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CONDENSER AND METHOD OF MAKING THE SAME

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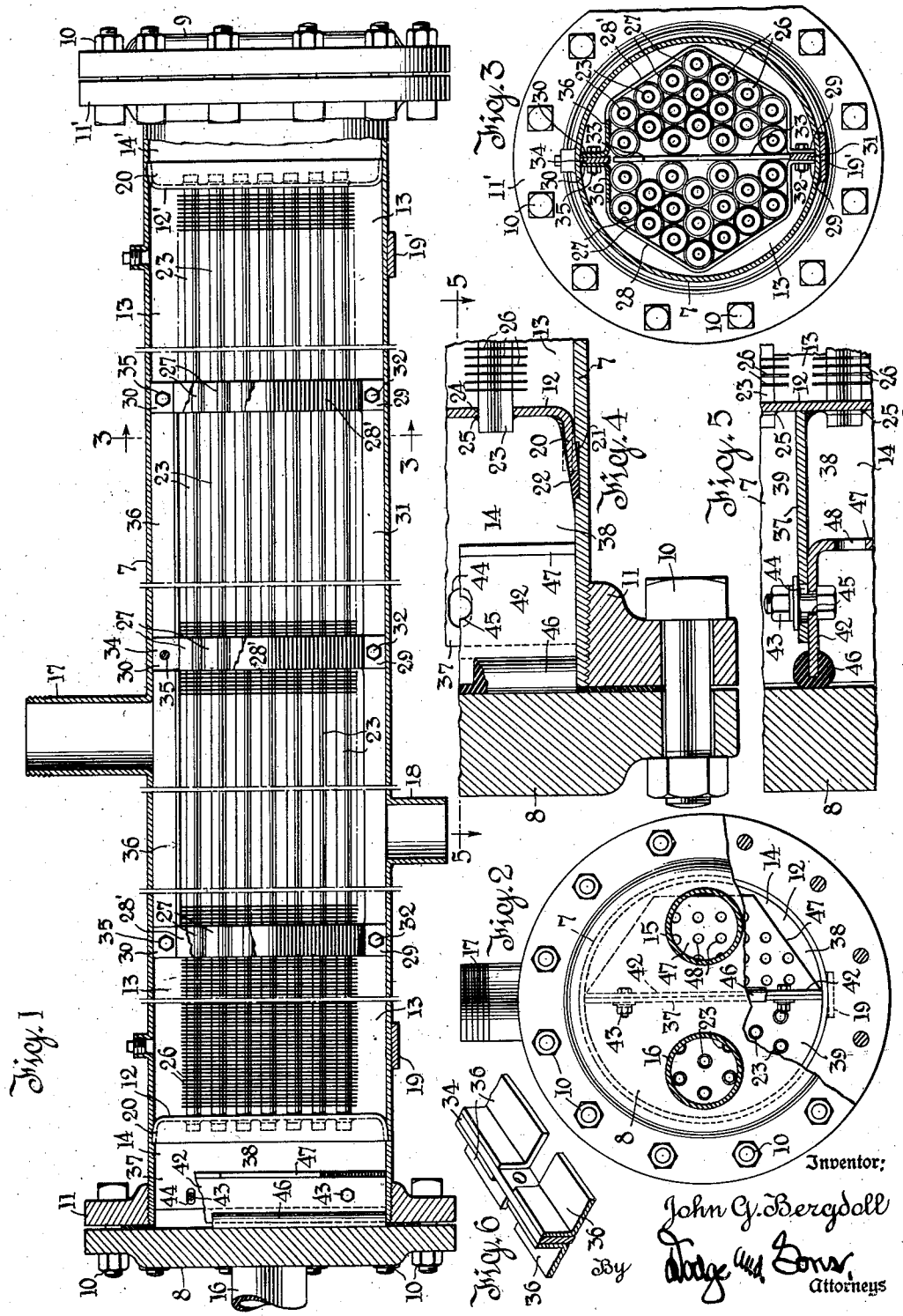


Fig. 1

Fig. 3

Fig. 4

Fig. 5

Fig. 2

Fig. 6

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CONDENSER AND METHOD OF MAKING THE SAME

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7 Claims. (Cl. 29—157.3)

This invention relates to condensers, particularly of the shell and tube type intended for use in refrigerating systems, and to a method of manufacturing such condensers.

The primary purpose of the present invention is to provide a very compact and highly efficient condenser adapted to be produced at low cost by a simple, practical method of manufacture. An important feature is the combination of materials used for the several parts, and the manner of securing the parts together, so as to insure efficient operation of the device.

Another object is to provide a condenser the various parts of which may be readily assembled and secured in place to form a rigid, unitary structure having strong, fluid-tight joints.

