Nov. 14, 1933. J. PRICE 1,935,412

FLUID COOLER

Filed June 12, 1931 2 Sheets-Sheet 1

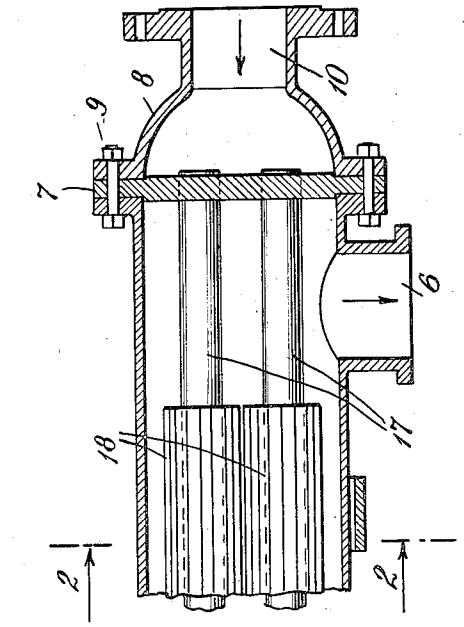


Fig. 1.

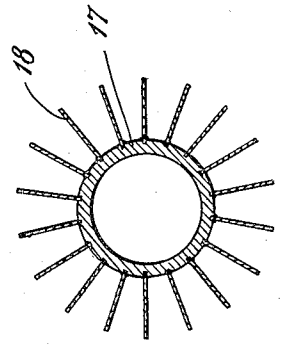
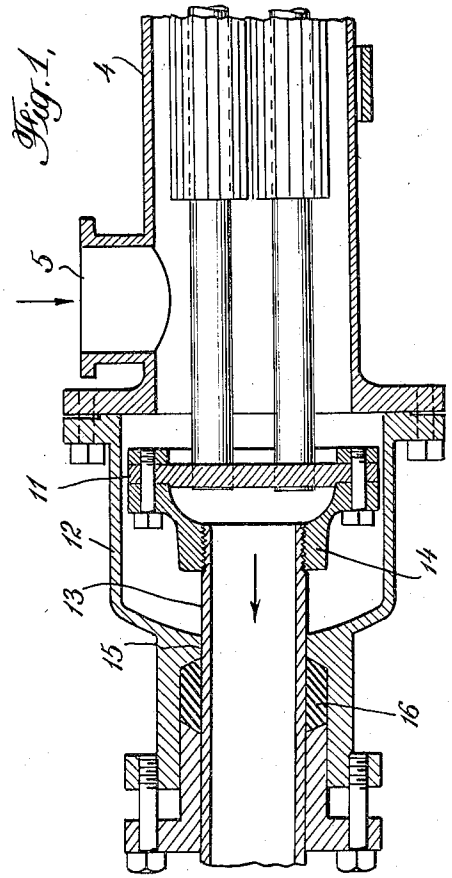


Fig. 3.



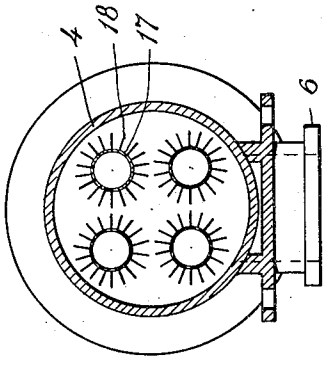


Fig. 2.

