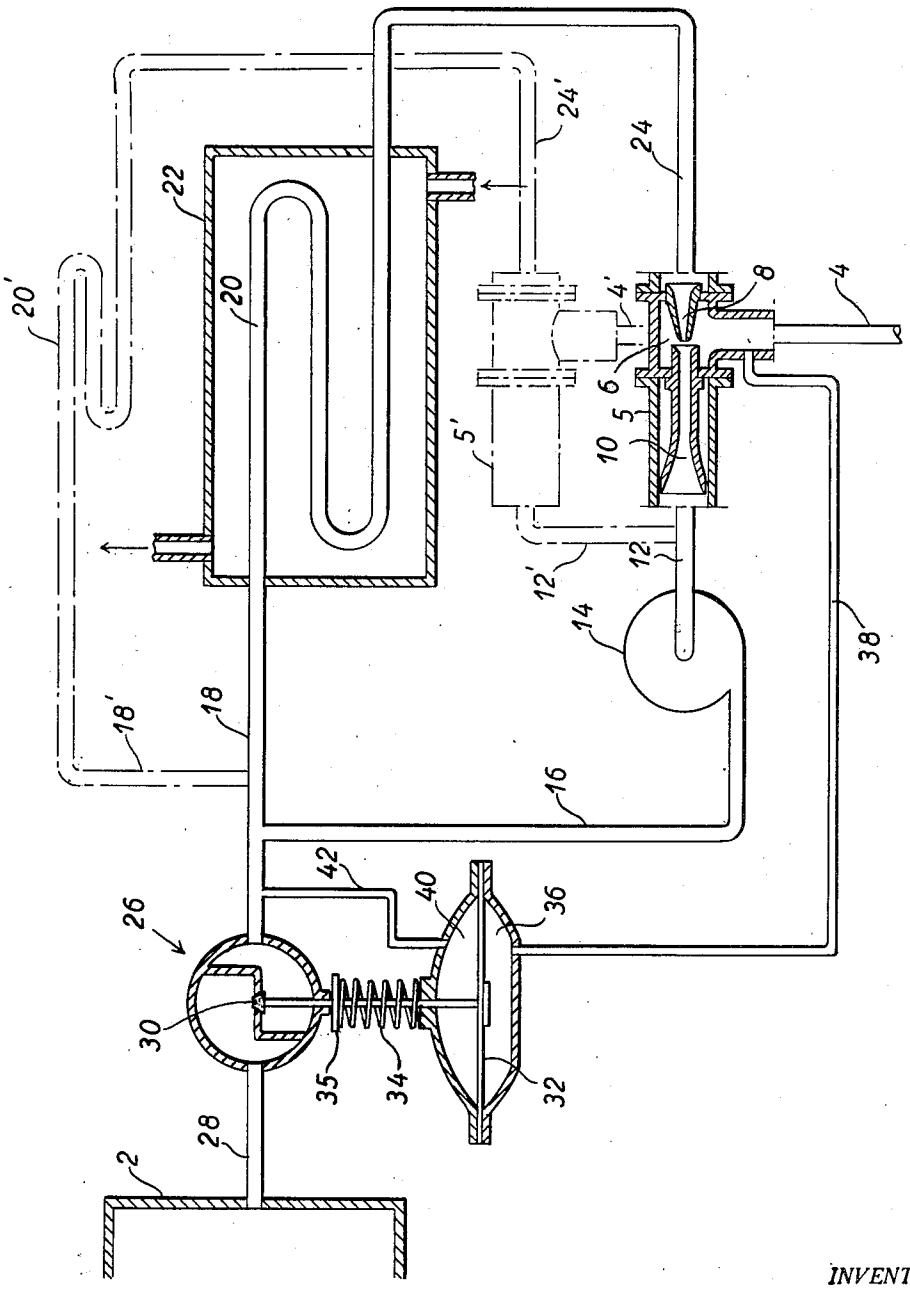
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CONDENSATE RETURN SYSTEM

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CONDENSATE RETURN SYSTEM

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This invention relates to a condensate return system. In one type of system provided for returning condensate to a boiler there is provided a centrifugal pump arranged to supply water to the nozzle of an eductor, the suction chamber of which receives the condensate to be pumped. The pressure recovery tube of the eductor discharges through a cooler to the boiler and from the cooler there is also provided recirculation to the intake of the centrifugal pump. The type of arrangement just described is inefficient since all of the net pumping action is accomplished by the jet, the latter being energized by the centrifugal pump which, however, does not have a net pumping action on the condensate. The cooling is to insure against too high a temperature in the jet but represents a loss of heat in the water or other liquid returned to the boiler. The advantage of the system just described is that it is unnecessary to provide any automatic devices to keep the centrifugal pump primed.

