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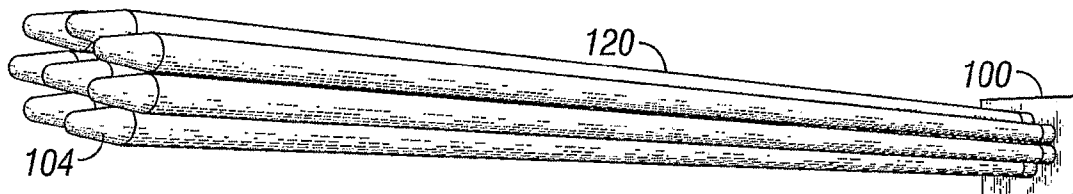
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(54) Title: MULTI-TUBE INSERTION FIXTURE AND PROCESS



(57) Abstract: A method and fixture for assembling a plurality of tubes (120) to a tubesheet (124). A first end of each of the tubes (120) is situated over a corresponding support rod (102) that extends from a pattern block (100) of the fixture. A first end of a plurality of locating members (104) is inserted into a second end of each of the tubes (120) such that a second end of the locating member (104) extends from the tube second end. The tubesheet (124) is then slid over the locating members (104) and tubes (120) such that each of a plurality of holes in the tubesheet (124) receive corresponding ones of the tubes (120).

MULTI-TUBE INSERTION FIXTURE AND PROCESS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a non-provisional application of U.S. Provisional
5 Application No. 60/705,998, filed on August 5, 2005, which is incorporated by
reference.

BACKGROUND

[0002] The present invention relates generally to cooling systems, and more
specifically to shell and tube condensers.

10 [0003] Shell and tube condensers typically have a plurality of tubes situated inside
a cylindrically-shaped outer shell. The ends of the tubes terminate in openings
defined in an end plate or "tubesheet" at each end of the shell. Opposite ends of the
tubes are open for directing a flow of fluid through the tubes. Known assembling
processes for shell and tube condensers have been problematic. For instance, it can be
15 difficult to keep the tubes aligned when inserting them in the shell and tubesheet. In
other instances, if the tubes are inserted into the tubesheet one at a time, it is possible
for a tube to be inserted into the wrong opening in one of the tubesheets. Locating the
proper opening in the tubesheets can be difficult due to the close proximity of the
openings and the tight tolerance of the concentric fits.

20 [0004] The present application addresses shortcomings associated with the prior
art.

SUMMARY

[0005] In accordance with certain teachings of the present disclosure, a method for assembling a plurality of tubes to a tubesheet includes situating a first end of each of the tubes over a corresponding support rod that extends from a pattern block. A first
5 end of a plurality of locating members is inserted into a second end of each of the tubes such that a second end of the locating member extends from the tube second end. The tubesheet is slid over the locating members and tubes such that each of a plurality of holes in the tubesheet receive corresponding ones of the tubes. Typically, two tubesheets are connected to opposite ends of a shell, so the assembled tubesheets
10 and shell are slid over the locating members and tubes.

[0006] The locating members may then be removed from the second end of the tubes. The second ends of the tubes are expanded to attach the tubes to the tubesheet. The assembly is then removed from the support rods and the remaining ends of the tubes are expanded to attach them to the tubesheet at the opposite end of the shell. In
15 some embodiments, the support rods are removable from the pattern block. The locating members have a first end that is receivable by the corresponding support rod, and a tapered second end that facilitates the proper tube being received by the corresponding hole in the tubesheet.

BRIEF DESCRIPTION OF THE DRAWINGS

20 [0007] Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0008] Figure 1 illustrates a typical tubesheet.

[0009] Figure 2 schematically illustrates a front view of a pattern block in accordance with the present disclosure.

[0010] Figure 3 schematically illustrates a support rod in accordance with the present disclosure.

5 [0011] Figure 4 schematically illustrates a locating member in accordance with the present disclosure.

[0012] Figure 5 is a perspective view of the support rods assembled to the mounting plate.

[0013] Figure 6 is a perspective view showing tubes situated over the support rods
10 with locating members inserted into the ends of the tubes.

[0014] Figures 7-10 are various views showing the shell and tubesheet being situated over the locating members and tubes.

[0015] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the
15 drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such
5 actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary
10 skill in the art having the benefit of this disclosure.

[0017] Figure 1 conceptually illustrates a typical tubesheet for a shell and tube condenser. In the illustrated tubesheet 10, eight holes 12 are defined for receiving the condenser tubes. Depending on the construction of the condenser, any number of tubes and tube patterns could be used. The condenser tubes are received in the
15 openings 12 of the tubesheet 10 and the tubes are expanded to fix them to the tubesheet 10.

