities before the solvent is returned to a reservoir for use in a subsequent cleaning cycle.

The optimum time required to recover the solvent varies considerably as a function of a number of variables including the weight of the load, the absorbency of the exposed area of the load, the temperature of the work chamber and other factors. If the cycle is too long the load may be overdried and damaged. Accordingly, the length of the extraction and recovery cycle must be automatically varied to avoid either of these two undesirable results.

One proposal for effecting automatic variation of the extraction and recovery cycle is disclosed in co-pending application Ser. No. 186,440, filed Apr. 10, 1962, for Coin Operated Dry Cleaning System. The apparatus disclosed in that application includes a device responsive to the flow of solvent during the recovery cycle which is effective to disable the automatic timer until the solvent flow diminishes to a point which indicates that the drying and solvent recovery process has been completed at which time the fixed timing operation is continued. While experience has shown that the operation of this prior apparatus is satisfactory in principle, nevertheless, it is difficult and expensive to manufacture, is relatively bulky and requires excessive maintenance.

It is accordingly, an important object of the present invention to provide improved solvent recovery apparatus

for dry cleaning machines which overcomes the above stated problems encountered with prior devices and which is of simplified, compact construction which may be manufactured and assembled at substantially reduced cost.

It is also an object of the present invention to provide improved solvent recovery apparatus which affords an extended maintenance-free service life.

It is a further object of the present invention to provide improved solvent recovery apparatus which may be disassembled and reassembled easily for cleaning, inspection or repair.

It is an additional object of the present invention to provide improved solvent recovery apparatus in which water and particles of varying specific gravity, including those which are lighter than water and heavier than solvent, are removed and either carried to a convenient point of disposal or collected in a convenient accessible position within the apparatus.

It is also an object of the present invention to provide improved solvent recovery apparatus for dry cleaning machines including a control for determining the length of the recovery cycle, the control having a considerably greater sensitivity than units heretofor available.

The dry cleaning fluid or solvent, usually perchlorethylene, is, in some instances, toxic or irritating and it is accordingly necessary that precautions be taken to prevent the escape of the fluids or fumes from the apparatus either during normal operation or abnormal operation.

In accordance with the present invention the solvent storage tank is separated from the dry cleaning apparatus by one or more novel traps which prevent the escape of fumes into the machine itself. The novel arrangement of the storage tank system and the trap system is such that in multiple dry cleaning machines served by a common storage and filtration system the solvent fumes cannot pass from one machine to the other.

Provision is also made in the present invention to automatically exhaust any residual fumes which may be in the dry cleaning housing when the door of the machine is opened for purpose of loading or extracting clothes.

It is accordingly an important object of the present invention to prevent the loss or escape of solvent in liquid or vapor form under all conditions of operation of one machine or set of multiple machines.

It is a further important object of the present invention to provide unique automatic safety controls which are effective to prevent damage to the machine or to the clothes being treated in the machine upon malfunction of one or more of the operating components of the machine.

More specifically, the present invention contemplates the provision of automatic safety controls which initiate an automatic shut down and alarm sequence when any of several conditions are detected which indicate failure of the solvent recovery to progress normally or upon failure of the clothes drum to rotate at proper speed. It is a feature of the invention that whenever the mechanism is automatically stopped due to malfunction of one of the components the door is held in locked position and can be opened only by an attendant with a key.

Additional objects and advantages will become apparent as the description proceeds in connection with the accompanying drawings in which:

FIGURE 1 is a diagrammatic illustration of a dry cleaning apparatus incorporating the present invention;

FIGURE 2 is an electrical diagram of the control circuit for the apparatus of FIGURE 1;

FIGURE 3 is an enlarged vertical central section of the solvent recovery apparatus shown removed from the remainder of the apparatus;

FIGURE 4 is a top plan view of the apparatus of FIGURE 3;

FIGURE 5 is a perspective view of a two-machine unit;

FIGURE 6 is a fragmentary vertical section taken along line 6—6 of FIGURE 5;

FIGURE 7 illustrates a terminal block adapted to be substituted for terminal block G in FIGURE 2;

FIGURE 8 illustrates a terminal block adapted to be substituted for terminal block H in FIGURE 2; and

FIGURE 9 is a time-operation chart graphically depicting the operational sequences of this dry cleaning apparatus.

As shown in FIGURE 1, the main housing of the dry cleaning machine, indicated generally at **10**, encloses a perforated tumbling and spinning drum **22** accessible through a door **12**. Drum **22** is supported on a shaft **14** which may be driven at either high speed by motor **16** or at low speed by motor **18**.

Attached to shaft **14** is a large diameter driven pulley **20**. Motor **16** drives a small pulley **24** and a larger pulley **26** while motor **18** drives a single small pulley **30**. The sizes of the pulleys are relative, depending on motor speed and the speeds at which drum **22** is to be driven.

