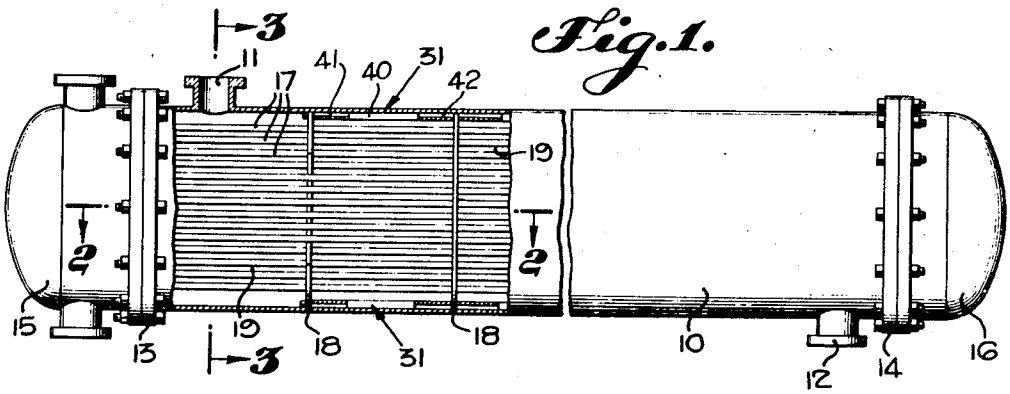
Jan. 10, 1950 F. D. JAMES 2,493,969

HEAT EXCHANGER

Filed Jan. 12, 1946 2 Sheets-Sheet 1

Fig. 1.



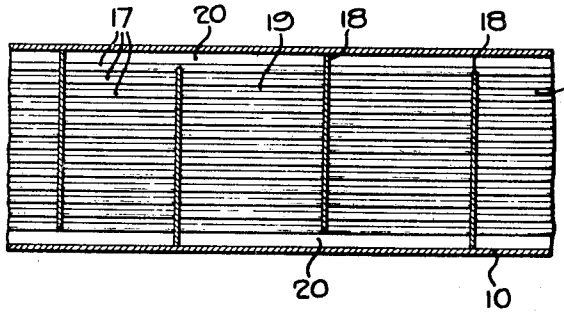


Fig. 2.

Fig. 3.

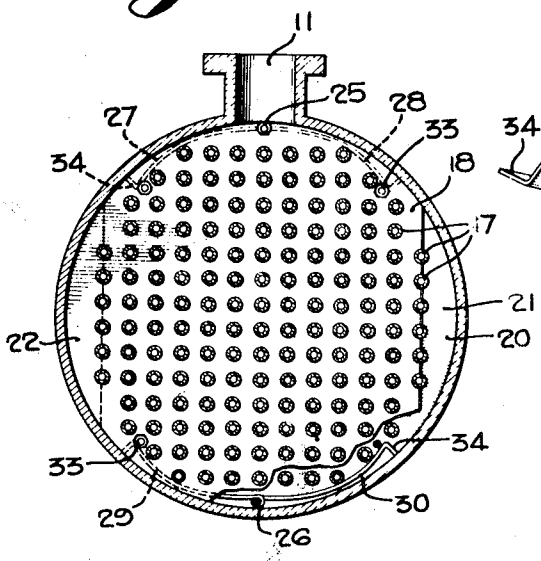
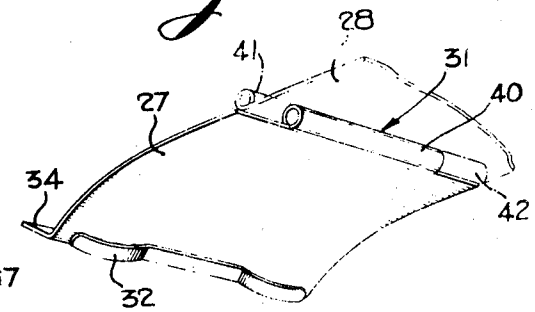


Fig. 4.



