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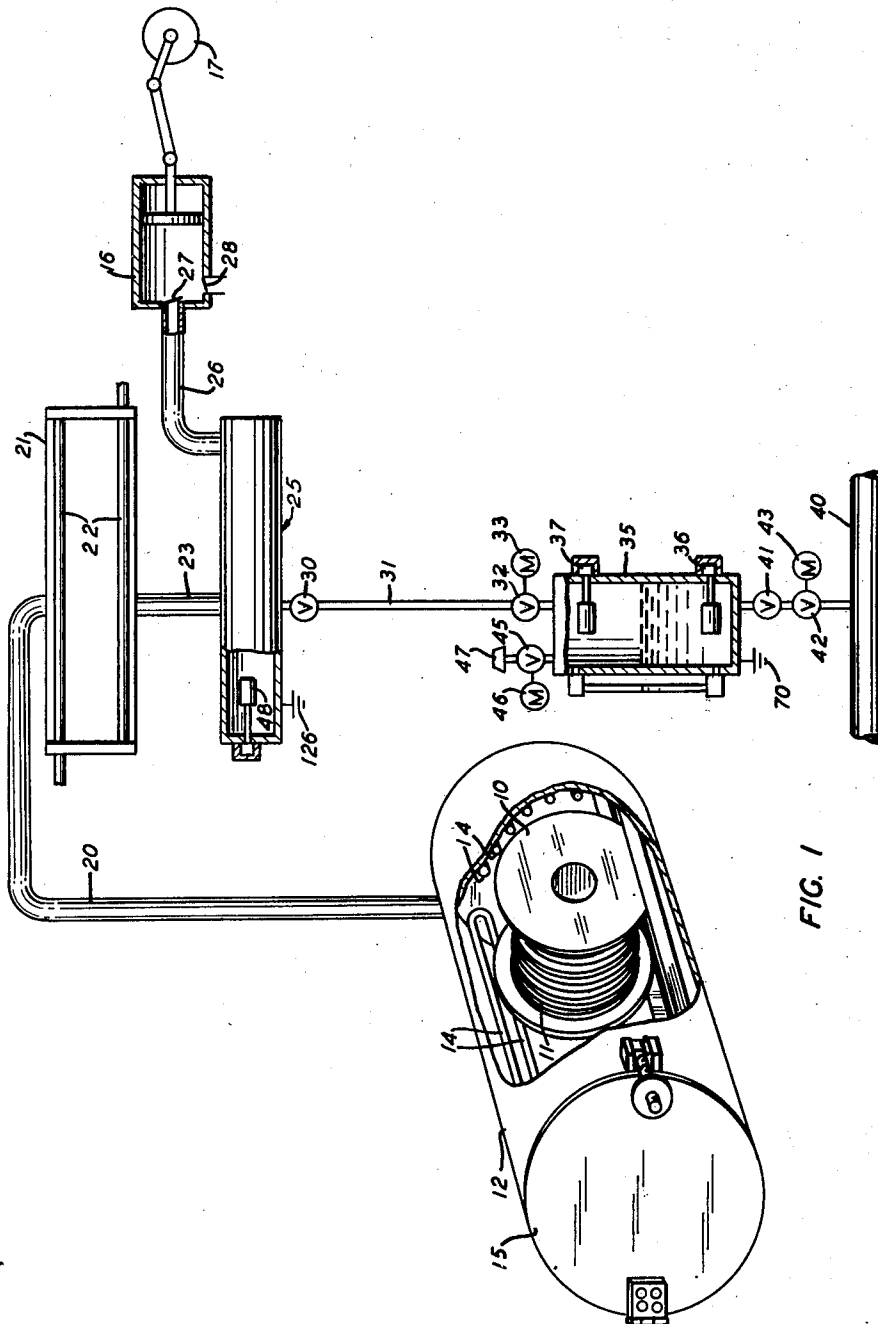


FIG. 1

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APPARATUS FOR HANDLING FLUIDS

