Vacuum Return Pumping Unit

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By

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This invention relates to improvements in vacuum return pumping units of the type generally used for maintaining the vacuum of heating systems and at the same time return condensate to the steam generating unit of the heating system.

Condensate return units are commonly used with heating plants for large buildings for creating a vacuum in the radiators and for returning the condensate taken from the radiators to the boiler supplying the steam for heating the building. Such units usually include a storage chamber for condensate, a centrifugal pump, an ejector, a sealing chamber into which the ejector discharges, and means for supplying water from the sealing chamber to the pump. Such units also include means for conducting water from the storage chamber to the ejector and a condensate return line from the pump or the sealing chamber to the boiler.

One of the difficulties involved in the operation of the systems of this type is the prevention of air from leaking into the system while the pump is not in operation. Difficulty has been encountered in certain instances, for example, because of the clogging of the valve in the condensate return line. There is always considerable sediment resulting from corrosion in systems of this type, and when the valve becomes fouled so that air may leak into the condensate return line, the vacuum in the heating system will be destroyed until the pump has again been put into operation.

Other problems encountered in the operation of vacuum producing condensate return units involve the handling of the air which normally leaks into the heating system and which is picked up by the condensate return unit.

Provision is usually made for the handling of this air along with the condensate from the heating system but in certain types of apparatus the handling of the air in this way causes irregular movement of the condensate due to the complete emptying of the storage chamber. It will be apparent, therefore, that under certain conditions, the ejector is operating almost entirely upon water, and then almost entirely upon air.

The primary object of the present invention, therefore, is to provide an improved unit of the type referred to which is constructed and arranged in such a manner as to overcome the difficulties discussed above and to solve the problems referred to.

Another object of the invention is to provide a simple condensate return unit which will operate smoothly and silently and which will require a minimum of attention.

According to a preferred form of the invention, the improved condensate return unit includes a storage chamber, a sealing chamber, a centrifugal pump, and an ejector discharging into the sealing chamber, the unit including means for separately delivering air and water from the storage chamber to the ejector and an improved means for automatically controlling the discharge of condensate from the pump to the condensate return line.

According to a preferred construction, means is provided for simultaneously evacuating air and water from the storage chamber, the air being conducted through a separate conduit in which is mounted an adjustable air control and check valve. The preferred unit also includes an automatic valve for controlling the return of condensate comprising a diaphragm control operated by means for balancing and unbalancing the water pressure on the two sides of the diaphragm in response to a predetermined change in the water level in the sealing chamber.

My invention includes other features, objects, and advantages which will be apparent from the following more detailed description thereof taken in connection with the accompanying drawings forming a part of this application.

In the drawings:

Fig. 1 is an elevational view, partly in section and with parts broken away, of a condensate return unit constructed in accordance with the present invention.

Fig. 2 is an enlarged detailed view partly in section showing the construction of the control valve and other details, looking from the right in Fig. 1.

Fig. 3 is an enlarged detailed sectional view of the adjustable air control and check valve unit shown in Fig. 1.

Referring to Fig. 1 of the drawings, the principal elements of the apparatus shown therein include a storage chamber 10 for receiving condensate and air from a heating or other steam system through an inlet line 13, a sealing chamber 14, a centrifugal pump 16, an electric motor 18 for driving the pump, and an ejector 20. Condensate is conducted from the chamber 10 to the ejector 20 through a conduit 22 which includes a sediment trap 23, a strainer 24 and a check valve 25. Air is conducted from the chamber 10 through a line 28 containing an adjustable air control and check valve unit 30. The chamber 14 serves primarily to seal the
pump 16 with water so that it is always filled or primed, and to provide a means for separating the air removed from the heating system, and for other purposes refer to Fig. 1, below. The air removed from any vacuum or condensate return system in which the apparatus of the present invention is employed is discharged from the chamber 14 to the atmosphere through a conduit 32 provided with a r as shown. The apparatus may be primed in a number of ways. For example, the water 34 and filling the chamber 14 with water to the necessary level. Water is conducted from the chamber 14 to the inlet of the pump 16 by means of a relatively large conduit 36, and water is returned to the chamber 14 from the pump outlet through a large conduit 31, and an ejector 20, which includes a nozzle 38 of predetermined bore which discharges into a Venturi tube 40. A stream of water passing from the nozzle 38 at high pressure into the Venturi tube 40 creates a vacuum in the chamber of the ejector 20 and thereby draws water and air through the lines 32 and 28.

