

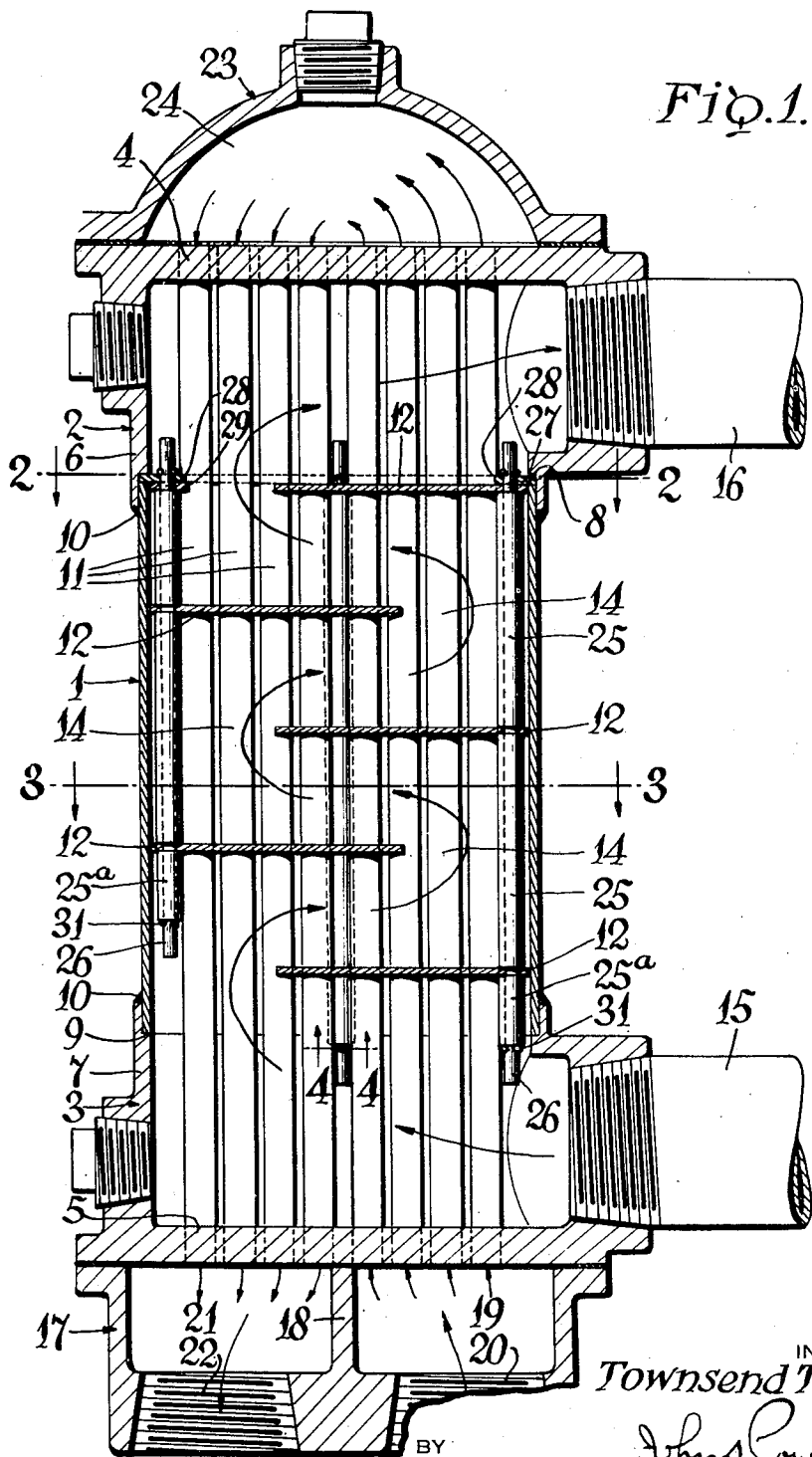
Feb. 21, 1950

T. TINKER
HEAT EXCHANGER

2,498,145

Filed April 9, 1948

4 Sheets-Sheet 1



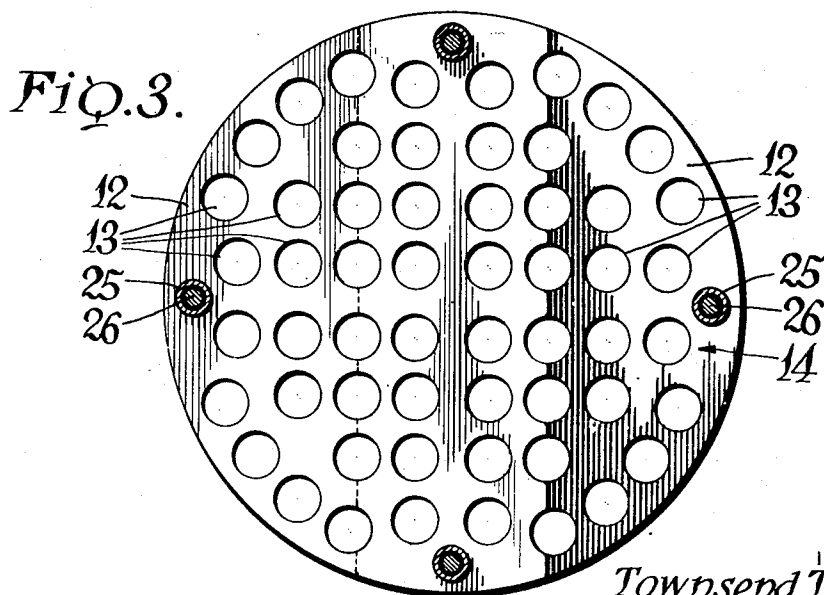