FLOYD O. JAMES,
INVENTOR

BY Hazard & Miller

ATTORNEYS

Jan. 10, 1950 F. D. JAMES 2,493,969

HEAT EXCHANGER

Filed Jan. 12, 1946 2 Sheets-Sheet 2

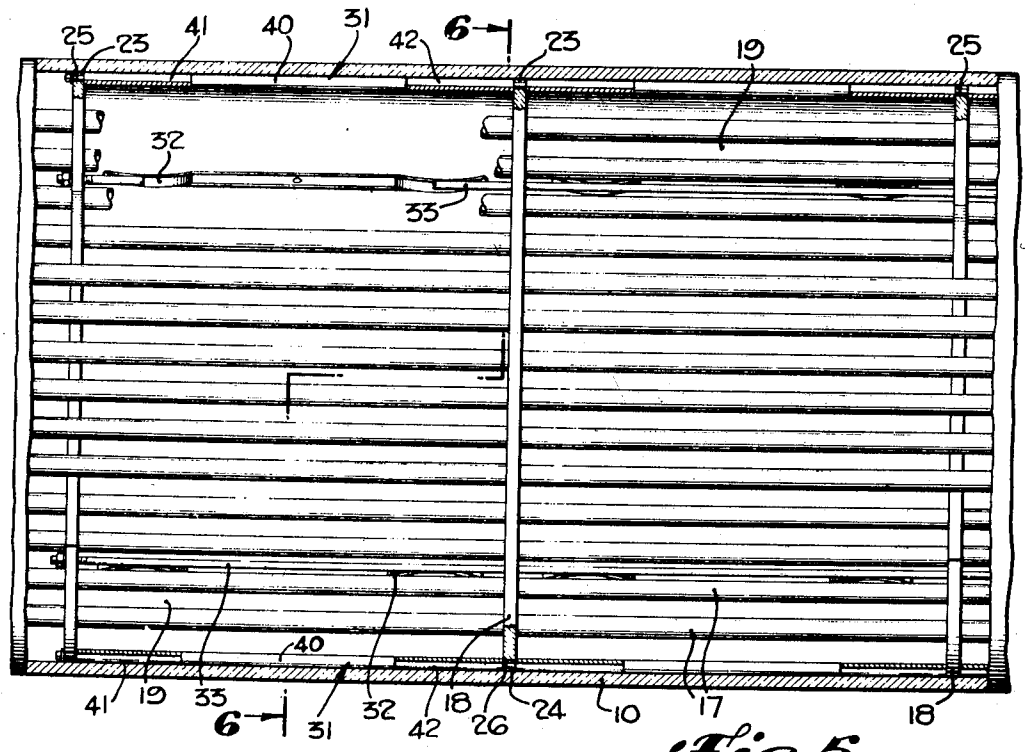


Fig. 5.

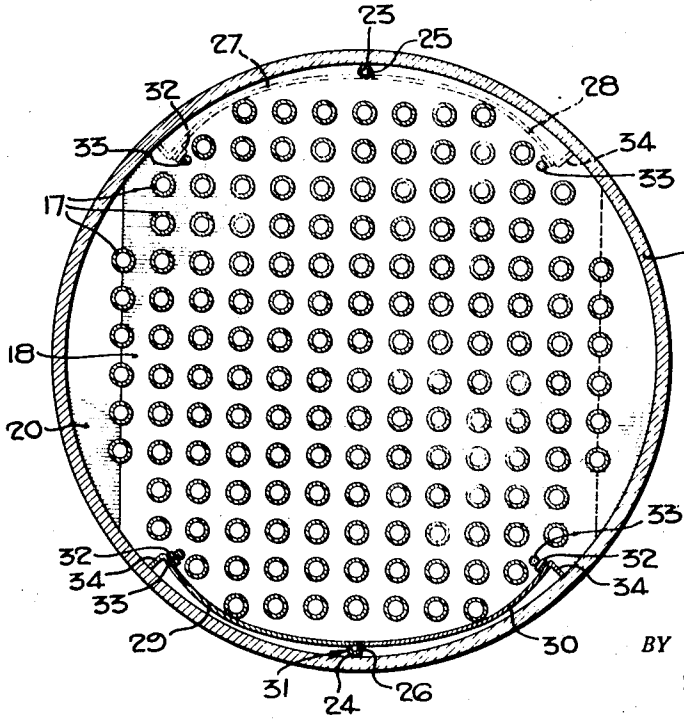


Fig. 6.