[0018] Figures 2-4 illustrate three components of a fixture for facilitating the assembly of a shell and tube device in accordance with aspects of the present disclosure. The fixture includes a pattern block 100, shown in Figure 2, a support rod
20 102 (Figure 3) and a tapered locating member, or "bullet" 104 (Figure 4). The particular pattern block 100 shown in Figure 2 defines eight holes 112 corresponding to the holes 12 of the tubesheet 10. The holes 12 may be threaded to receive a

threaded end of the support rods 102. The number and pattern of the holes 112 will of course vary depending on the configuration of the particular tubesheet being used.

[0019] Initially, the pattern block 100 and the support rods 102 are assembled as shown in Figure 5. To assemble the shell and tube device, one end of each of the
5 condenser tubes 120 is placed over a corresponding one of the support rods 102 as shown in Figure 6, leaving the opposite end of the tubes 120 free. The support rods 102 extending from the pattern block 100 allow multiple tubes 120 to be placed over the support rods 102 simultaneously. Once the tubes 120 are in place, the bullets 104
10 are inserted into the ends of the tubes 120 opposite the pattern block 102. As shown in Figure 4, the bullets 104 have one end 105 that is tapered. The opposite end 106 of the bullet 104 is sized such that it can be inserted into the tube 120 with the tapered end 105 extending therefrom. The tapered end 105 allows easier placement of the holes of the tubesheets 124 over the appropriate tube 120.

[0020] After the bullets 104 are inserted into the tubes 120, the shell 122 and
15 tubesheet 124 are placed over the tubes 120 as shown in Figures 7, 8 and 9. In the illustrated assembly, the shell 122 has a tubesheet 124 at either end of the shell 122. In Figure 7, the tapered ends of the bullets 104 receive the corresponding holes of the first tubesheet 124 at one end of the shell 122. The first tubesheet 124 is slid down the length of the tubes 120, as shown in Figure 8, until the tubesheet 124 reaches the
20 end of the tubes 120 being supported by the support rods 102 extending from the pattern block 100. When the second tubesheet 124 at the end of the tubes 120 opposite the pattern block 100 reaches the bullets 104, the holes of the second

tubesheet 124 receive the tapered end of the corresponding bullet 104 to facilitate situating the second tubesheet 124 about the tubes 120.

[0021] Once the shell 122 and tubesheets 124 are in place, the bullets 104 are removed as shown in Figure 10. The ends of the tubes 120 opposite the pattern block
5 100 are expanded to fix the ends of the tubes 120 in the holes of the tubesheet 124. The assembled tubes 120, shell 122 and tubesheets 124 are removed from the support rods 102 of the fixture, and the remaining ends of the tubes 120 are expanded to attach them to the tubesheet 124 at the opposite end of the shell 122.

[0022] As illustrated herein, the support rods 102 are received by the pattern block
10 100 such that the support rods 102 are oriented generally horizontally. However, the combined pattern block 100 and support rods 102 can be used with the rods oriented in other manners, such as vertically. Moreover, the number, size, pattern, etc. of the holes 112 in the pattern block 100 can be varied as necessary to support the associated shell and tube assembly.

[0023] The particular embodiments disclosed above are illustrative only, as the
15 invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular
20 embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Consequently, all such similar applications are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

CLAIMS

WHAT IS CLAIMED IS:

1. A method for assembling a plurality of tubes to a tubesheet, the method comprising the steps of:
 - 5 situating a first end of each of the tubes over a corresponding support rod that extends from a pattern block;
 - inserting a first end of a plurality of locating members into a second end of each of the tubes such that a second end of the locating member extends from the tube second end; and
 - 10 sliding a first tubesheet over the locating members and tubes such that each of a plurality of holes in the tubesheet receive corresponding ones of the tubes.
2. The method of claim 1, further comprising removing the locating members from the second end of the tubes.
- 15 3. The method of claim 2, further comprising attaching the tubes to the tubesheet.
4. The method of claim 3, wherein attaching the tubes to the tubesheet includes expanding the tubes.
5. The method of claim 1, wherein the first tubesheet is connected to a
20 first end of a shell and a second tubesheet is connected to a second end of the shell, the method further comprising sliding the first and second tubesheets and shell over the locating members and tubes such each of a plurality of holes in the first and

second tubesheets receive corresponding ones of the tubes, and the first and second tubesheets are situated at the first and second ends of the tubes, respectively.

6. The method of claim 5, further comprising attaching the second tubesheet to the second end of the tubes.

5 7. The method of claim 6, wherein attaching the second tubesheet includes expanding the second end of the tubes.