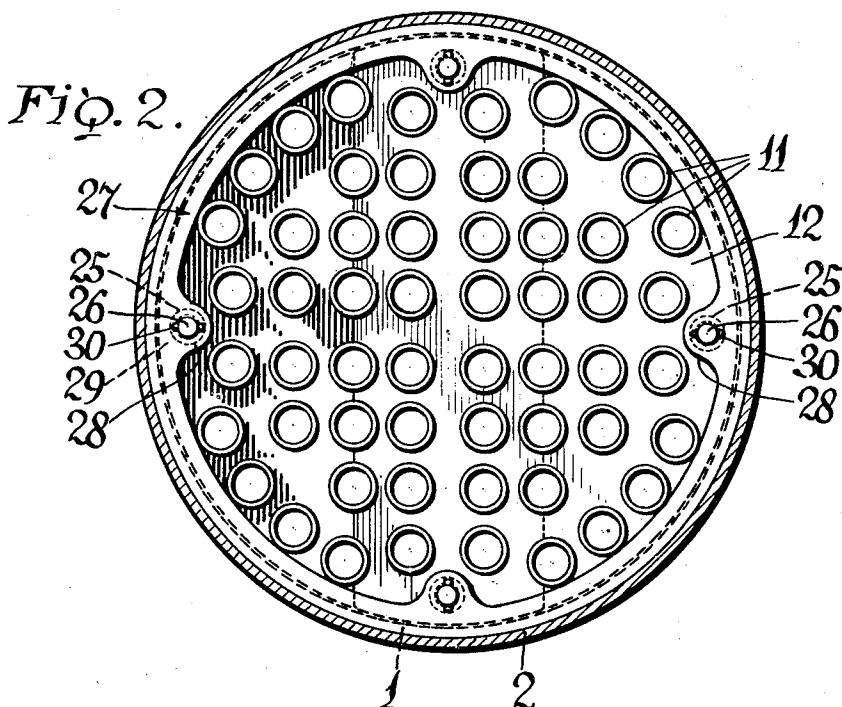
Feb. 21, 1950

T. TINKER
HEAT EXCHANGER

2,498,145

Filed April 9, 1948

4 Sheets-Sheet 2



BY

INVENTOR.
Townsend Tinker,
John Powers,
ATTORNEY.