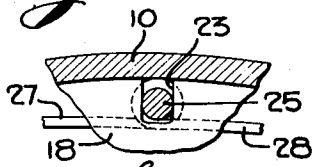


Fig. 7.

FLOYD D. JAMES,
INVENTOR.

BY Hazard & Miller
ATTORNEYS

Patented Jan. 10, 1950

2,493,969

UNITED STATES PATENT OFFICE

2,493,969

HEAT EXCHANGER

Floyd D. James, Whittier, Calif.

Application January 12, 1946, Serial No. 640,861

4 Claims. (Cl. 257—239)

1

This invention relates to improvements in heat exchangers and the like.

A conventional form of heat exchanger consists principally of an outer shell within which there is a tube bundle traversed at suitable intervals by cross flow baffles having alternately arranged sides spaced from the interior of the shell to permit of flow from one compartment defined by the cross flow baffles to the adjoining compartment. In effecting the heat transfer one fluid is conducted through the tubes of the tube bundle and the other fluid is conducted into the shell and caused to flow back and forth between the tubes of the tube bundle in a tortuous manner in progressing from one end of the shell to the other.

Heat transfer film coefficients for the tube side of the exchanger can ordinarily be calculated in accordance with mathematical formula and the predicted results obtained with a high degree of accuracy. On the shell side of the exchanger or in other words on the exterior of the tubes predicted performance has not been obtainable. The shell side film coefficients have generally been based on empirical data obtained by test of particular types or makes of heat exchangers.

I have determined that the inability to accurately calculate and predict performance on the shell side of the heat exchanger is largely due to leakage and by-passing between the tube bundle and the interior of the shell. Thus in the conventional construction the passage around the edge of the cross flow baffle extends approximately one-fourth of the circumference of the shell and if the flow through the compartments defined by the cross flow baffles were uniform between the tubes of the tube bundle the shell side performance could be calculated and predicted with great accuracy—at least as accurately as on the tube side. However, the transverse flow between the cross flow baffles is not uniform between the tubes and a substantial portion of the flow within the shell by-passes around the tube bundle or between the tubes of the tube bundle and the interior of the shell on opposite sides of the direction of transverse flow. A substantial portion of this by-passing fluid either contacts no tubes whatsoever or only a few of them. Inasmuch as the volume of by-passed fluid sometimes amounts to as high as 60% shell side performance of a heat exchanger cannot be accurately calculated and predicted.

An object of the present invention is to provide an improved heat exchanger consisting of a shell having a tube bundle therein and wherein cross

2

flow shields are arranged between the tube bundle and the interior of the shell which will effectively prevent by-passing around the tube bundle in the course of the transverse or cross flow. In this maner the cross flow is caused to flow between the tubes of the tube bundle at a uniform velocity and the velocity across the tubes and the pressure drop are readily maintained under the designers control to such an extent that shell side performance can be calculated and predicted with a high degree of accuracy. The efficiency of a given heat exchanger can thus be materially increased enabling smaller heat exchangers to be employed to effect a given or required heat exchanger.

In heat exchangers of this type the tube bundle must be withdrawn from the shell from time to time for purposes of inspection and maintenance. Precise workmanship on the tube bundle and on the interior of the shell is ordinarily unfeasible as a means of locating the tubes of the tube bundle so close to the shell as to prevent by-passing because such precise workmanship is not only expensive in the initial construction but is apt to hinder withdrawal of the tube bundle from the shell when this is necessary.

It is, therefore, another object of the present invention to provide an improved heat exchanger wherein relatively large tolerances are permissible between the tube bundle and the shell so that even if the exchanger becomes badly corroded the tube bundle may be readily withdrawn. At the same time the cross flow shields which are utilized to prevent by-passing provide an automatic and continuous take-up of clearance or tolerance between the tube bundle and the shell and are so arranged that they do not interfere with the withdrawal of the tube bundle from the shell or its installation therein.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a view in side elevation of a heat exchanger embodying the present invention, parts being broken away and shown in diametrical section.

Fig. 2 is a partial view in diametrical section taken substantially upon the line 2—2 upon Fig. 1.

Fig. 3 is a transverse section taken substantially upon the line 3—3 upon Fig. 1 in the direction indicated.

Fig. 4 is a perspective view of the inner side of one of the cross flow shields.