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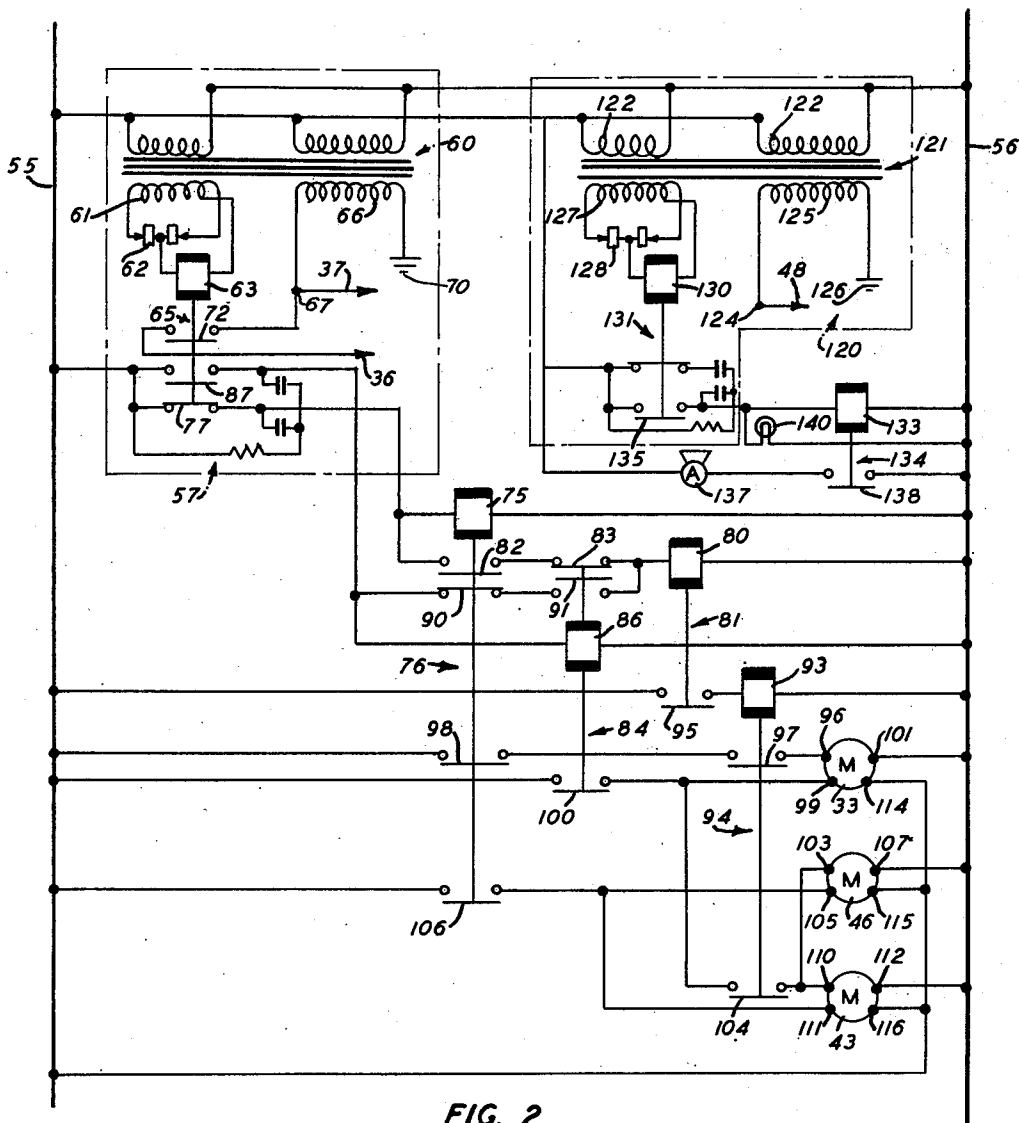


FIG. 2

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APPARATUS FOR HANDLING FLUIDS

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4 Claims. (Cl. 34—53)

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This invention relates to apparatus for handling fluids, and more particularly to automatic apparatus for discharging fluids from vacuum systems used for drying cables and the like.

