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HEAT EXCHANGER TUBE SUPPORTS

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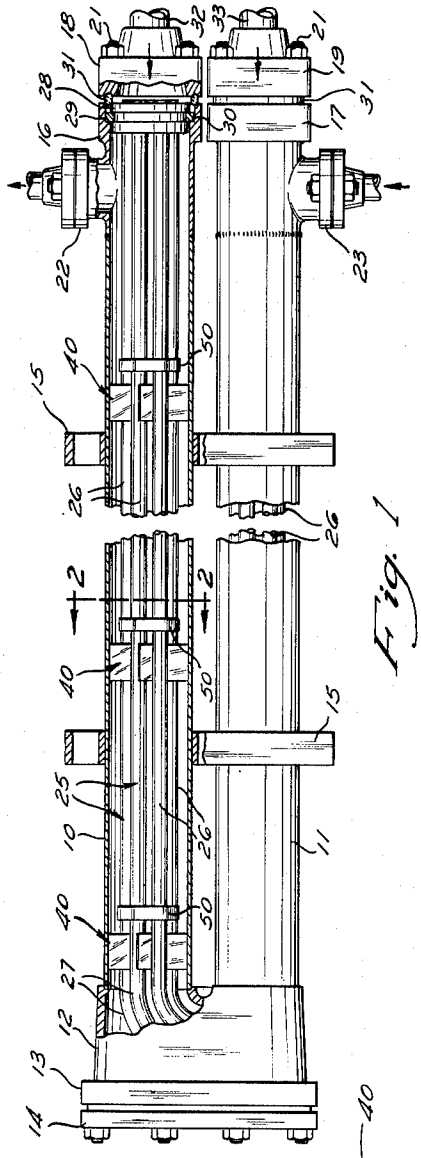

