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CONDENSATE REMOVAL APPARATUS

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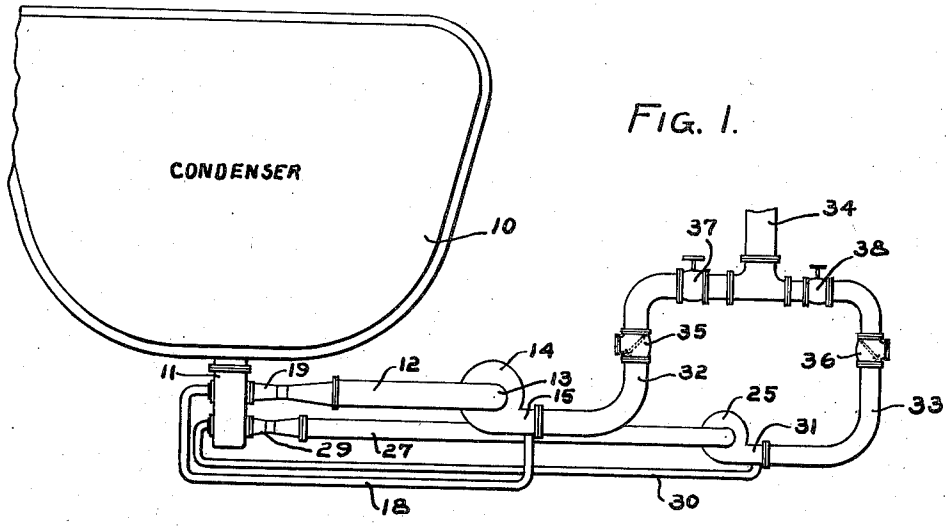


FIG. 1.

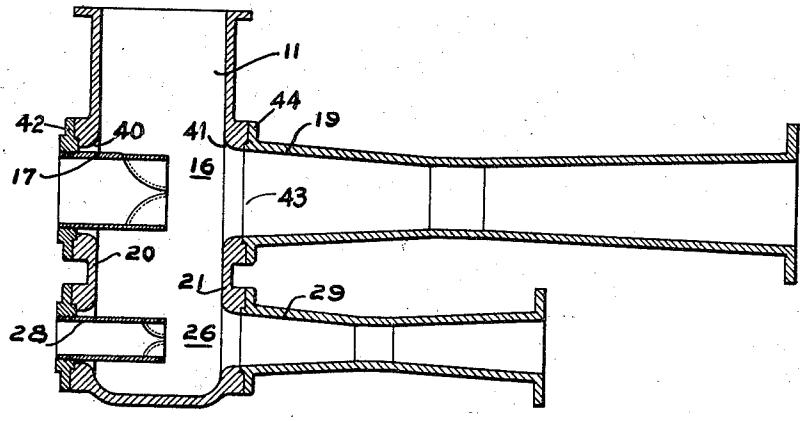


FIG. 2.

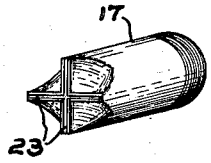


FIG. 3.

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CONDENSATE REMOVAL APPARATUS

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2 Claims. (Cl. 103—5)

My invention relates to condensers and it has for an object to improve condensate removal apparatus therefor so as to reduce the head room requirements.

It is customary, with steam power plant condensers, to have the condensate removal pump, usually of the centrifugal type, located sufficiently below the hotwell or condensate outlet as to maintain submergence of the pump. In accordance with my invention, I do not depend upon gravitational head to secure submergence, with the result that the pump may be located at a relatively higher level with respect to the hotwell. To this end, I provide a booster ejector associated with the conduit supplying condensate from the condenser to the pump inlet, the booster ejector being motivated by condensate received from the pump discharge and promoting the flow of condensate to the inlet of the pump, whereby, in operation, the pump may be adequately submerged, even though, from a gravitational point of view, it has zero or negative submergence. Therefore, it is apparent that, by the use of my invention, the required head room for condensate removal apparatus may be considerably reduced.