In the manufacture of lead sheath cables, the cable core is placed in a heated drying oven to remove any moisture from the insulation of the core before the sheath is applied. The oven is connected to a closed vacuum system including a vacuum pump which extracts the vaporized moisture from the oven, a condenser which condenses the moisture in the extracted gas and a tank which collects the condensed moisture. In the past, it has been the practice to stop the vacuum pump at periodic intervals and to open the vacuum system to drain the condensate from the tank. This procedure usually depended upon the vigilance of an operator, and resulted in losing the vacuum in the entire system each time the condensate was drained therefrom. In addition, this method of draining the vacuum system also is inherently dangerous in that it is possible for the level of the condensate in the tank to build up to such a point that some of the condensate could be drawn into the vacuum pump and seriously damage the pump and its prime mover.

An apparatus embodying certain features of the invention may comprise a closed space having a portion designed to receive a moisture bearing article, means for creating a vacuum in the closed space to extract moisture bearing gas from the article, means for condensing the moisture in the gas as the gas travels from the closed space to the vacuum creating means, means for collecting the resulting condensate in a portion of the closed space, means for disconnecting the condensate collecting portion from the remainder of the closed space when a predetermined amount of condensate is collected therein, and means for draining the condensate from the disconnected portion while maintaining a vacuum in the remainder of the closed space.

An object of the invention is to provide new and improved apparatus for handling fluids.

A further object of the invention is to provide new and improved automatic apparatus for discharging fluids from vacuum systems used for drying cable cores and the like.

Other objects and advantages of the invention will appear from the following detailed description of a specific apparatus embodying certain features of the invention, when read in conjunction with the appended drawings, in which:

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system used for drying cable cores and embodying certain features of the invention, and

Fig. 2 is a schematic wiring diagram showing a control circuit for the apparatus shown in Fig. 1.

Referring now to the drawings, and more particularly to Fig. 1, a reel 10 having a length of cable core 11 wound thereon is positioned in an oven 12 provided with a plurality of tubes 14—14 through which high temperature steam from a supply (not shown) is passed to heat the oven to a desired temperature. A door 15 is provided on the end of the oven for making the oven airtight when the door is closed. It is to be assumed that the cable core 11 contains a plurality of insulated conductors, and may contain several layers of paper tape served spirally around the composite core to separate the core from a lead sheath to be applied over the core. The paper covering of the core must be thoroughly dry before the lead sheath is applied in order to maintain its dielectric strength at a high value. The high temperature steam passing through the tubes raises the temperature of the oven to a point at which it vaporizes any moisture in the paper covering.

The oven 12 is connected to a vacuum system for extracting the vaporized moisture from the oven at a temperature lower than the boiling point of the moisture in the insulation. The vacuum system includes a vacuum pump 16 driven by a suitable electric motor 17. When the pump 16 is operating, the moisture laden gas in the oven is extracted through a pipeline 20 into a condenser 21 having a plurality of tubes 22—22 through which a cooling liquid such as water is circulated. As the extracted gas passes through the condenser, the moisture in the gas condenses and the condensate and the gas pass through a pipe 23 to a receiver 25. The condensate and the gas separate in the receiver 25, with the condensate falling to the bottom of the receiver while the gas travels through a pipe 26 to an inlet valve 27 of the pump 16. When the pump is operated by the motor 17, each stroke of its piston to the left, as viewed in Fig. 1, draws gas from the receiver into the pump, and each stroke of the piston to the right exhausts the gas through an exhaust valve 28 into the atmosphere. The condensate flows from the receiver 25 through a manually operable valve 30, a pipe 31 and a valve 32 operated by an electric motor 33 into a metallic control tank 35.

Fig. 1 is a schematic diagram of a vacuum system 55 The control tank 35 is provided with a low

level probe 36 and a high-level probe 37 which have portions extending into the tank so as to contact the condensate when it reaches their respective level in the tank. The valve 32 controls the flow of the condensate from the receiver into the tank and is held in its open position by the motor 33 as long as the level of the condensate is below the high-level probe 37. The bottom of the tank 35 is connected to a drain pipe 40 in series with a normally open, manually operable valve 41 and a valve 42 operated by an electric motor 43. A valve 45, operated by an electric motor 46, connects the top of the tank 35 to a vent device 47. The valves 42 and 45 are held in their closed positions by their respective motors as long as the level of the condensate is below the level of the high-level probe 37. The portions of the probes 36 and 37 which contact the condensate are insulated electrically from the tank 35. The receiver 25 is provided with a probe 48 similar to the probes 36 and 37 so as to be engaged by the condensate if the condensate reaches a predetermined level in the receiver.

