Sept. 11, 1928. 1,684,227

E. A. JOHNSEN

CONDENSER

Filed Jan. 6, 1927 4 Sheets-Sheet 1

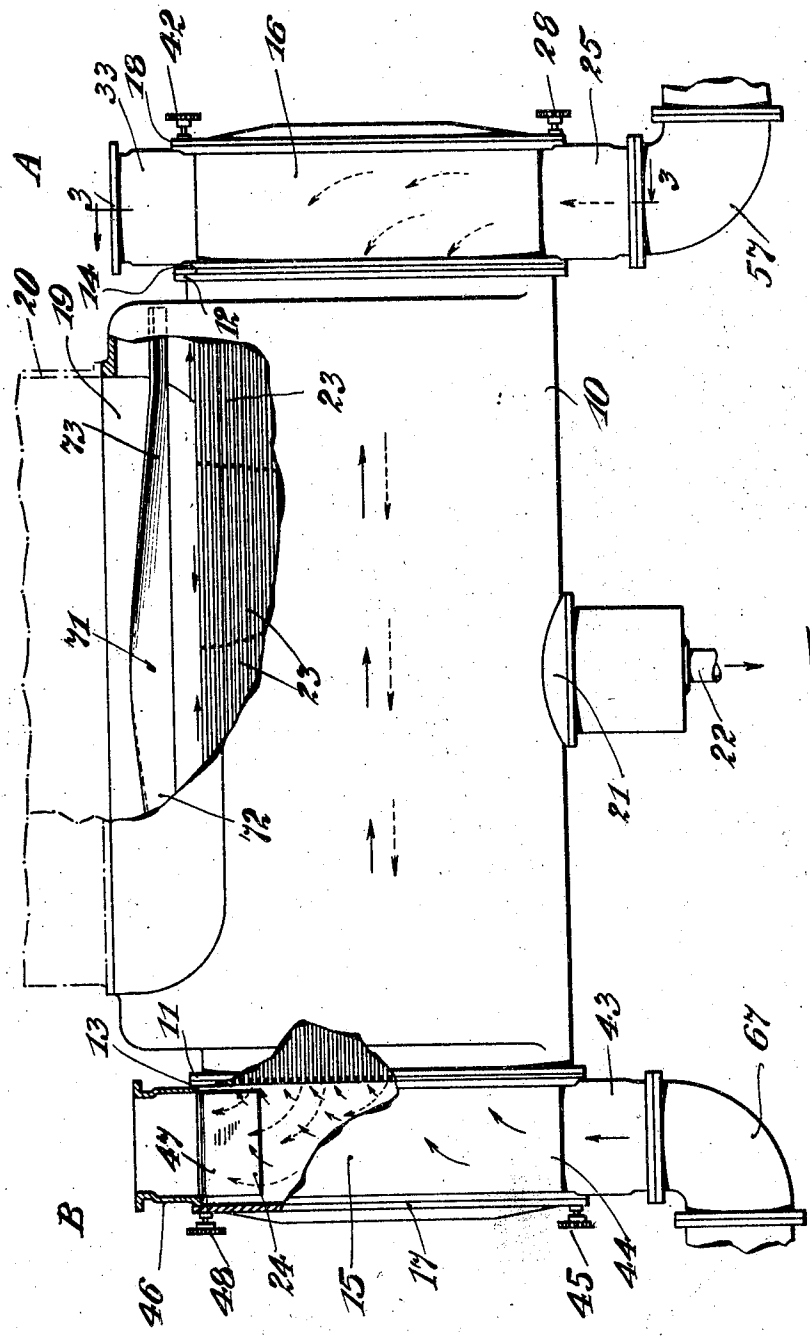


Fig. 1.