Pulleys **24** and **20** are connected by belt **32**, while pulleys **28** and **26** are connected by belt **34**. Pulley **26** incorporates an overrunning clutch (not shown) arranged to transmit power from motor **18** to shaft **14** and to prevent power transmission in the reverse direction.

When only motor **18** is energized, drum **22** will be rotated at a low speed. When motor **16** is energized, drum **22** will be rotated at high speed whether motor **18** is running, or not. The door **12**, hinged at **132**, is closed by lock **134** having bolt **136** spring biased into engagement with hasp **138**. Lock **134** is unlocked only either by energization of solenoid **140** at the end of the cycle or in an emergency by a key retained by an attendant. Solenoid **140**, when energized, withdraws bolt **136** from hasp **138** and permits door **12** to be opened. The circuit is arranged so that solenoid **140** is energized only after the cycle is completed and door **12** is kept locked throughout the complete machine cycle. Door switch **142** allows the machine to be started only when door **12** is closed.

Air and solvent circulation

Dry cleaning solvent **35** is contained in tank **36** which may hold 65 gallons and is pumped from tank **36** through conduit **38** by pump **40** driven by motor **42** which generally runs continuously while the machine is activated for use.

Solvent is continuously circulated through conduits **44**, **46** and **48**, carbon filter unit **50** and conduit **52** back to tank **36**, the carbon filter clarifying the solvent. Conduit **46** is also connected via pressure relief valve **54** and conduit **56** to the top of tank **36**. Valve **54** is normally closed, but opens if pressure in line **46** becomes excessive and allows solvent to flow through line **56** to return to tank **36**.

A conduit **58**, forming an extension of conduit **44** is connected to a nozzle **62** extending through the front panel **64** of housing **10**. When normally closed solenoid valve **60** in conduit **58** is energized, solvent will be sprayed out of nozzle **62** onto the clothes in drum **22** and will drain into the bottom of housing **10**, then through conduit **66** to vapor trap **68**, overflowing through lint screen **70** into base tank **72**. Solvent liquid level in trap **68** is maintained above the bottom outlet of conduit **66** by wall **71**. This vapor trap prevents travel of solvent fumes upwardly from tank **72** into housing **10** and out door **12**. As liquid flows over wall **71**, it drops down into screen type lint trap **70** before flowing down into tank **72**. Trap **70** is removably mounted inside tank **72** so accumulated lint can be cleaned therefrom.

From the bottom of tank **72**, solvent is pumped through return conduit **74** by pump **76** driven by motor **43** through check valve **78** and line **80** to filter **82**, from which solvent flows through conduit **84** to the top of tank **36**. Overflow conduit **86** connects the upper part of tank **36** with the interior of tank **72**.

The upper interior of housing **10** is connected through screen **88** to the inlet of blower **90** driven by motor **92**. The blower outlet is connected to a two-way damper **94** controlled by solenoid **96**. When the solenoid **96** is deenergized, the output of the blower is vented to the outside atmosphere. When the solenoid is energized, damper **94** is moved from the position shown in full lines to the dotted line position where it blocks outlet **100** and permits the blower to blow air and vapor from housing **10** through condenser **98**.

Condenser **98** is cooled by water flowing through coil **102**, the flow being controlled by solenoid valve **104** which opens when energized. Air and uncondensed vapor leaving condenser **98** are blown through duct **106**, past a two way damper **108** and through a heater **112**. Damper **108** is normally in the position shown in full lines, in which position it closes fresh air inlet **114**. When solenoid **110** is energized, damper **108** assumes the dotted line position, where it blocks flow through duct **106** but opens inlet **114** to admit fresh air to heater **112**.

Air and/or vapor from the heater **112** passes through duct **120** connected through front **64** of housing **10**, through the interior of drum **22** and housing **10** to blower **90**.

When condenser **98** is in operation, condensate flows into the lower portion of the condenser and drains through conduit **122** into separator **124** where water is separated and carried off through outlet **126**. The condensed solvent flows through drain **128** to tank **72**.

Water separator

One of the features of the present invention is the apparatus for separating water from the returning condensed solvent and the means for continuing the solvent extraction and condensation until the clothes are entirely dry, the time required varying with the type of clothes being cleaned.

As shown in FIGURES 3 and 4, separator **124** comprises an elongated cylindrical housing member **144** welded at its bottom end to angles **147** and bottom cover plate **146** which is bolted by angles **147** to the top wall of storage tank **72** so that separator **124** can be removed from tank **72** for servicing. At its upper end, the housing member **144** is closed by a removable cover plate **148**, normally held in place by the friction of an O-ring **150**. The cover plate **148**, which is provided with a small vent **152** to prevent any possible siphoning action, has soldered thereto cylindrical barrier tube **154** which projects downwardly into the interior of the housing member **144** in concentric relation therewith. A solvent recovery tube **156** extends through a central opening in the base plate **146** to which it is welded and is in direct communication with stub pipe **128** welded to base plate **146** and leading into the interior of the solvent storage tank **72**. At its upper end, the tube **156** provides an overflow rim **158**.