Fig. 1

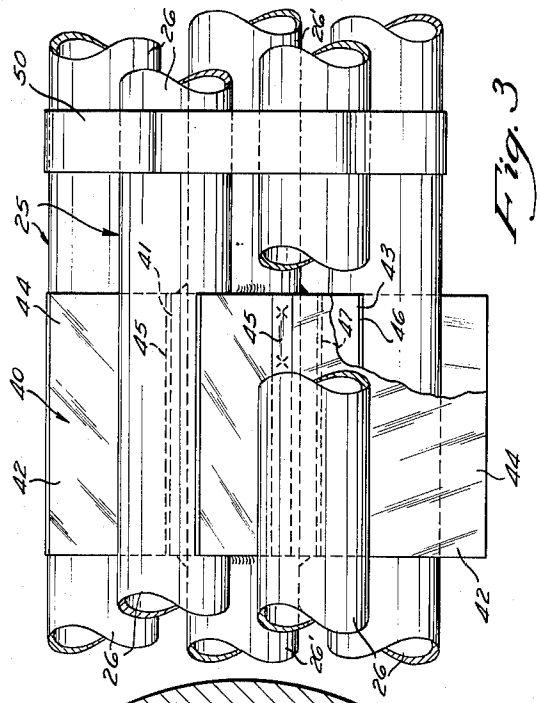

Fig. 3

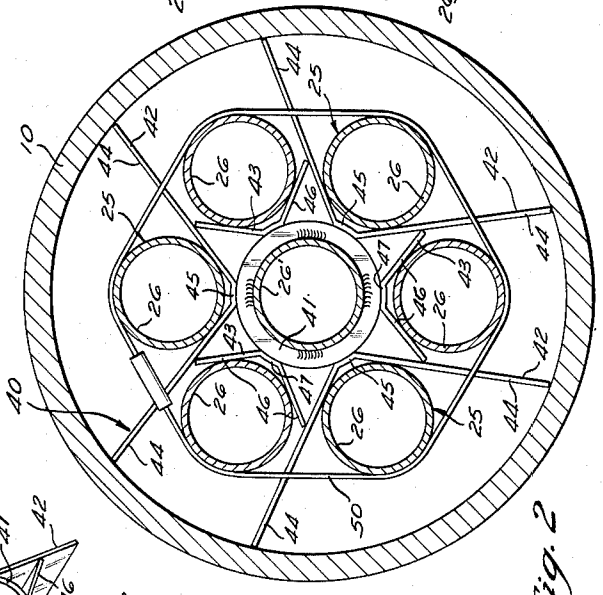

Fig. 2

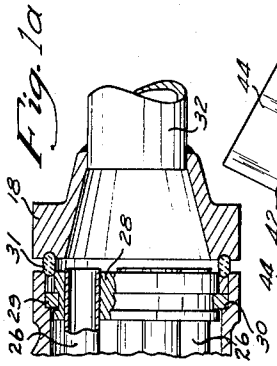

Fig. 1a

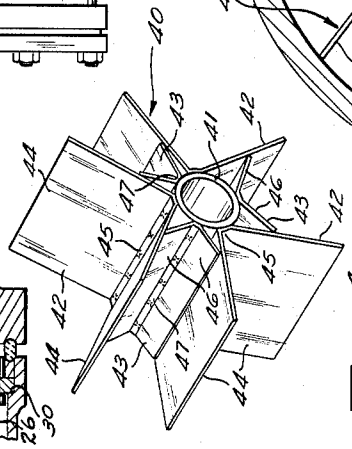

Fig. 4

INVENTOR.
EDWARD V. SKIBA
BY
Bosworth, Sessions, Herstrom & Knowles
ATTORNEYS

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HEAT EXCHANGER TUBE SUPPORTS

Edward J. Skiba, Rocky River, Ohio, assignor to Brown Fintube Company, Elyria, Ohio, a corporation of Ohio

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This invention relates to heat exchangers, and more particularly to the tubes of multiple tube heat exchangers. The invention is described herein as applied to a heat exchanger of the hairpin type, in which use the invention provides exceptional advantages.

Such a heat exchanger embodies a plurality of hairpin shaped tubes enclosed in a shell of hairpin shape. Each leg of the shell is of generally circular internal cross section and contains a bundle of straight tubes, consisting of the legs of the hairpin tubes, arranged in spaced parallel relation to each other. Such heat exchangers often are of considerable length. It is important that the tubes in the bundle in each leg of the shell be firmly supported relatively to each other and to the shell, but the length of the heat exchanger often makes it impossible to support the tubes in each bundle from only the end at which they are connected to the shell. For this reason, at least one and preferably several spacing means should be located along the length of the bundle to provide the desired support to the tubes.

The spacing means should satisfy several criteria. It should properly space and secure the tubes relatively to each other. It should space and locate the tubes relatively to the shell. It should permit relative longitudinal movement between the tubes and the shell, as can occur due to differences in thermal expansion of the tubes and the shell. It should not impair heat transfer between the fluid in the tubes and the fluid outside of the tubes in the shell, and preferably should increase heat transfer. While performing the above functions, it should not substantially increase the pressure drop on the fluid passing through the shell, since this would increase pumping costs and provide other difficulties. In the event the fluid passing through the shell is of the type which can vaporize under the conditions to which it is subjected in the shell, the spacing means should allow the resultant vapors to pass freely through the shell without vapor binding.

A general object of the invention is the provision of strong, simple and economical spacing means which satisfies the above criteria and provides other advantages. More specific objects include the provision of such spacing means which can be readily manufactured and installed. Other objects include the provision of a heat exchanger embodying such spacing means.

Further objects and advantages of the invention will be apparent from the following description of a preferred form, reference being made to the accompanying drawings in which,

FIGURE 1 is a side elevation with parts broken away of a preferred form of heat exchanger embodying the invention;

FIGURE 1*a* is an enlarged section of the sealing means joining the inner tubes, shell tube, and fluid pipe at one end of one shell tube;

FIGURE 2 is a cross section to an enlarged scale of one leg of the heat exchanger shown in FIGURE 1, the view being taken as indicated by line 2—2 of FIGURE 1;

FIGURE 3 is a side elevation of a portion of a tube bundle of the heat exchanger to the same scale as FIGURE 2; and

FIGURE 4 is a perspective of a spacer embodying the invention.