INVENTOR
Einar A. Johnsen
BY
his ATTORNEYS

Sept. 11, 1928. 1,684,227

E. A. JOHNSEN

CONDENSER

Filed Jan. 6, 1927 4 Sheets-Sheet 2

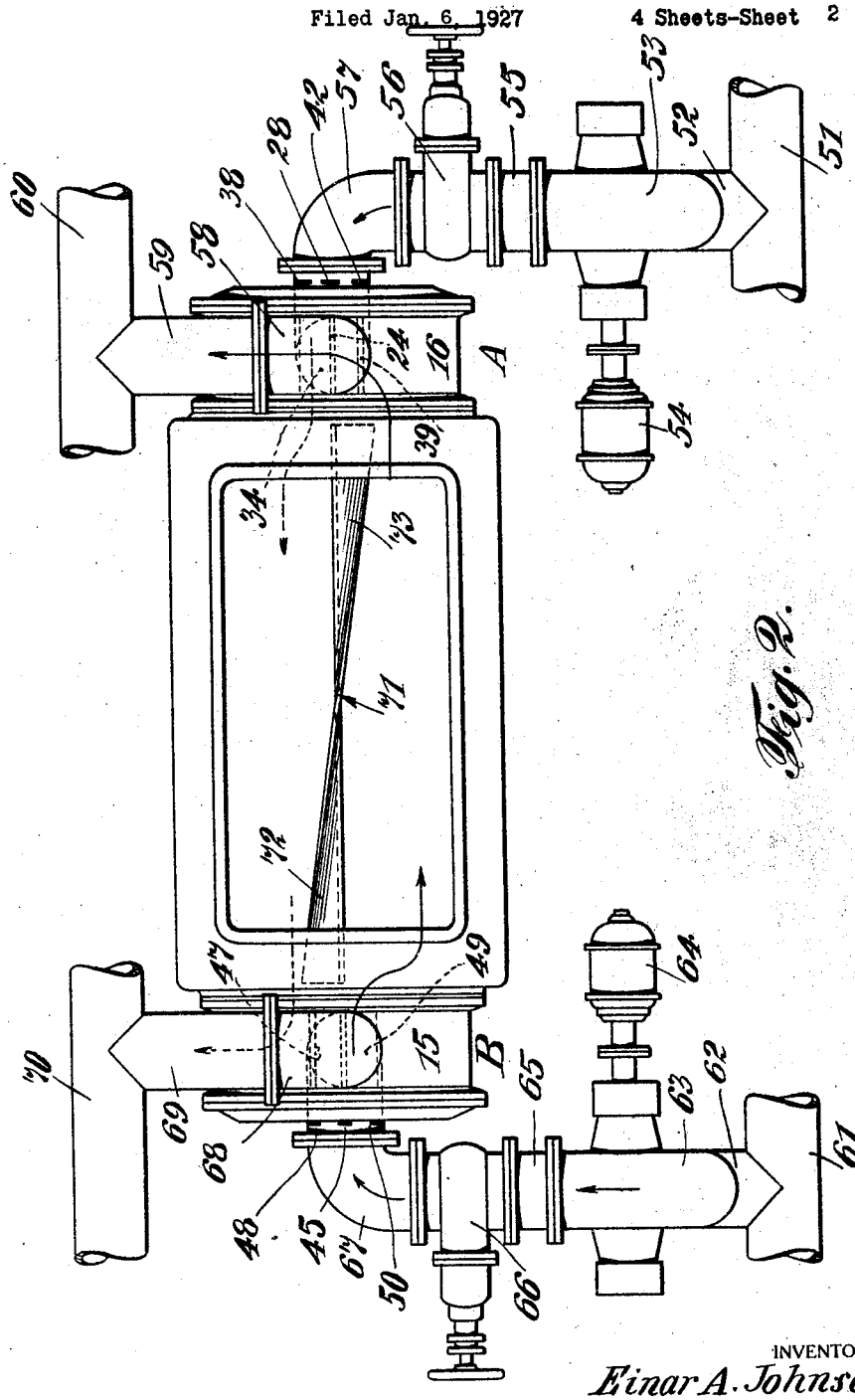


Fig. 2.

INVENTOR
Einar A. Johnsen
BY
his ATTORNEYS

Sept. 11, 1928. 1,684,227

E. A. JOHNSEN

CONDENSER

Filed Jan. 6, 1927 4 Sheets-Sheet 3

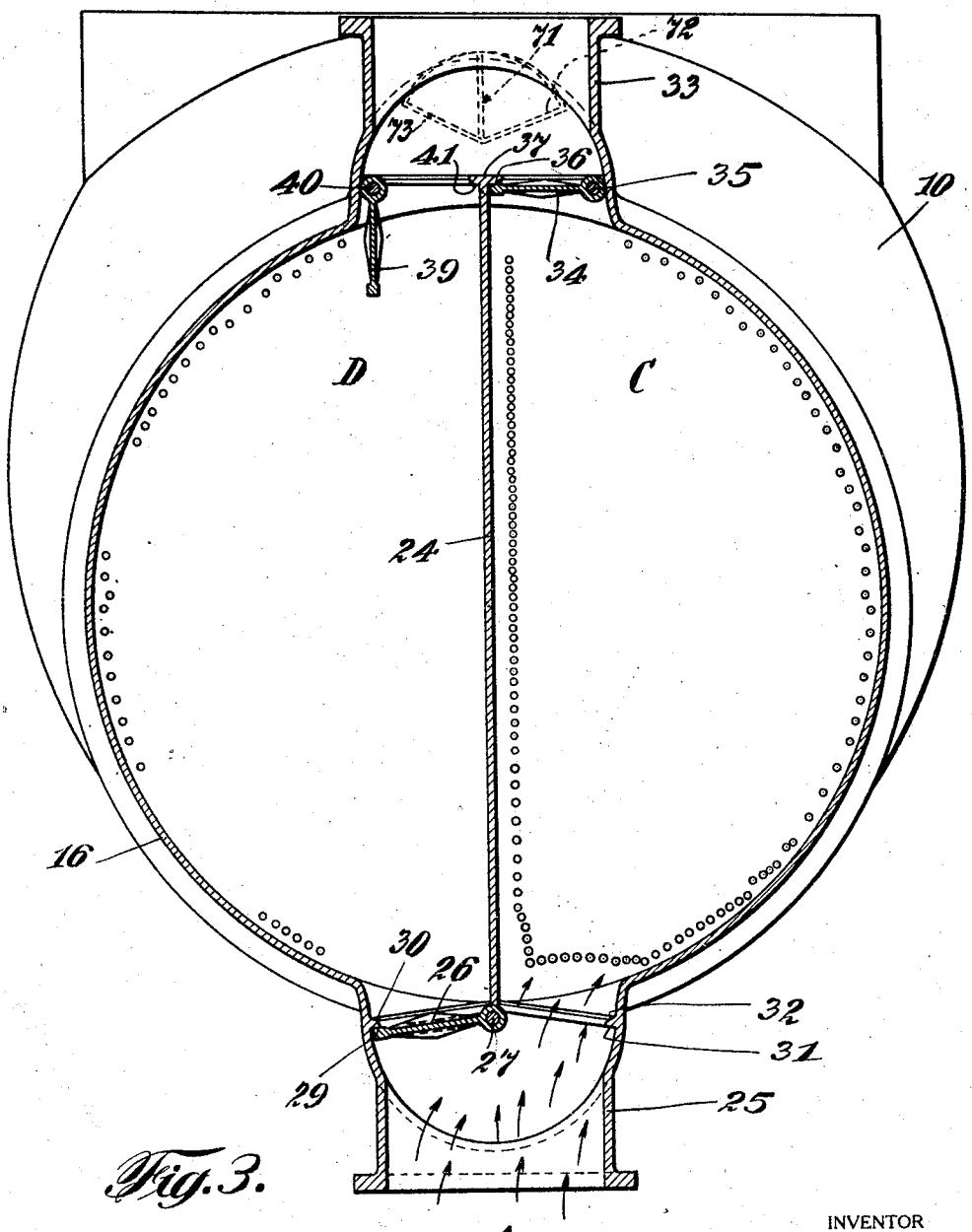


Fig. 3.

