Nov. 17, 1942. A. ABRAHAM, JR 2,302,513

HEAT EXCHANGER AND METHOD OF OPERATION

Filed Dec. 28, 1940 4 Sheets-Sheet 1

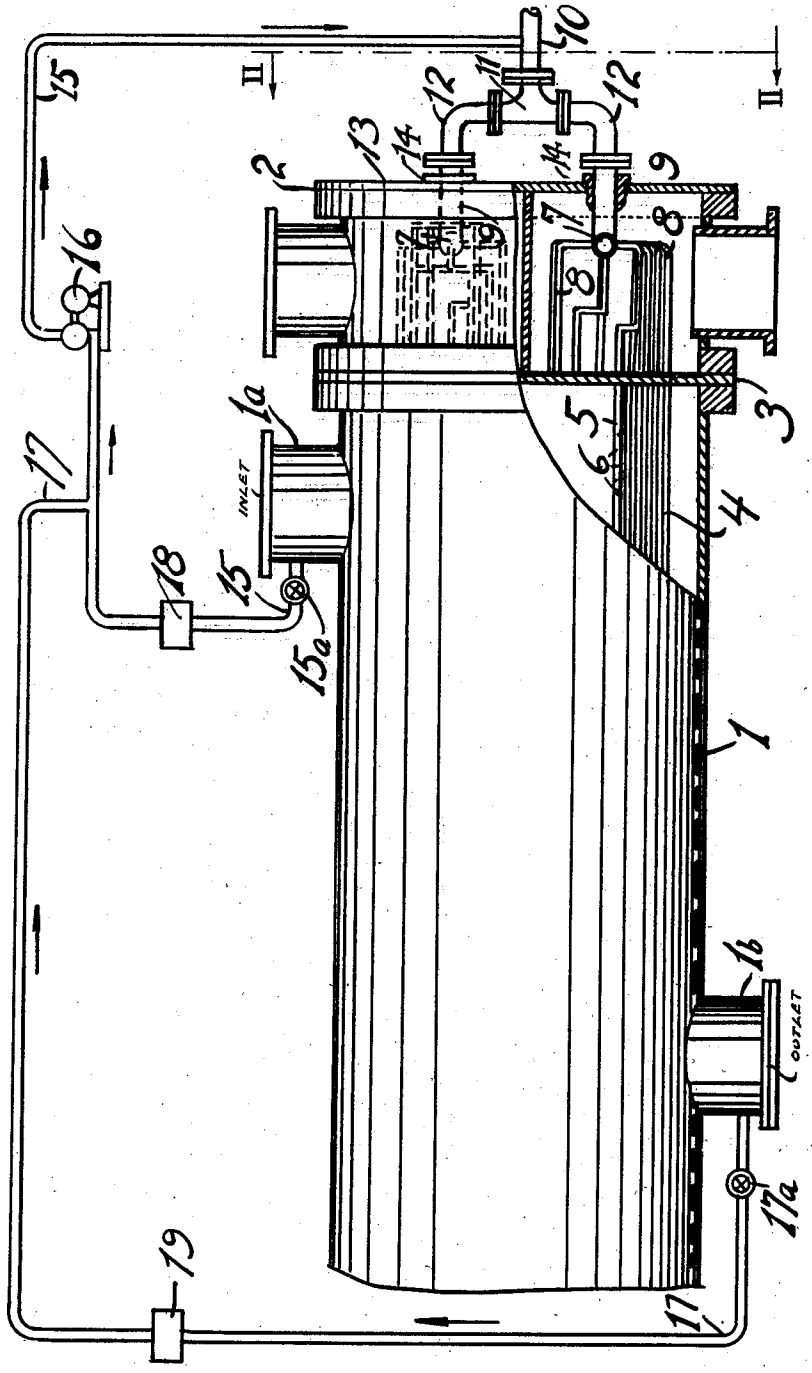


FIG. 1