INVENTOR
Joseph Price
BY
Pennie, Davis, Marvin & Edmonds
HIS ATTORNEYS

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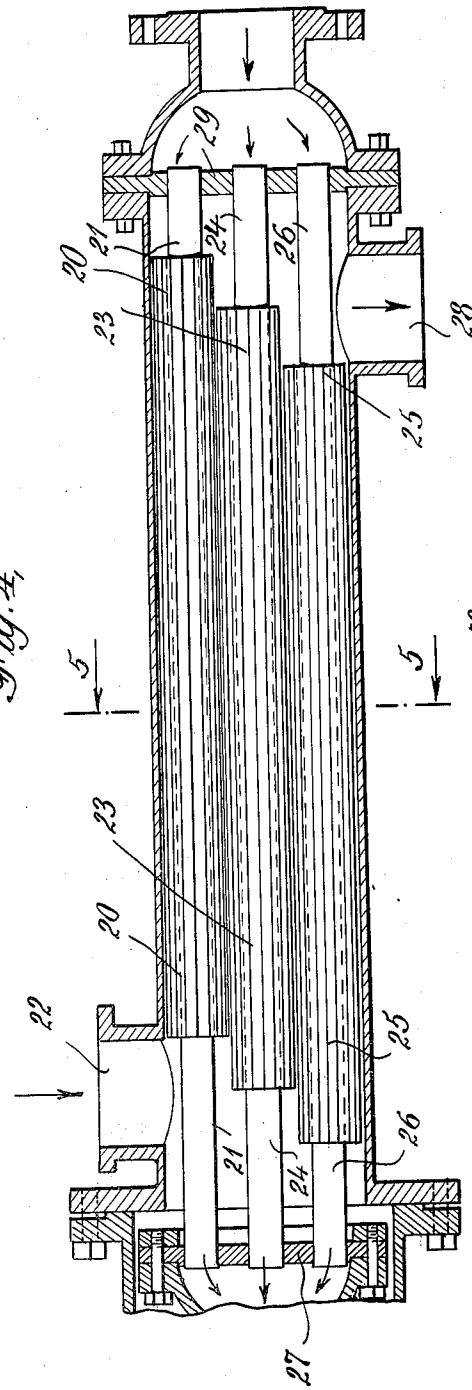


Fig. 4.

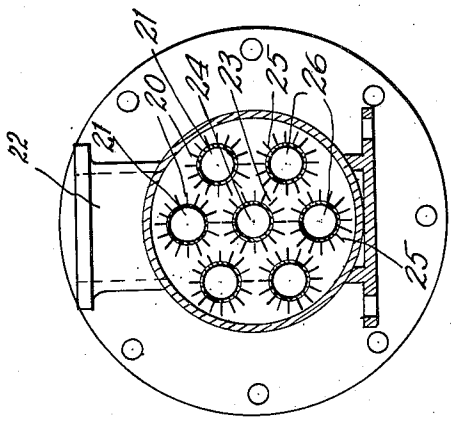


Fig. 5.

INVENTOR
Joseph Price
BY
Pennie, Davis, Marvin & Edmonds
HIS ATTORNEY

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FLUID COOLER

Joseph Price, West New Brighton, Staten Island, N. Y., assignor to The Griscom-Russell Company, New York, N. Y., a corporation of Delaware

Application June 12, 1931. Serial No. 543,787

5 Claims. (Cl. 257—236)

This invention relates to heat exchangers and more particularly concerns an improved heat exchange device for use in transferring heat between two confined fluids.

In certain operations involving the compression or other treatment of fluids which result in the heating thereof, it is necessary or desirable to subsequently cool the fluids by heat exchange with a suitable cooling medium. Thus, in air compressors, it is the usual practice to cool the compressed air leaving the pump or other compressing device, and when multi-stage compressors are employed, to cool the compressed air between successive compression stages. It is also desirable to cool inflammable gases and other fluids which are conveyed by pipe lines after such fluids have been heated by compression in pipe line pumps or otherwise.

With the above and other considerations in mind, it is an object of the present invention to provide an improved and simplified heat exchange device or cooler which is so constructed and arranged that the cooling fluid employed may be passed therethrough at high velocities. It is a further object of the invention to provide a cooler of the type described through which the fluid to be cooled may pass rapidly and without undue friction or retardation. The invention further includes the provision of an inexpensive, simple and efficient heat exchanger or cooler having comparatively few parts.

In general, the above and other objects of the invention are carried out by providing a shell type heat exchanger having a comparatively small number of tubes passing therethrough and by increasing the heat absorbing surface areas of such tubes by the use of fins thereon. The tubes employed preferably pass longitudinally through an elongated shell or container and the fluid to be cooled is introduced to such container transversely adjacent one end thereof and withdrawn therefrom transversely adjacent the same or the opposite end thereof. In a single pass heat exchanger, the fluid surrounding the tubes flows in one direction only through the shell or container, and consequently, the inlet and outlet ports of the shell are located at opposite ends thereof, whereas in an exchanger having an even number of fluid passes, such as a two or four pass exchanger, the fluid flows back and forth along the tubes and the inlet and outlet ports are both located at one end of the shell. The invention is equally applicable to either single pass or multiple pass heat exchangers. In a preferred form of the invention, the longitudinal cooling fluid tubes are provided with longitudinally extending radial fins along their central portions only, whereby such fins do not obstruct the flow of the fluid to be cooled as it enters and leaves the container of a single pass exchanger, or as the fluid passes transversely of the tubes in reversing its flow at the end of the container in a multiple pass exchanger. Because of the comparatively small number of tubes employed, the fluid passes through these tubes at a comparatively high velocity which prevents the formation of scale or the collection of sediment within the tubes, and further results in a rapid absorption of heat from the hot fluid. In order to further reduce the possibility of sediment collection or scale formation within the tubes, it is preferred in accordance with one embodiment of the invention to employ tubes having smooth and unobstructed interior surfaces.