Feb. 21, 1950

T. TINKER
HEAT EXCHANGER

2,498,145

Filed April 9, 1948

4 Sheets-Sheet 3

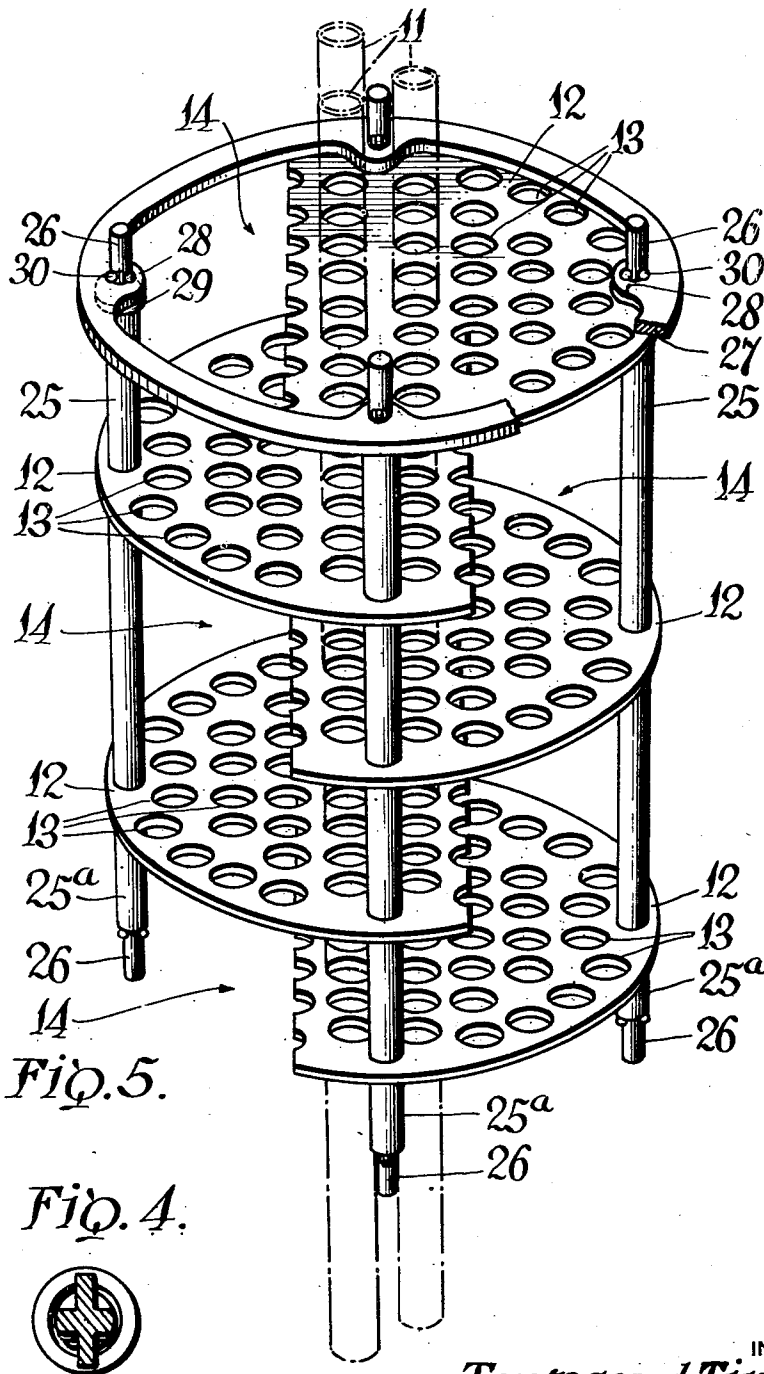


FIG. 5.

FIG. 4.



BY

INVENTOR.
Townsend Tinker,
John Sowers,
ATTORNEY.

Feb. 21, 1950

T. TINKER
HEAT EXCHANGER

2,498,145

Filed April 9, 1948

4 Sheets-Sheet 4

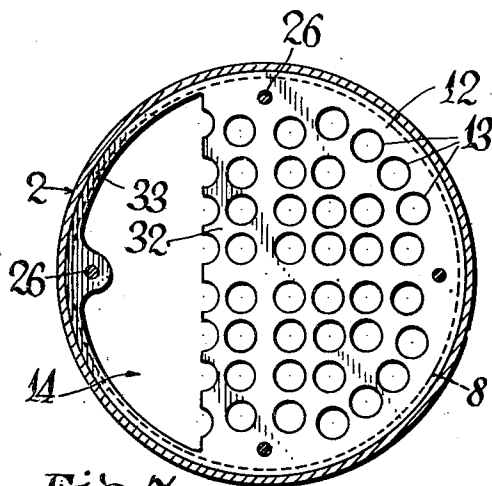


FIG. 7.

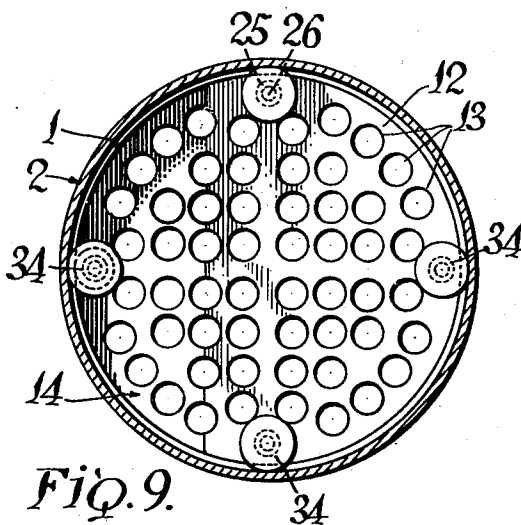


FIG. 9.