Fig. 5 is a view in side elevation of part of the heat exchanger embodying the present invention on a larger scale than the heat exchanger depicted in Fig. 1.

Fig. 6 is a traverse section taken substantially along lines 6—6 on Fig. 5 in the direction indicated.

Fig. 7 is an enlarged view of a portion of Fig. 6 showing the manner of supporting the shields from the baffles.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the improved heat exchanger in the main conforms in shape and design to a conventional heat exchanger having a shell 10 in which there is an inlet 11 and an outlet 12. The shell has flanges 13 and 14 at its ends to which may be attached heads 15 and 16 respectively. Within the shell there is disposed a tube bundle made up of a plurality of tubes 17 held together as a unit by transversely extending cross flow baffles 18 which define compartments 19. Opposite sides of these baffles are removed in alternative relationship as indicated at 20 so that as flow within the shell takes place from the inlet to the outlet, it is caused to undergo transverse flow across the tubes of the tube bundle in a tortuous manner.

Considering specifically Fig. 3 I have found that if the fluid within the shell passes from the inlet 21 in one compartment toward the outlet 22 therefrom that instead of passing uniformly across the tubes that a substantial portion bypasses around the tube bundle or as viewed in this figure between the top of the tube bundle and the top of the shell and between the bottom of the tube bundle and the bottom of the shell. This by-passing flow takes place even though outer tubes of the tube bundle are arranged rather close to the interior of the shell as only a very small space is required to permit a substantial amount of by-passing flow to take place. To prevent such by-passing and to cause the flow within the shell to proceed across the tubes with uniform velocity I provide recesses 23 and 24 in the edges of the cross flow baffles 18 on opposite sides of the direction of cross flow from the inlet 21 to the outlet 22, and positioned in these recesses longitudinally extending rods 25 and 26. I also provide anti by-passing shields 27, 28, 29, and 30 which have hinge type connections as illustrated at 31 with the rods. Each pair of shields 27 and 28, and 29 and 30, are alike so the hinged construction of shields 27 and 28 will be explained. Shield 27 has a center portion 40 reversely bent to receive rod 25 as shown in Fig. 4 and shield 28 has spaced portions 41 and 42 shown in phantom in Fig. 4 which portions are reversely bent to straddle portion 40 of shield 27 and also to receive rod 25 to thereby provide a hinged joint. These shields carry on their interiors suitable springs 32 which are engageable with longitudinally extending rods 33 that extend longitudinally of the tube bundle. If desired, the springs 32 may engage some of the tubes of the tube bundle instead of the rods 33. The anti by-passing shields have outwardly extending lips 34 the edges of which are engageable with the interior of the shell. Each set of four shields 27, 28, 29 and 30 bridges the space between two adjacent cross flow baffles 18.

The springs 32 serve to constantly urge these anti by-passing shields so that the edges on the lips 34 are constantly pressed against the interior of the shell thus in effect forming barriers that prevent by-passing around the tube bundle and causing flow to take place across the tubes in a uniform manner from the inlet 21 to the outlet 22 of any given compartment. The uniformity of flow thus produced by preventing by-passing enables the shell side performance of the heat exchanger to be predicted with a high degree of accuracy and materially increases the efficiency of the heat exchanger enabling smaller heat exchangers to be used to accomplish a given or required heat exchange. The tolerance or clearance between the cross flow baffles 18 and the interior of the shell may be considerable but regardless of the amount of such clearance it is automatically and continuously taken up by the outwardly urged cross flow shields. Such tolerance or clearance is frequently desirable in the initial manufacture of the heat exchanger as it permits of a less expensive construction and in the event of corrosion in the heat exchanger such clearance frequently facilitates the withdrawal of the tube bundle for purposes of inspection and repair. When the tube bundle is withdrawn the presence of the rods 25 and 26 and the anti by-passing shields thereon does not interfere with the withdrawal even though severe corrosion has taken place. The rods with their attached cross flow shields merely slide out of the shell with the tube bundle and may drop out of their respective recesses or be easily removed to facilitate the cleaning of the tubes of the tube bundle. When the tube bundle is again inserted into the shell the rods are applied to their recesses and the anti by-passing shields are forced inwardly against the action of the springs 32 sufficiently to permit of entry into the shell.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. An anti by-passing shield construction for a heat exchanger of the type having a shell and a tube bundle within the shell and cross flow baffles disposed along the tube bundle with recesses provided in the edges of the baffles along the length of the tube bundle, comprising a single rod adapted to be seated in the recesses so as to lie lengthwise of the tube bundle and laterally of the direction of cross flow, a plurality of pairs of shields for the rod, there being a pair of shields for each of the spaces between the baffles, the shields of each pair being disposed on opposite sides of the rod, the inner margins of the shields of each pair being reversely bent to provide knuckles through which the rod may slide, the outer margin of each shield being bent at an angle to the body of the shield toward the shell so as to be engageable with the interior surface of the shell, and a leaf spring fastened on the under side of each shield adjacent its outer margin engageable with the exterior of the tube bundle for urging the shields outwardly into engagement with the interior of the shell.