A second type of system has been used in which the centrifugal pump is located between the eductor and the return connection to the boiler, recirculation being effected from the outlet of the centrifugal pump to the eductor jet. The condensate which enters the eductor suction chamber is thus pumped by both the ejector and the centrifugal pump so that the efficiency of the system is appreciably greater than that first mentioned. However, in this last system a failure of sufficient supply of condensate will result in cavitation at the pump. It was necessary, therefore, to provide a control stopping the pump when conditions which would give rise to cavitation existed. The control system which was then required added to the complexity of the system.

In accordance with the present invention a condensate return system is provided having several advantages over the foregoing. In comparison with the second system it involves the use of a simple pressure responsive valve as its sole control element to maintain proper operation of the pump. On the other hand, it involves the efficiency characteristics of the second mentioned system, in contrast with the first, in that the condensate is pumped by both the eductor and the centrifugal pump.

In accordance with the present invention there is also provided a cooler in a proper location to improve the operation of the system without excessive cooling which would only require the further addition of heat in the boiler.

In the case of the system of the present invention it is also possible to operate two or more

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eductors in parallel, draining several sources of condensate which may be at different pressures.

The general objects of the present invention will be appreciated from the foregoing. These and other objects of the invention particularly relating to details of construction and operation will become apparent from the following description read in conjunction with the accompanying drawing in which the figure illustrates in diagram and in fragmentary sections the elements and connections of a preferred system embodying the invention.

A boiler with which the return system is associated is indicated at 2 and it may be assumed that the condensate from the system is concentrated in an inlet pipe 4 for return to the boiler. This inlet pipe 4 may also receive make-up water or other liquid in conventional fashion. It will, of course, be obvious that the system may handle other liquids as well as water though for simplicity of description it will be assumed that the invention is applied to a conventional steam system.

An eductor 5 comprises the suction chamber 6, the water jet nozzle 8 and the pressure recovery tube 10. The latter is connected through pipe 12 to the inlet of a centrifugal pump 14 which delivers water through the line 16 from which a recirculating branch extends in the form of a pipe 18, a cooling coil 20 and a pipe 24 communicating with the eductor nozzle. The coil 20 is cooled in any suitable fashion and may, for example, be finned for air cooling or may be water cooled as indicated by the jacket 22.

A connection 28 from the centrifugal pump output line 16 to the boiler 2 contains a pressure responsive valve 26 including the valve member 30, the stem of which is connected to a diaphragm 32 in a housing provided with chambers 36 and 40 connected respectively through lines 38 and 42 to the suction chamber of the eductor and to the output side of the centrifugal pump. A spring 34 acting upon an adjustable collar 35 on the valve stem urges the valve toward closed position. As will be evident a predetermined excess of pressure in the chamber 40 over the pressure in the chamber 36 will be required to open the valve.

Considering the system so far described, containing a single eductor, the operation is as follows:

Assume that operation is taking place with a certain quantity of condensate entering the inlet pipe 4. Obviously this same quantity of liquid must pass through the opening at the valve 30.

The pressures in the pipe 28 (the boiler pressure) and at the inlet 4 being substantially constant, and the pressure gain through the centrifugal pump being substantially constant, an equilibrium will be reached when the pressure in line 18 will exceed the pressure at inlet 4 to maintain valve 30 in such position that the pressure drop through the opening at valve 30 will equal the pressure drop between line 18 and the boiler pressure. The pressure recovery in the eductor will adjust itself so that the pressure gain of the eductor and of the pump in series will give this required pressure in line 18.