INVENTOR
Einar A. Johnsen
BY
his ATTORNEYS

Sept. 11, 1928. 1,684,227

E. A. JOHNSEN

CONDENSER

Filed Jan. 6, 1927 4 Sheets-Sheet 4

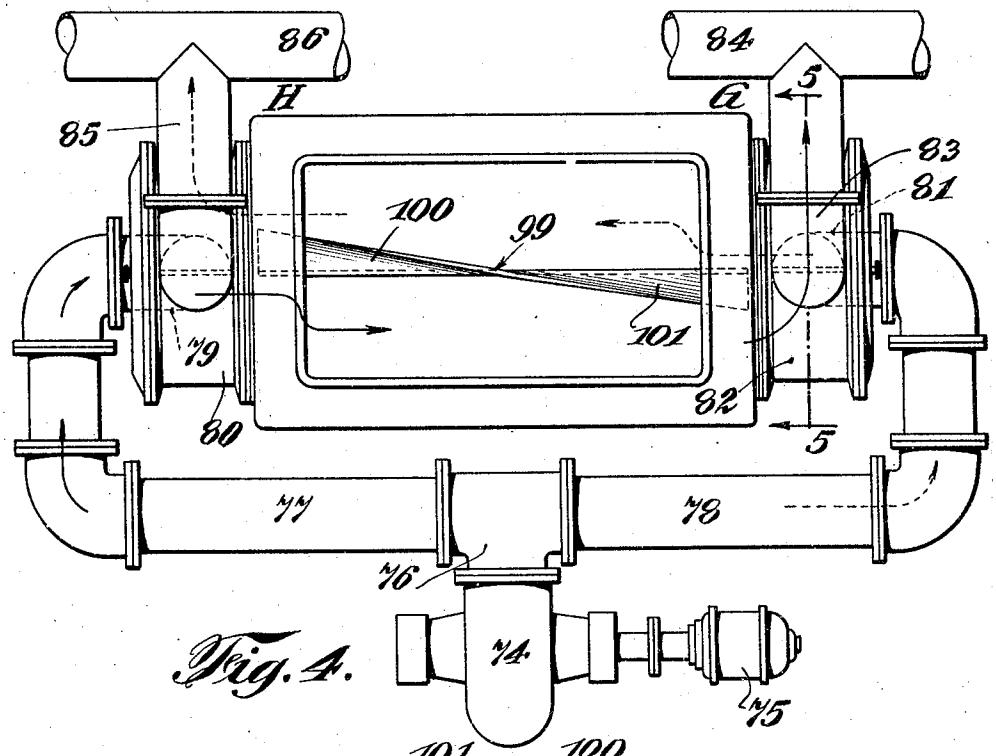


Fig. 4.

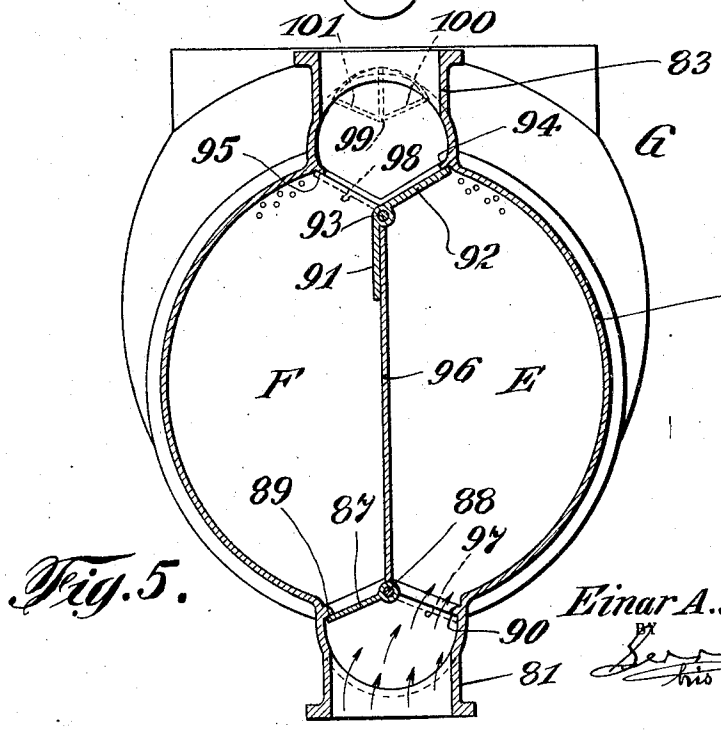


Fig. 5.

INVENTOR
Einar A. Johnsen
BY
his ATTORNEYS

Patented Sept. 11, 1928. 1,684,227

UNITED STATES PATENT OFFICE.

