

Sept. 6, 1932.

C. O. SANDSTROM

1,875,663

HEAT EXCHANGER

Filed Jan. 21, 1931

5 Sheets-Sheet 1

Fig. 1

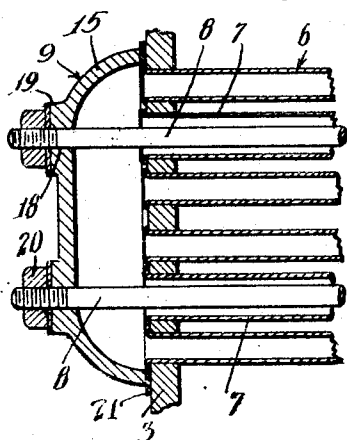
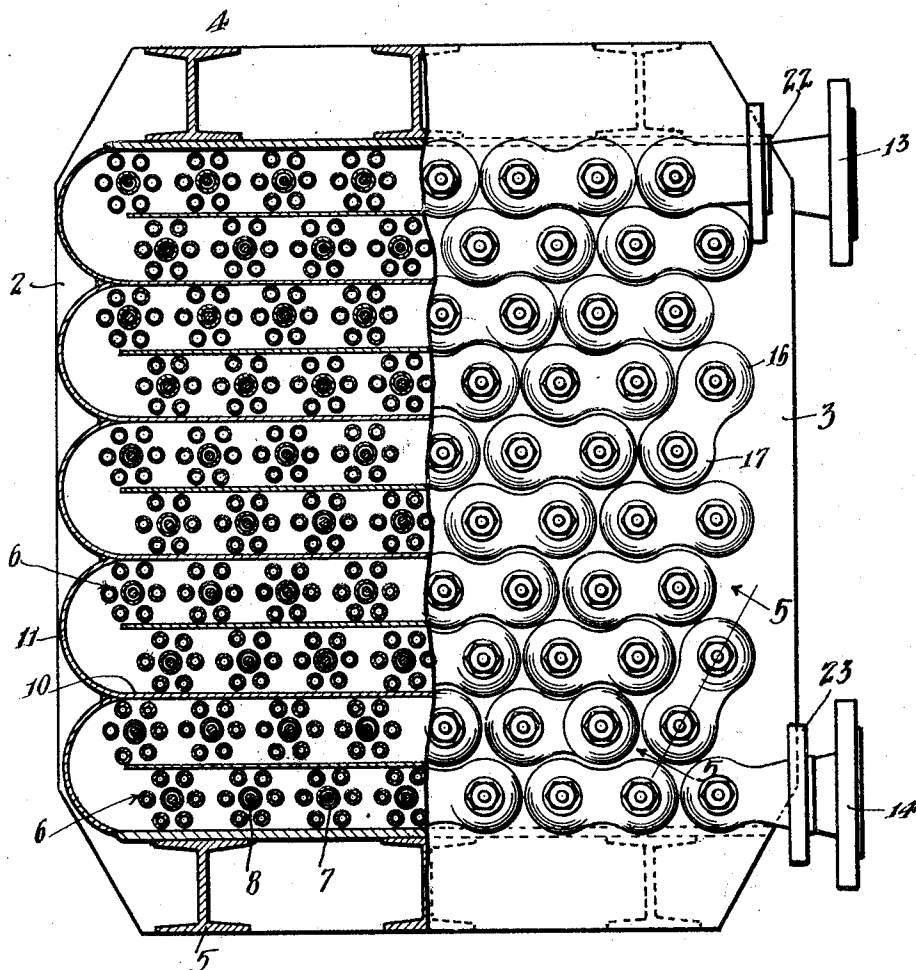


Fig. 5

Inventor
Charles O. Sandstrom.

By *Lyon & Lyon* attys.

Sept. 6, 1932.

