Aug. 17, 1948. C. E. LUCKE 2,447,259

CONDENSER

Filed Feb. 12, 1945

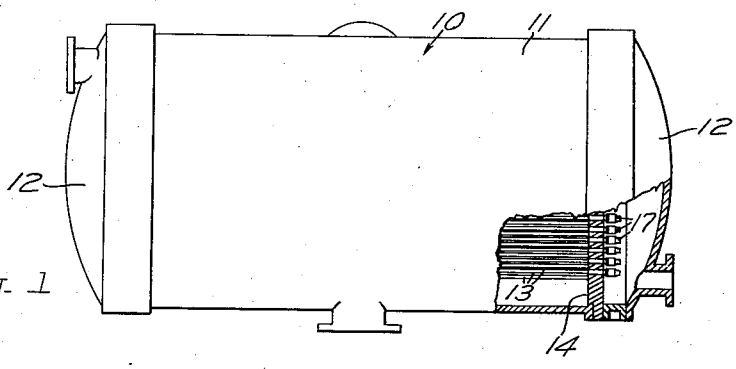

Fig. 1

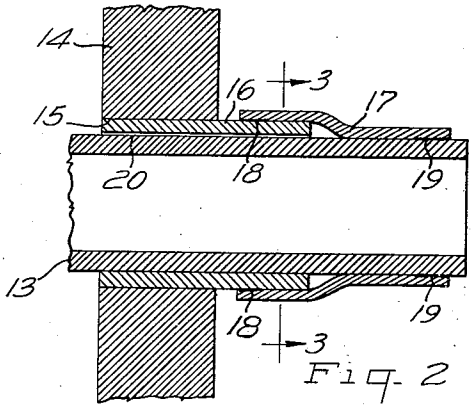

Fig. 2

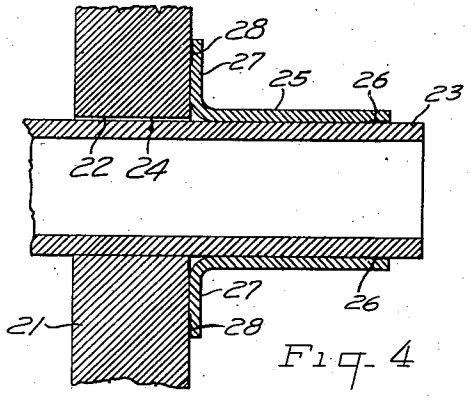

Fig. 4

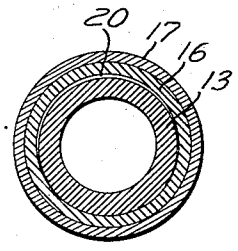

Fig. 3

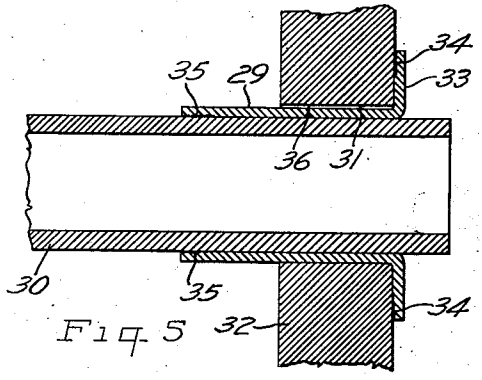

Fig. 5

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Patented Aug. 17, 1948

2,447,259

UNITED STATES PATENT OFFICE

2,447,259

CONDENSER

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Application February 12, 1945, Serial No. 577,412

2 Claims. (Cl. 285—30)

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This invention relates to surface condensers, and more particularly to the type wherein provision is made for accommodating relative expension and contraction of the tubes.

An object of the present invention is to provide a condenser wherein the tubes are so connected with the tube sheets which are fixed to the shell as to effectively accommodate relative expansion and contraction of the individual tubes with respect to the tube sheets without disrupting the connections between the tubes and the tube sheet structure.

Another object is to provide a surface condenser provided with tubes which are so mounted in the tube sheets as to have free axial movement relatively to the tube sheets to accommodate expansion and contraction of the individual tubes or relative axial shifting of the tube sheets, and in which novel means are provided for establishing fluid-tight joints between the individual tubes and the tube sheets, wherein the joints are of such construction as to accommodate all such relative expansion, and contraction, and shifting of the condenser parts without disrupting the joints.

Such structures as herein contemplated include vacuum condensers for steam power plants in which it is desired that the condenser steam or condensate be pure water utilized for feeding the boilers, and in which foul water, contaminated water, and impure water are normally used as circulating water to effect condensation of the steam. Leakage of any such circulating water into the steam condensate space would contaminate the condensate and make it unsuitable for boiler feeding purposes. This is especially serious in connection with modern high pressure boilers. Therefore, condensers made in accordance with the present invention are important in connection with steam power plants, especially condensers of the high vacuum type.

Large condensers may contain several thousand tubes which makes it highly desirable that the condenser be of such design as to facilitate all work in connection with necessary replacement repairs. The present invention embodies such a design.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing a condenser of a preferred form embodying the invention, and the

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features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a side elevational view partly in section of a conventional condenser illustrating the present invention incorporated therein.

Figure 2 is an enlarged longitudinal sectional view of a portion of one of the condenser tubes illustrating the fluid-tight connection between one of the tubes and the tube sheet.