Now assume that the quantity of liquid entering the eductor at 4 becomes less. The quantity passing valve 30 would now be less and the pressure drop across this valve would be less than before. A readjustment must therefore occur, the pressure in line 18 now dropping until the lower pressure difference between line 18 and inlet 4 produces a partial closure of valve 30 to increase the pressure drop for the decreased delivery of liquid so as to reattain a pressure equilibrium as previously set forth. Under these conditions the pressure in line 18 will be lower than before.

What is required for proper operation is a large change in valve position for a small change in the pressure in line 18 so that the changes in pressure in line 18 for considerable changes in quantity of liquid entering at 4 will be small, so that the pressure recovery across the eductor is maintained sufficiently high to prevent cavitation at the pump. This end is, of course, secured by providing a weak spring at 34.

An eductor is much less efficient than a centrifugal pump, and consequently it is desirable to get the required pressure rise primarily in the pump; the eductor is accordingly chosen to secure large volumetric delivery with little regard for pressure recovery except that sufficient pressure recovery is provided to avoid cavitation even under the condition of no liquid entry at 4. In other words, the system is arranged for continuous draining by prevention of cavitation of the pump at all times, there being then no necessity for stopping the pump.

The cooler provided in the position illustrated insures most effective operation of the eductor. The suction pressure in the eductor cannot be lower than the vapor pressure of the water used to energize the jet. If it was lower the jet would explode by flashing action, choking the throat of the pressure recovery tube and preventing the entrance of any condensate to the suction chamber. The cooler insures that the temperature of the water energizing the jet nozzle is lower than the boiling point corresponding to the pressure at the suction chamber inlet so that the jet water may condense a small quantity of free vapor and reduce the pressure at the throat of the eductor to produce a velocity entrance head for the water to be pumped.

The described system lends itself to multijet installations drawing condensate from a plurality of sources, each of which may be at a different pressure. The proportions of the jet and tube in each suction chamber are selected to accommodate the source pressure and a given pressure rise from line 12 to line 18. From any specified source pressure the total pressure rise between the source and boiler will consist of the pressure rise from line 4 to line 12 (which is variable) and the pressure rise from line 12 to line 28 (which is approximately constant). In order to suit the different inlet pressures at the eductors which may be draining condensate near saturation temperatures, it is necessary to apply different rates of cooling to the water passing through the several jets.

In the figure there is shown in construction lines the paralleling of the cooler-eductor combination heretofore described with a second such combination, the elements 18', 20', 24', 5', 4' and 12' of which correspond to the unprimed elements previously described. As will be obvious more than two of such combinations may be put in parallel. The only requirement of any such multiple arrangement is that the differential pressure regulating valve will have its control connections to the discharge of the centrifugal pump and to the inlet of that eductor having the lowest pressure rise through the tube. In other words, these control lines will be connected across the lowest pressure of difference between the several drain pressures and the pressure at the discharge of the centrifugal pump.

While theoretically, as described above, it is more desirable to apply the required amount of cooling to the water issuing from the jet, in practice it may often be found more convenient to cool the condensate entering the eductor. Reducing the temperature of the condensate being drained is quite effective, and since the pressures of condensate entering the eductor are relatively low, it is possible many times to select a cheaper heat exchanger due to the lower mechanical strength required. Thus the particular point of cooling is a matter subject to exercise of choice in the interests of economy.

It will be evident from the above that a simple system is provided to secure a condensate return system of high efficiency and of proper operating characteristics. It will be evident that various changes may be made in the system as will be evident to those skilled in the art without departing from the scope of the invention as defined in the following claims.

What I claim and desire to protect by Letters Patent is:

1. A system for the return of condensate from a plurality of sources to a boiler comprising a plurality of eductors, each having a nozzle, a suction chamber and a pressure recovery tube, the several suction chambers being connected to receive condensate from the respective sources, a pump receiving the combined discharges from the pressure recovery tubes, connections between the delivery side of the pump and said nozzles, a connection between the delivery side of the pump and the boiler, a pressure responsive valve in the last mentioned connection, and said pressure responsive valve having control connections to the delivery side of the pump and to that eductor suction chamber having the highest pressure therein.