C. O. SANDSTROM

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5 Sheets-Sheet 2

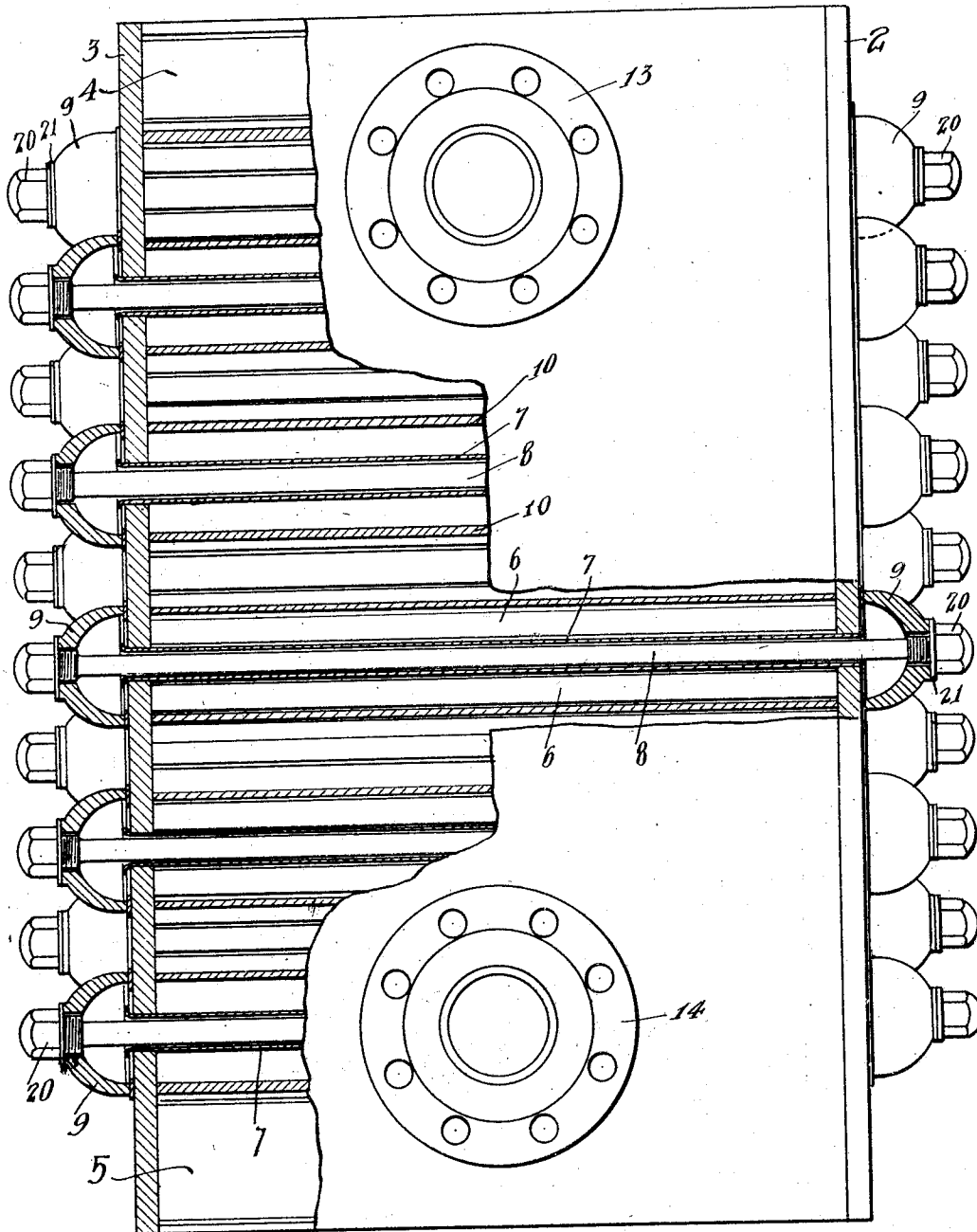


Fig. 2

Inventor
Charles O. Sandstrom
By Lyon & Lyon, atty.

Sept. 6, 1932.