The motor-operated valves 32, 42 and 45 are controlled by the probes 36 and 37 and an associated level control device 57 shown in Fig. 2. This figure is a schematic wiring diagram of a control apparatus which receives potential from busses 55 and 56 connected to a source of A. C. potential (not shown). The probes 36 and 37 are connected electrically to the control device 57, which device includes a transformer 60 the primary windings of which are connected in parallel and across the busses 55 and 56. A secondary winding 61 of the transformer 60 is connected to a rectifier 62, which converts the A. C. potential generated by the winding 61 to a D. C. potential suitable for energizing a coil 63 of a relay 65. A second secondary winding 66 of the transformer 60 has one side thereof connected directly to a terminal 67 to which the probe 37 is connected, and the other terminal thereof is connected to ground at 70. The tank 35 also is connected to the ground 70. The probe 36 is connected to the terminal 67 in series with a normally open contact 72 of the relay 65. An operating coil 75 of a relay 76 is connected across the busses 55 and 56 in series with a normally closed contact 77 of the relay 65.

An operating coil 80 of a time delay in closing relay 81 is connected across the busses 55 and 56 in series with the contact 77, a normally open contact 82 of the relay 76 and a normally closed contact 83 of a relay 84. An operating coil 86 of the relay 84 is connected across the busses 55 and 56 in series with a normally open contact 87 of the relay 65. The operating coil 80 of the relay 81 also is connected across the busses 55 and 56 in series with the normally open contact 87, a normally closed contact 90 of the relay 76 and a normally open contact 91 of the relay 84. An operating coil 93 of a relay 94 is connected across the busses 55 and 56 in series with a normally open contact 95 of the relay 81.

The motor 33, which operates the inlet valve 32 of the control tank 35, has a terminal 96 connected to the bus 55 in series with a normally open contact 97 of the relay 94 and a normally open contact 98 of the relay 76. A terminal 99 of the motor 33 is connected to the bus 55 in series with a normally open contact 100 of the relay 84. A terminal 101 of the motor 33 is connected directly to the bus 56. The motor 46, which operates the valve 45 connecting the tank

35 to the vent 47, has a terminal 103 connected to the bus 55 in series with a normally open contact 104 of the relay 94 and the normally open contact 100 of the relay 84. A terminal 105 of the motor 46 is connected to the bus 55 in series with a normally open contact 106 of the relay 76. A terminal 107 of the motor 46 is connected to the bus 56. The motor 43, which operates the drain valve 42, has a terminal 110 connected to the bus 55 in series with the normally open contact 104 of the relay 94 and the normally open contact 100 of the relay 84. A terminal 111 of the motor 43 is connected to the bus 55 in series with the normally open contact 106 of the relay 76. A terminal 112 of the motor 43 is connected to the bus 56. The motors 33, 46 and 43 are provided with terminals 114, 115 and 116 which are connected directly to the bus 55.

When the terminal 96 of the motor 33 is connected to the bus 55, the motor is energized to open its associated valve 32, and when the terminal 99 is connected to the bus 55 the motor is energized to close the valve 32. When the terminal 103 is connected to the bus 55 the motor 46 is energized to open its associated valve 45, and when the terminal 105 is connected to the bus 55 the motor is energized so as to close the valve 45. When the terminal 110 is connected to the bus 55 the motor 43 is energized so as to open its associated valve 42, and when the terminal 111 is connected to the bus 55 the motor 43 is energized so as to close the valve 42.