According to the present invention, the water returned to the system to which the apparatus is connected, is passed directly from the conduit 37 at the pressure of the water supply, through a control valve 42 and a return line 44. The valve 42, as shown in detail in Fig. 2 of the drawings, comprises a closure member 48 which seats upon a valve seat 46 and which is provided with a stem, as shown, connected to a flexible diaphragm 50, made, for example, of a synthetic rubber, the valve closure member 46 is normally held in seated position by a spring 52 mounted on the opposite side of the diaphragm 50. The valve 42 includes a passageway for water under pressure from the conduit 37 around the diaphragm, into a chamber back of the diaphragm, as well as a discharge passage therefrom. In the arrangement, water flows from the chamber in front of the diaphragm through an orifice 54 into the chamber in back of the diaphragm, the orifice being, for example, of about one-eighth inch bore, while the inlet and outlet of the conduit may be of about one-fourth inch bore. Water is discharged from the chamber in back of the diaphragm 50 through a conduit 55 which is of one-fourth inch bore or substantially larger than the orifice 54.

The conduit 55 leads to a pipe 56 which has a diameter at least equal to that of the conduit 55, and which connects into the upper part of the chamber 14, as shown in Fig. 1. The outlet of the pipe 55 is provided with a valve closure member 60 (Fig. 1), which seats against the outlet and which is operated by a float 62 in the chamber 14, the float arm being pivoted at 64 and having a connection, as shown, for operating the closure member 60 to open and close the end of the conduit 55.

The float 62 operates automatically to discharge water through the valve 42 in substantially the following manner: When the pump 16 is in operation, water from the chamber 14 is drawn through the line 36 and forced through a nozzle 38 at a predetermined pressure and capacity. The discharge of this stream of water through the Venturi tube 40 creates a vacuum in the ejector 20 and draws water through the line 32 and air through the line 34 charged through the venturi into the chamber 14.

The introduction of additional water to the chamber 14 raises the level therein, for example, from a priming level 66 at which the valve 60 is closed, to a level 68 at which the valve 60 is open. The opening of the valve 60 permits the flow of water through the pipe 55 and thereby reduces the water pressure back of the diaphragm 50. Since the opening continues as long as the liquid level in the chamber 14 remains at a level slightly below the height of the weir, but when the level drops, for example, to the position 68, the flow of water in the line 55 is stopped and the water pressure on each side of the diaphragm 50 becomes equalized, thereby permitting the seating of the member 46 by this pressure.

An important feature of the present invention which materially aids in the correlation of the operation of the apparatus, and permits the smooth operation of the valve 42, is the means for separately conducting air from the chamber 18 to the ejector 20. In this connection, the air control unit 30 is an important feature, since, as shown in Fig. 3, it includes an adjustable air control valve comprising a closure member 70 having a threaded connection as shown, so that it may be held at the desired distance from seat 72, to bleed the air-pump, through a small conduit 74 orifice 76. The valve 70 is immediately upon the stopping of the pump 16 or upon a sufficient reduction in the suction created by the ejector 20, thereby holding the vacuum created in the chamber 10. The check valve 28 also seals abruptly at the same time so that a vacuum is held in the chamber 10 and water is not permitted to leave the chamber 14, pump 16, ejector 20 and conduit 37, although the pressure in these elements of the apparatus falls to atmospheric, which is the pressure above the water in the chamber 14.

The structure and arrangement of the check valve 26 and of the strainer 24, are shown in detail in Fig. 2 of the drawings. The strainer comprises an important part of the system because its structure and arrangement are such that it is self-cleaning. The strainer 24 is mounted in vertical position and directly above the check valve 26. When water flows into the lower open end of a cylindrical mesh strainer member then laterally through the strainer member 76 into an annular chamber 80, from which it passes directly to the check valve 26. Member 76 is completely sealed with respect to chamber 80 and when the operation of the pump ceases and the check valve 26 closes, any solid materials collected on the inside of the strainer fall back into the interior of the strainer and settle in the pipe 22, and fall into the trap 23, from which they are periodically removed, the trap 23 being located at the bottom of the vertical section of the pipe 22.

Apparatus of this type are commonly provided with a float in the chamber corresponding to the chamber 10 which operates an electrical switch to start the motor 18 when the chamber is nearly filled with liquid and to stop the motor when the liquid level in the chamber merely seals the inlet of the materials in the chamber. In the present invention, the chamber corresponding to the chamber 10 is provided with a vacuum gage 84 and with a vacuum-operated electrical switch which will cut in the motor 18 when the vacuum is too low in the chamber 10, and cut off the motor when the vacuum reaches
the desired point. Such automatic means are not shown because they are conventionally or commonly employed. In such a dual automatic control arrangement, it will be apparent that the motor 16 may be kept in operation until the chamber 10 has been emptied to the desired extent and until the desired vacuum has also been obtained.