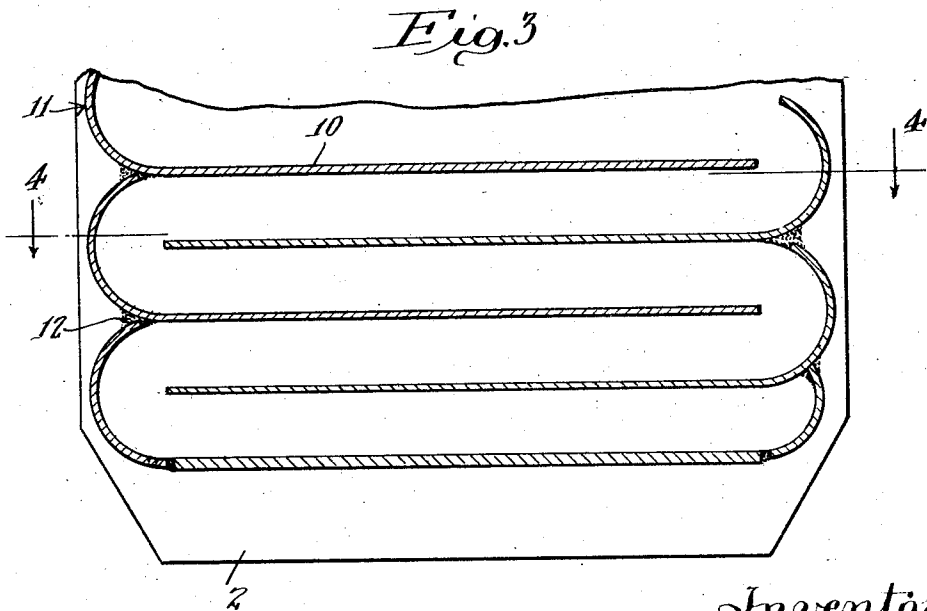
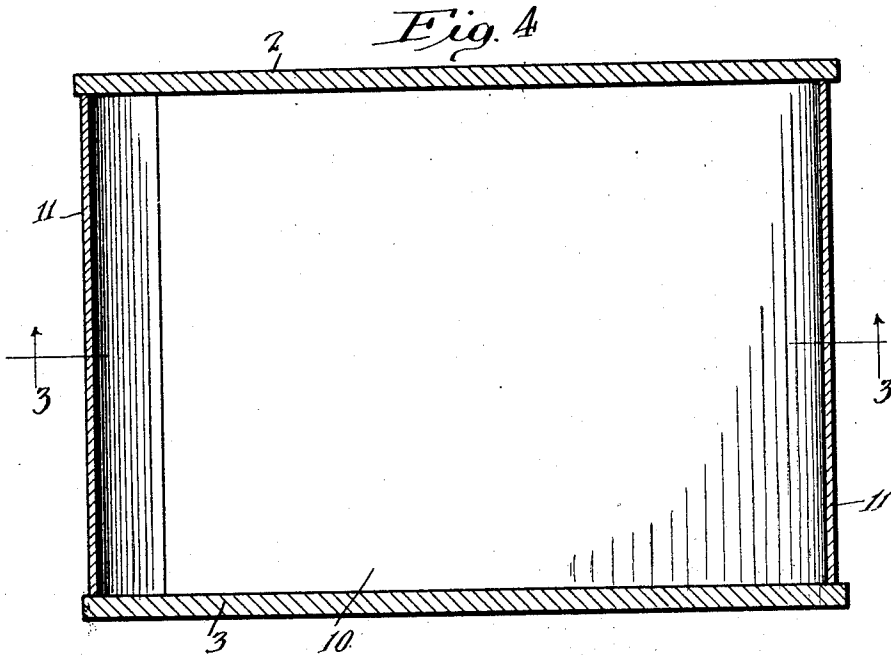
C. O. SANDSTROM

1,875,663

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5 Sheets-Sheet 3



Inventor
Charles O. Sandstrom
By Lyour Lyon, attys.

Sept. 6, 1932.