A tube **160** is positioned concentrically around the recovery tube **156** by a divider plate **162**, the outer periphery of which is sealed against the housing member **144** by an O-ring **164**. The plate **162** is welded to the tube **160** to maintain the parts in proper position. The lower end of the tube **160**, which rests on the upper surface of the bottom closure plate **146**, is provided with a plurality of ports **166** for a purpose to appear. The assembly is completed by a cylindrical fine mesh screen **168**, the lower end of which rests by its own weight on a sealing felt washer **170**. The unit is initially primed by filling the space formed above the divider plate **162** to the level of the overflow rim **172** provided by the top of the tube **160**.

The condensed solvent collected from the bottom of the condenser **98** passes by gravity through conduit **122** into the annular space between the housing **144** and the barrier tube **154**, thence around the bottom of the bar-

rier tube and through the screen 168, displacing solvent over the overflow rim 172 for passage through the ports 166 into the annular air bell formed in the space between the plates 146 and 162 and tubes 144 and 160.

Since the specific gravity of water is considerably less than that of a solvent, any water (which is extracted from the load and from the atmosphere) collects at the top of the solvent outwardly of the barrier tube 154. When sufficient water has been collected in this area, it passes outwardly from the apparatus through the water outlet tube 126 to any convenient point of disposal. Solvent entering the air bell through the ports 166 will be delivered to the solvent storage tank 72 at a controlled rate through an orifice 174 in the bottom closure plate 146, the rate of delivery being a function of the orifice diameter and the pressure head at the upstream side of the orifice. As solvent continues to flow into the air bell, the pressure therein increases. This pressure is communicated through a pipe 176 and a flexible hose 178, to a switch operator 180 having an actuator plunger 181 moved by a diaphragm 182. When the pressure in the air bell reaches a predetermined level, the diaphragm 182 and the plunger 181 will be displaced upwardly to open contact 184*a* of which 184 and to close contact 184*b* of switch 184 which, as described below, modifies the operating cycle of the dry cleaning apparatus.

As the condensate flow rate diminishes, indicating completion of the drying and solvent recovery cycle, the pressure developed in the air bell will diminish to a level which will permit the diaphragm 182 to return to its normal position to reclose contact 184*a* of the switch 184 to permit continuation of the programmed cycle and to re-open contact 184*b*.

In normal operation, the condensate flow rate, particularly during the initial portions of the recovery cycle, will be great enough to require an additional flow passage. This is provided by the solvent recovery tube 156 which has an overflow rim 158 higher than the primary overflow rim 172 and directs the excess solvent into the storage tank 72. It is to be noted that any dirt or other impurities which are lighter than water will be carried off through the water disposal pipe 126. Impurities which are heavier than the solvent will be prevented from passing to the orifice 174, or to the storage tank 72, by the fine mesh screen 168 and will gradually collect on the upper surface of the divider plate 162.

The construction of the separator apparatus is such that it may be easily cleaned at desired intervals. When the top cover plate 148 is axially removed from housing member 144, it carries the barrier tube 154 with it, exposing the screen 168 which may be removed for cleaning. Removal of the screen permits access to the upper end of the tube 160 which may be lifted out of the apparatus carrying the divider plate 162 and washer 170 with it to permit removal of any impurities collected on its upper surface. After cleaning, the parts may be quickly and easily reassembled.

General operation

The overall operation of the machine is depicted graphically in FIGURE 9.

The operation of the machine is controlled primarily by a series of single pole double throw microswitches 209–216 operated by a series of cams mounted on a shaft driven by a timer motor 204. Since the cams and shaft are conventional they have been omitted. Each microswitch has a terminal A and contacts B and C to which terminal A is alternately connected as required to energize the elements of the mechanism in proper sequence to perform the required cycle of operations. Terminal block H1 (FIGURE 8) adds two additional timer controlled switches 207 and 208.

The machine is loaded with clothes through door 12, the door is closed and the machine put into operation by inserting coins in coin box 202 to start timer motor 204. Tumbling by motor 18 starts immediately, followed a few seconds later by a four minute spray of solvent through nozzle 62 at approximately seven gallons per minute. A short tumble and drain period is followed by a two minute spin by motor 16 at approximately 265 r.p.m. At the end of the spin period, blower 90, condenser water in coil 102, the heater 116 are turned on, blower 90 circulates about 175 c.f.m. through the load, and 2.6 g.p.m. of water flows through condenser 98.

This starts drying of the clothes and condensation of the solvent which causes switch contact 184*a* to open as previously explained. At the end of 3½ minutes timer motor 204 stops until drying is completed, the reduced rate of condensation causing switch contact 184*a* to reclose which restarts the timer motor. Drying then continues for an additional two minutes. Following is a two minute deodorizing period during which fresh air is blown through the clothes and out of the vent. Tumbling is continued throughout the drying and deodorizing periods.