The improved apparatus of the present invention is particularly arranged for quiet, efficient operation over long periods of time without being serviced. The separate supply of air and water from the chamber 10 to the ejector 20 avoids the presence of slugs of air in the ejector, and, therefore, sudden changes in the vacuum and water pressure in the different parts of the apparatus. These features, coupled with the arrangement of the diaphragm valve, contribute to the smoothness of the operation because the pressure in the valve chamber in front of the diaphragm is maintained substantially constant, so that the diaphragm operates smoothly and quietly when the water pressure is changed on its opposite sides. When the valve member 50 is moved to closed position, the pressure back of the diaphragm is built up quickly, but not instantly, so that the valve member 45 is closed quietly as the pressure on the two sides of the diaphragm is equalized.

The valve 42 in its vertical arrangement with respect to the conduit 37, provides a construction which is difficult or impossible to fouled with any sediment which may pass the screen 78, because any vertical sediment is settled back into the conduit 37. Furthermore, the passages 54, 56, etc. are sufficiently large that no clogging is possible. The check valve 28 is also mounted above the bottom of the ejector chamber, so that it will be practically impossible to foul it with any fine sediment which may pass through the fine mesh of the screen 78.

While the apparatus of the present invention has been described in connection with its use in a vacuum heating system, this is only one example of a system in which the apparatus may be used. It may be employed in conjunction with other systems in which steam is used as a heating means or as a processed means and in which it is desirable to maintain a subatmospheric pressure or vacuum, regardless of whether or not the water discharged through the line 44 is sent to a boiler unit or to any other part of the plant. The apparatus, for example, may be used in various process industries for the maintenance of predetermined subatmospheric pressures, such for example, as in vacuum drying and other operations.

From the foregoing description, it will be apparent also that the liquid discharged through the line 44 may be supplied at the pressure created by the pump 16, to a boiler, distilling unit, or other process operation.

In the apparatus as shown and described, the chambers 16 and 14 may be of any desired capacity, and the chamber 10 may be positioned at any convenient point with respect to the pump 16 and the chamber 14. The chamber 16, however, is primarily a sealing chamber for the pump, and one of its important functions is to keep the pump primed with liquid. However, other changes may be made in the apparatus without departing from the spirit and scope of the invention.

What I claim as new is:

1. In a vacuum producing apparatus of the type described, which includes a vacuum chamber, a centrifugal pump, an ejector, and a sealing chamber into which the ejector discharges, the pump being arranged to draw liquid from the sealing chamber and supply it under pressure to the ejector, and the ejector being connected to the vacuum chamber to draw liquid and gas therefrom, the improvement which comprises separate means for conducting and controlling the flow of gas from the vacuum chamber to the ejector including a flow control valve and a check valve, means for discharging liquid from the outlet of said pump including a diaphragm controlled valve, and means for controlling the movement of the diaphragm of said valve in response to changes in the liquid level in the sealing chamber.

2. In a vacuum producing apparatus of the type described, which includes a vacuum chamber, a centrifugal pump, an ejector, and a sealing chamber into which the ejector discharges, the pump being arranged to draw liquid from the sealing chamber and supply it under pressure to the ejector, and the ejector being connected to the vacuum chamber to draw liquid and gas therefrom, the improvement which comprises means for discharging liquid from the outlet of said pump including a diaphragm controlled valve, and means for controlling the operation of the diaphragm of said valve in response to changes in the liquid level in the sealing chamber, said last-mentioned means including an orifice for the flow of liquid from one side of the diaphragm to the other and a valve operated by a float in the sealing chamber for controlling the flow of liquid through said orifice.

3. In a vacuum producing apparatus of the type described, which includes a vacuum chamber, a centrifugal pump, an ejector, and a sealing chamber into which the ejector discharges, the pump being arranged to draw liquid from the sealing chamber and supply it under pressure to the ejector, and the ejector being connected to the vacuum chamber to draw liquid and gas therefrom, the improvement which comprises separate means for conducting and controlling the flow of gas from the vacuum chamber to the ejector including a flow control valve and a check valve, means for discharging liquid from the outlet of said pump including a diaphragm controlled valve, said valve being arranged so that liquid at the pump pressure covers one side of the diaphragm, an orifice from said side to the opposite side of the diaphragm for the flow of liquid, a conduit of larger diameter than said orifice leading from said opposite side, and a valve in said conduit controlled by a float in said sealing chamber to release liquid from said opposite side of the diaphragm and thereby permit the opening of the diaphragm controlled valve by the liquid at pump pressure acting on the diaphragm.