C. O. SANDSTROM

1,875,663

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5 Sheets-Sheet 4

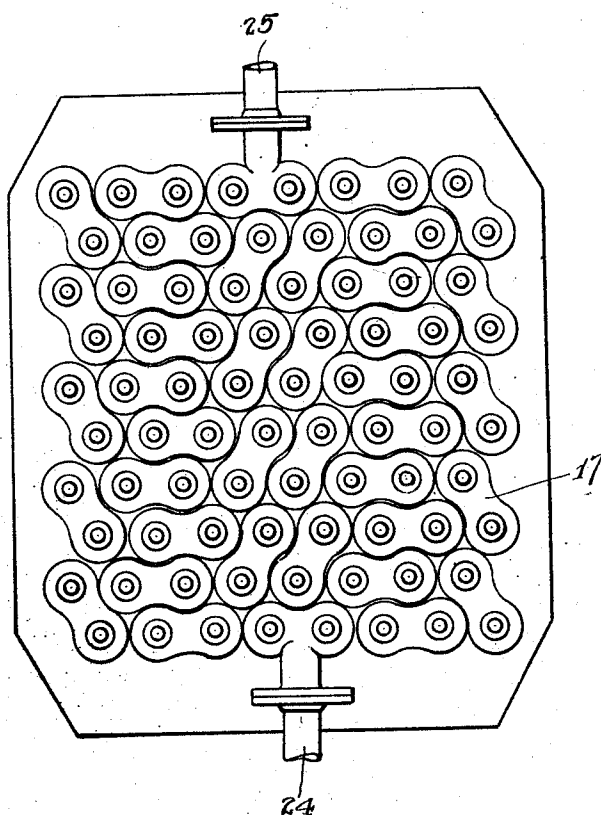


Fig. 6

Inventor

Charles O. Sandstrom

By

Lyon & Lyon

Attorneys

Sept. 6, 1932.