As shown in FIGURES 1 and 2 of the drawings, a preferred form of heat exchanger embodying the invention comprises a pair of parallel external or shell tubes **10** and

11. These tubes are connected at their rear ends to a return bend housing **12** having a rear opening surrounded by a flange **13** to which is bolted the cover **14** which closes the opening. The shell tubes may be supported by frame members **15** or by any other convenient means. The forward ends of the shell tubes **10** and **11** are provided with flanges **16** and **17**, respectively, to which pipe-connecting fittings **18** and **19** are secured by bolts **21**. Fluid is supplied to and discharged from the interior of the shell tubes through the connections **22** and **23** which are welded to the tubes **10** or **11** near the flanges **16** and **17**. In the form of the heat exchanger shown in the drawing, the connection **23** is the inlet and connection **22** is the outlet, as indicated by the arrows. It will be understood, however, that the direction of flow through the shell tubes may be reversed if desired.

To provide a path for another fluid or commodity to flow in heat exchange relation to the fluid or commodity within the shell tubes, a plurality of hair pin tubes **25** are disposed in the shell tubes. Each of illustrated tubes **25** comprises two bare straight sections or legs **26** connected by a return bend **27** within the return bend housing **12**. In the form of the invention shown in the drawings, seven hairpin tubes are employed, the straight tube sections **26** being arranged in two bundles, one in each shell tube, so that there is one tube section **26'** (see FIGURE 2) at the center of each bundle with its axis substantially coincident with that of the shell tube, and six outer tube sections equidistantly and equiangularly spaced around the central tube axis. A greater or lesser number of tubes may be utilized without departing from the invention, although the outer hairpin tubes surrounding the inner tube or tubes are preferably even in number. As shown in FIGURES 1 and 1*a*, the forward ends of the tubes **26** in each bundle are fixed in a tube sheet **28** which is supported by a split locking ring **29**, which is disposed in a groove in the tube sheet **28** and engages an inner flange **30** in the corresponding shell tube **10** or **11**, against the force exerted by a sealing ring **31** that is engaged by the corresponding fitting **18** or **19**. Bolts **21** hold the fittings **18** and **19** in place and draw them against the sealing rings **31**. The rings **31** make sealing engagement with the adjacent tube sheet **28** and the adjacent flange **16** or **17** of the shell tube **10** or **11**. Thus, there are fluid tight connections between the interiors of pipes **32** and **33** connected to fittings **18** and **19** and the interiors of hairpin tubes **25**, and the spaces within the shell tubes **10** and **11** and surrounding the hairpin tubes are also sealed at the forward end of the heat exchanger, by the rings **31**. This type of connection is disclosed in detail and claimed in the copending application of John W. Brown, Jr. and John W. Nevins, Serial No. 32,349, filed May 27, 1960, and owned by the assignee of the present application. Any convenient sealing means may be employed, however, inasmuch as the sealing means forms no part of the present invention.

Pipes **32** and **33** connect the hairpin tubes to an external fluid system. Pipe **32** connected to fitting **18** constitutes the inlet and pipe **33** connected to fitting **19** constitutes the outlet, thus providing for counterflow of the fluids in the illustrated heat exchanger. Obviously the flow can be reversed if desired, and it will be evident that the connecting pipes **32** and **33** and the lateral connections **22** and **23** can be arranged to connect a plurality of heat exchanger units such as shown in FIGURE 1 in series or in multiple.