A further important object is to provide a condenser having a maximum extent of cooling surface and capacity for a given size, whereby to effect substantial savings in material used and space occupied by apparatus designed to accomplish a certain amount of work. A feature of the invention is the improved procedure followed in mounting the water tubes in the tube sheets and the method of assembling and securing the tubes, tube sheets and shell.

Simple and efficient means for supporting the water tubes and properly spacing them between the tube sheets, and effective means for distributing the gas to be condensed as it enters the cooling chamber, are also features of the construction.

Other objects and purposes will be apparent from the following detailed description, taken in connection with the accompanying drawing illustrating a preferred form of the condenser, and in which:

Figure 1 is a longitudinal, vertical section of the improved, completely assembled condenser with one end thereof appearing in side elevation;

Fig. 2 is an end elevation viewing the condenser from the left in Fig. 1, the water box head being broken away to show the cooling water distributing means;

Fig. 3 is a section on line 3—3 of Fig. 1, showing the supporting means for the nest of water tubes and the inlet baffle for the refrigerant gas;

Fig. 4 is an enlarged fragmentary section of the lower left-hand corner of the condenser as it appears in Fig. 1, and shows the details of the joint between the tube sheet and the shell;

Fig. 5 is a section on line 5—5 of Fig. 4 showing further details of the water box baffle or partition and the water distributor; and

Fig. 6 is a fragmentary perspective of the refrigerant gas inlet baffle means and filler piece.

Referring to the drawing, it will be seen that the completely assembled condenser comprises an elongated steel shell 7 of relatively small diameter as compared with its length. The ends of the shell are closed by main or outer heads 8 and 9 removably secured thereto by bolts and nuts 10 extending through suitable openings in the heads and in cooperating flange rings 11, 11' threaded onto the shell. Gaskets are located between the outer heads and flanges 11, 11' to insure tight joints.

Located in shell 7 are spaced copper water tube sheets 12, 12' which form the usual cooling space 13 between the tube sheets and water boxes 14, 14' between the tube sheets and the shell heads 8 and 9. The condenser head 8 is provided with a cooling water inlet 15 and a cooling water outlet 16; also an inlet 17 for the condensable refrigerant gas entering cooling chamber 13 and a refrigerant liquid outlet 18 leading therefrom. Pads 19, 19' are adapted for mounting the condenser in the position of Fig. 1.

Each copper tube sheet or head 12, 12' is provided with a peripheral flange 20 which, as shown in full lines in Fig. 4, projects into an annular groove 21 formed in the inner surface of shell 7. The copper flange 20 is welded around its edge to the steel shell as indicated at 22, thus forming a strong, fluid-tight joint between the tube sheet and the shell. Although not limited thereto, preferably the copper tube headers are welded to the steel shell by means of the method set forth in an application Serial No. 194,218, filed March 9, 1938, by Albert T. Light. This method has been utilized with marked success in constructing the present condenser and has aided materially in the practicability and high efficiency of the condenser in commercial use.

Extending between copper tube sheets 12, 12' is a multiplicity of open-ended copper tubes 23 having their ends mounted in corresponding openings 24 in the tube sheets. These tubes are brazed or soldered to the copper tube sheets 12, 12' as indicated at 25, so as to form a rigid, unitary structure and prevent possible leakage between the tubes and the heads, or, if desired the tubes may be expanded or rolled into place in the heads to secure similar results.

Copper water tubes 23 are of small diameter and are arranged in closely nested relation in the steel shell. This serves to provide a very large area of heat transference surface in a relatively small volume. In order to provide maximum

cooling capacity in a condenser of given size, the copper water tubes 23 are each provided with a multiplicity of closely arranged, copper fins 26. These fins, which are in the form of annular disks secured to the tubes 23 by soldering, brazing, or in any other suitable manner, extend into close proximity to the tube sheets 12, 12', as shown in Figs. 1 and 4.

Since the present condenser is an elongated device of small diameter, the span between tube sheets 12, 12' is considerable. Means are necessary therefore to support the water tubes 23 in the shell 13 between the tube sheets and to hold them in spaced relation so that the tubes will be securely retained in properly assembled position at all times. The tube spacing means used for this purpose comprise individual copper sleeves 27 mounted on the fins 26 of the several water tubes. The sleeves 27 are elongated so as to engage a number of the fins and are secured thereto by soldering, or otherwise. Sleeves 27 are arranged in a plurality of transversely disposed groups, preferably three, suitably spaced from each other on the tubes, as shown in Figs. 1 and 3. As appears from Fig. 3, the sleeves of each group bear against each other and thus maintain the water tubes in the desired spaced relation illustrated.