In describing the invention in detail, reference will be made to the accompanying drawings, in which;

Figure 1 is a sectional side view of a heat exchanger embodying the invention;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 and viewed in the direction of the arrows;

Fig. 3 is an enlarged sectional view of one of the finned tubes of the exchanger shown in Figs. 1 and 2;

Fig. 4 is a sectional side view, similar to Fig. 1, showing a modified form of heat exchanger embodying the invention; and

Fig. 5 is a sectional view, taken along the line 5—5 of Fig. 4, and viewed in the direction of the arrows.

Referring to the drawings, the heat exchanger therein shown to illustrate one embodiment of the invention comprises generally a container having a substantially cylindrical shell 4. A transverse inlet port 5 is provided in the shell 4 adjacent one end thereof and a transverse outlet port 6 is disposed adjacent the other end of the shell, the ports 5 and 6 being preferably located on opposite sides of the shell 4 as shown.

A tube sheet 7 having a head 8 thereon is fixed in fluid-tight engagement with one end of the shell 4 by suitable means such as the bolts 9. An inlet port 10 is provided in the head 8 to admit cooling liquid or other fluids to the outer surface of the tube sheet 7. A floating tube sheet 11 is preferably employed at the opposite end of the shell 4, this sheet being suitably carried within the fixed head 12 by means of a pipe 13 which is fixed to the sheet 11 through the bonnet 14. The

pipe 13 extends through an opening 15 in the head 12 and is slidably carried in fluid-tight engagement with this opening by means of a packed joint of any suitable construction, as shown at 16. A plurality of substantially parallel spaced conduits or tubes 17 pass longitudinally through the container shell 4, and the opposite ends of these tubes pass through and are connected in fluid-tight engagement with the tube sheets 7 and 11. The tubes 17 preferably have smooth unobstructed interior surfaces, and each tube is provided with a plurality of heat absorbing projections or fins 18 on the outer surface thereof. The fins 18 are preferably disposed radially about each tube and extend longitudinally of the tubes as shown. In accordance with the invention, the fins 18 extend between the inlet and outlet ports 5 and 6 of the shell 4, terminating short of these ports as clearly shown in Fig. 1. With this arrangement, the tubes 17 are bare of fins along the portions thereof disposed in the path of the fluid entering and leaving the container through the transverse ports 5 and 6, and accordingly, the fins 18 do not obstruct or retard the flow of fluid into or out of the container.

Although integral fins may be used, it is preferred in certain cases to employ separate fins formed of a metal of high thermal conductivity, such as copper or an alloy of copper, and to anchor these fins to the outer surfaces of the tubes, as shown in Fig. 3. The fins 18 extend longitudinally of the tubes 17 and are preferably straight or substantially straight. In other words, each fin may lie in a plane passing through or parallel to the axis of its tube, or each fin may be curved to form a long pitch helix so that each fin is wrapped around its tube a few times in the length of the fin. In the appended claims, the statement that the fins extend longitudinally of the tubes means, as stated above, that the fins are either straight and lie in planes passing through or parallel to the tube axes or are slightly curved helically about the tubes.

In order that a large heat absorbing surface may be presented to the fluid passing through the container shell 4, the fins 18 are comparatively long and as shown in Fig. 2, are preferably of sufficient radial length to extend across substantially the entire cross section of the shell 4 outside of the tubes. With this arrangement, the heat absorbing surface area of the tubes is very large and a small number of tubes through which a cooling fluid passes at a high velocity may be employed to abstract considerable quantities of heat from the hot fluid passing between the ports 5 and 6. The comparatively large spaces between the bare ends of the tubes provide substantially unobstructed passages for the ingress and egress of fluid to be cooled through the ports 5 and 6, and accordingly, the heat exchanger is both efficient and inexpensive, providing a rapid exchange of heat with a comparatively small number of tubes and without retardation of the gas or air flowing through the container.

Although various fluids may be passed through the tubes 17 and the shell 4, it is generally preferred to pass a hot gaseous fluid, such as compressed air, illuminating gas, etc., through the shell and to cool this gas by passing a liquid cooling medium, such as refrigerated water or some other cooled liquid, through the tubes 17.