Electrical circuits and operation of controls

A three-wire supply circuit has a potential of 230 volts across outside line L1 and L3 and 115 volts from center line L2 to either outside line L1 or L3.

When the apparatus is completely shut down, it is in the condition shown in FIGURE 2.

Terminal block G (FIGURE 2) may also take the form of block G1 (FIGURE 7). Terminal block H (FIGURE 2) may be of the form of block H1 (FIGURE 8).

When block G is used, manually closing switches 218 and 219 drives circulating pumps 40 and 76 by energizing motors 42 and 43 since terminals T2 and T3 are internally connected to T4. It is often desirable to keep pump 76 in operation to filter the solvent even when the dry cleaning machine is not running.

Block G1 may be used in place of block G to provide more sensitive control of the machine after switches 218 and 219 are manually closed and to control the level of solvent in tank 72.

If the solvent is too high, rising float 312 (pivoted to the wall of 72) opens contact 314*a* (FIGURE 7) in float switch 311 to stop pump 40 by de-energizing motor 42 by breaking the circuit between terminals T2 and T4.

If the solvent level is too low, falling float 312 opens contact 315*a* to stop pump 76 by de-energizing motor 43 by breaking the circuit between terminals T3 and T4. This prevents air from being drawn into filter pump 76 and may also serve as a warning of either a low solvent level in the machine or clogging of filter 82.

Switches 314 and 315 may be operated by separate cams to control each switch individually or by a lost motion linkage so a wide variation in level is permitted before switch contact 314*a* or 315*a* is opened so that both pumps will usually be in operation. When solvent level is within proper limits, both switch contacts 314*a* and 315*a* are closed.

If tank 36 is filled with solvent 35 to the top of overflow pipe 86 during continuous operation to return the solvent to tank 72, pump 76 will remain in operation to filter the solvent to provide clean filtered solvent for the next cleaning operation even when the dry cleaning machine is not running through a timed cleaning cycle.

Mechanism associated with block G1 also maintains the solvent at a given temperature. The temperature of the solvent in tank 36 is preferably kept within the 70°–78° F. range. When 78° F. is reached, a temperature sensitive element 301 closes contact 302*a* of switch 302 to energize solenoid 304 opening a valve 305 to permit cooling water to circulate through coil 306 in tank 36. After the solvent has been cooled sufficiently, contact 302*a* opens, and cooling water circulation stops. If the solvent temperature exceeds 80° F., element 301 opens a normally closed contact 303*a* of switch 303 to prevent

damage to clothes in drum 22 by de-energizing motor 42 so that pump 40 cannot deliver any more solvent through nozzle 62 to the clothes until this condition is corrected.

When door 12 is opened to load drum 22 with clothes, blower 90 draws fresh air through open door 12 and blows it out exhaust outlet 100. More specifically opening door 130 energizes blower 90 by closing door switch contact 142*a* to complete a circuit from line L1 through line 230, closed contacts 228*b* and 228*e* of fail-safe relay 228, line 234, door switch contact 142*a*, line 238, blower motor relay coil 240 to close its normally open contact 240*a*, blower motor 92, and line 242 to line L2. De-energized solenoid 96 positions damper 94 in its solid line position.

When the door is closed after the machine has been loaded, contact 142*a* is opened and contact 142*b* is closed to energize relay 268 by forming a circuit from line L1 to line 234 contact 142*b*, line 283, closed contact 216*c* of switch 216, line 272, relay coil 268 and line 270 to line L2.

Energizing relay coil 268 closes its normally open contact 268*b* to energize door latch solenoid coil 140 by closing a circuit from line L1 to contact 142*b* and then through line 283, line 282, normally closed contact 264*d* of relay 264, line 265, door solenoid coil 140, line 266, normally open contact 268*b*, now closed by its energized relay coil 268, and line 270 to line L2. Energized door latch solenoid coil 140 holds bolt 136 out of engagement with hasp 138 so that the door can be opened by the operator at any time until the machine is started.

After the operator finishes loading the clothes into drum 22 and closes door 12, the operator inserts the required coins in coin switch box 202. This action energizes start relay coil 264, energizes timed motor 204 to provide the timing action for the cleaning cycle, forms a holding circuit to maintain start relay coil 264 energized after the coin-actuated switch opens, and starts drum 22 to rotate to tumble the clothes therein.

More specifically, closing contact 202*a* of coin box 202 energizes start relay coil 264 by forming a circuit from line L1 to door switch contact 142*b*, and then through line 283, line 280, closed contact 202*a*, line 278, relay coil 264, line 266, closed contact 268*b* and line 270 to line L2.

Energizing start relay coil 264 closes relay contacts 264*c* and 264*e* to energize timer motor 204 and a holding circuit for relay 264.