Since the length of the heat exchanger and hence the length of the shell tubes **10** and **11** and the straight sections **26** of the hairpin tubes are great in comparison to the diameters of the tubes, lengths of **20** or more feet with shell tubes of four inches or less in diameter and hairpin tubes of ⅞ inch outside diameter being not uncommon, the tubes in the tube bundles, if unsupported except at

the tube sheets, will bend and sag and in many cases will touch each other as well as the wall of the shell tube, resulting in a decrease in heat exchange efficiency, a possible increase in pressure drop and generally less efficient operation of the exchanger. In order to eliminate these difficulties, the present invention provides supporting and spacing devices **40** for supporting the tubes **26** in proper position with respect to each other and with respect to the surrounding shell tubes **10** and **11**. In the illustrated embodiment there are several supporting devices **40** disposed along the length of the bundle of the straight tube sections **26** in each of the shell tubes. One of the supporting devices **40** is shown separately in perspective in FIGURE 4 and is shown in place and to an enlarged scale in FIGURES 2 and 3.

As illustrated in the drawings, each supporting device or spacer **40** comprises a central member **41** in the form of a short tubular member which is adapted to be mounted on and preferably fixed to the central tube section **26'** of the bundle of tubes in each shell tube. The central member **41** supports a set of identical channel members **42** equally spaced about the member **41**. A second set of smaller channel members **43**, identical to each other, is also mounted on central member **41**, the members **43** being alternately disposed relative to members **42**.

Each channel member **42** is formed of a piece of sheet metal bent to have two diverging side wall **44** connected at the bottom to a narrow base **45** fixed, as by welding, to the exterior of central member **41**. Each side wall **44** is wide enough to extend from the outer surface of member **41** to the inner surface of the shell tube **10** or **11**. Each smaller channel member **43** of the other group is also formed of a piece of sheet metal bent to have two identical side walls **46** joined to a narrow base **47** fixed as by welding to the exterior of central member **41**. The side walls **46** of each member **43** are considerably narrower than the side walls **44** of members **42**. The outer edges of side walls **46** being located close to, and preferably in contact with the outer surfaces of the side walls **44** of the channel members **42**.

In the preferred embodiment, the cross sectional shape of the channel members **43** is identical to the cross sectional shape of the channel members **42** up to the point where the side walls **44** of channel members **42** are engaged by the outer edges of the side walls **46** of channel members **43**. This is shown in FIGURE 2. The channel members **43**, and the lower portions of the alternately disposed channel members **42** thus provide identical V-shaped bearing surfaces which contact the straight lengths **26** of the outer tubes **25** in a bundle when the spacer is mounted in place with its central member **41** surrounding the central tube **26'**. The outer tubes are preferably held in contact with these surfaces by a band or strap **50** located adjacent to the spacer, as shown in FIGURES 1, 2 and 3. This band or strap may be any conventional type of metal strapping applied in a conventional manner and hence requires no further description.

Spacers of the kind described above may be readily manufactured by preforming strips of metal into long channel members having the cross sections of members **42** and **43**, and fixing these long channel-shaped members in the proper alternating relationship on a central tubular member approximately as long as the channel members and having the cross section of member **41** by welding the narrow bottom walls of such channel-shaped members to the outer surface of the central tubular member, preferably in accordance with the method and apparatus disclosed in J. W. Brown, Jr. Patents 2,298,249 and 2,298,250 issued October 6, 1942. The long welded assembly is then cut into short spacer members **40** of the desired length. Although the outer edges of the narrow walls **46** of channel members **43** also could be welded to the wide outer side walls **44** of the channel members **42**, this is not necessary as a practical matter because these edges are wedged in place by the forces developed between these edges and

the outer surfaces of side walls **44** when the side walls of members **42** and **43** are urged toward the central member **41** by the forces exerted on the side walls by the tubes **26** when the spacer is in place in the heat exchanger.

In the assembly of a heat exchanger embodying spacers **40**, the desired number of spacers **40** are slid onto the central straight tube section **26'** of each bundle, arranged in the proper and preferably uniformly spaced relation, and if desired are welded to such tube section as shown in FIGURE 2. Thereafter, the straight sections **26** of the outer tubes in the bundle are positioned within the channel members **42** and **43** as shown in FIGURE 2, and the straps **50** are applied. The tube sheet **28** at each end of the tube bundle is then mounted and fixed in place, and the heat exchanger is assembled in the usual manner. During assembly the outer edges of the wide channel members **42** engage the shells **10** and **11** and facilitate sliding the tube bundles into the shells.