The probe 48 provided in the receiver 25 is connected to a level control device 120, which is similar to the control device 57 and includes a transformer 121 having primary windings 122—122 connected in parallel and across the busses 55 and 56. The probe 48 is connected electrically to a terminal 124 of a secondary winding 125 of the transformer, and the other terminal of the same secondary winding is grounded at 126. The receiver 25 (Fig. 1) also is connected electrically to the ground 126. A secondary winding 127 of the transformer 121 is connected across a rectifier 128 designed to supply D. C. potential to an operating coil 130 of a relay 131 forming part of the control device 120. An operating coil 133 of a relay 134 is connected across the busses 55 and 56 in series with a normally open contact 135 of the relay 131. An alarm device 137, such as a horn, a bell, or a light, is connected across the busses 55 and 56 in series with a normally open contact 138 provided on the relay 134. An indicating lamp 140 is connected in parallel with the coil 133 of the relay 134.

The control devices 57 and 120 and the probes 36, 37 and 48 are identical in construction and operation, and are designed to effect sequential operation of the valves 31, 42 and 45 and the alarm 137 in accordance with the level of the condensate in the control tank 35 and in the receiver 25. While various control devices may be used, the control devices 57 and 120 and the probes 36, 37 and 48 referred to herein are manufactured by Photoswitch, Incorporated, of Cambridge, Massachusetts and are described in their Bulletin PF 479 entitled "Level Controls." Therefore, the control devices and probes have been described only insofar as it is necessary for a complete understanding of the invention.

Operation

Let it be assumed that the reel 10 containing a length of the cable core 11 to be dried is

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positioned in the oven 12, that the door 15 is closed, that steam is passing through the tubes 14—14 to raise the temperature of the oven sufficiently to vaporize the moisture in the paper covering of the cable core and that the motor 17 is energized in a conventional manner to drive the vacuum pump 16. The pump 16 draws the gas from the oven 12 and creates a vacuum in the oven, whereby the moisture in the paper vaporizes at a temperature lower than the normal boiling point of the moisture. The extracted moisture bearing gas passes through the condenser 21, the receiver 25 and through the inlet valve 27 into the pump 16, and discharges the gas through the exhaust valve 28. As the gas extracted from the oven 12 containing the vaporized moisture from the cable passes through the condenser 21, cold water circulating through the pipes 22—22 condenses the moisture in the gas. The liquid condensate and the gas pass from the condenser 21 through the pipe 23 to the receiver 25, where the liquid condensate falls to the bottom of the receiver while the gas passes through the pipe 26 into the pump 16. The liquid condensate that collects in the receiver 25 drains by gravity through the normally open valve 30 and flows through the pipe 31 to the valve 32 which is held closed by the motor 33 when the system is placed in operation.

The busses 55 and 56 are energized simultaneously with the starting of the pump 16 so that the control devices 57 and 120 are supplied with a suitable operating potential when the pump starts to extract the gas from the oven 12 and form the condensate in the tank 35. When potential is supplied to the control device 57, it energizes the transformer 60 but the current through the secondary winding 61 is not of sufficient magnitude to energize the relay 65 because the probes 36 and 37 and the winding 66 are open-circuited. As long as the condensate of the tank 35 does not bridge the probes 36 and 37, the relay 65 remains in its deenergized position in which its normally closed contact 77 connects the operating coil 75 of the relay 76 across the busses 55 and 56.

Energization of the coil 75 closes its normally open contacts 82, 98 and 106, and opens its normally closed contact 91. Closure of the contact 82 connects the operating coil 80 of the time delay relay 81 across the busses in series with the normally closed contact 83 of the relay 84. When the time delay relay 81 completes a predetermined timing cycle, it closes its normally open contact 95 to energize the operating coil 93 of the relay 94. Energization of the relay 94 closes the normally open contact 97, which connects the terminal 96 of the motor 33 across the busses 55 and 56 in series with the contact 98 previously closed by the energization of the relay 76. Thus, the motor 33 is energized to open its associated valve 32 and allows the condensate to flow from the receiver 25 through the valve 32 into the control tank 35.