8. The method of claim 6, further comprising removing the tubes from the support rods.

9. The method of claim 8, further comprising attaching the first tubesheet
10 to the first end of the tubes.

10. The method of claim 9, wherein attaching the first tubesheet includes expanding the first end of the tubes.

11. The method of claim 1, further comprising attaching the support rods to the pattern block.

15 12. A fixture for assembling a plurality of tubes to a tubesheet, the fixture comprising:

a pattern block;

a plurality of support rods, each of the support rods having first and second ends, the first ends being attachable to the pattern block, the second
20 ends adapted to receive one end of a corresponding tube; and

a plurality of locating members, each of the locating members defining a first end that is receivable by a second end of a corresponding tube.

13. The fixture of claim 12, wherein the locating members each define a tapered second end.

5 14. The fixture of claim 13, wherein the first end of the support rods is threaded.

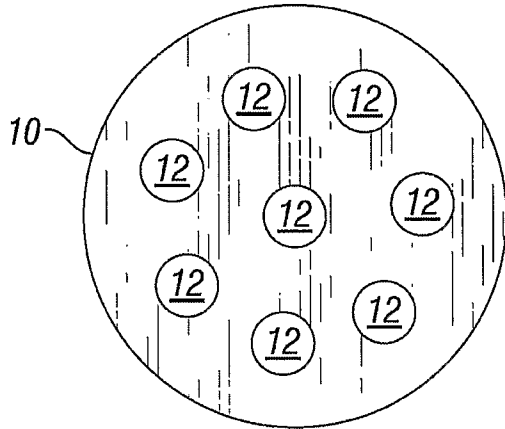


FIG. 1

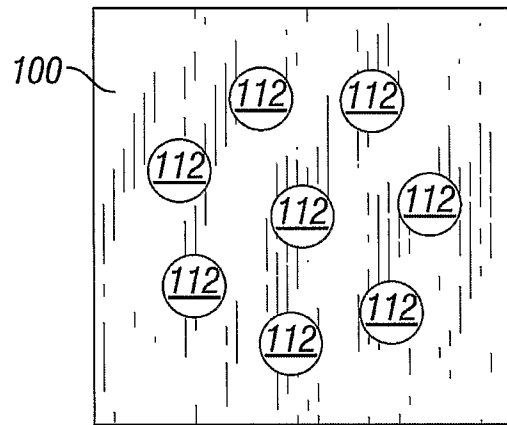


FIG. 2

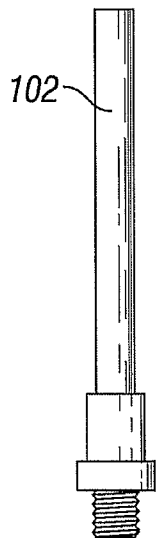


FIG. 3

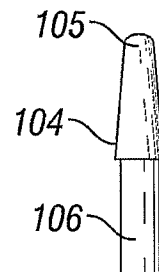


FIG. 4

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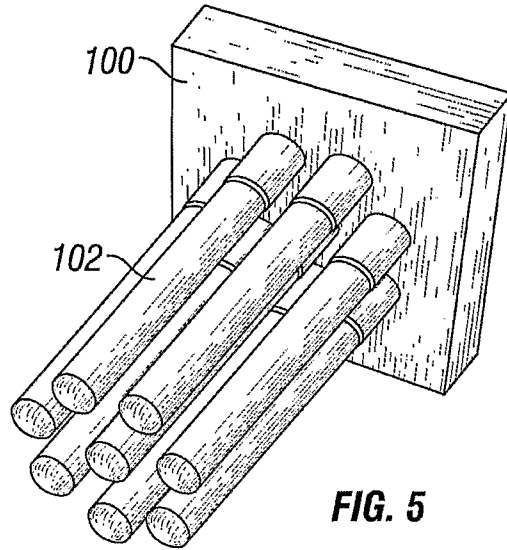