While the invention may be applied to condensers both of the land and marine type, it is particularly useful in connection with the latter type because of greater assurance of maintaining submergence of the pump in case of listing of the ship in such manner as to raise the pump below the bottom of the condenser and because of limited room frequently encountered aboard ship, particularly where the condenser is located near to the ship's bottom. Therefore, if applied to naval craft, the improved system of condensate removal provides for maintenance of operation even though listing of the ship should occur for any reason, as, for example, on account of being hit during a naval engagement and it makes possible location of the condenser in a relatively low position. Also, where the invention is applied to condensers of the marine type, it is desirable to provide condensate removal pumps of different capacities, one being sufficiently large to handle condensate under full power operating conditions and the other being relatively smaller as determined by low power requirements, each of the pumps having an ejector motivated by condensate supplied from the exit side of the pump and both pumps being connected to a common discharge line through branches having valves which function to prevent back flow of condensate from an active pump through an inactive pump. It is a further object of my invention to provide apparatus of this character having the advantageous features of construction and of operation just pointed out.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 is a diagrammatic view showing my improved condensate removal means;

Fig. 2 is an enlarged sectional view of the condensate ejector and hotwell as shown in Fig. 1; and,

Fig. 3 is a detail view of one of the water nozzles.

Referring to the drawing more in detail, I show a steam condenser 10 having a hotwell or condensate collection chamber 11. Condensate is supplied from the collection chamber or hotwell by means of the conduit 12 to the inlet 13 of the centrifugal pump 14 having an outlet 15.

Instead of having the pump 14 arranged below the bottom of the hotwell or collection chamber 11 sufficiently to secure positive submergence of the pump, as is customary, the pump is shown elevated considerably from the usual location, and the elevation may be such that the pump may have zero or negative submergence instead of positive submergence. To provide for satisfactory operation of the elevated pump, the positive head at the inlet of the latter must be provided for in some way. Accordingly, an ejector, at 16, is shown associated with the conduit 12 to promote the flow of condensate through the conduit to the inlet of the pump, whereby proper operating submergence may be secured even though the gravitational submergence is insufficient or negative. The ejector includes a motive nozzle 17 supplied with condensate, serving as motive fluid, from the outlet 15 of the pump 14, by means of the branch conduit 18, the nozzle 17 discharging the motive jet into the diffuser or combining tube 19. Thus, it will be seen that energy derived from the pump discharge is available to provide a positive head at the pump inlet; and, therefore, satisfactory submergence of the pump may be secured even though, from a gravitational point of view, the submergence is practically zero or negative. As illustrated the ejector, at 16, is comprised in part by the collection chamber or hotwell structure. To this end, opposed walls 20 and 21 of the hotwell or collection chamber carry

the nozzle 17 and the diffuser or combining tube 19.

As shown in Fig. 3, the motive fluid nozzle 17 is modified so as to provide a cruciform discharge area, as indicated at 23, whereby the entrainment area of the jet may be greatly increased and cavitation troubles minimized. The advantage of this construction will be apparent when it is considered that the cross-section of an ordinary jet varies as the square of the radius whereas the boundary thereof varies as the radius. Accordingly, as a jet is made larger, the flow of fluid increases disportionately compared to the boundary surface. By using the cruciform structure, the disadvantage of large jets on this account is very largely minimized, for it will be apparent that the cruciform discharge area in which the elements are relatively narrow assures of a relatively greater jet entrainment surface to jet flow in consequence of which entrainment is greatly improved.

While a single condensate removal pump and booster ejector may be used, as just described, yet, in naval applications, it may be desirable to provide two condensate removal pumps, one being a large pump 14 for removal of condensate when operating under full power conditions and a relatively smaller pump 25 serving to remove condensate when the ship is operated at relatively lower power conditions, or at cruising speed. The pump 25 is provided with a booster ejector, at 26, associated with the condenser or condensate collection chamber 11 in a manner similar to the ejector 16. To this end, I show the chamber 11 connected by a conduit 27 to the pump 25 and the booster ejector 26 is comprised by a nozzle 28 and a diffuser 29 suitably positioned with respect thereto. As in the case of the ejector, at 16, the nozzle and the diffuser elements are preferably carried by walls of the chamber 11. The nozzle 28 is supplied with water from the discharge side of the pump 25 by means of the conduit 30.

The pumps 14 and 25 have their outlets 15 and 31 connected to branch conduits 32 and 33, respectively, which are joined to the discharge conduit 34.

Check valves 35 and 36 are arranged in the branches 32 and 33, respectively, and are arranged to prevent backflow into an inoperative pump when the other pump is operative. Also, there are shown valves 37 and 38 arranged in the outlets of the pipes 32 and 33 and arranged beyond the check valves 35 and 36 so that either pump and its associated apparatus may be isolated from the discharge line.