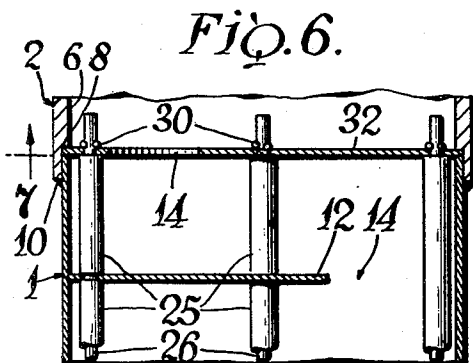


FIG. 6.

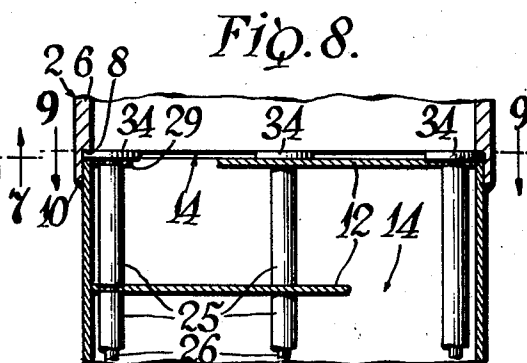


FIG. 8.

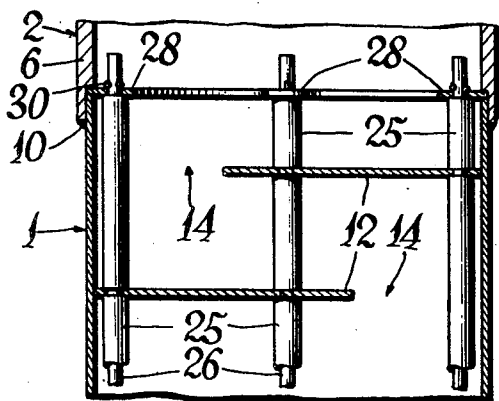


FIG. 10.

BY

INVENTOR.
Townsend Tinker,
John S. Lowe
ATTORNEY.

UNITED STATES PATENT OFFICE

2,498,145

HEAT EXCHANGER

Townsend Tinker, Orchard Park, N. Y., assignor
to Ross Heater & Manufacturing Co., Inc., Buf-
falo, N. Y., a corporation of New York

Application April 9, 1948, Serial No. 20,169

11 Claims. (Cl. 257—224)

1

This invention relates to improvements in heat exchangers of the fixed head type. Heretofore exchangers of this type have included an enclosing casing consisting of a shell, tube plates at the ends of the shell, these plates in a type of construction frequently used being formed as parts of "hubs," i. e. being integral with cylindrical walls attached to and which form continuations of the shell, parallel tubes extending through the shell and having their ends secured in the tube plates, and chambers connected to the tube plates and providing for the flow of the internal fluid or liquid medium through the tubes in either a straight or U-shaped path, baffle plates arranged transversely of the shell and having "windows" in staggered or off-set relation whereby the external fluid or liquid medium flows through the shell in a tortuous path, and sleeves between the baffles and between the end baffles and the tube plates for holding the baffles in determinately spaced relation. In this type of construction the spacing sleeves are usually mounted either on tie rods which are connected to the tube plates or on selected tubes, the tie rods being more frequently employed.

The baffles, spacing sleeves and the elements upon which the sleeves are mounted, tie rods or tubes, constitute a tube "cage." In respect to the tube cage and its relation to other features of the heat exchanger, both of the prior art forms have a common objection and each has certain individual objections.

The common objection concerns manufacturing economy. In both forms the spacing sleeve carrying means, tie rods or tubes, are first engaged in one of the tube plates, e. g. and as shown, the upper tube plate, the designation of this tube plate as the "upper" tube plate being herein used for convenient brevity. With the spacing sleeve carrying means secured to the upper tube plate the tube cage is built up step by step, first placing a series of spacing sleeves, then a baffle, then another series of spacing sleeves, then another baffle, and so on until the tube cage has been completed.

The objection to this practice is that the tube plates are delivered from a foundry and the tube cage cannot be constructed until the tube plates are received, following which the manufacture involves both the building of the tube cage, and its securement to the upper tube plate. This practice is uneconomical in that it does not permit the tube cages to be assembled until the plates have been received.