Timer motor circuit is formed from line L1 through relay 228, contact 142*b*, and then through line 276, normally open relay contact 264*e* closed by its energized relay coil 264, line 262, normally closed timer contact 210B, line 250, timer motor 204 and line 254 to line L2.

The holding circuit is formed to keep start relay coil 264 energized before coin-actuated switch contact 202*a* opens. Closing relay contacts 264*c* and 264*e* forms the holding circuit from line L1 to door switch contact 142*b* and then through line 283, line 282, normally open relay contact 264*c* closed by its energized relay coil 264, closed relay contact 264*e*, line 276, relay coil 264, line 266, closed relay contact 268*b*, and line 270 to line L2.

Tumble motor 18 is energized by either of the circuits from line L1 to closed contact 264*c* of relay 264 and then through line 262, line 256, line 258, motor 18 and line 260 to line L2. Energization of motor 18 rotates drum 22 to tumble the clothes therein.

The timer now moves switch 215 from contact C to contact B to energize damper solenoid 96 to close exhaust 100 and to de-energize damper solenoid 110 to close exhaust 114 by damper 109.

A few seconds later, timer motor 204 moves switch 216 from contact 216C to contact 216B and switch 211 from contact 211B to contact 211C.

Opening contact 216C de-energizes relay coil 268 to open normally open relay contact 268*b* to de-energize door latch solenoid 140 to lock door 12 and to break the holding circuit de-energize relay coil 264 to open contacts 264C and 264*e* and close normally closed contacts 264*d* and 264*f*. Relay contact 264*e* is also opened but motors 204 and 18 remain energized by a circuit described below.

Timing motor 204 is kept energized by closed contact 216B forming a holding circuit from line L1 through contact 228*b* and 228*e* of relay 228 to line 283 and then through closed contact 216B, line 256, closed contact 210B, line 250 timer motor 204 and line 254 to line L2.

Tumble motor 18 is kept in operation by closed contact 216B forming a holding circuit from line L1 to closed contact 216B and then through line 258, motor 18 and line 260 to line L2.

Solenoid valve 60 is opened to spray solvent on the clothes through nozzle 62 when timer motor 204 closes contact 211C to form a circuit from line L1 to line 256 and then through closed contact 211C, line 284, solenoid valve 60 and line 286 to line L2 to energize and open solenoid valve 60.

Now a solvent drain period occurs. After four minutes of spray by nozzle 62, timer motor 204 causes switch 211 to open contact 211C to stop solvent spray through nozzle 62. Then, solvent drains from the clothes as they are tumbled by motor 18 for about one-half minute following cutoff of spray through nozzle 62.

Following the drain period, solvent extraction begins. Now, timer motor 204 energizes spin relay 226 to energize spin motor 16 to spin drum 22 at 265 r.p.m. to extract solvent from the clothes by centrifugal force.

Spin relay 226 is energized by timer motor 204 opening contact 212B and closing contact 212C. Closing contact 212C forms a circuit from line L1 to line 256, closed contact 212C, line 288, spin motor relay coil 226 and line 290 to line L2. This energizes spin motor relay 226 and closes its relay contact 226*a*. Closing relay contact 226*a* energizes spin motor 16 by forming a circuit from line L1 through line 225, contact 226*a* and motor 16 to line L2.

After two minutes of spinning, spinning stops and solvent recovery begins. At this time timer motor 204 closes contacts 212B, 213C and 214C and opens contacts 212C, 213B and 214B to de-energize spin motor 16 to discontinue spinning; to energize solenoid 104 to cause water to flow through condenser coil 102; to energize relay coil 118 to energize heating coil 116; and to energize blower motor 92 to circulate air and solvent vapor by blower 90 for drying the clothes in drum 22 and recovering the solvent vapor. However, tumbling continues because tumble motor 18 has remained energized throughout the spin period.

Closing contact 213C forms a circuit from line L1 to line 256, contacts 213C, line 292, and parallel circuits to line L2 through normally closed thermostat 117 and heater relay 118 and through condenser water solenoid 104. Energizing relay coil 118 closes contacts 118*a* and 118*b* to energize by 230 volts heating coil 116 from line L1 through normally open contact 18*a* (back contact of the starter for motor 18) closed when motor 18 is energized, normally open relay contact 118*a* now closed by its energized relay coil 118, heating coil 116, normally open relay contact 118*b* now closed by its energized relay coil 118, and normally closed thermal overheat switch 119 to line L3. Heater 112 incorporates heating coil 116 controlled by thermostat 17 to maintain air leaving blower 90 at 150° F. when heater 112 is on. Overheat switch 119 disconnects coil 116 when heater 112 exceeds 255° F. Back contact 18*a* of motor 18 assures that heating coil 116 will not be on to heat damage the clothes if tumble motor 18 is not running.