A combined clamping and supporting device encircles the nest of water tubes around each group of tube sleeves 27 and engages the shell 7. This device comprises a pair of duplicate, arc-like members 28, 28' having lower ears 29 and upper ears 30. Extending between the lower ears 29 of the three supporting devices, as shown in Figs. 1 and 3, is a horizontal filler and connecting bar 31. Registering openings in ears 29 and bar 31 receive bolts 32 which securely connect the bar and the several supporting devices together. A rigid, bar-like extension 33 on connecting bar 31 (Fig. 3) projects upwardly between the water tubes at each group of sleeves 27 so as to engage certain of the sleeves and further aid in maintaining the tubes in proper position.

A filler and connecting bar 34, similar to bar 31, extends between the upper sets of ears 30 of the tube clamping devices. Alined openings in bar 34 and ears 30 receive bolts 35 to secure these parts. Welded to the opposite faces of bar 34 are pairs of angle strips or baffles 36. The construction described provides a rigid assembly which serves properly to space and support the intermediate portions of the water tubes in the shell, while baffles 36 serve to spread the condensable gas entering at inlet 17 and thus assures its distribution throughout cooling chamber 13.

Located in water box 14 is an upright partition plate 37 which divides the water box into a water-receiving compartment 38 into which water inlet 15 opens, and water discharge compartment 39 from which leads water outlet 16. Plate 37, which closely fits the interior of shell 7 and against tube sheet 12, is welded at its top and bottom edges to the interior of the shell, while the remainder of the joint is made fluid-tight with plastic cement.

A supplemental plate 42 serves to complete separation of the two compartments 38, 39 into which water box 14 is divided. Plate 42 is mounted on plate 37 by means of bolts and nuts 43 located in registering openings 44, 45 in plates 37 and 42, respectively. A grooved, rubber gasket strip 46 on the outer edge of plate 42 seals against shell head 8. Plate 42 has a lateral extension 47 formed with a number of perforations 48. Extension 47 is arranged in line with the cooling water which enters at inlet 15 and hence serves to distribute the water uniformly to the water tubes 23. Bolts and nuts 43 permit removal of distributer plate 42 after head 8 is removed. Openings 44 in plate 37 are elongated so that plate 42 may be adjusted to insure sealing of gasket 46 against head 8 when the latter is in place.

The construction described provides a condenser of the two-pass type, in that the cooling water in travelling from inlet 15 to outlet 16 passes through the tube nest twice. The water from inlet 15 first flows through half of the water tubes in parallel, through water box 14', and thence back through the other half of the water tubes in parallel. However, insofar as certain features of the invention are concerned, the condenser may be of the single-pass type in which the cooling water flows through all of the tubes in one direction. In this case, the water inlet would be at one end of the condenser and the outlet at the other end. The partition in water box 14, of course, would be omitted.

An important feature of the invention is the novel method employed in assembling the tubes, tube sheets and shell of the condenser and in permanently securing these parts together. The tube nest, comprising copper tube sheets 12, 12' and copper finned tubes 23, is assembled first to form a separate unit adapted to be inserted in the steel shell 7. To accomplish this, the flanged tube sheets 12, 12' are temporarily mounted in suitable holding means so that they are arranged relatively to each other exactly as they will be in the completely assembled condenser. The finned tubes 23, which are longer than the distance between the spaced tube sheets, are mounted, one at a time, in their proper openings 24 in the tube sheets by first placing one end of the tube in its opening in one tube sheet and then flexing the tube to shorten the distance between its ends and thus permit passage of the tube between the tube sheets and insertion of the opposite end of the tube in its opening in the other tube sheet. After all of the tubes are mounted in the tube sheets in this manner, each tube is secured to the tube sheet at 25 by brazing or soldering.

The supporting devices for the tube nest and their connecting bars 31 and 34 are now mounted on the tubes to complete the assembled unit which is slid into proper position in the shell 7. The outside diameter of the tube sheet flanges 20, 20 at this time (as indicated by dotted lines in Fig. 4), and the outside measurements of the pipe supporting means, are such as to permit ready passage of the tube nest through the shell during this operation. Each copper flange 20 is now expanded, by hammering or rolling, into its groove 21 in shell 7 and securely bonded to the steel shell by a continuous line of welding 22. The remaining parts of the condenser are now put in place, as already described, and the device is ready for use.

The construction described, together with the particular combination of materials used, affords a sturdy, compact condenser having a considerably greater capacity than have other known condensers of equal size. Economy in materials used and time consumed in manufacture of the device is an outstanding feature of the invention, since the condenser illustrated may be produced for as little as one half the cost of present conventional condensers.

