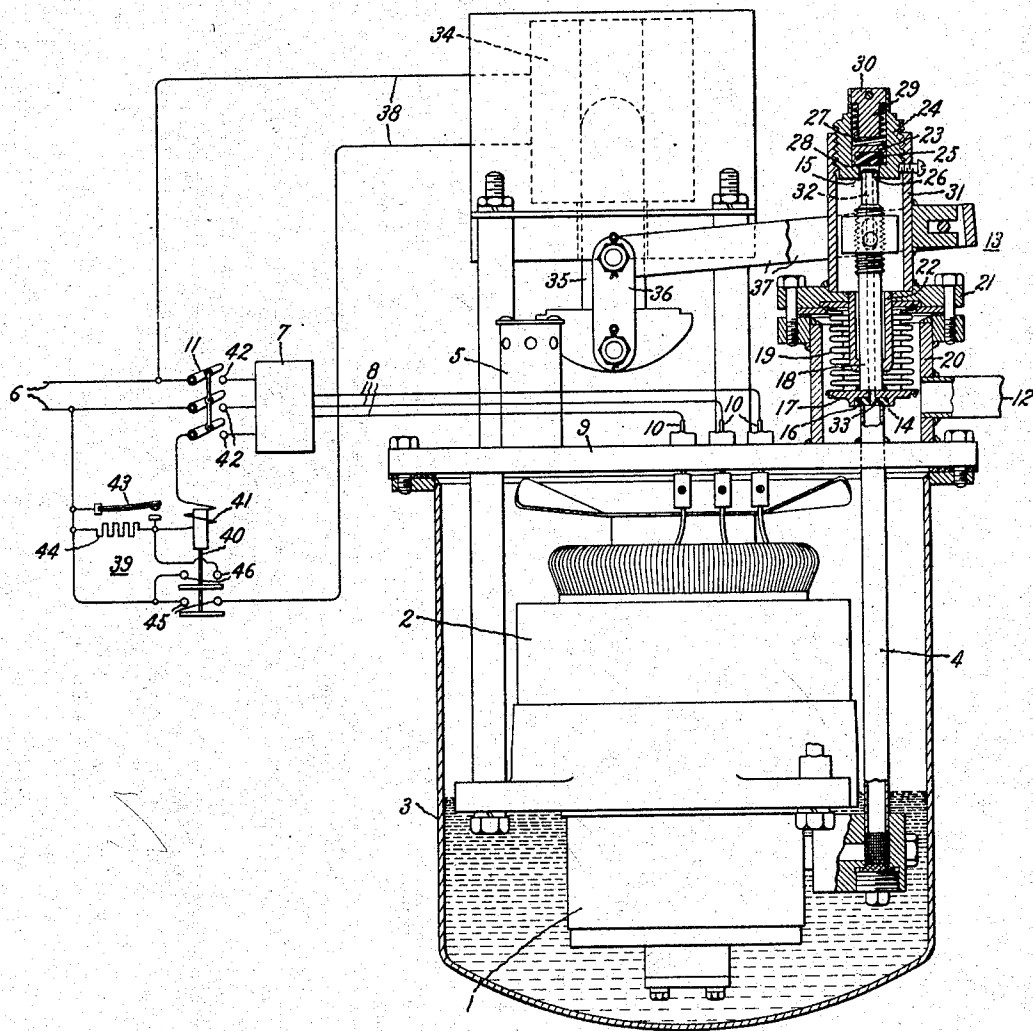


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VACUUM PUMP APPARATUS
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VACUUM PUMP APPARATUS

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4 Claims. (Cl. 230—222)

My invention relates to vacuum pump apparatus, particularly to roughing pump apparatus operating in connection with a high vacuum mercury condensation pump for evacuating mercury arc rectifiers or like devices of the metal tank type, and its general object is to provide a vacuum pump apparatus of this character which is of simplified and durable construction and of increased efficiency and reliability in operation.

A particular object of the invention is to provide, for the vacuum pump apparatus, a valve means and automatically operated control means therefor so arranged that high starting torque usually required in operation of the vacuum pump, and difficulties due to creepage of oil from the pump into contact with valve members or due to creepage of oil into the vacuum chamber of the rectifier or like device, are obviated.