Closing contact 214C forms a circuit from line L1 to line 256, contact 214C, blower motor relay coil 240 to close its normally open contact 240*a*, blower motor 92 and line 242 to line L2. Now, blower 90 circulates air

and solvent vapor from housing 10 through condenser 98, where most of the solvent is condensed; and circulates air and uncondensed vapor through duct 106 and heating coil 116 so that heated gases are returned to the inside of drum 22 through nozzle 120 for recirculation through the clothes in drum 22 to absorb more vapor therefrom before re-entry into blower 90.

Solvent recovery now takes place. Solvent condensate flows from condenser 98 through conduit 122 and separator 124 to tank 72, as previously explained. Solvent recovery takes place in two different periods: (1) a timed solvent recovery period controlled by timer motor 204 and (2) a variable time solvent recovery period controlled, independently of timer motor 204, by the solvent recovery rate acting on pressure sensitive switch 184.

During variable solvent recovery, the machine is controlled by switch 184 with either the terminal block H in FIGURE 2 or the block H1 in FIGURE 8. Block H will be used for the remainder of this description, and the use of block H1 will be described hereafter under the heading "Safety Features."

During the timed recovery period, solvent recovery test contact 209C is momentarily closed by timer motor 204 to determine whether or not solvent recovery is taking place properly to guard against failure of the apparatus by such causes as lack of circulation of cooling water through condenser 98 or failure of blower 90 to operate. The electrical controls and timer circuits are so arranged that normally closed flow switch contact 184*a* must be opened or tripped within a predetermined time after drying and solvent recovery starts to indicate proper operation of the solvent recovery and drying systems. If solvent recovery is not taking place properly, the flow switch contact 184*a* is not opened or tripped within this time period, an electrical pulse energizes fail-safe relay 228, the machine is shut down, and alarm signal 235 is actuated.

If the solvent recovery is taking place properly, the machine proceeds into the variable time solvent recovery period. Then, when switch 184*a* closes, it indicates that solvent recovery is complete so that control of the machine cycle is then again returned to timer motor 204 to start the next operation.

The operation of test contact 209C will now be considered in more detail. If solvent condensation and recovery is proceeding normally, switch 184 will open contact 184*a*. After three minutes of this timed solvent recovery period, timer motor 204 momentarily closes solvent recovery test contact 209C. Then, either of the following two modes of operation will occur.

First, if contact 184*a* has not opened, this action would indicate that alarm signal 235 should be sounded and the machine shut down because solvent recovery was not taking place properly. This would occur if there were no water flowing through condenser coil 102 or if blower 90 failed to operate. Then, when switch 209 closes contact 209C, fail-safe relay 228 is energized by forming a circuit from line L1 through line 230, normally closed contact 228*b*, line 244, terminal T6, closed contact 184*a*, terminal T7, line 246, contact 209C, line 229, fail-safe relay coil 228, line 231, and normally closed push button switch 233 to line L2.

Now, the Machine-Shut-Down-and-Alarm-Circuit Sequence starts. Energizing relay coil 228 opens contacts 228*b* and 228*e* of relay 228 to break circuits through line 234 to de-energize damper solenoid 96, timing motor 204, tumble motor 18, water solenoid 104, heater relay 118 and blower motor 92. De-energizing heater relay 118 de-energizes heating coil 116 and the machine is shut down.

Energizing relay coil 228 also closes contact 228*d* of relay 228. Closing contact 228*d* holds relay coil 228 energized and energizes alarm signal 235 by forming a holding circuit from line L1 through line 230, closed contact 228*d* relay coil 228, line 231 and switch 233 to line L2 to keep relay coil 228 energized after contact 228*b* is opened. A circuit is also completed from line L1 through line 230, contact 228*d*, line 229, terminals T8 and T9, line 237 and alarm signal light 235 to line L2 to cause signal 235 to be energized.

To restore operation, the operator must: open contact 209C by rotating timer motor out of test fire position and manually open push button switch 233 momentarily to de-energize fail-safe relay coil 228 and to de-energize alarm signal 235 by opening contact 228*d*. Then, contacts 228*b* and 228*e* return to their normal closed position to remake any necessary circuits to continue the operation of the machine from the new timer setting. This is the end of the Machine - Shut - Down - and - Alarm - Circuit-Sequence.

If condensate recovery is proceeding normally, the rate of flow of the condensed solvent will open switch contact 184*a*. Then, closing of test contact 209C momentarily will not affect the operation of the machine.

At the end of the timed solvent recovery period, drying is usually not complete and the solvent flow will normally maintain contact 184*a* open. Now, the machine enters the variable time solvent recovery period. At this time, timer motor 204 opens contact 210B and closes contact 210C. Opening contact 210B de-energizes and stops timer motor 204. Switch 184 controls the machine's cycle during the variable time solvent recovery period. Hence, timer motor 204 is stopped until drying is complete and contact 184*a* closes in response to the decrease in solvent recovery flow to indicate that the clothes are substantially dry and that solvent recovery is substantially complete.