2. In a heat exchanger, a shell, a tube bundle within the shell having cross flow baffles with removed sides in staggered relation defining compartments in which cross flow is caused to take place transversely through the tube bundle, and means for preventing by-passing between the tube bundle and the shell comprising a pair of rods disposed on opposite sides of the tube bundle,

there being recesses provided in the edges of the baffles along the length of the shell into which the rods are seated so as to be disposed laterally of the direction of cross flow, a plurality of pairs of anti by-passing shields for each rod, there being a pair of shields on each rod for each of the spaces between the baffles, the shields of each pair of shields being disposed on opposite sides of the rod, the inner margins of the shields of each pair being reversely bent to provide knuckles through which the rods may slide to swingably mount the shields, the free margin of each shield being bent outwardly toward the shell so as to be engageable with the interior surface of the shell, and a leaf spring fastened on the under side of each shield adjacent its outer margin engageable with the exterior of the tube bundle for urging the shields outwardly and into engagement with the interior of the shell.

3. An anti by-passing shield construction for a heat exchanger of the type having a shell and a tube bundle within the shell and cross flow baffles disposed along the tube bundle with recesses provided in the edges of the baffles along the length of the shell, comprising a single rod adapted to be seated in the recesses so as to lie lengthwise of the tube bundle and laterally of the direction of cross flow, a plurality of pairs of shields for the rod, there being a pair of shields for each of the spaces between the baffles, the shields of each pair being disposed on opposite sides of the rod, one shield of each pair having a narrowed center portion which is reversely bent to provide a center knuckle, the other shield of each pair having spaced portions reversely bent to provide a pair of spaced knuckles, the rod being slidable through the knuckle with the spaced knuckles straddling the center knuckles to swingably mount the shields, the free margin of each shield being bent outwardly so as to be engageable with the interior surface of the heat exchanger shell, and a leaf spring fastened on the under side of each shield adjacent its outer margin engageable with the exterior of the tube bundle for urging the shields outwardly into engagement with the interior of the heat exchanger shell, the rod and the springs being the sole means of mounting the shield construction and the shields being otherwise unconnected and unfastened to the baffles or tube bundle.

4. An anti by-passing shield construction for a heat exchanger of the type having a shell and a tube bundle within the shell and cross flow baffles disposed along the tube bundle with recesses provided in the edges of the baffles along the length of the shell, comprising a single rod adapted to be seated in the recesses so as to lie lengthwise of the shell and laterally of the direction of cross flow, a plurality of pairs of shields for the rod, there being a pair of shields for each of the spaces between the baffles, the shields of each pair being disposed on opposite sides of the rod, there being at least one knuckle provided on the inner margin of each shield, the rod being slidable through the knuckles, the free margin of each shield being bent outwardly so as to be engageable with the interior surface of the shell, and a leaf spring on the under side of each shield adjacent its outer margin engageable with the exterior of the tube bundle for urging the shields outwardly into engagement with the interior of the heat exchanger shell, the rod and the springs being the sole means of mounting the shield construction and the pairs of shields being otherwise unconnected and unfastened to the baffles or tube bundle.

FLOYD D. JAMES.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,183,160	Coulter et al.	Dec. 12, 1939
2,202,494	Jacocks	May 28, 1940

FOREIGN PATENTS

Number	Country	Date
516,682	Germany	Jan. 26, 1931