EINAR A. JOHNSEN, OF MOUNTAIN LAKES, NEW JERSEY, ASSIGNOR TO ENGINEERING DEVELOPMENT COMPANY, OF NEW BRUNSWICK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

CONDENSER.

Application filed January 6, 1927. Serial No. 159,274.

My present invention relates to a condenser and more particularly to a surface condenser. The condenser in which my invention is incorporated is what may be termed a multi single-pass condenser, that is a condenser having a plurality of banks of tubes and constructed to provide for a flow of independent circulating mediums in opposite directions through adjacently placed banks of tubes. The invention also makes provision for devices self contained in a surface condenser for reversing the direction of the flow of the circulating cooling medium through the banks of tubes without reversing the direction of the flow of the circulating medium as delivered by the pumps or other means for causing the flow thereof for the purpose of cleaning the tubes.

I am aware that single pass surface condensers have been heretofore employed. In this type of surface condenser all the circulating medium is caused to flow from one end to the other through the condenser tubes whereby the ends of the tubes at which the circulating medium is admitted is cooler than the ends at which the circulating medium is discharged. This makes it necessary in this type of condenser to place the exhaust steam inlet off center and nearer the cooling medium inlet end than the outlet end of the condenser tubes. Furthermore, in this type of condenser to provide for the requisite quantity of cooling medium, pipe lines of relatively large diameter must be employed.

I am also aware that heretofore condenser tubes have been cleaned in various manners, for example by the use of a sand blast, by forcing plugs through the tubes, by using metal brushes for scraping the tubes, and in various other and similar manners. Moreover, it has also been proposed heretofore, to reverse the direction of the flow of the cooling medium in order to clean the condenser and the condenser tubes. The necessity of maintaining the condenser tubes in a cleanly condition is no doubt self evident. The efficiency of a surface condenser depends mainly on the coefficient of heat exchange between the steam to be condensed and the circulating cooling medium. This in turn is dependent largely upon maintaining a uniform quantity of flow of the circulating medium through the condenser tubes and also upon the condition, that is the cleanliness of the tubes. These conditions are believed to be self-evident. In any event, in condenser practice, it is necessary in order to maintain a desired vacuum, and at the same time to operate the pumps for the circulating medium at their normal capacities, to clean the condenser and the tubes thereof at more or less frequent intervals. The frequency with which it is found necessary to clean the condensers and its tubes depends upon operating conditions. In many places the water available for circulating purposes particularly at certain seasons of the year contains almost all kinds of refuse, débris and other foreign substances which clog the condenser tubes and may contain various chemical substances which have a tendency to form a scale or to otherwise clog the space in the tubes and to thus affect the conditions of the tubes to the detriment of the coefficient of heat transfer.

The reversal of the direction of the flow of the circulating medium is most effective in a single pass condenser because in this type of condenser all the refuse collected on the tube sheet or within the tubes is entirely removed from the condenser by reversing the direction of the flow of the circulating medium. The reversal of the direction of the flow of the circulating medium in multi-pass condensers is just as necessary in order to maintain the same in a proper operating condition as in the case of single pass condensers, but the invention in the present case is one which relates solely to a multi single-pass condenser in which provision may be made for reversing the direction of the flow of the circulating medium without changing the direction of the flow of the circulating medium to the condenser.

The condenser made in accordance with my invention is constructed to obviate the difficulties to which reference has hereinbefore been made. The condenser is constructed to include a plurality of banks of tubes with means for directing independent cooling mediums to predetermined banks of tubes causing these cooling mediums to flow in opposite directions in adjacent banks of tubes whereby the exhaust steam inlet may be placed in a centrally disposed position in the shell inasmuch as there are banks of tubes the cooler ends of which are at oppositely disposed ends

of the condenser, and inasmuch as the circulating medium is divided, pipe lines of appreciably smaller capacity may be employed for conducting the circulating medium both to and from the condenser. The pipe lines required for reversing the flow of the circulating medium through a single pass condenser of the ordinary type are relatively large and must be made to include valves so that the piping is more or less complicated and also occupies so much space as to be so relatively costly as to make the practice substantially prohibitive. In the present invention devices are employed in the condenser, referably in the water boxes, making the same self contained, whereby the direction of the flow of the circulating medium may be reversed in order to clean the tubes without the use of valves in the pipe lines, without the necessity of dismantling the condenser, and without changing the direction of the flow of the circulating medium as the same is delivered by the pumps or other devices for causing the circulating medium to flow.

Moreover, in carrying out the present invention the condenser made in accordance therewith is also preferably fitted with a baffle plate for deflecting relatively more of the incoming exhaust steam to the cooler end or ends of the banks of tubes, that is the end or ends at which the circulating medium is admitted to the tubes than is deflected to the warmer end or ends of the tubes or the ends at which the circulating medium leaves the tubes. Still furthermore, it will be apparent that the invention may be applied to a vertical as well as to a horizontal condenser and in any construction the direction of the flow of the circulating medium may be reversed at predetermined intervals and for a sufficient space of time to maintain the condenser tubes in a sufficiently clean condition to render efficient service while maintaining the condenser in constant operation.

In the drawing Figure 1 is an elevation and partial cross section illustrating a condenser apparatus made in accordance with my present invention.

Fig. 2 is a plan of the same on a slightly reduced scale.

Fig. 3 is a section on line 3—3, Fig. 1 on an enlarged scale.

Fig. 4 is a plan showing another form of the invention, and

Fig. 5 is a section on line 5—5, Fig. 4.