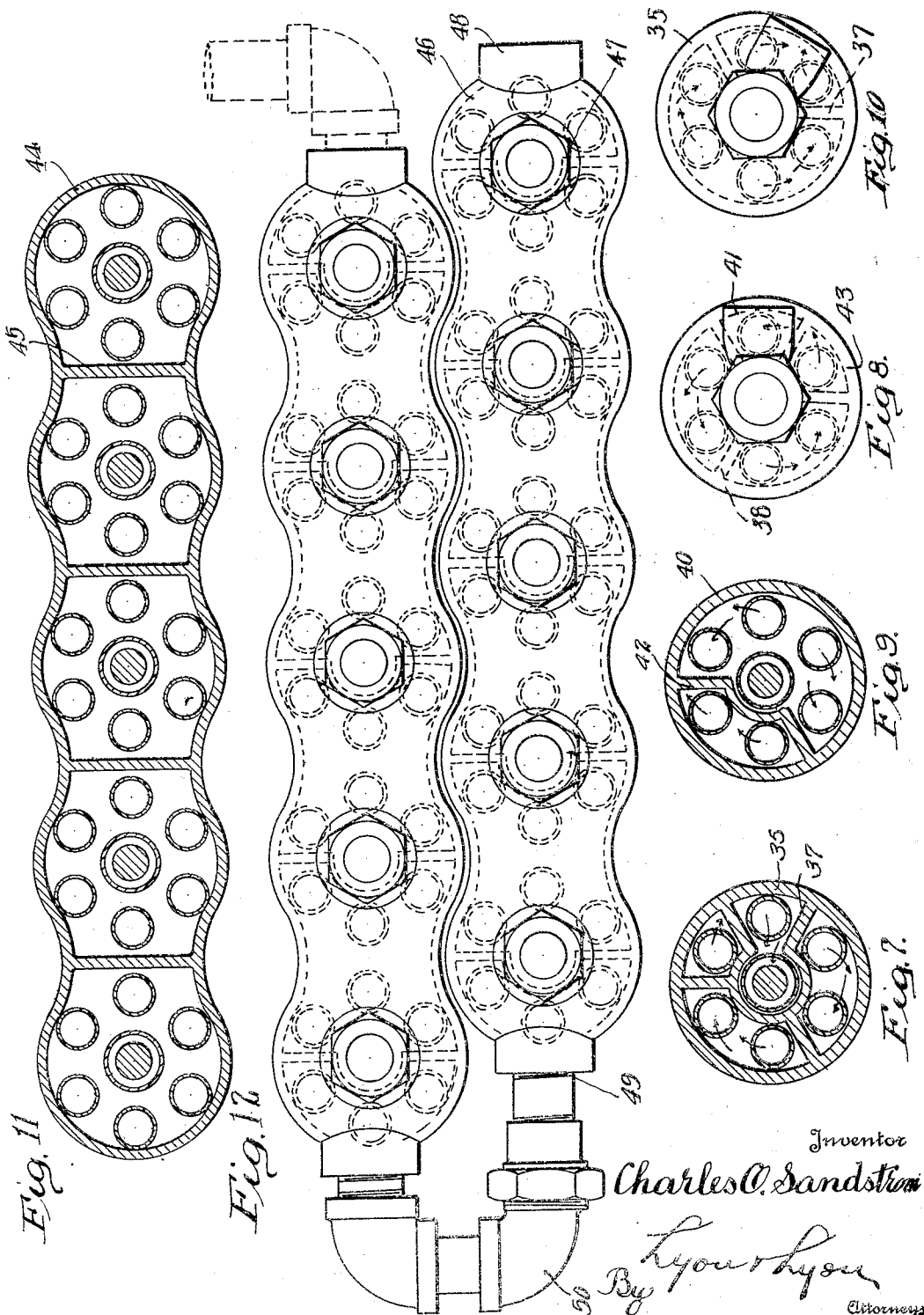
C. O. SANDSTROM

1,875,663

HEAT EXCHANGER

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5 Sheets-Sheet 5



UNITED STATES PATENT OFFICE

CHARLES O. SANDSTROM, OF LOS ANGELES, CALIFORNIA

HEAT EXCHANGER

Application filed January 21, 1931. Serial No. 510,203.

This invention relates to a heat exchanger.

The conventional type of heat exchanger is a circular shell to the ends of which are welded the tube sheets. One edge of the baffling is welded to the inside of the shell and the opposite edge is kept away from the shell a distance necessary to form a passage for the circulation of the fluid. The remaining edges of the baffles fit into grooves cut into the tube sheets; a source of leakage, but unavoidable because of construction difficulties. It is seen that this arrangement produces a condition at the end of the pass that is unfavorable to smooth flow. The tube sheet is sometimes extended to form a bolting flange, it being reinforced if necessary. Increased capacity is obtained by increasing the diameter of the shell which, in turn, necessitates increased thickness of metal in the shell.

A flanged boiler head cover with baffles suitably disposed provides the chambers for directing the flow through the different tube passes. The chambers formed by this baffling produces a very unfavorable condition for the flow of the fluid. In fact, this arrangement causes a large pressure drop through the exchanger. In the larger sizes and for high pressures, the cost of plate and bolts is a large portion of the total cost of the exchanger.

It is the general object of the present invention to provide a heat exchanger in which the shell of the exchanger is formed in such a manner as to provide a smooth flow from one baffle passage to the next with a minimum of hydraulic loss, and it is a further object of the present invention to provide a heat exchanger with return fittings so designed as to provide a smooth flow from one tube passage to the next with a minimum of hydraulic losses, and to provide such return fittings as are capable of being constructed in a simple and economical manner and capable of being arranged in various positions to change the number of fluid passages through the heat exchanger.

In general, the present heat exchanger is characterized by the fact that the shell of the heat exchanger is formed by curving one

end of each baffle plate and welding the curved ends of the baffle plates to the adjacent baffle plates so that the curved ends of the baffle plates provide both the shell of the container and a curved smooth flow return passage from one baffle space to the adjacent baffle space. By this construction of the shell of the exchanger and the baffle spaces the face of the heat exchanger or the extent of heat exchanging surface can be increased indefinitely by increasing the length of the passages or baffle plates and this does not require any increase in the thickness of the metal. This is a great advantage in producing exchanges of large capacity. Moreover, the baffles may be welded to the tube sheets at intervals between the cluster of tubes and around the curved portions so that the baffles provide stays for the tube sheets and relieve the tubes of any tensile stress which might induce leakage at the tube holes.

In place of the usual expensive heavily constructed flanged boiler head for forming the return passages for the tubes such as are employed in conventional heat exchangers, the heat exchanger of the present invention employs a number of return fittings, each arranged so that they may be attached to the exchanger in various manners so that, for example, all of the clusters of tubes may, if desired, be arranged in series to provide a long fluid passage through the exchanger or a number of parallel paths for passage of fluid through the tube clusters may be provided so as to provide an increased capacity in the heat exchanger. Moreover, by the use of the present invention the heat exchanger may be made especially adaptable for use with liquids that foul the tubes passing through them. Because on account of the provision of parallel banks of paths for the fluid any one bank or path may be cleared out while the others or other remains in use.