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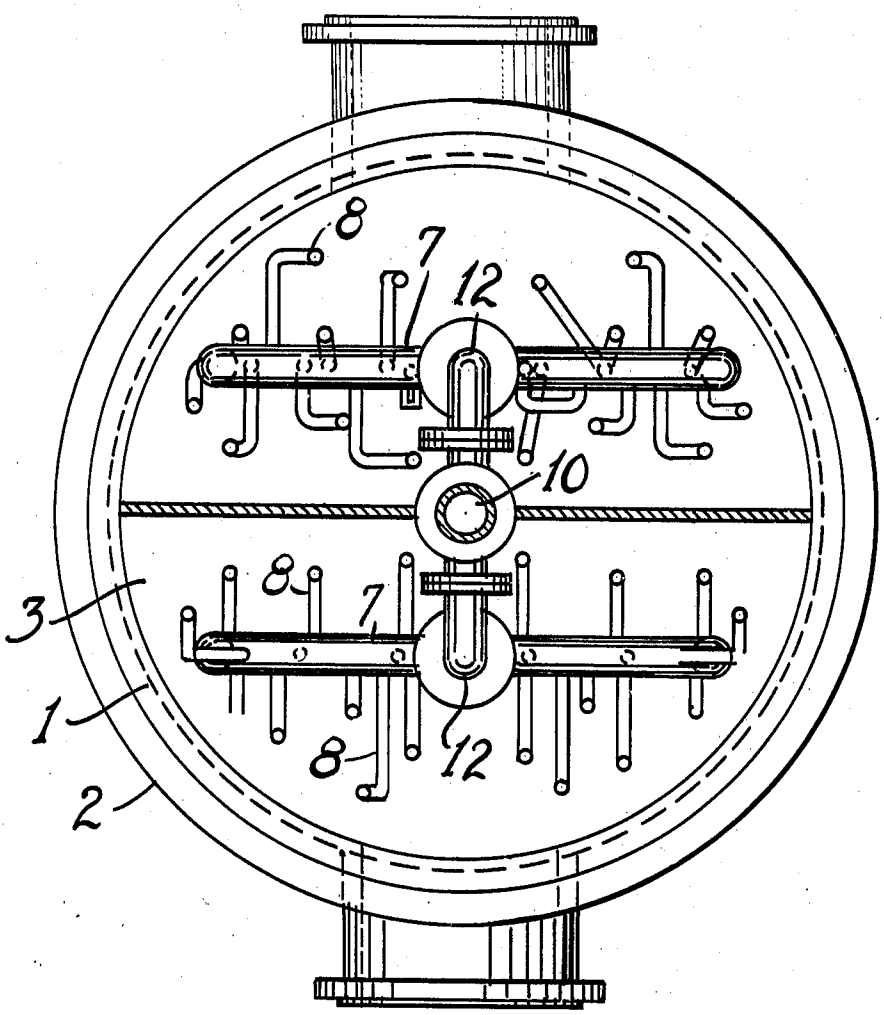


FIG. - 2

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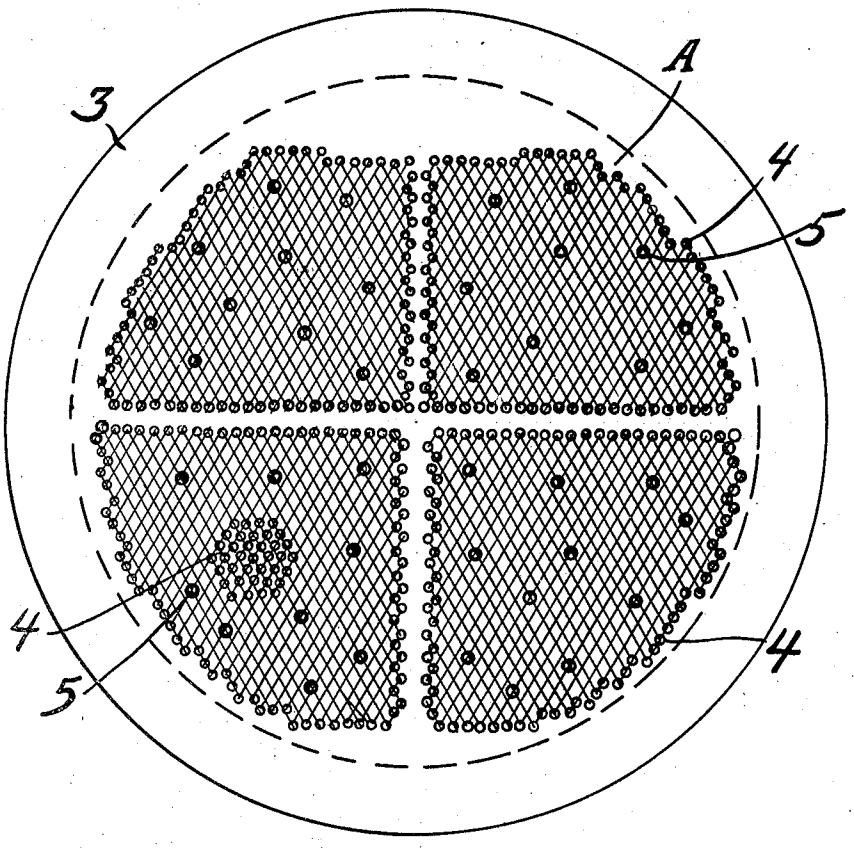