The individual objections in connection with

2

the form in which the tie rods are used are concerned with manufacture and are: (1) the added manufacturing expense of drilling recesses in the upper tube plate in which the ends of the tie rods are secured and threading these recesses for cooperation with the threaded ends of the tie rods, (2) the fact that the tie rods are located so close to the inner circumferential face of the casing that no room is permitted for the use of the ordinary drilling chuck and special long-shanked drilling and threading tools are required, the shanks by reason of their length being liable to breakage; and (3) where the tube plates are formed as parts of the hub due to the extent of the cylindrical part of the hub the workman, in drilling the recesses in the upper tube plate for the securement of the tie rods, has to do his work virtually in the dark, that is to say in a dark corner of the hub and, therefore, requires a spot light in order to locate and center the drilling and threading tools and to maintain their alignment during the drilling and threading operations.

The individual objection in connection with the form in which selected tubes are used to support the spacing sleeves is concerned with maintenance and is: When the tubes which carry the spacing sleeves become corroded, as they inevitably will in the majority of cases, they cannot be removed for replacement purposes without the collapse of the baffle system. The result is that these particular tubes cannot be removed without a complete rebuilding of the tube cage as consisting of the baffle plates, the spacing sleeves and the tubes upon which the sleeves are mounted. This is true even though but one of the tubes which carries the spacing sleeves may require replacement due to corrosion.

The invention overcomes the foregoing objections and is directed to improvements in the tube cage, proposing novel features of construction and relation whereby the tube cage may be initially constructed as a structurally independent, economically produced, integer, that is to say an integer independent of the tube plates and not dependent on either of them for support, may be assembled as an integer in the course of the manufacture of the heat exchanger, and, as assembled, is supported by the shell but without attachment to it.

An embodiment of the invention is illustrated in the accompanying drawings wherein:

Figure 1 is a central longitudinal section of a heat exchanger equipped with a tube cage in accordance with the invention.

Figure 2 is a cross section on the line 2—2 of Figure 1, looking in the direction of the arrows.

Figure 3 is a cross section on line 3—3 of Figure 1, looking in the direction of the arrows.

Figure 4 is a detailed cross section, to a somewhat enlarged scale, on the line 4—4 of Figure 1, looking in the direction of the arrows.

Figure 5 is a perspective view of the tube cage in accordance with the invention and as an independently constructed integer, ready for assembly in a heat exchanger.

Figure 6 is a partial central longitudinal section of a heat exchanger equipped with a tube cage of modified construction.

Figure 7 is a cross section on the line 7—7 of Figure 6.

Figures 8 and 9 are views similar to Figures 6 and 7 and showing another modified construction of the tube cage unit.

Figure 10 is a view similar to Figure 7 and showing still another modification of the tube cage unit.

The improvements are equally applicable to fixed head heat exchangers mounted vertically or horizontally and wherein the internal fluid or liquid medium may flow in a single pass or in two or more passes.

The improvements are also equally applicable to constructions which utilize plain tube plates or to constructions wherein the tube plates are parts of hubs. The terminology "tube plate element" contemplates either form.

The tube plate element to which the shell is attached overhangs the upper end of the shell, thereby to delimit an internal annular recess 9a. In the construction shown the tube plate elements are formed with inwardly presented annular rabbeted shoulders 8 and 9. The upper and lower tube plates are designated as 4 and 5 and, in the constructions wherein they form parts of hubs they are integral with cylindrical walls 6 and 7 respectively. In the hub form of construction the shoulders 8 and 9 are formed internally adjacent the open ends of the hubs.

The end portions of the shell 1 project in close fitting relation into the cylindrical skirts from which the shoulders 8 and 9 extend and are positively secured to the tube plate elements, preferably by annular external welds 10. In the hub form of construction the shell 1 is, of course, directly connected to the walls 6 and 7 and these walls are in alinement with the shell and are functional continuations of the shell.

In the fixed head type of heat exchanger parallel tubes 11, provided in any suitable number and arrangement in accordance with standard practice, extend between the plates 4 and 5 and their end portions extend through openings in these plates and are secured in the usual manner. The tubes 11 are employed in connection with a system of baffle plates 12 arranged transversely of the casing, these plates being of usual form and arrangement in that they are in determinately spaced relation, have openings 13 through which the tubes extend, and are shaped to provide windows 14 which in adjacent plates are in staggered or offset relation. The windows 14 delimit a tortuous path of flow for the external liquid or fluid medium which enters the casing at its lower end through the inlet connection 15 and which escapes from the casing at its upper end through the outlet connection 16. The plates 12 may be of any suitable form to provide the windows 14. As shown, and in accordance with common practice, they have curved edges which follow the out-

line of a circle and, beyond the diameter of the circle, have a transverse straight edge, the plates thereby being major fractions of discs in order to provide the spaces which constitute the windows 14.