Closure of the normally open contact 106 of the relay 76 connects the terminal 105 of the motor 46 and the terminal 111 of the motor 43 across the busses 55 and 56 prior to the energization of the relay 81 and the opening of the inlet valve 32 by the motor 33. Therefore, as soon as potential is supplied to the control device 57, the relay 76 is energized and effects the closure of the drain valve 42 and the vent valve 45 before the relay 81 closes its contact 97 to effect the opening of the inlet valve 32 by the motor 33.

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The closure of the valves 42 and 45 maintains the system between the oven and the pump air tight, whereby the pump continues to evacuate the vaporized moisture gas from the oven 12 and creates a vacuum in the oven 12, the condenser 21, the receiver 25 and the tank 35. As long as the condensate in the tank 35 does not touch the high-level probe 37, the valves 45 and 42 will remain in their closed positions and the pump continues to evacuate the gas from the oven 12. During this period the oven 12 continues to vaporize the moisture in the insulation of the cable core 11, and the moisture bearing gas withdrawn from the oven 12 continues to pass through the condenser 21 and the condensate from the gas collects in the tank 35.

When the level of the condensate in the control tank 35 reaches the high-level probe 37, the terminal 67 of the secondary winding 66 is connected to ground 70 through the condensate and the probe 37. As a result, both terminals of the winding 66 are grounded, which causes the magnetic field of the transformer 60 to increase to such an extent that the current supplied to the rectifier 62 is sufficient to energize the operating coil 63 of the relay 65 of the control device 57. Energization of the relay 65 closes its normally open contacts 72 and 87 and opens its normally closed contact 77. Closure of the contact 72 connects the low-level probe 36 to the terminal 67 of the transformer winding 66, whereby the terminal 67 is maintained at ground potential until the condensate falls below the level of the low-level probe 36.

The opening of the normally closed contact 77 disconnects the coil 75 of the relay 76 from the busses 55 and 56, whereupon the relay 76 is deenergized and its contacts 82, 98 and 106 drop open and its contact 90 returns to its normally closed position. The opening of the contact 82 of the relay 76 deenergizes the coil 80 of the relay 81. Closure of the contact 87 connects the coil 86 of the relay 84 across the busses 55 and 56, which closes its normally open contacts 91 and 100 and opens its normally closed contact 83. Closure of the contact 100 connects the terminal 99 of the motor 33 to the bus 55, whereupon the motor 33 is energized so as to close the valve 32 and thereby disconnect the tank 35 from the receiver 25. Closure of the valve 32 stops the flow of the condensate into the tank 35 and at the same time maintains a vacuum in the system including the oven 12, the condenser 21 and the receiver 25.

Closure of the contact 91 occurs simultaneously with the closure of the contact 100 and connects the operating coil 80 of the time delay relay 81 across the busses 55 and 56 in series with the normally closed contact 90 of the relay 76 and the contact 87 of the relay 65. When the relay 81 completes its predetermined timing cycle, which is designed to allow the motor 33 sufficient time to close the valve 32, it closes its normally open contact 95 to connect the operating coil 93 of the relay 94 across the busses 55 and 56. Closure of the contact 104 of the relay 94 connects the terminals 103 and 110 of the motors 46 and 43, respectively, to the bus 55 in series with the closed contact 100 of the relay 84. The motors 43 and 46 then are energized so as to open their respective valves 45 and 42. The open valve 45 connects the control tank 35 to a vent 47, which admits air into the tank, and the open valve 42 permits the condensate to drain from the control tank 35 into the drain pipe 40.

As long as the low level probe 36 contacts the condensate in the tank 35 the transformer winding 66 has both terminals thereof connected to ground 70 and the transformer 61 maintains the coil 63 energized. As the condensate drains from the tank 35 and falls below the level of the probe 36, the terminal 67 of the transformer is disconnected from ground 70. The removal of the terminal 67 from ground potential reduces the magnetic field of the transformer 60 so that the winding 61 no longer provides sufficient current to the rectifier 62 to energize the coil 63. As a result, the coil 63 is deenergized and its contacts 72 and 87 drop open and its contact 77 returns to its normally closed position.