FIG.-3

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HEAT EXCHANGER AND METHOD OF OPERATION

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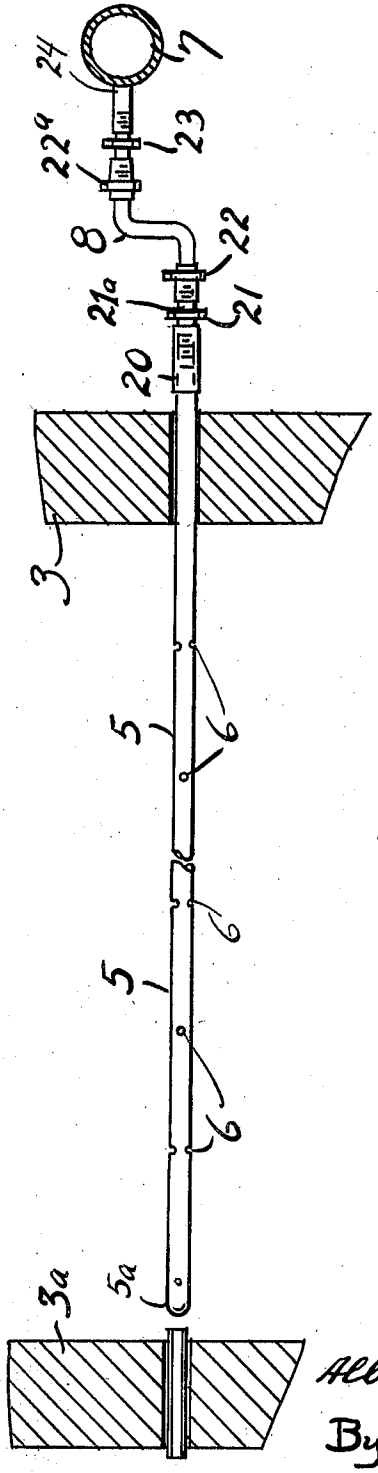


FIG-4

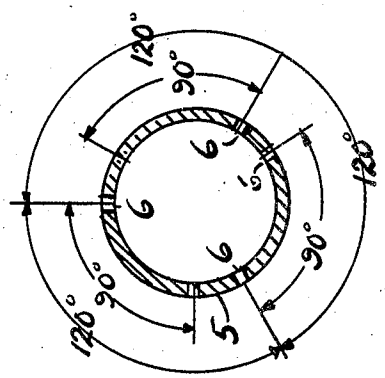


FIG-5

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Patented Nov. 17, 1942 2,302,513

UNITED STATES PATENT OFFICE

2,302,513

HEAT EXCHANGER AND METHOD OF OPERATION

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Application December 28, 1940, Serial No. 372,040

3 Claims. (Cl. 257—236)

The present invention relates to a heat exchange system and to a method of heat exchanger operation. It is an object of the invention to provide a method of operation according to which, the deposition of solid or solidifiable materials as an insulating coating on the heat exchange surfaces is substantially inhibited. More particularly, the invention relates to the operation of a tube and shell exchanger of the type in which the tube elements are of small diameter and are disposed in a closely packed bundle, the close proximity of the tubes tending to facilitate the building up of undesirable coatings which, at times, may partially or entirely obstruct the flow of fluid in the shell through certain portions of the tube bundle.