The pump apparatus in which my present invention has been embodied preferably includes an electrically driven pump mechanism which is essentially similar to pump mechanisms heretofore utilized as compressors for refrigerator apparatus. This pump mechanism is preferably vertically mounted, the rotary pump itself being submerged in an oil bath in a substantially sealed container and being driven by an electric motor mounted in the container and above the rotary pump.

In accordance with my invention, in the suction pipe leading from a point on the pump below the oil level to the exhaust pipe line of the rectifier is mounted a combined intake valve apparatus and relief valve apparatus, the combined apparatus being so arranged and controlled that when the pump is brought to a stop the intake valve is closed and, simultaneously, the relief valve is opened to admit air at atmospheric pressure into the suction pipe of the pump.

The relief valve remains open while the pump stands idle, thereby destroying the vacuum in the pump and pump suction pipe and preventing all possibility of creeping of oil or oil vapor into contact with the intake valve and into the vacuum chamber of the rectifier. Upon restarting of the pump the intake valve is held closed and the relief valve is held open for a predetermined time interval to admit air as above described to the pump and pump suction pipe. This time interval is sufficient to permit the pump to come up to normal speed unloaded, thereby eliminating the high starting torque encountered when the pump is required to start against vacuum. The time interval is extended, after the pump comes up to speed, for such a period that the pump runs idle

long enough to clear the pump chamber and pump suction pipe of all oil or foreign gases. At the termination of this predetermined time interval the valve control means operated to close the relief valve, thereby cutting off the connection of the pump suction pipe to atmosphere and, simultaneously, to open the intake valve thereby to connect the pump suction pipe to the exhaust pipe line of the rectifier for normal evacuation of the rectifier tank.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawing, the single figure thereof is a semi-diagrammatic cross sectional view of a vacuum pump mechanism for an iron tank rectifier or the like, in which my invention has been embodied.

In the figure, the numeral 1 designates a vertically mounted rotary exhaust pump driven by an electric motor 2. The pump and motor are enclosed in a casing 3 normally filled with oil to such a height that the pump is totally submerged in the oil bath to prevent air or other gases from entering the pump and to seal the pump. Exhaust gases from the rectifier enter the pump through a pump suction pipe 4 and after passing through the pump and pump exhaust valve (not shown) into the casing 3 escape to atmosphere through an air port 5.

The motor is supplied with current from a suitable current source, such as a single phase alternating current source, for example, connected to supply lines 6, the current being controlled for starting and running through suitable motor control means indicated by the rectangle 7, the control means 7 being connected to the motor by leads 8 insulated from the cover 9 by bushings 10. In order to start and stop the pump manually a switch means indicated by the numeral 11 is provided in the supply lines to the motor.

To control the connection of the pump 1 to the exhaust line 12 which is connected to the vacuum chamber (not shown) of a device such as an iron tank rectifier, and to control the admission of air at atmospheric pressure to the pump, a control valve apparatus designated generally by the numeral 13 is connected between the pump suction pipe 4 and the exhaust line 12. The valve apparatus in the present embodiment of the invention is preferably constituted by a unitary assembly mounted on the cover 9 of the pump casing 3 and comprising a main valve means 14 for

controlling the connection of the pump 1 to the exhaust line 12, and a second valve means 15 to control the admission of air at atmospheric pressure to the pump.

5 The main valve means 14 includes the upper open end of pump suction pipe 4 and a valve disc 16 of rubber or other suitable material mounted in a valve foot 17 which is connected to the lower end of a valve stem 18.

10 The valve foot 17 is welded or otherwise fastened in vacuum-tight relation to the lower end of a bellows or syphon valve member 19 which is provided to give flexibility to the movement of the valve stem 18 and to seal off the valve means 14 from atmospheric pressure. The bellows 19, valve foot 17 with its rubber disc 16, the upper end of pump suction pipe 4, and the lower portion of valve stem 18 are enclosed within a vacuum-tight casing 20 having a cover member 21, the upper end of bellows or syphon member 19 being connected in vacuum-tight relation to cover member 21. A sleeve 22 for guiding the stem 18 projects downwardly from cover 21.