In a modified form of the invention, shown in Figs. 4 and 5, the fin area of the heat exchanger unit is materially increased by extending the fins on the tubes located adjacent the side of the shell remote from the inlet or outlet port to points more closely adjacent the ends of the shell than the points at which the fins on the other tubes terminate. Thus, the fins 20 on the tubes 21 adjacent the inlet port 22 terminate short of the inlet port, the fins 23 on the tubes 24 at the center of the shell laterally with respect to the inlet port extend part way across a projection of the port and the fins 25 on the tubes 26 located adjacent the side of the shell remote from the inlet port extend substantially completely across a projection of the inlet port but yet terminate short of the tube sheet 27. A similar arrangement of the fins is employed adjacent the outlet port 28, where the fins 25 on the tubes 26 terminate short of the outlet port and the fins 23 and 20 on the tubes 24 and 21 more remote from the port extend to points closer to the tube sheet 29. In general, the fins on the tubes at different lateral distances from each port are extended to different points short of the tube ends in such a manner that a substantially wedge shaped opening across the tubes is presented, this opening diverging toward the shell port.

It will be noted that the fin area in the modification of Figs. 4 and 5 is appreciably greater than the fin area of the modification of Fig. 1, and an increased heat exchanging efficiency is accordingly obtained in the modified device. It has been found that the extended fins on the tubes remote from the ports do not undesirably obstruct the passage of fluid between the ports and the longitudinal spaces between the fins, and both a satisfactory rate of fluid circulation and an increased heat exchanging surface is obtained in the modification of Figs. 4 and 5.

The improved heat exchanger of the present invention has marked advantages over heat exchangers previously employed for the purposes indicated. Thus, it has been found that the total heat transferring surface of the comparatively small number of fins used in the exchanger of the present invention is substantially as effective in absorbing heat from the fluid to be cooled as is the surface of the comparatively large number of bare tubes formerly employed in heat exchangers of this type. Thus, for example, it has beeen found that a heat exchanger having 85 bare tubes of ⅝ inch diameter, each 12 feet long, could be replaced by a heat exchanger embodying the present invention and having only four pipes, each 16 feet long and ¾ inch in diameter, and each provided with eighteen ½ inch copper fins, the two constructions having substantially the same heat exchanging capacity. Because of the high heat exchanging efficiency with relation to the number of tubes employed, the construction of the present invention effects a saving in cost of from 30 to 40% as compared with a bare tube construction of equal capacity.

I claim:

1. In a heat exchanger, an elongated container having a transverse port disposed in the side wall thereof adjacent one end thereof, a plurality of spaced tubes passing longitudinally through said container and a plurality of fins on each of said tubes extending longitudinally of said tubes and terminating short of the ends of said container, the fins on the tubes adjacent the side of said container in which said port is located terminating at points more remote from said end of said container than the fins on the tubes re-

mote from the side of said container in which said port is located.

2. In a heat exchanger, an elongated container having a transverse port disposed in the side wall thereof adjacent one end thereof, a plurality of spaced tubes passing longitudinally through said container and a plurality of fins on each of said tubes extending longitudinally of said tubes and terminating short of the ends of said container, the fins on the tubes located at increasing lateral distances from the port terminating at points increasingly close to said end of said container whereby a substantially wedge shaped transverse passage is provided between the port and the spaces between the finned portions of the tubes.

3. In a heat exchanger, an elongated container having a transverse port disposed in the side wall thereof adjacent one end thereof, a plurality of spaced tubes passing longitudinally through said container and a plurality of fins on each of said tubes extending longitudinally of said tubes and terminating short of the ends of said container, each of said fins lying in a plane passing through the axis of its tube, the fins on the tubes most closely adjacent said port terminating at points more remote from said end of said container than said port and the fins on the tubes located at increasing lateral distances from said port terminating at points increasingly close to the end of said container.

4. In a heat exchanger, an elongated container having a transverse port in the side wall thereof, a plurality of spaced tubes passing longitudinally through said container and across said port and a plurality of fins on each of said tubes, the fins on the tubes located at different lateral distances from said ports terminating at different points longitudinally of the container.

5. In a heat exchanger, an elongated container having a transverse port in the side wall thereof, a plurality of spaced externally finned tubes passing longitudinally through said container and across said port, the fins on the tubes located at different lateral distances from said port terminating at different points longitudinally of the container.

JOSEPH PRICE.