Referring to the drawing and particularly to Figs. 1 to 3 inclusive, the condenser in which my invention is incorporated includes many features common to the usual surface condenser. It consists of a shell 10 having flanges 11 and 12 at the ends thereof with tube plates 13 and 14 and water boxes 15 and 16, together with their covers 17 and 18 all connected in the usual manner. The shell 10 is made with an opening 19 preferably at the top thereof for the admission of exhaust steam from a turbine or other prime mover, which may be conveyed to the condenser by a pipe or conduit 20 employed for this purpose. The condenser shell is also provided preferably in the bottom thereof with an opening 21 which may be connected by a pipe 22 or otherwise to a hot well or condensate pump or other discharge for the condensate. In the customary manner also, there are banks of tubes 23 extending through the condenser shell and at their ends secured in any desired manner in the tube plates of the condenser. Furthermore, the banks of tubes may be arranged in any suitable layout.

In this form of the invention the condenser tubes 23 are so spaced and the water boxes provided with partition walls as to make the condenser in reality a double one pass unit, that is a unit in which there are two single pass arrangements for the circulating medium and in which normally the circulating medium flows in opposite directions. To this end the water box 16 as indicated in Fig. 3 is provided with a transverse partition wall 24. As illustrated, this partition wall is in a vertically disposed position, but as will be understood the arrangement may be such that the partition wall assumes any necessary position in the water box. The inlet connection of this water box 16 at the A end of the condenser is indicated at 25. This inlet connection 25 is fitted with a valve 26. As illustrated, this valve 26 may be called a flap valve. The valve 26 is mounted on a shaft 27 which is journaled in the water box, passes through one side thereof and also through the cover 18 and exteriorly thereof is fitted with a gear or a hand wheel by means of which the shaft may be turned to place the valve in any desired position. In the position as indicated in Fig. 3, the peripheral portion of the valve bears against a valve seat 29 provided therefor by a rib 30 on the interior of the inlet connection. In an oppositely disposed position in this inlet connection there is a valve seat 31 in a rib 32 on the inner side of the inlet connection 25.

Preferably in an oppositely disposed position the water box 16 is provided with a discharge nozzle or connection 33 for the circulating medium. In this discharge nozzle or adjacent thereto there is a valve 34. This valve is also illustrated as a flap valve and is mounted to swing on a shaft 35. The peripheral portion of the valve is adapted to bear against a seat 36 provided therefor by the flanged head 37 of the partition wall 24 or otherwise. The shaft 35 is journaled in the walls of the water box, passes through the water box cover and exteriorly thereof is fitted with a gear or hand wheel by which the shaft may be turned to determine the position of the valve 34. In a similar but

oppositely disposed position in the discharge nozzle 33 or adjacent thereto there is a valve 39. This valve 39 is mounted on a shaft 40 and adapted in one position to bear at its peripheral portion against a seat 41 also provided by the flanged head 37 of the partition wall 24. The shaft 40 is journaled in the walls of the water box, passes through the cover therefor, and exteriorly thereof is provided with a gear or hand wheel 42 by which the shaft may be turned to determine the position of the valve 39.

At the opposite or B end of the condenser the water box 15 is provided with an intake connection 43 similar to the intake connection 25 and in which there is mounted a valve similar in all respects to the valve 26. The shaft on which this valve is mounted passes through the cover 17 of the water box 15 and exteriorly thereof is fitted with a gear or hand wheel 45 by which the position of this valve may be determined.

The water box 15 at the B end of the condenser is also provided with an outlet connection or nozzle 46 similar to the outlet connection 33. In this outlet connection 46 there is a valve 47 which corresponds to the valve 34. The shaft on which this valve is mounted passes through the cover of the water box and exteriorly thereof is fitted with a gear or hand wheel 48 by means of which the position of the valve is determined. In like manner in the discharge connection 46 or adjacent the same there is a valve 49 which corresponds to the valve 39. The shaft on which this valve is mounted extends through the cover of the water box 15 and exteriorly thereof is fitted with a gear or hand wheel 50 by means of which the position of the valve is determined.

In prevalent surface condenser practice, it is usual to employ two or more circulating pumps, and in the form of the invention which has just been described this practice is illustrated. As is shown in Fig. 2, 51 represents a portion of a supply line for a cooling medium. This supply line is connected to any suitable source of supply and may be provided with a branch 52 leading to the suction end of a centrifugal or other pump 53 driven by a motor 54. The discharge end of the pump is connected by a pipe line 55 to one side of a valve 56, and the other side of the valve 56 is connected by a pipe line 57 to the intake connection 25 of the water box 16 at the A end of the condenser. The discharge connection 33 of this water box is connected by an elbow 58 or otherwise and a branch pipe 59 to a discharge pipe line 60 which may lead to a cooling tower or other apparatus. In like manner, 61 represents a portion of a supply line for a cooling medium. This is fitted with a branch 62 leading to the suction end of a centrifugal or other pump 63 driven by a motor 64. The discharge end of the pump 63 is connected by a pipe 65 to one side of a valve 66, and the other side of the valve 66 is connected by a suitable pipe line 67 to the inlet connection 43 of the water box 15 at the B end of the condenser. The discharge connection 46 of this water box is connected by an elbow 68 or otherwise and a branch pipe 69 to a section 70 of the discharge pipe line for the circulating medium.

In this type of apparatus it is preferable to provide a diaphragm in the condenser shell arranged directly within the exhaust steam inlet in order as will be understood to direct or deflect a greater portion of the incoming exhaust steam to the cooler ends of the condenser tubes than is directed to the warmer ends thereof. As illustrated in the drawing, such a diaphragm or baffle is indicated at 71. This may be constructed of a sheet of metal or otherwise in a double curved form as indicated at 72 and 73 so as to deflect the incoming steam as hereinbefore stated.