Figure 3 is a sectional view taken along the line 3—3 of Figure 2.

Figure 4 is a view similar to Figure 2 but illustrating a different form of construction.

Figure 5 is a view similar to Figure 2 and illustrating another type of construction.

Referring more particularly to the drawings, Figure 1 illustrates a condenser 10 which includes a shell 11 and heads 12. Tubes 13 are incorporated in the shell 11, with the ends of the tubes supported in tube sheets 14, the latter being fixed to the shell structure 11 in the usual manner, as by clamping the tube sheets between the ends of the shell and the heads 12. Figure 2 illustrates the manner in which fluid-tight connections are established between the individual tubes and the tube sheet, which connections are such as to compensate for all necessary expansion and contraction of the tubes. In the structure shown, the tube sheet 14 is provided with an opening 15 within which is firmly secured a short length of tubing 16, as by expanding the tubing in the manner common to condenser tubes. The tube 13 extends through the tubing or anchor element 16 and projects a short distance beyond the outer face of the tube sheet 14. Upon the projecting end of the tube 13 is mounted a rubber connecting element 17. This element is of tubular contour and is inserted over both the projecting end of the tube 13 and the anchor element 16. The connecting element 17 is bonded at 18 to the outer face of the anchor element 16 and at 19 to the outer face of the tube 13. Each bond 18 lies adjacent one end of the connecting element 17 so that a considerable portion of the connecting element is detached from both the tube 13 and the anchor element 17.

The tube 13 is of such diameter with respect to the anchor element 16 as to move freely relatively thereto in an axial direction to compensate for expansion and contraction of the tube. Figure 2 illustrates clearance 20 between the tube and the anchor element 16, which clearance is in an exaggerated degree. Accordingly, the tubes 13 of Figure 1 are independently connected with the tube sheet 14 so that each tube may expand

or contract independently of all the tubes in the bundle. Expansion of the tube 13 in Figure 2 places the connecting element 17 in tension, while contraction of the tube places the connecting element in compression, the latter being capable of buckling to accommodate contractions in relatively large amounts.

In a construction such as that shown in Figure 4, the tube sheet 21 is provided with an opening 22 through which the tube 23 is passed to project a short distance beyond the outer face of the tube sheet. This tube is also of such diameter with respect to the bore 22 as to have free axial movement relatively to the tube sheet. Such freedom is indicated by the clearance 24, the latter being shown in an exaggerated degree.

Upon the outer end of the tube 23 is mounted a connecting element 25 which may comprise rubber of tubular contour. One end of the connecting element 25 is bonded at 26 to the outer face of the tube 23 and the opposite end of the connecting element is flared to provide a flange 27 which is bonded at 28 to the outer face of the tube sheet 21. The bond 28 is confined to an area adjacent the perimeter of the flange 27 so that the connecting element 25 is detached from the tube sheet 21 and the tube 23 throughout the greater length of the connecting element. The construction shown is substantially identical with that illustrated in Figure 2 in that expansion of the tube 23 places the connecting element in tension, while contraction of the tube places the connecting element in compression.

The construction of Figure 5 differs in that a rubber connecting element 29 is inserted over one end of the tube 30 but between the tube and the face of the bore 31 in the tube sheet 32. The connecting element 29 is of tubular contour, and its outer end is flared to provide a flange 33 which is bonded at 34 to the outer face of the tube sheet 32. The other end of the connecting element 29 is bonded at 35 to the tube 30. While the connecting element 29 is interposed between the tube 30 and the tube sheet 32, sufficient clearance is provided between the connecting element and the face of the bore 31, as indicated at 36 to permit free expansion and contraction of the tube 30 in an axial direction relatively to the tube sheet 32. The construction of Figure 5 differs from the connections of Figures 2 and 4, principally in the fact that expansion of the tube 30 places the connecting element 29 in compression while contraction of the tube places the connecting element in tension. However, the connection shown in Figures 2, 4, and 5 are similar in that the tubes may expand and contact independently of the supporting tube sheet as well as with respect to one another. Such expansion and contraction may be obtained without disrupting the essential fluid-tight joints between the tubes and the tube sheets.

The term rubber as herein employed also includes equivalent materials of the synthetic class. Many types of plastic now on the market may be employed as a substitute material for the rubber connecting elements illustrated in the drawings. In the case of vacuum condensers where this invention is particularly applicable and useful, the temperatures are always relatively low and this fact makes it possible to use a greater variety of rubber-like materials, including natural rubber, than would be possible if the temperatures were substantially higher.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In a surface condenser, the combination with a tube sheet provided with a plurality of tube receiving openings, and tubes extending through said openings, of means connecting each of said tubes to said tube sheet to permit movement of the tubes relative to the tube sheet comprising a tubular sleeve of flexible material extending through a tube receiving opening in the tube sheet and having its inner end bonded to a tube, the outer end of said flexible sleeve having an annular laterally extending flange thereon, said flange being bonded at its perimeter to said tube sheet to provide a flexible fluid tight seal between the tube and sheet.

2. In a surface condenser, a tube sheet, a tube, a tubular rubber sleeve mounted on the tube and connected thereto by surface adhesion near the inner end of the sleeve, said sheet having an opening slightly larger than the diameter of the sleeve carrying section of the tube, said tube and sleeve being mounted in said opening, said sleeve having a flange connected by surface adhesion to the outside of the tube sheet around said opening.

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