The second valve means, 15, includes a valve seat member 23 slidably mounted within a valve seat casing 24 and having in its lower face a valve disc 25 of rubber or other suitable material, and further includes the upper end or tip 26 of the valve stem 18, this upper portion of the stem being adapted to slide freely in the lower portion of valve seat casing 24, into and out of contact with disc 25. The valve seat 23, together with its rubber disc 25, is biased downwardly toward the valve tip 26, by a spring 27 mounted in valve seat casing 24. Downward motion of the slidable seat 23 is limited by suitable stop means such as an offset 28 in valve seat casing 24, and upward motion of seat 23 and its disc 25 is also limited by a stop means, such as a downwardly extending portion 29 of a plug 30 which retains spring 27 within valve seat casing 24.

To mount the valve seat 23 and its disc 25 of the valve means 15 in proper alignment with stem 18 and to provide a support for means to actuate the valve mechanism, a supporting and mounting member 31 is provided preferably constituted by a casing member so arranged that the interior of the casing is at atmospheric pressure. The support or casing 31 is preferably mounted on the cover 21 of the vacuum-tight valve casing 20.

To admit air at atmospheric pressure through the upper valve means 15 into the pump suction pipe 4 and the pump 1, a hole 32 is provided in valve stem 18 extending longitudinally there-through and registering with a hole 33 provided in valve foot 17 and rubber disc 16 of the lower or intake valve means 14.

To operate the valve mechanisms 14 and 15 an electrical actuating means is preferably provided which in the present embodiment of the invention comprises a solenoid 34 having a plunger 35 which is connected as by suitable link and lever mechanism, comprising, for example, two links 36 and two levers 37, to valve stem 18, the levers 37 being pivoted on the supporting and mounting member 31. The solenoid 34 is connected by leads 38 to the current supply line 6 through a switch means designated by the numeral 39. In order to delay the actuation of valve means 13 by the solenoid 34 for a predetermined time interval after the manual closing of starting switch 11, the solenoid switch means 39 comprises a suitable relay such as a relay 40 the actuating coil 41 of which is adapted to be supplied with current, through contacts 42 of the switch 11 and

through a thermostatic switch 43 having a heater element 44, to close contacts 45 in one of the solenoid leads 38 and simultaneously to short-circuit the heater 44 through contacts 46.

In operation of the apparatus above described, 5 the various parts being initially in the positions shown in the drawing, upon closing of the starting switch 11, starting and running current is supplied to motor 2 in a usual manner through the motor control means 7. When the pump is 10 started and is up to normal speed, heating current is supplied to heater 44 of the thermostatic switch 43 through contacts 42 of switch 11.

The pump 2 now runs idle, since intake valve 14 between pump suction pipe 4 and exhaust line 12 is closed, by the atmospheric pressure on the upper side of valve foot 17, and relief valve 15 is open permitting air at atmospheric pressure to enter the upper end or tip 26 of valve stem 18 and to flow through longitudinal hole 32 of stem 18 and hole 33 of valve foot 17 and valve disc 16 into the pump suction pipe 4 and thence into pump 1. After a predetermined period of time, for example 30 seconds, the thermostatic element of switch 43 operates to short-circuit itself, thereby to supply sufficient current to actuating coil 41 of relay 40 to close the contacts 45. The period of idle running of the motor is sufficient to permit the clearing of all oil or foreign gases out of the pump before normal operation begins.

When contacts 45 are closed by the relay coil 41 at the end of the time interval determined by thermostatic switch 43, current is supplied to solenoid 34 through leads 38; the plunger 35 is then drawn up thereby lifting the valve stem 18 by an amount sufficient to open intake valve 14 by the lifting of rubber disc 16 away from the end of pipe 4, and simultaneously to close relief valve 15 by the forcing of tip 26 of valve stem 18 into contact with rubber disc 25. The upward motion of valve stem 18 is preferably such that valve seat 23, carrying disc 25, is forced upward against the pressure of spring 27 into contact with stop 29, the end of valve stem 18 then preferably continuing its upward motion for a short distance to dig slightly into the rubber disc 25 to insure a vacuum-tight joint between the disc 25 and the tip 26 of the valve stem.