The present invention together with various objects and advantages thereof will best be understood from a description of a preferred form or example of a heat exchanger embodying the invention. For this purpose there is hereafter described, with reference to the accompanying drawings, the preferred

form or example of the heat exchanger embodying the invention.

Referring to the drawings:

Figure 1 is an elevation of the preferred form of the heat exchanger.

Figure 2 is an enlarged elevation partially in vertical section and at right angles to Figure 1.

Figure 3 is a fragmentary vertical section through the heat exchanger showing the edge view of the baffle plates and their curved ends taken on line 3—3 of Figure 4.

Figure 4 is a section on the line 4—4 of Figure 3.

Figure 5 is a section through one of the tube fittings taken through the longest axis thereof.

Figure 6 is an elevation similar to Figure 1 of the heat exchanger with the heat exchanger shown as provided with fittings arranged in a somewhat different manner than in Figure 1 and with slightly modified forms of entrance fittings.

Figure 7 is a section through a cap or fitting of a modified form used when it is desired to pass the liquid through each of the tubes of each cluster in sequence.

Figure 8 is a similar view of a front cap or fitting for the same type of exchanger as used with the cap of Figure 7.

Figure 9 is a similar view of a further modified rear cap for use when it is desired to pass the liquid through the tubes in a modified manner.

Figure 10 is a similar view of a front cap to be used with the modified rear cap shown in Figure 9.

Figure 11 is a front view of a rear cap for use when it is desired to pass the liquid through tubes in a further modified manner.

Figure 12 is a view of a front cap for the same modification.

Referring to the drawings, the heat exchanger comprises a pair of tube sheets 2 and 3 which extends beyond the shell of the exchanger and are welded to the ends of I-beam stiffeners 4 and 5 at the top and bottom of the exchanger. These I-beam stiffeners 4 and 5 serve as supports on the foundation and for supports for superimposing a plurality of exchangers, when this is desired.

6 indicates clusters of tubes which are arranged in hexagonal form with a large tube 7 in the center of the cluster. The large central tube 7 of each cluster is larger than the others in order to accommodate bolts 8 which hold the return fittings 9 of the exchanger in position against the tube sheets. The clusters or tubes 6 are arranged in horizontal rows, as shown in Figure 1, and each row of tubes or clusters 6 is disposed within a baffle passage.

The baffle passages for the exchanger as well as the shell of the exchanger are provided by means of baffle plates 10, which baffle plates are curved at one end, as indicated at

11, the alternate baffle plates in the exchanger being curved at opposite ends. The straight or free ends of the baffle plates extend to approximately the center of curvature of the curved ends of the baffle members and the curved ends of the baffle plates are in turn welded to the adjacent upper baffle members at approximately the start of the curvature of such upper baffle members, as indicated at 12. The edges of the baffle members are welded to the tube sheets 2 and 3 at intervals between the clusters of tubes 6 and around the curved portions 11 so as to form tight fluid passages and to operate to hold the tube sheets in position.

In this manner the curved ends 11 of the baffle members provide the outer shell of the heat exchanger and at the same time provide smooth curving return passages for the baffle spaces between adjacent baffle members. An inlet fitting 13 is provided at the upper end of the exchanger for introducing fluid between the baffles at the top of the exchanger and an outlet or discharge fitting 14 is attached to the exchanger and communicates with the lower baffle passage.

The return fittings 9 each comprise a body member 15 rounded at its opposite ends as at 16 and 17, respectively, each rounded portion of the body 15 of the fittings being adapted to enclose one cluster of tubes 6 and the body 15 of the tube fittings provides a smooth connecting passage between the ends of sufficient length to cover the distance between the centers of the tube clusters. At the head of each rounded portion of the bodies 15 of the fittings there is an opening 18 and the outside of the fittings are flattened, as indicated at 19, to receive the cap nuts 20. The bolts 8 which pass through the large tube 7 of the clusters extend through the fittings 9 and are threaded at their ends to the nuts 20 so that the nuts, fittings and bolts provide a means for holding the tube sheets together and the fittings are thereby held pressed solidly against the tube sheets so as to eliminate any escape of fluid from the edges of the fittings where they contact with the tube sheets. While in all cases it may not be necessary, gasket material 21 may be placed between the edges of the fittings and the tube sheets when desired.