FIG. 5

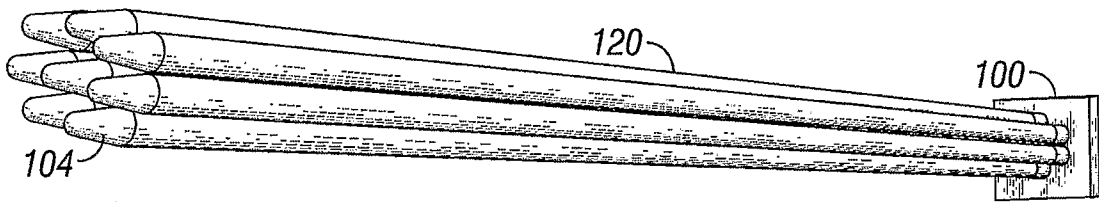


FIG. 6

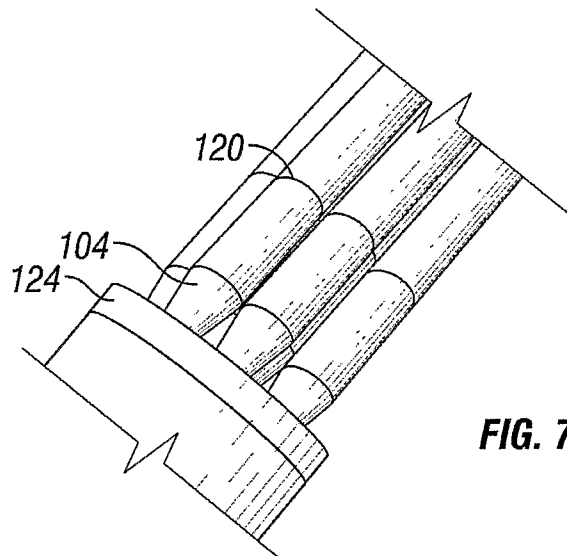


FIG. 7

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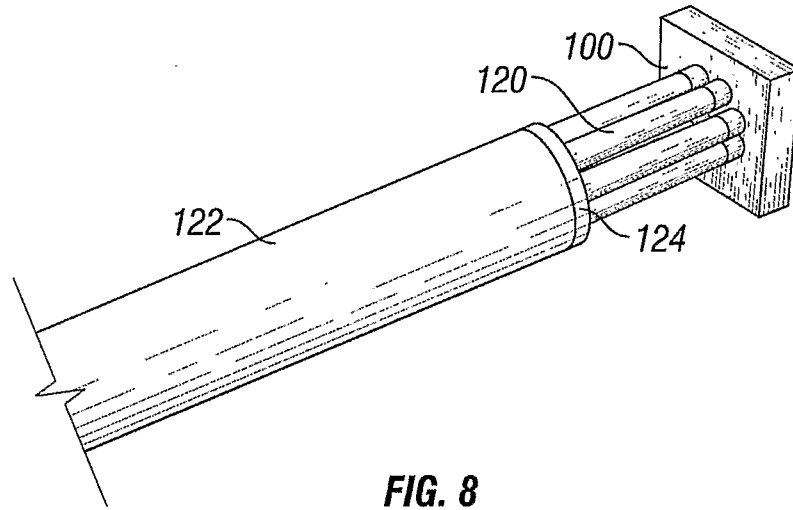


FIG. 8

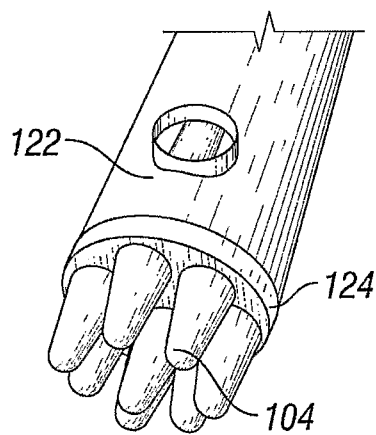


FIG. 9

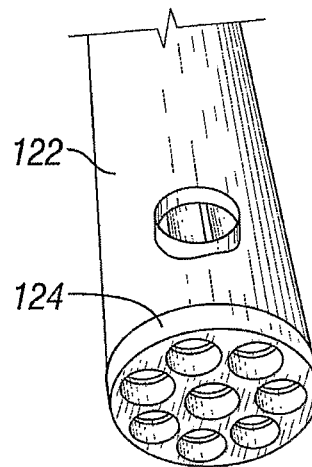


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/028324

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23P15/26 B23P19/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B23P F28D F28B F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 01 034623 A (HITACHI LTD) 6 February 1989 (1989-02-06)	1-3, 5, 6, 8, 9, 11-13
Y	abstract; figures	4, 7, 10, 14
Y	----- US 6 138 747 A (KROGER DALE LEWIS [US] ET AL) 31 October 2000 (2000-10-31) column 2, line 59 - column 3, line 14; figures 1,3	4, 7, 10
Y	----- US 5 442 853 A (VETTER KLAUS-DIETER [US]) 22 August 1995 (1995-08-22) column 4, line 60 - line 64 column 5, line 46 - line 53 figures 4,5 -----	14

Further documents are listed in the continuation of Box C.

See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/028324

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 1034623	A	06-02-1989	NONE	
US 6138747	A	31-10-2000	US 6178636 B1	30-01-2001
US 5442853	A	22-08-1995	US 5533251 A	09-07-1996