The tube plates 5 and 4 form parts of fixed heads which are respectively completed by casings 17 and 23. The casing 17, in accordance with usual practice, is attached to the lower face of the lower tube plate 5 and is provided with a central diametrical partition 18 which delimits an inlet chamber 19 having an inlet opening 20 and an outlet chamber 21 having an outlet opening 22. The casing 23, in accordance with usual practice, is attached to the upper face of the upper tube plate 4 and provides a reverse flow chamber 24. The internal fluid or liquid medium enters the heat exchanger through the inlet 20 and flows upward through the tubes 11 which communicate with the inlet chamber 19 to the chamber 23 where its direction of flow is reversed, the medium then flowing downward through the remaining tubes, which are in communication with the outlet chamber 21, and escaping through the outlet opening 22.

The determinately spaced relation of the baffle plates 12 is maintained by spacing sleeves 25 which are mounted on tie rods 26, the plates 12 having openings adjacent their perimeters through which the tie rods extend. At least four tie rods are preferably employed, three of which pass through each of the plates 12.

According to the invention the baffle plates, tie rods and spacing sleeves are independently assembled as an independent integer having at one end provision for its support within the casing independently of the adjacent head to which the tube plates are secured. In the course of the assembly of the heat exchanger the integer, as an integer, is incorporated in the heat exchanger construction and is rigidly supported by the shell by means of an element which forms a part of the integer and for its supporting function has a close fit within the recess 9a, the supporting element as fitted in the recess 9a being securely maintained in clamped relation by and between the upper end of the shell and the adjacent tube plate element.

In the construction preferred, and shown in Figures 1 to 5, a tube cage supporting ring 27 is arranged above and in adjoining relation to the uppermost plate 12 and has an outside diameter greater than the diameter of this plate 12 whereby it projects to a suitable extent beyond the periphery of the plate. The ring 27 provides the supporting part for the tube cage integer and is formed with co-planar lugs 28 which project radially inward and are severally provided with openings through which the tie rods 26 extend. One of the spacing sleeves 25 located immediately below the uppermost baffle plate 12 will be in alinement with the window 14 and is utilized to provide additional support for the ring 27. Manufacturing economy requires that the spacing sleeves 25 be cut to uniform lengths in accordance with their positions in the heat exchanger. Therefore, a washer 29 of the same thickness as the uppermost baffle plate is fitted between such sleeve and the adjacent lug 28 in order to take up the space between the sleeve and the lug.

The tie rods 26 are held against downward displacement relatively to the ring 27 by any suitable mechanical expedient, for example by providing them with oppositely projecting lugs 30 which may be formed by a crimping tool and which are

5

in engagement with the lugs 28. In like manner the tie rods 26 are held by any suitable mechanical expedient against displacement in the opposite direction relatively to the endmost plates 12 through which they extend. As shown, the tie rods project substantially below the lowermost plates 12 through which they extend and their downwardly projecting portions carry sleeves 25a similar to the sleeves 25 and by which the lowermost plates 12 are supported, the tie rods being formed below the sleeves 25a with crimped lugs 31 which engage lower edges of the sleeves 25a. By means of the lugs 30 and 31 the tie rods are held against displacement in either direction relatively to the baffle plates and a rigid structurally independent tube cage unit is provided, this unit being shown in Figure 5, and consisting of the baffle plates 12, the ring 27, the sleeves 25 and 25a and the tie rods 26. In this unit the outside diameter of the ring 27 is less than the inside diameter of the cylindrical upper hub wall 6 below the shoulder 8 to an extent merely sufficient to enable the ring to fit closely within the wall 6 and against the shoulder 8. The diameters of the baffle plates 12 similarly conform to the inside diameter of the shell 1. The ring 27 projects beyond the uppermost baffle plate 12 to an extent equal to the thickness of the shell 1.