In the assembled heat exchanger the outer tubes are firmly and accurately located relatively to each other and to the central tube by their engagement with the side walls **44** and **46** of the channel members **42** and **43** of the spacers **40**, against which side walls they are held by the straps **50** adjacent each spacer. As illustrated in FIGURE 2, the outer edges of the side walls **44** of the wide channel members **42** engage the inner surfaces of the shells and accurately locate the bundles as a whole relatively to the shells. The walls **44** of channel members **42** and the walls **46** of channel members **43** provide addition heat exchange surfaces which increase transfer of heat between fluid flowing inside of the tubes **25** and the fluid flowing outside of the tubes and inside of the shells. Moreover, the spacing and heat transfer functions of the spacers **40** are provided without substantially increasing the pressure drop on the fluid flowing through the shell outside of the tubes, since all extended surfaces of the spacer are parallel to the direction of fluid flow. These geometrical relationships of the parts of the spacer also permit vapors which might arise from vaporizing type shell fluids to pass freely through the heat exchanger without vapor binding, as could occur with transverse plate type supports. All of these desirable results can be achieved at relatively low cost. The spacers themselves are rugged and have long life.

In the illustrated embodiment, the side walls **44** and **46** of channel members **42** and **43** are flat; this is preferable since it not only facilitates the forming of the channel members on relatively simple equipment but also because it promotes heat transfer by providing space between each channel member and the surface portion of each outer tube which is nearest the central tube. However, if desired, the lower portion of each channel member can be made to conform to the outer surface of the tube, or can be made of other configurations than shown. It is desirable, however, that the portions of the various channel members which contact the tubes be identical so as to provide for the desired equidistant and equiangular spacing of outer tubes of identical cross section in the bundle.

The number of wide channel members **42** should be equal to the number of the narrow channel members **43**, since they are alternately disposed; this means that there is an even number of channel shaped bearing surfaces available for supporting outer tubes in a bundle. The number of wide members **42** and of narrow members **43** may, of course, be an odd or even number, but the total number of members **42** and **43** should be an even number which is determined by the number of tubes which it is desired to support by the spacer.

While the illustrated spacer is formed of sheet metal parts welded to a central member, it is apparent that it may be formed of other materials and in other manners. Furthermore, while the spacers of the invention have been disclosed as used in hairpin type heat exchangers having bare tubes, they may be employed to support and

space tubes in a bundle in other types of heat exchangers. Moreover, they may be used to support finned tubes in hairpin or other type heat exchangers, as by engaging bare portions of such tubes.

Various changes and modifications in the invention will be apparent to those skilled in the art. It is therefore to be understood that the patent is not limited to the preferred form of the invention disclosed herein or in any manner other than by the scope of the appended claims.

I claim:

1. A heat exchanger comprising an elongated shell; a bundle of elongated heat exchange tubes located in said shell, said tubes being spaced from each other and disposed substantially parallel to each other and to said shell and substantially equiangularly spaced around a central axis; and a spacer engaging said tubes and said shell to locate said tubes with respect to said shell and to each other, comprising a first set of outwardly opening channel members of substantially identical cross section extending longitudinally along and spaced substantially equiangularly about said axis, each of said channel members having outwardly diverging sidewalls, a second set of channel members alternately disposed between the channel members of said first set and extending longitudinally along and disposed substantially equiangularly around said axis, each of said channel members of said second set being of substantially identical cross section and having outwardly diverging sidewalls, the sidewalls of the channel members of said second set terminating adjacent to sidewalls of adjacent channel members of said first set, and means for locating said channel members with respect to each other, each channel member receiving and supporting one of said heat exchange tubes to locate said tubes substantially equiangularly about said axis, and the sidewalls of said channel members in said first set engaging said shell to locate said spacer and said tubes with respect to said shell.