Referring now more particularly to the structure of each ejector, for example, the ejector 16, on opposite walls 20 and 21 of the collection chamber 11 is formed with similar and alined openings 40 and 41. The nozzle 17 extends through the opening 40 and has its discharge end disposed about midway between the walls 20 and 21, the nozzle being provided with an annular flange 42 which overlaps the boundary of the opening 40 and is coupled to the wall 20 externally of the collection chamber in any suitable manner. The combining tube 19 has the inlet end 43 of its passage arranged to register with the opening 41 so that said opening may constitute an entrance for the combining tube, the combining tube having an annular flange 44 which is coupled externally of the wall 21 in any suitable manner. As shown, the openings 40 and 41 are similar and they are preferably both rounded so that the nozzle and combining tube elements may be associated with either opening. Thus, it will be seen that manufacture and assembly of the apparatus is facilitated in that the nozzle and combining tube elements are formed separately from the collection chamber, are fastened to the latter externally, and may be arranged in either opening. As already pointed out, each nozzle is formed with a plurality of slit-like discharge passages so as to provide a high ratio of surface to cross-sectional area of the jet, whereby a large entrainment effect is secured. Not only is the jet modified in this way to induce a large entrainment effect, but this result is further achieved by having the discharge end of the nozzle arranged substantially midway between the rear walls, whereby a discharging jet is exposed internally of the collection chamber for action upon condensate.

From the foregoing, it will be apparent that I have provided a condenser installation which does not require that the condensate removal pump shall be located at a relatively low level with respect to the condenser shell, this being made possible for securing submergence by means other than gravity, that is, by using water from the discharge of the pump to serve as motive fluid to motivate a booster ejector which provides a positive head, or submergence, for the pump. Also, it will be seen that the condenser shell is provided with a collection chamber especially arranged and modified to provide for the ejectors, the chamber having its exposed walls carrying the nozzles and the combining tubes, respectively, of the ejectors. Furthermore, the discharge ends of the nozzles are axially spaced with respect to the inlet ends of the combining tubes so that portions of the jets of adequate axial length are exposed internally of the collection chamber to secure entrainment of water from the latter into the combining tube. In installations, for example, on naval craft, where operation under different speed and power conditions is required, I prefer to utilize a plurality of pumps, each pump being provided with a booster ejector. Assuming that a naval ship is required to operate under high speed and high power and under cruising speed and low power conditions, then a pair of centrifugal pumps suitable for operation under these conditions may be provided, that is, a large pump for the high speed and high power condition and a smaller pump for the cruising speed and low power condition, the large and small pumps having large and small booster ejectors to secure submergence either because of location of the pumps at a level or levels relatively higher than customary or because of listing of the ship. If large and small pumps are used, than the outlets thereof are preferably connected to branches of a main discharge conduit and each branch has valve means therein to prevent back-flow of water through an idle pump when the other pump is in operation.

While I have shown an ejector motivated by condensate received from the pump discharge and operating to maintain satisfactory pump submergence, it will be obvious that any means utilizing energy derived from the pump discharge for boosting the flow of condensate to the inlet of the pump for this purpose may be used.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of

various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a condenser installation, a condenser having a shell, large and small condensate removal centrifugal pumps, large and small booster ejectors for supplying condensate from the shell to the inlets of the large and small pumps, respectively, motive fluid conduits for the large and small ejectors and connected to the outlets of the large and small pumps, respectively, a discharge conduit including branches connected to the outlets of the pumps, and valve means arranged in the branches and serving to prevent backflow through an idle pump when the other pump is in operation.

2. In a condenser installation, a condenser having a shell, a condensate collection chamber in communication with the interior of the shell, large and small ejectors each including a nozzle and a combining tube carried, respectively, by opposed walls of the chamber, large and small centrifugal pumps having their inlets supplied from the combining tubes of the large and small ejectors, respectively, motive fluid conduits for the nozzles and connected to the outlets of the large and small pumps, respectively, the discharge ends of the nozzles being spaced from the inlet ends of the combining tubes so that adequate entrainment area of each jet is exposed interiorly of the chamber to effect entrainment of condensate therefrom to its combining tube, a discharge conduit having branches connected to the outlets of the pumps, and valve means arranged in the branches and serving to prevent back-flow through an idle pump when the other pump is in operation.

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