4. In a pumping unit of the type described, which includes a receiving chamber for liquid and gases, a centrifugal pump, an ejector, and a sealing chamber elevated with respect to the pump and into which the ejector discharges, the pump being arranged to draw liquid from the sealing chamber and deliver it to the ejector for the operation thereof, the ejector being connected to the receiving chamber to draw liquid and gas therefrom, the improvement which comprises a conduit for delivering liquid from the lower portion of said receiving chamber into said ejector, said conduit including a vertical section at the upper portion of which a self-cleaning strainer is mounted, a check valve between the strainer and the ejector, a separate conduit for delivering gases from the supply chamber to the ejector, and a conduit connected with the
discharge side of the pump for delivering liquid from the unit.

5. In a pumping unit of the type described, which includes a receiving chamber for liquid and gas, a centrifugal pump, an ejector, and a sealing chamber into which the ejector discharges, the pump being arranged to draw liquid from the sealing chamber and to deliver liquid through the ejector, and the ejector being connected to the receiving chamber for drawing liquid and gases therefrom, the improvement which comprises means for discharging liquid from the unit including a conduit connected into the pump discharge containing a diaphragm controlled valve, the diaphragm of which is subject to the liquid pressure delivered by the pump, means responsive to the liquid level in the sealing chamber for controlling the opening of said valve, means for separately conducting gas and liquid from the receiving chamber to the ejector, and means for controlling the flow of gas to the ejector arranged to prevent irregular operation of the pump whereby a substantially uniform liquid pressure is maintained in the conduit for discharging liquid from the unit up to the valve therein.

6. In a pumping unit of the type described, which includes a receiving chamber for liquid and gas, a centrifugal pump, an ejector, and a sealing chamber into which the ejector discharges, the pump being arranged to draw liquid from the sealing chamber and arranged to supply liquid to operate said ejector, and the ejector being connected to the receiving chamber for drawing liquid and gases therefrom, the improvement which comprises means for discharging liquid from the unit including a bypass conduit from the pump outlet containing a diaphragm controlled valve, both sides of the diaphragm of which are subjected to the liquid at the pressure delivered by the pump when the valve is closed, means responsive to a change in the liquid level in the sealing chamber for relieving the pressure on one side of the diaphragm thereby permitting said valve to open, means for separately conducting gases and liquid from the receiving chamber to the ejector, and means for controlling the flow of gases to the ejector arranged to prevent irregular operation of the pump and ejector whereby a substantially uniform liquid pressure is maintained at the diaphragm controlled valve.

7. In a vacuum pumping apparatus including a vacuum chamber for receiving liquid and gases, a supply chamber for a body of liquid, an ejector arranged to discharge into the supply chamber, means arranged to conduct liquid and gases from the vacuum chamber to the inlet of the ejector, and a centrifugal pump connected to receive liquid from the supply chamber and deliver liquid under pressure to the ejector to effect its operation, the improvement in which the means arranged to conduct liquid and gases from the vacuum chamber to the ejector comprises separate conduits for liquid and gases, the conduit for liquid being connected into the lower portion of the vacuum chamber while the conduit for gases is connected into the upper portion of the vacuum chamber, a check valve in each conduit to prevent reverse flow therein, and a flow regulating means in the conduit for gases.

8. In a vacuum pumping apparatus including a vacuum chamber for receiving liquid and gases, a supply chamber for a body of liquid, an ejector arranged to discharge into the supply chamber, means arranged to conduct liquid and gases from the vacuum chamber to the inlet of the ejector, and a centrifugal pump connected to receive liquid from the supply chamber and deliver liquid under pressure to the ejector to effect its operation, the improvement which comprises a conduit connected into the discharge side of the pump for delivering liquid from the pumping apparatus, a diaphragm-controlled valve in said conduit, means for biasing the valve to closed position, the diaphragm of the valve being arranged so that one side thereof is subjected to the pressure of the liquid from the pump for opening the valve, a restricted passageway for conducting liquid at the pump pressure to the opposite side of the diaphragm, a conduit including a control valve for discharging liquid from said opposite side of the diaphragm, and means for opening and closing said control valve in response respectively to the rise and fall of the liquid level in the supply chamber, thereby permitting the opening and closing respectively of the diaphragm-controlled valve.

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The following references are of record in the file of this patent:

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