When the level of the condensate in the tank 35 causes the relay 63 to be deenergized in this manner, the opening of the contact 87 deenergizes the relays 84, 81 and 94 in that order, whereupon their respective contacts return to their deenergized positions shown in the diagram. The reclosing of the contact 77 energizes the relay 75, which in turn effects the sequential energization of the time delay relay 81 and the relay 94 in the manner described hereinabove. Closure of the contact 98 of the relay 76 connects the terminals 105 and 111 of the motors 46 and 43, respectively, to the bus 55, whereupon the motors are energized so as to close their respective valves 45 and 42. Some time after the valves 45 and 42 are closed, the time delay relay 81 completes its timing period and closes its normally open contact 95 to energize the coil 93 of the relay 94. Energization of the relay 94 closes its contacts 97 and 104. However, only the closure of the contact 97 is effective at this point, and it connects the terminal of the motor 33 to the bus 55 in series with the contact 98 of the relay 76. The motor 33 now is energized so as to open its associated valve 32, whereupon the condensate collected in the receiver 25 and pipe 31 while the condensate was draining from the control tank 35, flows from the receiver 25 through the valves 30 and 32 into the control tank.

Since the valve 45, which connects the vent 47 to the control tank 35, and the drain valve 42 are closed before the valve 32 is opened by the motor 33, the opening of the valve 32 does not affect the vacuum in the oven 12, the condenser 21 and receiver 25 except for the small amount of air admitted into the control tank 35 when the condensate was draining into the pipe 40. The operation of the valves 32, 42 and 45 in the above-described sequence permits the condensate to be drained from the tank 35 while the pump is operating to extract the vaporized moisture gas from the oven 12.

The pump continues to operate, and the condensate collects in the control tank 35 until it reaches the high-level probe 37. At this point the valve 32 is closed and the valves 42 and 45 are open in the above-described sequence to drain the condensate from the tank. This procedure is carried out by the control device 57 in conjunction with the probes 36 and 37 throughout the entire operating period of the pump in extracting the moisture from the cable core 11.

If the control device 57 should fail to drain the control tank 35 in the manner described, the condensate would fill the control tank and eventually would start to fill the receiver 25 to such a point that some of the condensate might be sucked into the pump 16 with the extracted

gas from the receiver 25. If such a condition should occur, the presence of the liquid condensate in the pump would result in serious damage in the pump and to the motor 17. To prevent such a condition from occurring, the probe 48 is mounted in the receiver 25 and is connected electrically to the control device 120 so as to actuate the alarm 137 and light the lamp 140 when the level of the condensate reaches the probe 48. As long as the condensate in the receiver 25 does not reach the probe 48, the secondary winding 122 is open-circuited and keeps the secondary winding 127 from generating sufficient current to energize the coil 130 of the relay 131. As a result, the normally open contact 135 remains open and the relay 134 remains deenergized.

However, if the condensate collected in the receiver 25 reaches the level of the probe 48, the terminal 124 of the transformer winding 122 is connected to ground through a circuit including the probe 48 and the condensate in the receiver. When the terminal 124 of the transformer is grounded it causes the winding 127 to generate sufficient current through the rectifier 128 to energize the coil 130 of the relay 131. Energization of the relay 131 closes its normally open contact 135 and connects the coil 133 of the relay 134 across the busses. Closure of the contact 135 also connects an indicating lamp 140 across the busses to indicate that the level control device 57 is not functioning and that the condensate has reached the probe 48 positioned in the receiver 25.

Energization of the relay 134 closes its normally open contact 138, which connects the signal device 137 across the busses to announce the fact that the vacuum system should be shut down before the condensate reaches such a level in the receiver 25 that it will be drawn into the pump 16.

While the above-described apparatus is particularly adapted for discharging fluids from a vacuum system used for drying cable cores and the like, it may be readily adapted for discharging liquids from various types of vacuum systems without departing from the spirit and scope of the invention.