2. A heat exchanger comprising an elongated shell; a plurality of elongated heat exchange tubes of generally circular substantially identical cross section located in said shell in substantially parallel relation and substantially equidistantly and equiangularly spaced from an axis extending longitudinally of said shell; and a spacer engaging said tubes and said shell to locate said tubes with respect to said axis and said shell comprising a first set of channel members of substantially identical cross section extending longitudinally along and spaced substantially equidistantly and equiangularly about said axis, each of said channel members having sidewalls formed of sheet material, a second set of channel members of substantially identical cross section alternately disposed between said channel members of aid first set and extending longitudinally along and spaced substantially equidistantly and equiangularly about said axis, each of said channel members of said second set having outwardly diverging sidewalls formed of sheet material and having their outermost edges in close proximity to adjacent sidewalls of adjacent channel members of said first set, the sidewalls of said channel members of said first set extending outwardly beyond the edges of said channel members of said second set, said channel members of said first and second sets having substantially identical lower portions up to the portions of the walls which are in close proximity, and means for locating said channel members with respect to each other, the lower portion of each of said channel members receiving and bearing against one of said heat exchanger tubes so that all said tubes are located with their axes in substantially parallel relation and substantially equidistantly and equiangularly spaced from said first axis, and the outwardly extending sidewalls of said first set of channel members engaging said shell to locate said spacer and said tubes and said shell.

3. A heat exchanger comprising an elongated shell; a bundle of elongated heat exchange tubes located in said shell, said tubes being disposed substantially parallel to each other and to said shell and substantially equidistantly and equiangularly spaced around a central axis; and a spacer engaging said tubes and said shell to locate said tubes with respect to said axis and said shell comprising a tubular central member, a first set of channel members of substantially identical cross section extending longitudinally along and spaced equiangularly around said central member, each of said channel members having outwardly diverging side walls, and a second set of channel members alternately disposed between the channel members of said first set and extending longitudinally along and disposed equiangularly around said central member, each of said channel members of said second set being of substantially identical cross section and having outwardly diverging side walls, the side walls of the channel members of the second set terminating adjacent to side walls of adjacent channel members of the first set, each channel member receiving and supporting one of said heat exchanger tubes to locate said tubes substantially equidistantly and equiangularly from said central axis, and the side walls of said channel members in said first set engaging said shell to locate said spacer and said tubes with respect to said shell.

4. A heat exchanger comprising an elongated shell; a bundle of elongated heat exchange tubes located in said shell, said tubes being spaced from each other and disposed substantially parallel to each other and to said shell and substantially equidistantly and equiangularly spaced around a central axis; a spacer engaging said tubes and said shell to locate said tubes in said shell comprising a tubular central member, a first set of channel members of substantially identical cross section extending longitudinally along said central member and spaced equiangularly around said central member, each of said channel members having outwardly diverging side walls, and a second set of channel members alternately disposed between the channel members of said first set and extending longitudinally along and disposed equiangularly around said central member, each of said channel members of said second set being of substantially identical cross section and having outwardly diverging side walls, the side walls of the channel members of the second set terminating adjacent to the side walls of adjacent channel members of the first set, the side walls of said channel members of said first and second sets receiving and supporting one of said heat exchanger tubes to locate said tubes substantially equidistantly and equiangularly from said central axis and the side walls of said channel members in said first set engaging said shell to locate said spacer and said tubes in said shell; and means surrounding said bundle of tubes for holding said tubes in contact with the side walls of the channel members in which the tubes are disposed.