It will be understood that the baffle 71 functions to direct the greater portion of the incoming exhaust steam to the cooler ends of the condenser tubes during the normal operation of the apparatus when the flow of the cooling medium through the tubes is in a predetermined direction as indicated by the arrows in Figure 1 of the drawings, and that the intervals when the cooling medium is caused to flow in the opposite direction for the purpose of cleaning the tubes are relatively short so that when the direction of the flow of the cooling medium is reversed the reversal of the stated function of the baffle plate will not materially affect the operation of the condenser.

In the normal use of this apparatus both pumps are operated and the valve 26 in the inlet connection 25 is set in a position shown in Fig. 3, while the valves in the outlet connection 33 are also set in the position as illustrated in this figure of the drawing. The corresponding valves at the opposite or B end of the condenser are set in positions oppositely disposed to those illustrated in Fig. 3. With the valves thus set the circulating medium passing through the pump 53 passes through the valve 56 to the inlet connection 25, and thence is directed to the bank of tubes C, passing therethrough from the A to the B end of the condenser, and thence passing through the outlet connection 46 to the discharge line 70. The circulating medium passing through the pump 63 passes through the valve 66 and pipe line 67 to the inlet connection 43 of the water box at the B end of the condenser, thence this circulating medium is directed to the banks of tubes D and passes through the same from the B to the A end of the condenser, and thence through the discharge connection 33 and the pipe line 59 to the discharge line 60. It will now be readily apparent that by reversing the positions of the valves the direction of the flow of the cir-

culating medium may be reversed, that is to say by reversing the positions of these valves the circulating medium from the pump 53 will be directed to pass in the opposite direction through the bank of tubes D and the circulating medium from the pump 63 to pass in the opposite direction through the bank of tubes C, and that this is effected without the reversal of the pumps.

In some instances, for example in certain latitudes, or at certain times, or in cold weather, it may be necessary to employ but one pump. In such an event, either of the pumps may be employed in the structure as illustrated, and the direction of the flow of the water through the condenser will depend upon the pump which is in service. One pump causing the circulating medium to pass in one direction through the condenser tubes and the other pump causing the circulating medium to pass in the other direction through the condenser tubes, whereby to effect a reversal of the flow of the circulating medium it is only necessary to shut down one pump and operate the other, for example in the use of the pump 53 the valve in the inlet connection 25 is placed in a central or neutral position and the valves in the outlet connection 33 are both closed, whereas the valves in the outlet or discharge connection 46 are both open, and it is immaterial in what position the valve in the inlet connection 43 may be placed, but as will be understood the valve 66 must be closed. With this arrangement all the circulating medium will pass in the same direction through both banks of tubes, that is will flow from the A to the B end of the condenser. To reverse the direction of the flow the pump 53 is shut down, the valve 56 closed, the pump 63 operated and the valve 66 opened. In this event, the valve in the inlet connection 43 is placed in a central or neutral position, the valves in the outlet connection 46 are both closed, and the valves in the outlet connection 33 are both opened, it being immaterial in what position the valve in the inlet connection 25 may be placed In this arrangement all the circulating medium will pass through both banks of tubes from the B to the A end of the condenser and will be discharged through the outlet connection 33.

In some installations, particularly where relatively small condenser units are sufficient for taking care of the exhaust steam, it is quite customary to employ a single circulating pump, and as illustrated in Figs. 4 and 5 of the drawing an apparatus of this type is shown in which the present invention is incorporated. In this apparatus a circulating pump is indicated at 74. This may be driven by a motor 75. The discharge end of the circulating pump is connected to a pipe line 76 having two branches 77 and 78. The pipe line 77 leads and is connected to the inlet connection 79 of a water box 80 at one end of a condenser shell, and the pipe line 78 leads and is connected to the inlet connection 81 of a water box 82 at the opposite end of the condenser shell. The discharge connection 83 of the water box 82 is connected to a discharge line 84. Similarly the discharge connection 85 of the water box 80 is connected to a discharge line 86. It will be understood that the suction end of the pump 74 is connected to any suitable source of supply and that the discharge lines 84 and 86 may be connected separately or together to a cooling tower or the circulating water may be disposed of in any suitable manner.

In the inlet connection 81 of the water box 82 I provide a valve 87. This is preferably a flap valve and is mounted on a shaft 88 journaled in bearings provided therefor in the walls of the water box and adapted in one extreme position to bear at its peripheral portion against a valve seat 89 and in its other extreme position to bear at its peripheral portion against a valve seat 90, these valve seats being provided by suitable ribs or otherwise formed for this purpose in the inlet connection. The shaft 88 extends through the cover employed with the water box and exteriorly thereof may be fitted with any suitable device for turning the shaft to shift and determine the position of the valve.

In or adjacent to the discharge connection 83 of the water box 82 I also employ a valve. As indicated this is an angular valve having parts 91 and 92 formed at an angle to each other. This valve is mounted on a shaft 93 which is journaled in bearings provided therefor in the walls of the water box and the part 92 of the valve is adapted at its peripheral portion to bear against a valve seat 94 formed in the walls of the water box when the valve is in one extreme position, and when the valve is in the other extreme position the peripheral portion of the part 91 thereof is adapted to bear against a valve seat 95. The water box is provided with a transverse partition wall 96 and the shaft upon which the valves are mounted and the valves themselves are so constructed to cooperate with the end portions of the partition wall as to form substantially water tight joints.