The unit thus constructed and characterized is ready for assembly, as a unit, in the course of the assembly of the heat exchanger. The heat exchanger assembly operation is as follows: The tube cage unit is fitted to the upper hub 2 by inserting the ring 27 into the cylindrical top wall 6 and against the annular shoulder 8. The tube cage is thereupon turned about its axial center until the tube openings in the baffle plates align with the tube openings in the plate 4. Two or three tubes, as shown by dot and dash lines in Figure 5, are then inserted through aligning openings in the baffle plates and the tube plate 4 and their upper ends are secured to the tube plate, these tubes serving to key the tube cage to the tube plate and thereby to hold the tube cage against displacement about its axial center. The shell 1 is thereupon fitted to the hub 2 by inserting its upper portion into the cylindrical wall 6 to a position in which its upper end engages the projecting portion of the ring 27. The shell 1 is then secured to the hub 2 by applying the weld 10. The shell 1 and the shoulder 8 cooperate to clamp the ring 27 in its assembled position in the heat exchanger, and the shell 1, by engagement with the ring 27, provides support for the tube cage. The independently constructed tube cage unit is thereby fixed in position and does not depend for support upon the tube plate 4, that is to say, it is wholly confined and supported by the arrangement of the ring 27 between the shoulder 8 and the upper end of the shell 1. The remaining tubes are then inserted through the openings in the baffle plates and the tube plate 4 and their upper ends are secured to the tube plate. With the assembly at this stage the lower hub is then fitted upon the shell, with the openings in the lower tube plate 5 taking over the lower end portions of the tubes. The lower hub is then secured to the shell by the weld 10 and the ends of the tubes are secured to the lower tube plate. The heads 17 and 23 are then secured to the respective tube plates 5 and 4. Spacing sleeves are not required between the baffles at the ends of the series and the adjacent tube plates.

In the event any of the tubes 11 should require

6

replacement this can be readily and quickly effected by removing the heads 17 and 23, disconnecting the ends of the tubes from the tube plates, pulling the tubes from the heat exchanger, inserting new tubes, and securing their ends to the tube plates. In such renewal of the tubes the tube cage remains as a unit in its assembled relation in the heat exchanger and no operation involving any part of the tube cage is required. Thereby the improvements greatly facilitate and renders more economical the tube renewal operation.

In the modified construction shown in Figures 6 and 7 the independent tube cage supporting ring 27, as such, is not employed and its function is served by the uppermost baffle plate, here designated 32. For this purpose the baffle plate 32 is formed with a continuous marginal annulus 33 of suitably greater outside diameter than the inside diameter of the shell, the outside diameter of the annulus 33 corresponding to the outside diameter of the ring 27 of the previous embodiment. The crimped lugs 30 of the tie rods directly engage the upper face of the annulus 33 and the annulus, similarly to the ring 27, provides the part by which the tube cage unit is supported by the shell 1, the annulus being clamped between the upper end of the shell 1 and the shoulder 8.

In the modified construction shown in Figures 8 and 9 the independent tube cage supporting ring 27, as such, is not employed and the provision for the support of the tube cage unit by the shell 1 is afforded by the tie rods. For this purpose the projecting upper end portions of the tie rods are formed with disc-shaped heads 34 which may be produced by an upsetting operation. The heads 34 project under the shoulder 8 of the cylindrical wall 6 and are clamped against the shoulder by the upper end of the shell 1, the heads 34 thereby supporting the tube cage unit in the heat exchanger. Three of the heads 34 also engage the uppermost baffle plate to prevent downward displacement of the tie rods.

The supporting ring 27, instead of being arranged in adjoining relation to the uppermost baffle plate 12, as shown in Figures 1 to 5, may be spaced from it to a practically permissible extent. This modification is shown in Figure 10, the ring 27 being supported in spaced relation relatively to the uppermost baffle plate 12 by additional spacing sleeves 25. In other respects the modified construction shown in Figure 10 conforms to the construction shown in Figures 1 to 5.

I claim:

1. For use as a part of a heat exchanger which includes a tube plate element and a shell attached to the tube plate element and wherein the tube plate element overhangs the upper end of the shell, thereby in combination with the shell to delimit an internal annular recess, and in assembled relation in such heat exchanger, an independently constructed unitary tube cage comprising a series of determinately spaced baffle plates having tube openings and formed to provide circulation windows, the baffle plates being arranged whereby the windows provided by adjacent plates are in staggered or offset relation, thereby to provide a tortuous path of flow, spacing sleeves between the baffle plates to maintain them in determinately spaced relation, tie rods upon which the spacing sleeves are mounted, the baffle plates having openings adjacent their perimeters through which the tie rods pass, means at corresponding ends of the tie rods to hold

them against axial displacement in one direction relatively to the baffle plates, means at the opposite corresponding ends of the tie rods to hold them against axial displacement in the opposite direction relatively to the baffle plates and to provide support for the baffle plates, and supporting means structurally independent of the tube plate element, rigidly fixed at one end of the unit, projecting radially outward relatively to the baffle plates and closely and freely fitting within the annular recess, the supporting means thereby being in cooperation in a clamped relation with the tube plate element and the adjacent end of the shell.