The return fittings 9 thus described provide a simple and economical means for connecting the different tube passages or clusters of tubes with each other, resulting in a structure more economical to build and lighter in weight than the usual flanged boiler head baffles used for connecting tube passages. Moreover, the return fittings are made so as to provide a smooth flow for the fluid passing from one tube cluster to another and the hydraulic losses of the exchanger are less than in those exchangers using the usual flanged boiler heads for this purpose. More-

over, by providing individual tube fittings for each cluster of tubes it is possible to arrange the passages through the tube clusters in a great variety of manners.

As shown in Figure 1, the tube fittings are arranged so as to provide a single passage for fluid through the tube clusters, all of the tube clusters being in series. However, it will be readily apparent that by connecting each row of tube clusters with the succeeding lower row of tube clusters by the tube fittings and changing the form of the inlet fittings 22 and discharging fitting 23 so that the inlet fitting 22 feeds into the entire upper row of tubes and the discharge fitting 23 discharges from the entire lower row of tubes, there can be provided many parallel paths for the flow of fluid through the exchanger, thus permitting a greater amount of fluid to be passed through the tubes. In a similar manner by proper arrangement of the tubes fittings, and proper addition of inlet and outlet fittings any number of passages for fluid may be provided.

When the exchanger is arranged to provide a plurality of fluid passages there-through it will be apparent that the fittings connected with any one passage may be removed, while the fluid is still permitted to pass through the remaining passages, and one of the passages cleared out and again placed in series without the necessity of shutting down the exchanger.

In Figure 1, 22 indicates an inlet or outlet fitting at one end of the tube passages and 23 an inlet or outlet fitting at the other end of the tube passages; either fitting 22 or 23 may be used as an inlet and either fitting 23 or 22 may be used as the outlet, depending on the direction that it is desired that the fluid pass through the heat exchanger, i. e. whether the flow is to be parallel or counter to the general direction of flow of the fluid around the tubes.

Now referring more particularly to the modified form of the invention shown in Figure 6, we have there illustrated the fittings or caps 17 arranged so that the fluid which passes through the clusters of tubes 6 may have two or a greater number of passages, depending on the desire of the operator, this form of the exchanger being adapted to have a part of the exchanger shut down while the remainder continues to operate. In the form of the invention shown in Figure 6 there is shown an inlet fitting 24 connecting in the center of one of the bank of tubes and a similar fitting 25 at the upper end of the exchanger which may be used for exhausting the liquid or fluid flowing through the tube. If the fittings or caps 24 and 25 only are used for introducing and withdrawing fluid from the tubes of the exchanger, two parallel paths of flow will be provided in the exchanger.

Now referring to Figures 7 to 11 inclusive, modified forms of fittings are diagrammatically illustrated by which the fluid may be caused to pass through the tubes in each cluster in different manners.

Referring to Figures 9 and 10 particularly, there are shown fittings to be bolted against the tube sheets 2 and 3 of the exchanger and receive only fluid from one cluster of tubes. Rear caps 35 are provided and front caps 36 are provided. Arrows indicate the direction of flow of fluid through the tubes of the front and rear caps 36 and 35, respectively. The rear caps 35 are provided with baffles 37 in the form illustrated and the front caps are provided with baffles 38 in the arrangement illustrated. The front cap is also provided with an inlet socket 39. With this form of cap placed on the exchanger the fluid will flow successively through each tube of each cluster and then be transferred to the next cluster by connecting pipes from the inlet socket 39 of one cap to the other. In Figures 7 and 8 there is shown a rear cap 40 and a front cap 41 with baffles 42 and 43 so arranged that the fluid will pass first through two tubes of a cluster, returning by way of three tubes of the cluster, and then pass again through two tubes of the cluster before it is transferred to the next cluster of tubes.