Although the use of a tube and shell exchanger, in which the tube bundle is one of closely spaced small diameter tubes, has been found to be most efficient when the tube surfaces are clean, it has also been found that this efficiency is more rapidly reduced by fouling of the tube surfaces, and plugging of the narrow spaces between tubes. Furthermore, due to the close relationship between tubes, the cleaning of the tube bundle by conventional means is not entirely successful, so that the initial efficiency of the structure is not easily retained or recovered even by frequent cleaning operations.

It is, therefore, a further object of the invention to increase the length of the efficient operating period of an exchanger of the type contemplated, and avoid the necessity for frequent shut-down periods. At the same time, it is also an object of the invention to provide for increased turbulence in the flow of fluid through the shell and around the exchanger tubes.

These and other objects of the invention may be fully understood from the following specifications when they are read in conjunction with the accompanying drawings, in which:

Fig. 1 is a side elevation of a heat exchanger, with parts broken away;

Fig. 2 is a cross-sectional view of the exchanger in Fig. 1 taken along the line II—II with the cover plate 13 of the header box 2 removed, the manifold header 7 and manifold conduits 8 remaining in position and the conduits 9, the L connections 12, the T connection 11 and the supply conduit 10 replaced;

Fig. 3 is a diagrammatic cross-section through the exchanger tube bundle, indicating a tube arrangement therein;

Fig. 4 is a vertical section through a portion of the tube bundle headers, illustrating a single agitating tube, and a form of manifold connection; and

Fig. 5 is a cross-section through an agitating tube.

With specific reference to the drawings, the numeral 1 designates an exchanger shell, having a header box 2, and including a fixed tube sheet 3 held between the shell and header in conventional fashion. The exchanger shell 1 is of conventional form also, having inlet and outlet nozzles 1a and 1b. Within the exchanger shell 1 is disposed a tube bundle, consisting of a multitude of closely spaced tubes 4, of which the greater number extend through both tube sheet 3 and a floating sheet at the opposite end, and are rolled into permanent fluid-tight contact with the respective tube sheets. However, according to the present invention, certain of these tubes 4 are converted as agitating tubes, separately designated by the numeral 5, also sealed in the fixed sheet 3, but extending outwardly into the header box, as shown.

These tubes, of which there are any required number in a bundle, are perforated or provided with spray nozzles, as at 6, in such manner as to permit the discharge of a high pressure agitating fluid into the spaces between exchanger tubes 4, contacting certain groups of tubes with high velocity jets of fluid, and agitating the fluid surrounding the tubes 4. As shown, each tube 5 is connected to a manifold header 7 by means of manifold conduits 8. In order to maintain a suitable distribution of the agitating fluid, it is preferable that the tubes 5 be connected in groups to a group manifold header. Thus, the tubes 5 in the upper half of the bundle are connected to one header, while those in the lower half are connected to another. Each header 7 is provided with a header inlet conduit 9 designed for connection to a single supply conduit 10 by means of T and L connections 11 and 12, respectively. It is necessary that provision be made for passage of the conduit elements 9 through a cover plate 13 for the header box. As shown, a fluid-tight relationship is established between the conduit elements and the cover plate, by means of gland members 14, the elements 9 extending outward through the plate into flanged engagement with the L connections 12.

Connected to the shell inlet 1a is a draw-off line 15, leading to the suction side of a pump 16. A similar line 17 connects the shell outlet line 1b with the draw-off line 15, or the suction side of the pump 16. Suitable valves 15a and 17a

are provided in the lines 15 and 17, respectively. Also, each of the lines may be equipped with filter elements 18 and 19 for a purpose later set forth. The supply conduit 10 is connected into the pressure discharge outlet of the pump 16.