In the water box 80 at the opposite end of the condenser there is a valve in the inlet connection 79 corresponding to the valve 87 in the inlet connection 81, and furthermore, in the outlet connection 85 of the water box 80 there is a valve similar in all respects to the angular valve having the parts 91 and 92, as hereinbefore described, in the outlet connection 83 of the water box 82.

It will be understood that the condenser shell is provided with tubes connected at their ends in and extending between the tube plates placed between the water boxes and the

ends of the condenser shell, and that the partition wall 96 in the water box 82 so far as the flow of the circulating medium is concerned divides these tubes into two banks as indicated at F and E. In the use of this apparatus the water from the circulating pump is delivered to the inlet connections 79 and 81 of the water boxes. In the normal operation of the apparatus the valve 87 and the parts 91 and 92 of the angular valve are set in positions as indicated in Fig. 5. The corresponding valves at the other end of the condenser are placed in oppositely disposed positions. Consequently the circulating medium passing from the pump to and through the inlet connection 81 flows to the right hand compartment of the water box 82 as indicated in Fig. 5, and through the banks of tubes E from the G to the H end of the condenser, and thence to the outlet connection 85 and to the discharge line 86, whereas the circulating medium passing through the line 77 enters the inlet connection 79 of the water box 80 and to the tubes F passing through the same in the opposite direction, that is from the H to the G end of the condenser, and thence to the left hand compartment in the water box 82 as viewed in Fig. 5 and to the outlet connection 83 through the discharge line 84. It will be apparent that to effect a reversal of the direction of the flow of the circulating medium the valves in the inlet and discharge connections of the water boxes must be placed in the positions opposite to that hereinbefore described, in other words, the flap valve 87 is then placed in the position indicated at 97 in dotted lines and the angle valve with the parts 91 and 92 thereof as indicated in the position shown in dotted lines at 98, the valves at the other end of the condenser must also be reversed, and with all these valves in their reversed positions the circulating medium entering the inlet connection 82 will obviously flow through the bank of tubes F from the G to the H end of the condenser and be discharged at the H end thereof, whereas the circulating medium passing to the inlet connection 79 will flow through the bank of tubes E from the H to the G end of the condenser and be delivered at the G end thereof.

It is also preferable in this form of apparatus to employ a baffle plate as indicated at 99 and having oppositely disposed and curved portions 100 and 101 for directing the greater portion of the incoming exhaust steam to the cooler ends of the bank of tubes.

From the foregoing it will now be understood that the condenser made in accordance with my invention preferably includes two adjacently placed banks of tubes through which circulating mediums may be passed, together with suitable devices for causing the circulating medium to flow under normal conditions in opposite directions through these banks of tubes, that as illustrated, these devices for directing the flow of the circulating medium are located in the water boxes of the condenser and are so constructed as to assume oppositely disposed or reversible positions in order to effect a reversal of the direction of the flow of the circulating medium, although manifestly, the construction may be such that the devices, whether valves or other constructions, may be permanently fixed in position to direct the flow without providing for a reversal thereof as may be all that is necessary in installations where clean water is available for use as a circulating medium. It will furthermore be apparent that in either event the capacities of the pipe lines need be only approximately one half of that required for use in a single pass condenser of ordinary construction of like capacity, that the use of valves in the pipe lines is eliminated, with the possible exception of course, of one valve in the discharge line from each pump when a multiplicity of pumps is employed, and that together with these advantages the additional advantage of a centrally placed exhaust steam inlet is obtained.

I claim as my invention:

1. In a surface condenser, a shell, a plurality of tubes therein, and means in the condenser for reversing the direction of the flow of a cooling medium through the said tubes.

2. In a surface condenser, a shell, a plurality of tubes therein, and means in the condenser for reversing the direction of the flow of a cooling medium through the said tubes without reversing the direction of the flow of the cooling medium supply.

3. In a surface condenser, a shell, tube plates, a plurality of tubes within the shell, water boxes, and means contained in a water box for reversing the direction of flow of a cooling medium through the said tubes.

4. In a surface condenser, a shell, tube plates, a plurality of tubes within the shell, water boxes and means contained in a water box for reversing the direction of flow of a cooling medium through the said tubes without reversing the direction of the flow of the cooling medium supply.

5. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the tube plates, water boxes, a transversely disposed partition wall in a water box, and means in the water box having the transverse partition for reversing the direction of the flow of a cooling medium and directing the flow of the same to a predetermined bank of said tubes.

6. In a surface condenser, a shell, tube plates, banks of tubes lying in the shell and extending between the said tube plates, water boxes, a transverse partition wall in a water box, means in the water box having the transverse partition therein for reversing the di-

rection of the flow of a cooling medium and directing the flow of the same through a predetermined bank of tubes, and a discharge connection for the said cooling medium.

7. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, means in one water box for directing the flow of a cooling medium to either bank of tubes, means in the other water box for directing the flow of the cooling medium to either bank of tubes, and means associated with each water box for the discharge of the cooling medium therefrom.

8. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, a discharge connection for each water box, means associated with one water box for directing the flow of a cooling medium to either bank of tubes, and means in the other water box for directing the flow of the cooling medium to either bank of tubes whereby the means for directing the flow of the cooling medium to the banks of tubes may be set to cause the cooling medium entering one water box to flow in one direction through one bank of tubes and to be discharged from the discharge connection of the other water box and the cooling medium entering the other water box to flow in the opposite direction through the other bank of tubes and to be discharged from the discharge connection of the first aforesaid water box.

9. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, an outlet connection for each water box, means associated with the inlet connection of each water box for directing the flow of a cooling medium to either bank of tubes, and means associated with the discharge connection of each water box for determining the direction of the flow of the cooling medium therefrom whereby the said means may be set in oppositely disposed positions to cause the cooling medium entering one water box to flow in one direction through one bank of tubes and to be discharged from the discharge connection of the other water box and the cooling medium entering the said other water box to flow in the opposite direction through the other bank of tubes and to be discharged from the discharge connection of the first aforesaid water box.

10. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, an outlet connection for each water box, means associated with the inlet connection of each water box for directing the flow of a cooling medium to either bank of tubes, and devices for changing the positions of the said means to reverse the direction of the flow of the cooling medium through the said banks of tubes without reversing the direction of the flow of the cooling medium supply.

11. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, an outlet connection for each water box, a transverse disposed partition wall in each water box, and means associated with the partition walls in each water box for directing the flow of a cooling medium to, through and from either bank of tubes whereby the said means may be set to direct the flow of the cooling medium into one water box to and through either bank of tubes and discharge the cooling medium from the discharge connection of the other water box and to direct the flow of a cooling medium entering the said other water box to either bank of tubes and to discharge the same from the discharge connection of the first aforesaid water box.

12. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, an outlet connection for each water box, a transverse disposed partition wall in each water box, means associated with the end portions of the partition walls and the inlet and discharge connections of the water boxes for causing a cooling medium entering the inlet connection of one water box to be directed to one bank of tubes and to be discharged from the discharge connection of the other water box and the cooling medium entering the said other water box to be directed to the other bank of tubes and to be discharged from the discharge connection of the first aforesaid water box, and devices for reversing the positions of the said means for reversing the direction of the flow of the cooling medium through the said banks of tubes without reversing the direction of the flow of the cooling medium supply.

13. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, an outlet connection for each water box, a transverse disposed partition wall in each water box, valves each associated with one end of a partition wall and operative in the inlet connection of the corresponding water box, and other valves each associated with the opposite end of a partition wall and operative in the discharge connection of the corresponding water box, whereby the said valves may be set to direct the flow of a cooling medium entering one water box to either bank of tubes and to be discharged from the

discharge connection of the other water box and to direct the flow of the cooling medium entering the said other water box to either bank of tubes causing the same to be discharged from the discharge connection of the first aforesaid water box.

14. In a surface condenser, a shell, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, an inlet connection for each water box, an outlet connection for each water box, a transverse disposed partition wall in each water box, valves each associated with one end of a partition wall and operative in the inlet connection of the corresponding water box, other valves each associated with the opposite end of a partition wall and operative in the discharge connection of the corresponding water box, whereby a cooling medium entering one water box may be directed to and through one bank of tubes and discharged from the discharge connection of the other water box and a cooling medium entering the inlet connection of the said other water box is caused to flow in the opposite direction through the other bank of tubes and to be discharged through the discharge connection of the first aforesaid water box, and means for changing the positions of the said valves to reverse the direction of the flow of the cooling medium through the said banks of tubes without reversing the direction of the flow of the cooling medium supply.

15. In a surface condenser, a shell, banks of tubes therein, a water box at each end of the shell, means for supplying a cooling medium to both water boxes, and means shiftable to position in each water box whereby when placed in oppositely disposed positions in the respective water boxes the cooling medium supplied to one water box is caused to flow in one direction through one bank of tubes and to be discharged from the other water box and the circulating medium supplied to the said other water box is caused to flow in the opposite direction through the other bank of tubes and to be discharged from the first aforesaid water box and when the said means are placed in the reversed positions the circulating medium is caused to flow in the opposite direction through the said banks of tubes.

16. In a surface condenser, banks of tubes therein, a water box at each end of the shell, and valves shiftable to position in the inlet and discharge ends of both water boxes whereby when the valves are set in one position a circulating medium supplied to the inlet connection of one water box is caused to flow in one direction through one bank of tubes and to be discharged from the other water box and the circulating medium supplied to the other water box is caused to flow in the opposite direction through the other bank of tubes and to be discharged from the first aforesaid water box and when the said valves are shifted to opposite positions the circulating medium supplied to the water boxes is caused to flow through the banks of tubes in the other direction.

17. In a surface condenser, a shell having an opening for the admission of exhaust steam, a plurality of tubes in said shell, means in the condenser for reversing the flow of a cooling medium therethrough, and a baffle plate in the shell adjacent the said opening for the admission of exhaust steam and adapted to direct the steam upon entering the shell to the cooler end of the tubes.

18. In a surface condenser, a shell having an opening for the admission of exhaust steam, tube plates, banks of tubes lying within the shell and extending between the said tube plates, water boxes, means in one water box for directing the flow of a cooling medium to either bank of tubes, means in the other water box for directing the flow of the cooling medium to either bank of tubes, discharge nozzles each associated with a water box whereby the cooling medium admitted to one water box is discharged through the discharge connection of the other water box, and a baffle plate in the shell adjacent the said opening for the admission of exhaust steam and adapted to direct the steam upon entering the shell to the cooler ends of the tubes.

19. In a surface condenser, a shell, banks of tubes therein, a water box at each end of the shell, means for directing the circulating medium supplied to one water box to flow through one bank of tubes in one direction and to be discharged from the other water box, means for directing the circulating medium supplied to the said other water box to flow through the other bank of tubes in the other direction and to be discharged from the first aforesaid water box, and a baffle plate in the said shell adapted to direct the greater portion of incoming exhaust steam to the cooler ends of the said banks of tubes.

Signed by me this 22nd day of December, 1926.

EINAR A. JOHNSEN.