Closing contact 184*a* energizes timer motor 204 by forming a circuit from line L1 through line 230, contact 228*b*, line 244, terminal T6, contact 184*a*, terminal T7, line 246, contact 209B, line 248, contact 210C, line 250, timer motor 204 and line 254 to line L2. As timer motor 204 rotates, it opens contact 210C to break the circuit just described and to close contact 210B. Closing contact 210B maintains timer motor 204 energized by forming a circuit from line L1 through line 230, contact 228*b*, line 232, contact 228*e*, line 234, contact 142*b*, line 283, contact 216B, line 256, contact 210B, line 250, timer motor 204 and line 254 to line L2.

Now, solvent recovery stops and the clothes are deodorized. Two minutes after rotation of timer motor 204 resumes, heating coil 116 is de-energized and water through condenser coil 102 is shut off since solvent recovery is complete. The clothes are deodorized by energizing solenoid 110 and de-energizing solenoid 96 to allow dampers 108 and 94, respectively, to open ports 114 and 100 for exhausting air and vapor from housing 10 and drum 22 as the clothes continue to be tumbled by energized tumbling motor 18.

To accomplish this, timer motor 204 opens contacts 213C and 215B and closes contacts 215C and 213B. Opening contact 213C de-energizes and closes solenoid valve 104 and de-energizes relay coil 118 to open normally open contacts 118*a* and 118*b* to de-energize heating coil 116. Opening contact 215B de-energizes damper solenoid 96, and closing contact 215C energizes damper solenoid 110.

After two minutes of the deodorizing operation, the cycle is completed and the machine is stopped. Now, timer motor 204 and tumbling motor 18 are de-energized and stopped, door latch solenoid 140 is energized so that door 12 can be opened, and blower motor 92 is restarted to exhaust any fumes from drum 22 during the unloading and loading operations.

This is accomplished when timer motor 204 opens contact 216B, closes contact 216C, opens contact 214C and closes contact 214B. Opening contact 216B de-energizes and stops timer motor 204, de-energizes motor 18 and stops the tumbling operation, and de-energizes damper solenoid 110 to close port 114 with damper 109 in the full line position. Opening contact 214C de-energizes blower motor 92.

Closing timer switch contact 216C re-energizes relay 268 to close contact 268*b* to re-energize door latch solenoid 140, as described at the beginning of the cycle, to retract bolt 136 from hasp 138 so that door 12 can be opened. When door 12 is opened, switch 142 opens contact 142*b* and closes contact 142*a* to re-energize blower motor 92 so that blower 90 will suck air through the door opening and exhaust through open port 100 any solvent fumes from within machine housing 10 during the clothes loading and unloading operation because solenoid 96 is de-energized at open contact 216B.

The machine has now completed a cycle, and is ready for reloading and restarting by insertion of coins in coin box 202.

Safety features

When block H1 (FIGURE 8) is substituted for block H, the aforementioned mode of operation is still obtained because the connections between terminals T6 and T7 and between terminals T8 and T9 are the same in both blocks. However, the additional structure in block H1 gives the additional and desirable safety features.

These safety features, including use of test contact 209C, operate on the assumption that at the conclusion of any dry cleaning cycle, the load should be dry and free of solvent. This eliminates any health hazard to users of the machine by inhaling solvent fumes either from escape of solvent from the open door or from solvent still on clothes after removal from the machine if the solvent was not completely removed because of an operating failure of some component essential to complete solvent recovery. These safety features also operate on the assumption that a reliable indication that the operation is progressing satisfactorily to this end may be ascertained from the rate of solvent recovery condensate flow, the speed and temperature of the air flow in duct 106, the temperature of the water in condenser coil 102, and the speed of rotation of drum 22. If the rate of condensate flow is insufficient to open pressure switch contact 184*a* when test contact 209C closes or if one of the last-mentioned speed or temperature indications occur, this serves as a warning that, at the close of the cycle, the load would be found saturated with solvent. The fail-safe relay coil 228 is energized in any of the manners mentioned hereafter and door 12 remains locked except by an attendant using a key, after he sees signal alarm 235. Even if the electricity fails, de-energized door latch solenoid 140 will keep door 12 locked.

Since test contact 209C described heretofore checks the operation of the machine only momentarily and in only one portion of the machine cycle, it is desirable to check the operation of the machine more frequently so as to get safer operation. This is done by the circuits provided by block H1.

Each safety feature will be first described as to how it energizes fail-safe relay coil 228 and then all of the safety features will be described as they go into the Machine - Shut - Down - and - Alarm - Circuit - Sequence earlier described. If test contact 209C does not energize fail-safe relay 228, solvent recovery must be proceeding at a normal rate, switch contact 184*a* must be open, and switch contact 184*b* must be closed. If at any time during solvent recovery the temperature of the water in condenser coil 102 rises to an unsafe level or the temperature of the air in conduit 106 rises to an unsafe level, it indicates that the condensing action is not occurring properly. These temperatures will respectively close contact 323*a* of switch 323 or contact 326*a* of switch 326.