In the end elevation of Fig. 2, the arrangement of the manifold header 7 and the manifold conduits 8 are illustrated substantially in plan view, while in Fig. 3, the pattern formed by the agitator tubes in the tube bundle is clearly indicated. As illustrated in Fig. 3, only a portion of the total exchanger tubes 4 in the bundle are shown. In Fig. 3, the tubes omitted are denoted by the lines A, the intersecting points of which indicate the center point of each tube omitted.

Fig. 4 provides an enlarged view of a single agitator tube, showing its connection in the tube sheet 3 and with the manifold header 7. As shown, the tube 5 has been formed by cutting an exchanger tube at the floating-head tube sheet 3*a*, and sealing both the opening in the sheet 3*a* and the end of the tube 5 as at 5*a*. The outer end of the tube 5 is preferably extended through the fixed sheet 3 a short distance and sealed with respect thereto. To the projecting end of the tube 5, a brass collar 20 is permanently secured, provision being made to receive a threaded bushing 21 having a nipple 21*a* adapted to receive a fitting 22 carried by the manifold conduit 8. The conduit 8 is connected to the header by means of fitting 22*a*; the union 23 and a collar member 24 carried by the manifold header 7.

Perforations 6 in the tube 5 provide for discharge of agitating fluid into the tube bundle during the cleaning operation. As shown in Figs. 4 and 5, preferably these perforations are disposed in circumferential series of three at spaced intervals along the tube 5, the three perforations in each series separated by 120°, and the perforations of one series staggered with relation to those adjoining by 90°.

In the operation of the heat exchanger described, a fluid material is circulated through the shell around the tubes in the bundle, in heat exchange relation to another fluid passed through the tubes 4. The operation differs from the conventional method, however, in that a small portion of the shell fluid entering or leaving the exchanger is withdrawn from either the inlet line 1*a* or the outlet line 1*b*, by suction of the pump 16, and under pressure of the pump is then forced through the conduit connections 10, 11 and 12, into the manifold headers 7 by way of the conduit elements 9, and thence into the tubes 5 by way of connections 8. The fluid is supplied to tubes 5 under a pressure sufficiently higher than that of the fluid in the shell to produce a jet discharge, through the openings 6, into the area immediately adjacent each tube 5. The filter elements 18 and 19 serve to remove any solid or solidifiable materials that may be present in the material drawn from either the inlet or outlet lines, and prevent clogging of the jet-ways 6 in the pipes 5.

Although for most operating conditions it is most desirabe to draw the jetting portion of the shell fluid from the outlet line 17, it may be found that with a hot liquid containing substantial quantities of dissolved solidifiable material, such as wax in a hot oil, less difficulty will be experienced by drawing the jetting portion from the hot stream entering the exchanger shell by way of line 15. Furthermore, when the present operating method is followed while employing the exchanger as a condenser for a gaseous material, such as hot propane gas, it will be less costly to pump the liquefied material drawn from the outlet than the gaseous form delivered at the inlet.

Obviously, the invention has been described with reference to a specific form of apparatus, and the method as applied thereto. The inventive concept, however, is of broader scope and is not to be considered as limited by any description or specified embodiment disclosed for the purpose of illustration. It is contemplated that various changes or modifications may be made in the apparatus or method as set forth above, entirely within the scope of the appended claims.

It is claimed:

1. Method of inhibiting the deposition of solid or solidfiable materials on the exterior surfaces of numerous, closely spaced tubular elements in a heat exchange apparatus in which a fluid is passed about the exterior of said elements and a second fluid is passed through said elements in indirect heat exchange with said exterior fluid, which method comprises the substantially continuous jetting of a portion of said exterior fluid into effective agitating contact with the fluid surrounding said elements.

2. Method according to claim 1 in which the fluid jetted is drawn from said exterior fluid leaving the heat exchange operation.

3. In a tube and shell heat exchange apparatus, means for passing a fluid about the exterior of the tubes, means for passing a fluid through the interior of the tubes, jets in the form of openings in tubes paralleling and interposed among the tubes of the heat exchanger, the jets being arranged to impinge adjacent the surfaces of the tubes of the heat exchanger, and means for supplying said jets with a portion of said exterior fluid under pressure sufficient to agitate said exterior fluid and to inhibit the formation of external deposits on said tubes.

ALBERT ABRAHAM, JR.