Since, in the above described upward motion of valve stem 18, the relief valve is caused to close and the intake valve 14 is caused to open, the pump 1 is now sealed from atmosphere and is connected to exhaust line 12 for normal operation in exhausting the evacuated chamber of the rectifier or other device to which exhaust line 12 is connected.

When the pump mechanism is stopped, as by the manual opening of switch 11, solenoid 34 is deenergized, plunger 35 drops to its lower position illustrated in the drawing, and valve stem 18 moves downwardly thereby reclosing intake valve 14 and reopening relief valve 15, the valve seat 23 which carries rubber disc 25 being moved down, in contact with the upper end of the valve stem, by the pressure of spring 27 until the valve seat 23 rests against the stop 28. When the pump is thus stopped and the intake valve 14 is caused to close, air at atmospheric pressure is immediately admitted to the pump suction pipe 4 and pump 1 through valve 15 as hereinbefore described. Therefore the vacuum existing in these parts of the apparatus is destroyed and creepage of oil from casing 3 or from the pump into contact with rubber disc 16 of the intake valve 14, or creepage of this oil past the valve 14 into

the exhaust line 12 and thence to the evacuated chamber of the rectifier or other device, is effectually prevented.

Upon further starting and stopping of the pump the above described cycle of operations, including the period of idle running of the motor connected to atmosphere, followed by the closing off of the valve between pump and atmosphere and the opening of the valve between pump 1 and exhaust line 12, is repeated.

My invention has been described herein in a particular embodiment for purposes of illustration. It is to be understood, however, that the invention is susceptible of various changes and modifications and that by the appended claims I intend to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent in the United States is:

1. A control valve apparatus adapted to be interposed between an exhaust line and an exhaust pump, said valve apparatus including a hollow valve stem, valve means at one extremity of said stem adapted to open and to close the path from said exhaust line to said pump, and a second valve means at the other extremity of said stem operable simultaneously with said first-named valve means to admit air through said stem to said pump from outside said exhaust line when said first-named valve means is in closed position and to exclude air to said pump from outside said exhaust line when said first-named valve means is in open position.

2. A control valve apparatus adapted to be interposed between an exhaust line and an exhaust pump, said valve apparatus including a hollow valve stem, a valve casing and a valve supporting member, the interior of said valve casing being at the pressure of said line, the interior of the valve supporting member being at atmospheric pressure, a valve means in said valve casing at one extremity of said stem to control the connection of said pump to said exhaust line, a valve means at the other extremity of said stem in said valve supporting member to

control the admission of air at atmospheric pressure to said pump through said hollow stem, and means to operate said two valve means simultaneously.

3. A unitary control valve apparatus adapted to be interposed between an exhaust line and a vacuum pump, said valve apparatus comprising a valve stem having a longitudinal aperture therethrough, an intake valve between the pump and the exhaust line including a valve disc connected to one end of said valve stem and having an aperture therethrough registering with said aperture of said stem, a relief valve open to atmosphere and comprising the other end of said stem and a valve disc adapted to close said aperture of said stem, and means to move said valve stem longitudinally to actuate said intake and relief valves, whereby said control valve apparatus is operable to connect the pump to the exhaust line and simultaneously to disconnect the pump from atmosphere and operable thereafter to disconnect the pump from the exhaust line and simultaneously to connect the pump to atmosphere.

4. A control valve apparatus adapted to be interposed between an exhaust line and a vacuum pump, said valve apparatus comprising a valve stem, an intake valve between the pump and the exhaust line including a valve disc member connected to an end of said stem, said stem and said disc member being apertured to permit the passage of air therethrough, a resilient vacuum-tight support connected to said disc member and surrounding said end of said stem, a vacuum-tight casing surrounding said resilient support, said disc member, and said end of said stem, said casing being connected to said exhaust line and to said pump, a relief valve, a relief valve supporting member, said relief valve comprising the tip of the other end of said stem and a valve disc slidably mounted in said relief valve supporting member, and means to move said valve stem to open said intake valve and simultaneously to close said relief valve.

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