2. A system for the return of condensate from a plurality of sources to a boiler comprising a plurality of eductors, each having a nozzle, a suction chamber and a pressure recovery tube, the several suction chambers being connected to receive condensate from the respective sources, a pump receiving the combined discharges from the pressure recovery tubes, connections between the delivery side of the pump and said nozzles, a cooler in each of said connections, a connection between the delivery side of the pump and the boiler, a pressure responsive valve in the last mentioned connection, and said pressure responsive valve having control connections to the

delivery side of the pump and to that eductor suction chamber having the highest pressure therein.

3. A system for the return of condensate to a boiler comprising an eductor having a nozzle, a suction chamber and a pressure recovery tube, a pump receiving liquid from said pressure recovery tube, a connection between the delivery side of the pump and said nozzle, a connection between the delivery side of the pump and the boiler, and a pressure responsive valve in the last mentioned connection, said valve including valve actuating means connected to the delivery side of the pump and to the suction chamber of the eductor to regulate the pressure at the delivery side of the pump and the pressure at the eductor nozzle in accordance with the quantity of condensate entering the eductor chamber.

4. A system for the return of condensate to a boiler comprising an eductor having a nozzle, a suction chamber and a pressure recovery tube, a pump receiving liquid from said pressure recovery tube, a connection between the delivery side of the pump and said nozzle, a cooler in said connection, a connection between the delivery side of the pump and the boiler, and a pressure responsive valve in the last mentioned connection, said valve including valve actuating means connected to the delivery side of the pump and to the suction chamber of the eductor to regulate the pressure at the delivery side of the pump and the pressure at the eductor nozzle in accordance with the quantity of condensate entering the eductor chamber.

5. A system for the return of condensate from a plurality of sources to a boiler comprising a plurality of eductors, each having a nozzle, a suction chamber and a pressure recovery tube, the several suction chambers being connected to receive condensate from the respective sources, a pump receiving the combined discharges from the pressure recovery tubes, connections between the delivery side of the pump and said nozzles, a connection between the delivery side of the pump and the boiler, and a pressure responsive valve in the last mentioned connection, said valve including valve actuating means connected to the delivery side of the pump and to that eductor suction chamber having the highest pressure therein, to regulate the pressure at the delivery side of the pump and at the eductor nozzle in accordance with the quantity of condensate entering the eductor chamber.

6. A system for the return of condensate from a plurality of sources to a boiler comprising a plurality of eductors, each having a nozzle, a suction chamber and a pressure recovery tube, the several suction chambers being connected to receive condensate from the respective sources, a pump receiving the combined discharges from the pressure recovery tubes, connections between the

delivery side of the pump and said nozzles, a cooler in each of said connections, said arrangement providing a plurality of parallel groups of coolers and eductors in series with said parallel group in series with the pump, a connection between the delivery side of the pump and the boiler, and a pressure responsive valve in the last mentioned connection, said valve including valve actuating means connected to the delivery side of the pump and to that eductor suction chamber having the highest pressure therein, to regulate the pressure at the delivery side of the pump and at the eductor nozzle in accordance with the quantity of condensate entering the eductor chamber.

7. A system for the return of condensate to a boiler comprising an eductor having a nozzle, a suction chamber and a pressure recovery tube, a pump receiving liquid from said pressure recovery tube, a connection between the delivery side of the pump and said nozzle, a connection between the delivery side of the pump and the boiler, and a pressure responsive valve in the last mentioned connection, said valve including valve actuating means connected to the delivery side of the pump and to the suction chamber of the eductor, said actuating means closing the valve when the pressure difference between the delivery side of the pump and said suction chamber is not greater than the shut-off pressure head of the pump and opening the valve when such pressure difference is exceeded by reason of the sum of the pressure gains through the eductor and pump.

8. A system for the return of condensate to a boiler comprising an eductor having a nozzle, a suction chamber and a pressure recovery tube, a pump receiving liquid from said pressure recovery tube, a connection between the delivery side of the pump and said nozzle, a connection between the delivery side of the pump and the boiler, and a pressure responsive valve in the last mentioned connection, said valve including valve actuating means connected to the delivery side of the pump and connected to the suction chamber of the eductor, said valve actuating means acting in response to pressures received through said connections to open the valve only when the eductor is receiving condensate.

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