2. A heat exchanger tube cage as set forth in claim 1 wherein the supporting means consists of an annular element.

3. A heat exchanger tube cage as set forth in claim 1 wherein the supporting means consists of a ring held in fixed relation to the adjacent end baffle plate of the series, the ring projecting to a suitable extent outward beyond the plate and being formed with co-planar lugs projecting radially inward and severally provided with openings through which the tie rods extend.

4. A heat exchanger tube cage as set forth in claim 1 wherein the supporting means consists of a ring fixed in adjoining relation against an end baffle plate of the series, the ring projecting to a suitable extent outward beyond the plate and being formed with co-planar lugs projecting radially inward and severally provided with opening through which the tie rods extend.

5. A heat exchanger tube cage as set forth in claim 1 wherein the supporting means consists of a ring fixed in adjoining relation against an end baffle plate of the series, the ring projecting to a suitable extent outward beyond the plate and being formed with co-planar lugs projecting radially inward and severally provided with openings through which the tie rods extend and wherein a spacing sleeve in alignment with the window of the baffle plate which the ring adjoins is interposed between the lug aligning with such window and the succeeding baffle plate.

6. A heat exchanger tube cage as set forth in claim 1 wherein the means at the opposite corresponding ends of the tie rods includes sleeves mounted upon the tie rods and having supporting engagement with the adjacent baffle plates.

7. In a heat exchanger, the combination with a casing including an end hub formed with a tube plate and a cylindrical wall provided near its open end with an internal annular rabbeted shoulder and a shell having an end portion fitting within such cylindrical wall, the shell being attached to the wall, of an independently constructed unitary tube cage comprising a series of determinately spaced baffle plates having tube openings and formed to provide circulation windows, the baffle plates being arranged whereby the windows provided by adjacent plates are in staggered or offset relation, thereby to provide a tortuous path of flow, spacing sleeves between the baffle plates to maintain them in determinately spaced relation, tie rods upon which the spacing sleeves are mounted, the baffle plates have openings adjacent their perimeters through which the tie rods pass, means at corresponding ends of the tie rods to hold them against axial displacement in one direction relatively to the baffle plates,

means at the opposite corresponding ends of the tie rods to hold them against axial displacement in the opposite direction relatively to the baffle plates and to provide support for the baffle plates, and supporting means rigidly fixed at one end of the unit and projecting radially outward relatively to the baffle plates, the supporting means being confined against the annular shoulder by the adjacent end of the shell.

8. A heat exchanger as set forth in claim 7 wherein the supporting means consists of an annular element.

9. A heat exchanger as set forth in claim 7 wherein the supporting means consists of a ring held in fixed relation to the adjacent end baffle plate of the series and formed with co-planar lugs projecting radially inward and severally provided with openings through which the tie rods extend.

10. A heat exchanger as set forth in claim 7 wherein the supporting means consists of a ring fixed in adjoining relation against an end baffle plate of the series and formed with co-planar lugs projecting radially inward and severally provided with openings through which the tie rods extend.

11. For use as a part of a heat exchanger which includes a tube plate element and a shell attached to the tube plate element and wherein the tube plate element overhangs the upper end of the shell, thereby in combination with the shell to delimit an internal annular recess, and in assembled relation in such heat exchanger, an independently constructed unitary tube cage comprising a series of determinately spaced baffle plates having tube openings and formed to provide circulation windows, the baffle plates being arranged whereby the windows provided by adjacent plates are in staggered or offset relation, thereby to provide a tortuous path of flow, spacing sleeves between the baffle plates to maintain them in determinately spaced relation, tie rods upon which the spacing sleeves are mounted, the baffle plates having openings adjacent their perimeters through which the tie rods pass, heads upon the tie rods at corresponding ends thereof, the heads engaging the adjacent baffle plate to prevent axial displacement of the tie rods in one direction relatively to the baffle plates, and means at the opposite corresponding ends of the tie rods to hold them against axial displacement in the opposite direction relatively to the baffle plates and to provide support for the baffle plates, the heads projecting radially outward beyond the adjacent baffle plate and the projecting portions of the heads closely and freely fitting within the annular recess, the heads thereby being in cooperation in a clamped relation with the tube plate element and the adjacent end of the shell, and providing supporting means for the unit rigidly secured at one end thereof.

TOWNSEND TINKER.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
898,363	Holdsworth	Sept. 8, 1908
2,152,266	McNeal	Mar. 28, 1939
2,181,704	McNeal	Nov. 28, 1939