5. A heat exchanger comprising an elongated shell; a plurality of elongated heat exchange tubes of generally circular substantially identical cross section located in said shell in substantially parallel relation and substantially equidistantly and equiangularly spaced from an axis extending longitudinally of said shell; a plurality of spacers disposed at spaced locations along said bundle, each of said spacers engaging said tubes and said shell to locate said tubes in said shell comprising a central member, a first set of channel members of substantially identical cross section supported from and around said central member at locations equidistantly and equiangularly spaced from said axis, each of said channel members having side walls formed of sheet material, and a second set of channel members of substantially identical cross section alternately disposed between said channel members of said first set, supported from and around said central member at locations equidistantly and equiangularly spaced from said axis, each of said channel members of said second set having outwardly diverging side walls formed of sheet

material and having their outermost edges in close proximity to adjacent side walls of adjacent channel members of said first set, the side walls of said channel members of said first set extending outwardly beyond the edges of said channel members of said second set, said channel members of said first and second sets having substantially identical lower portions up to the portions of the walls thereof which are in close proximity, the lower portion of each of said channel members receiving and bearing against one of said heat exchanger tubes so that all said tubes are located with their axes in substantially parallel relation and substantially equidistantly and equiangularly spaced from said first axis, and the outwardly extending side walls of said first set of channel members engage said shell to locate said spacer and said tubes in said shell; and means holding each of said tubes against the lower portion of the channel member of said spacer which receives said tube.

6. A hairpin type heat exchanger comprising an elongated shell of hairpin shape having two straight legs; a plurality of elongated hairpin-shaped heat exchange tubes defining two bundles of straight tube sections each of which bundles is disposed longitudinally in one of the legs of the shell, the tubes in each bundle being of generally circular cross section with one of said tubes located centrally of the bundle and others of substantially identical cross section located in substantially parallel relation to and substantially equidistantly and equiangularly spaced from the axis of the central tube; spacers engaging said tubes in said shell legs to locate said tubes, each of said spacers comprising a tubular central member mounted coaxially on the central tube in a bundle, a first set of channel members of substantially identical cross section supported from and around said central member at locations equidistantly and equiangularly spaced from its axis, each of said channel members having outwardly diverging sheet metal side walls, a second set of channel members of substantially identical cross section alternately disposed between said channel members of said first set, supported from and around said central member at locations equidistantly and equiangularly spaced from its axis, each of said channel members of said second set having outwardly diverging sheet metal side walls the outermost edges of which are in close proximity to the side walls of adjacent channel members of said first set, the side walls of said channel members of said first set extending outwardly beyond the edges of said channel members of said second set, said channel members of said first and second sets having substantially identical lower portions up to the portions of the walls thereof which are in close proximity, the lower portion of each of said channel members receiving and bearing against one of said heat exchanger tubes other than said central tube in a bundle so that all said tubes are located with their axes in substantially parallel relation and substantially equidistantly and equiangularly spaced from the axis of said central tube and the outwardly extending side walls of said first set of channel members engage said shell to locate said spacer and said tubes in said shell; and means holding each of said tubes of a bundle against the lower portion of the channel member of said spacer which receives said tube.

7. A spacer for locating an even number of elongated members of generally circular substantially identical cross section with their axes in substantially parallel relation and substantially equidistantly and equiangularly spaced from the axis of the spacer, said spacer comprising a central member having an axis coincident with the axis of the spacer; a first set of channel members of substantially identical cross section supported from said central member at locations therearound equidistantly and equiangularly spaced from the axis of the spacer, each of said channel members having side walls formed of sheet material; a second set of channel members of substantially identical cross section, alternately disposed between said channel members of said first set and supported from and around said central member at locations equidistantly and equiangularly spaced from the axis of said spacer, each of said channel members of said second set having outwardly diverging side walls formed of sheet material the outermost edges of which side walls are located in close proximity to adjacent side walls of adjacent channel members of said first set, the side walls of said channel members of said first set extending outwardly a substantial distance beyond the edges of said channel members of said second set, said channel members of said first and second sets having lower portions which are substantially identical in cross section up to the portions thereof at which their side walls are in close proximity, said channel members of said first and second sets being adapted to bear against the elongated members of generally circular cross section.

References Cited in the file of this patent

UNITED STATES PATENTS

1,767,652	Daley	June 24, 1930
2,804,284	Otten	Aug. 27, 1957

FOREIGN PATENTS

480,574	Great Britain	Feb. 24, 1938
600,592	Canada	June 28, 1960