Switch contact 323*a* closes in response to rise in water temperature in condenser coil 102 if water fails to flow through the condenser coil or if the temperature of the cooling water is too high. Closing switch 323 energizes fail-safe relay coil 228 by forming a circuit from line L1 through line 230, normally closed contact 228*b*, line 244, terminal T6, contact 184*b*, line 321, closed contact 323*a*, line 325, terminal T8, line 229, fail-safe relay coil 228, line 231 and switch 233 to line L2.

Switch contact 326*a* may close in response to rise in air temperature for any of many reasons, including a blocked screen in the air flow path, excessive air leakage from conduit 106, etc. Switch contact 326*a* is set to close when a suitable upper air temperature limit, such as 110° F., is reached. Closing switch 326*a* forms a circuit from line L1 along the circuit just described except through closed contact 326*a* and line 327 instead of through closed contact 323*a* and line 325.

If drum 22 fails to be rotated properly during the machine cycle, the clothes may remain in a wad so as to be neither properly cleaned nor properly dried but may be laden with solvent when door 12 is opened. To guard against this type of failure, the machine has a tumble speed sensing switch 330 such as a centrifugally actuated switch, designed to close contact 330*a* if shaft 14 is either stationary or rotating at a too low speed. Timer switch 207 operated by motor 204 has its contact 207C closed shortly after switch contact 216B is closed and is opened shortly before contact 216B is opened to monitor operation of tumble motor 18 by switch contact 216B. If switch contact 330*a* closes while switch contact 207C is closed, the fail-safe relay coil 228 is energized by a circuit from line L1 to line 256 and then through terminal T10, line 256*a*, contact 207C, contact 330*a*, line 335, terminal T8, line 229, fail-safe relay coil 228, line 231, and closed switch 233 to line L2.

If blower 90 does not operate properly during solvent recovery, the clothes will be inadequately dried and laden with solvent to cause an unsafe condition when door 12 is opened. To guard against this problem, air flow sensing switch 332 is provided. This switch is in series with contact 208C which is closed by motor 204 shortly after contact 214C is closed and opened shortly before contact 214C is opened. If air flow does not exist or is below a predetermined minimum while switch contact 208C is closed, switch contact 332*a* will close to form a circuit along the same path as that for switch 330 except through closed switch contacts 208C and 332*a* instead of closed contacts 207C and 330*a*.

After fail-safe relay coil 228 is energized as above described, the earlier described Machine-Shut-Down-and-Alarm-Circuit-Sequence occurs to shut down the machine.

After repair of the defect has been made, operation may be restored by following the steps earlier described in this aforementioned sequence to restore operation.

Multiple units

Coin operated machines are preferably installed in multiples as shown in FIGURE 5. A single solvent storage and filtration system A, including only one base tank 72, storage tank 36, filters 50 and 82, and pumps 44 and 76 are provided for a pair of cleaning machines M1 and M2, each machine having its own coin switch box 202 and controls as previously described.

As shown in FIGURE 6, a single base tank 72 is located beneath machines M1 and M2. Machine M1 incorporates separator 124B, which discharges into tank 72 through drain 128B, and conduit 66B which discharges into tank 72 through air trap 68B and lint trap 70B. Machine M2 incorporates separator 124C, which discharges into tank 72 through drain 128C and conduit 66C, which discharges into tank 72 through air trap 68C and lint trap 70C.

Since the two machines may be started at different times and may be at different parts of their respective cycles at any given time, it is important that solvent vapor not be transferred from one machine to the other. The provision of liquid traps 68B and 68C prevents such transfer without need for valves. The traps 68B and 68C, lint traps 70B and 70C, etc. correspond in structure and

mode of operation to corresponding parts shown and described in FIGURE 1.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

1. Dry cleaning apparatus including a housing and a receptacle therein for clothes, and a circuit for recirculating dry cleaning solvent through said receptacle and said housing, first and second storage tanks in series in said circuit, a conduit directly connecting said housing to said first storage tank, a first pump for delivering solvent from said first storage tank to said second storage tank, a second pump for delivering solvent from said second storage tank to said housing for return to said first storage tank, means responsive to a fall in the level of solvent in said first storage tank for deenergizing said first pump, and means responsive to a rise in the level of solvent in said first storage tank for de-energizing said second pump.

2. The combination according to claim 1 together with means responsive to a rise in the temperature of said solvent above a predetermined maximum for de-energizing said second pump.

3. The combination according to claim 1 together with means responsive to a rise in the temperature of said solvent above a predetermined maximum to cool said solvent.

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