Water is the cooling medium usually used and,

hence, it is common practice in the art to refer to the cooling medium as "water", and to "water boxes", "water tubes", etc. In using such terms in the specification and claims, the terminology of the art is adopted merely for convenience, but no necessary limitation to water is implied, since any suitable fluid medium may be used. While the example illustrated and described refers to a condenser, it is obvious that the invention is applicable to other types of heat exchangers and it is intended that the appended claims define apparatus of this general nature.

What is claimed is:

1. A condenser comprising an elongated, cylindrical steel shell of relatively small diameter; removable heads on the ends of the shell; and an elongated, water tube nest located in the shell to form water boxes between the shell heads and the tube nest, said nest comprising a pair of relatively widely spaced, perforated, copper tube sheets having peripheral flanges, a multiplicity of closely-nested, open-ended, copper tubes having their ends located in the perforations in said tube sheets and secured thereto, as by brazing or soldering, to form fluid-tight joints between the tubes and the tube sheets, a series of closely-arranged, annular copper fins secured on each of the tubes, and coacting means on the fins on the several tubes to maintain the tubes in properly spaced relation, the water tube nest constituting a separate, unitary structure assembled and inserted in the shell and secured thereto by expanding said tube sheet flanges against the interior of the shell and welding the flanges to the shell to form fluid-tight joints between the shell and the tube sheets.

2. The combination in apparatus of the class described of an elongated, one-piece shell of relatively small diameter; spaced tube sheets arranged in said shell inwardly of the ends thereof to provide water box space at each end thereof and a cooling space between the sheets, said shell having an inlet and an outlet for said cooling space to permit entry and discharge of the fluid under treatment; heads closing the ends of the shell; a multiplicity of closely-arranged, elongated water tubes connected at their ends to said tube sheets; a plurality of spaced tube supporting devices mounted on the tubes between said tube sheets and engaging the shell; and rigid means connecting said supporting devices together to maintain them rigidly in proper supporting position at all times, said rigid connecting means for the supporting devices including baffle means arranged directly in line with said fluid inlet to intercept and spread the stream of incoming fluid in all lateral directions and thereby increase the distribution and circulation of the fluid in said cooling space.

3. The combination in apparatus of the class described of a shell having an open end; a removable head closing said end of the shell; a water tube sheet in the shell forming a water box between said sheet and said head; a series of water tubes having their ends connected to the tube sheet; a main partition plate dividing said water box longitudinally into water-receiving and water discharge compartments and having fluid-tight joints with the shell and the tube sheet, said head having a cooling water inlet for the water-receiving compartment and a cooling water outlet for the water discharge compartment; a supplemental partition plate adjustably and removably mounted on the main partition plate; and packing means between said supplemental plate and the shell head.

4. The combination of claim 3 further characterized in that said supplemental partition plate has a perforated extension projecting therefrom into line with the cooling water inlet to distribute the incoming water uniformly to the water tubes.

5. The method of making separate, unitary water tube nests for use in apparatus of the class described which comprises securing a pair of correspondingly perforated water tube sheets in temporary holding means in desired spaced relation to each other; locating in a perforation in one of said sheets one end of an open-ended water tube of a length greater than the distance between the tube sheets; flexing the tube transversely to reduce the distance between its ends; locating the opposite end of the tube in the corresponding perforation in the other tube sheet while the tube is so flexed; and securing the ends of the tube in place in said tube sheets.

6. The method of making separate, unitary water tube nests for use in condensers which comprises securing a pair of correspondingly perforated tube sheets in temporary holding means in desired spaced relation to each other; locating in a perforation in one of said sheets one end of an open-ended, finned water tube of a length greater than the distance between the tube sheets; flexing the tube transversely to reduce the distance between its ends; locating the opposite end of the tube in the corresponding perforation in the other tube sheet while the tube is so flexed; similarly mounting additional tubes, one at a time, in their corresponding perforations in the tube sheets until the nest of tubes is complete; and permanently securing the ends of the tubes in place in the tube sheets, as by brazing or soldering.

7. The method of making condensers which comprises arranging a multiplicity of open-ended, finned, copper water tubes with their ends located in perforations in a pair of spaced, perforated, copper tube sheets having edge flanges; securing said tubes in the tube sheets, as by brazing or soldering, to form a separate, unitary water tube nest; inserting said tube nest as a unit entirely within an open-ended, one piece, steel shell so as to leave water box space at each end of the shell; expanding said tube sheet flanges against the interior of the shell; and welding said flanges to the interior of the shell to form fluid-tight joints between the steel shell and the copper tube sheets.

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