Now referring more particularly to Figure 11 of the drawings, I have there illustrated a rear cap or fitting to be placed on the exchanger when it is desired to have the fluid flow through four tubes of a cluster, return through three tubes of a cluster, and then be transferred to the next cluster of tubes. In the figure there is indicated a rear cap 44 which may be one integral cap extending across each horizontal row of clusters of tubes of the exchanger and is provided only with partitions 45 between each cluster. The corresponding front cap (shown in Figure 12) of the exchanger may also be formed integral for each horizontal row of cluster of tubes, said cap 46 is provided, however, with baffles 47 which divide each cluster of tubes in two parts, one part being made to include the central tubes 7. An inlet 48 is provided at one end of the fitting and an outlet 49 at the other end of the fitting. Suitable piping 50 may be provided for connecting each of the fittings 46 with the adjacent fitting.

While the particular form of heat exchanger herein described is well adapted to carry out the objects of the present invention, it is to be understood that various modifications and changes may be made without departing from the present invention, and this invention includes all such modifications and changes as come within the scope of the appended claims.

I claim:

1. A heat exchanger comprising tube sheets, tubes connecting the tube sheets, baffle mem-

bers having their edges engaging the tube sheets, said baffle members having curved ends which form return passages for the baffle passages formed by the baffle members, and means providing return passages for the tubes.

2. A heat exchanger comprising tube sheets, baffle plates contacting at their edges with the tube sheets and having one end curved, the straight ends of the baffle members extending approximately to the center of curvature of the curved ends of adjacent baffle members, and the curved ends of the baffle members being secured to adjacent members, whereby there are provided baffle passages and the curved ends of the baffle members form smooth flow return passages for the baffle passages, tubes held by said tube sheets within the baffle passages, and means for providing return passages for the tubes.

3. A heat exchanger comprising tube sheets, tubes connected to the sheets, baffle members having their edges engaging the tube sheets, said baffle members having curved ends which are secured to the adjacent baffle members, each baffle member having a straight end which is located at substantially the center of curvature of the curved end of an adjacent baffle member, and means for providing return passages for the tubes.

4. A heat exchanger comprising tube sheets, tubes connected to the sheets, baffle members having their edges engaging the tube sheets, said baffle members having curved ends which are secured to the adjacent baffle members, each baffle member having a straight end which is located at substantially the center of curvature of the curved end of an adjacent baffle member, and individual return caps for each tube cluster operably adapted to be separately connected with the tube sheets.

5. A heat exchanger comprising tube sheets, tubes connected with the sheets, means providing a baffled exterior passage for fluid to flow around the tubes, the tubes being arranged in clusters, and individual return fittings for connecting separate clusters of tubes with an adjacent cluster of tubes.

6. A heat exchanger comprising tube sheets, tubes connecting the tube sheets, the tubes being arranged in clusters, retaining rods passing through the clusters of tubes, and return fittings for individually connecting clusters of tubes together, said retaining rods operating to hold the return fittings against the tube sheets.

7. A heat exchanger comprising tube sheets, a cluster of tubes connecting the tube sheets including a relatively large central tube, a rod passing through said central tube and tube sheets, and a return fitting engaging said rod and held thereby against said tube sheet.

8. A heat exchanger comprising a plurality of clusters of tubes, tube sheets receiving the tubes, means providing a baffled passage for fluid around the exterior of the tubes, return fittings for the tubes adapted to connect a single cluster of tubes with a single adjacent cluster of tubes, whereby the clusters of tubes may be arranged in series or in a number of parallel paths, and means for holding the return fittings against the tube sheets.

9. A heat exchanger comprising a plurality of tubes, tube sheets connected with the tubes, means for providing a baffled passage for fluid exterior of the tubes, a plurality of separately formed return caps for the tubes, the tubes being arranged so that by attaching the return caps to the tube sheets in different positions certain tubes may be in some cases connected in series and in other cases connected in parallel, and retaining means for holding the return caps against the tube sheets.

10. A heat exchanger comprising tube sheets, baffle members connected at their edge with the tube sheets and having one end curved, the straight ends of the baffle members extending approximately to the center of curvature of the curved ends of the adjacent baffle members, the curved ends of the baffle members being secured to the adjacent baffle members, thereby providing continuously connected baffle passages in which the curved ends of the baffle members form smooth flow return passages, tubes held by said tube sheets within the baffle passage, and means providing return passages for the tubes, whereby the tubes may be connected together in different positions to provide various arrangements of tube passages through the exchanger.

Signed at Los Angeles, California, this 14th day of January, 1931.

CHARLES O. SANDSTROM.