What is claimed is:

1. In apparatus for discharging fluids from a vacuum system including a vessel designed to receive a moisture bearing article, a vacuum pump for extracting moisture bearing gas from the article and means for condensing the moisture in the extracted gas as it travels from the vessel to the pump, the improvement which comprises means normally communicating with the vessel for collecting the condensate so produced, a detector sensitive to changes in the level of the condensate within the collecting means, means actuated by the detector for disconnecting the condensate collecting means from the vessel when the condensate reaches a predetermined high level in the collecting means, means actuated by the detector for automatically opening the collecting means to the atmosphere a predetermined time interval after the collecting means is disconnected from the vessel to drain the condensate therefrom, and means actuated by the detector when the condensate within the collecting means reaches a predetermined lower level for closing the collecting means to the atmosphere to terminate the draining of the condensate therefrom and for reconnecting the collecting means to the vessel, whereby the condensate may again collect within the collecting means.

2. Apparatus for discharging fluids from a vacuum system including a vessel designed to receive a moisture bearing article and a vacuum pump for extracting moisture laden gas from the article, which comprises means connected to the vessel for condensing any moisture in the extracted gas as the gas travels from the vessel to the pump, means connected to the condensing means and to the pump for separating the resulting condensate from the extracted gas, means connected to the separating means for collecting a resulting condensate, a detector sensitive to changes in the level of the condensate within the collecting means, means actuated by the detector when the condensate within the collecting means reaches a predetermined high level to disconnect said collecting means from the vessel, means actuated by the detector for automatically opening the collecting means to the atmosphere a predetermined time interval after the collecting means is disconnected from the vessel to drain the condensate therefrom, and means actuated by the detector when the condensate within the collecting means reaches a predetermined lower level to close the collecting means so as to terminate the draining of the condensate therefrom and to reconnect the collecting means to the vessel whereby the condensate may again collect within the collecting means.

3. Apparatus for discharging fluids from a vacuum system including a vessel designed to receive a moisture bearing article and a pump for extracting moisture laden gas from the vessel, which comprises means connected to the vessel for condensing any moisture in the gas extracted from the vessel as the gas travels from the vessel to the pump, means connected to the condensing means and to the pump for separating the resulting condensate from the gas, a tank for collecting the condensate, a conduit connecting the tank to the separating means, a motor-operated, normally open valve located in said conduit, a vent communicating with the tank, a second motor-operated, normally closed valve located in the vent, a drain communicating with the lower end of said tank, a third motor-operated, normally closed valve located in the drain, a detector sensitive to changes in the level of the condensate within the tank, means actuated by the detector for operating the valve in the conduit to disconnect the tank from the separating means when the condensate within the tank reaches a predetermined high level, means actuated by the detector a predetermined time interval after the tank is disconnected from the separating means for opening the valve in the vent whereby the tank is connected through the vent to the atmosphere, means actuated by the detector when

valve in the vent is opened for actuating the valve in the drain to discharge the condensate which has collected within the tank, means actuated by the detector for closing the valve in the drain when the condensate within the tank has reached a predetermined lower level to terminate the draining of the condensate from the tank, and means actuated when the valve in the drain has been reclosed to sequentially close the valve in the vent and open the valve in the conduit to reconnect the tank to the separating means.

4. Apparatus for discharging fluids from a vacuum system including a vessel designed to receive a moisture bearing article and a vacuum pump for extracting moisture laden gas from the article, which comprises means connected to the vessel for condensing any moisture in the extracted gas as the gas travels from the vessel to the pump, means connected to the condensing means and to the pump for separating the resulting condensate from the extracted gas, a tank for collecting the condensate, a conduit connecting said tank to the separating means, a drain provided in the tank, a detector sensitive to the level of the condensate within the tank, a motor-driven valve located in the conduit actuated by the detecting means when the condensate within the tank reaches a predetermined high level to disconnect the tank from the separating means, a motor-driven exhaust valve actuated by the detector a predetermined time interval after the tank has been disconnected from the separating means to open the tank to the atmosphere, a motor-driven drain valve actuated by the detector after the exhaust valve has been operated to open the drain in the tank to allow the condensate to be evacuated therefrom, means actuated by the detector to close the drain valve when the condensate within the tank reaches a predetermined lower level and to close the exhaust valve, and means actuated by the detector, when the drain valve and exhaust valve have been closed, to open the valve in the conduit to reconnect the tank to the separating means, whereby the condensate may again collect within the tank.

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