

[54] **HEAT EXCHANGER ARRANGEMENT**

[72] Inventors: **Pierre H. Pacault, Ville d'Avray; Albert Dostantni, Avon, both of France**

[73] Assignee: **Babcock & Wilcox, Limited, London, England**

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[51] Int. Cl.....**F28f 7/00**

[58] Field of Search.....**165/76, 77; 176/30, 31**

[56] **References Cited**

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Primary Examiner—Meyer Perlin

Assistant Examiner—Theophil W. Streule

Attorney—J. Maguire

[57]

ABSTRACT

A heat exchanger arrangement wherein a plurality of cylindrical modular heat exchanger units are stacked upright in side-by-side relation within an enclosure and can be transferred into and out of the enclosure, one at a time, through a passage in the floor thereof. To transfer any given heat exchanger unit out of the enclosure, the unit is detached from its base, hoisted by an overhead travelling crane into a position overlying the floor passage and then lowered vertically into a basculating bridge underneath the floor. The bridge is then tilted into a horizontal attitude to discharge the unit. Transfer of a unit into the enclosure is accomplished by following the foregoing procedure in reverse order.

9 Claims, 5 Drawing Figures

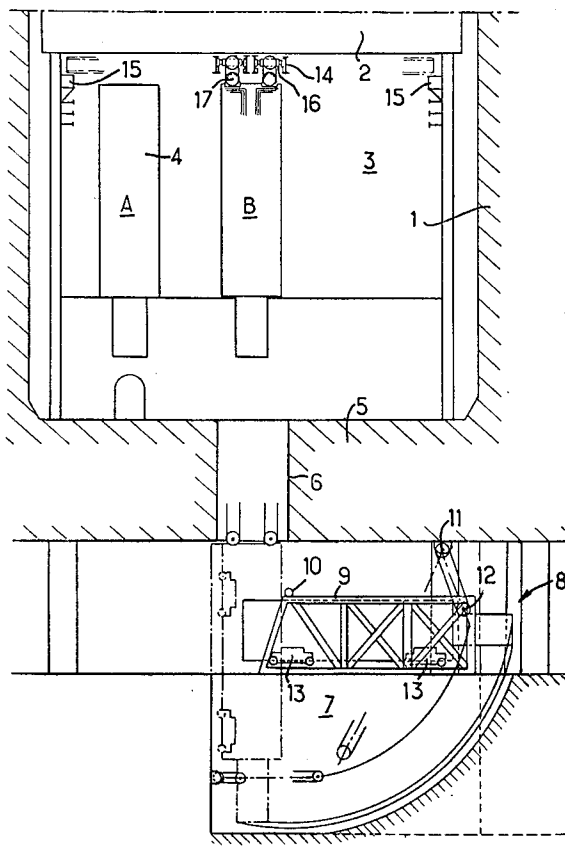
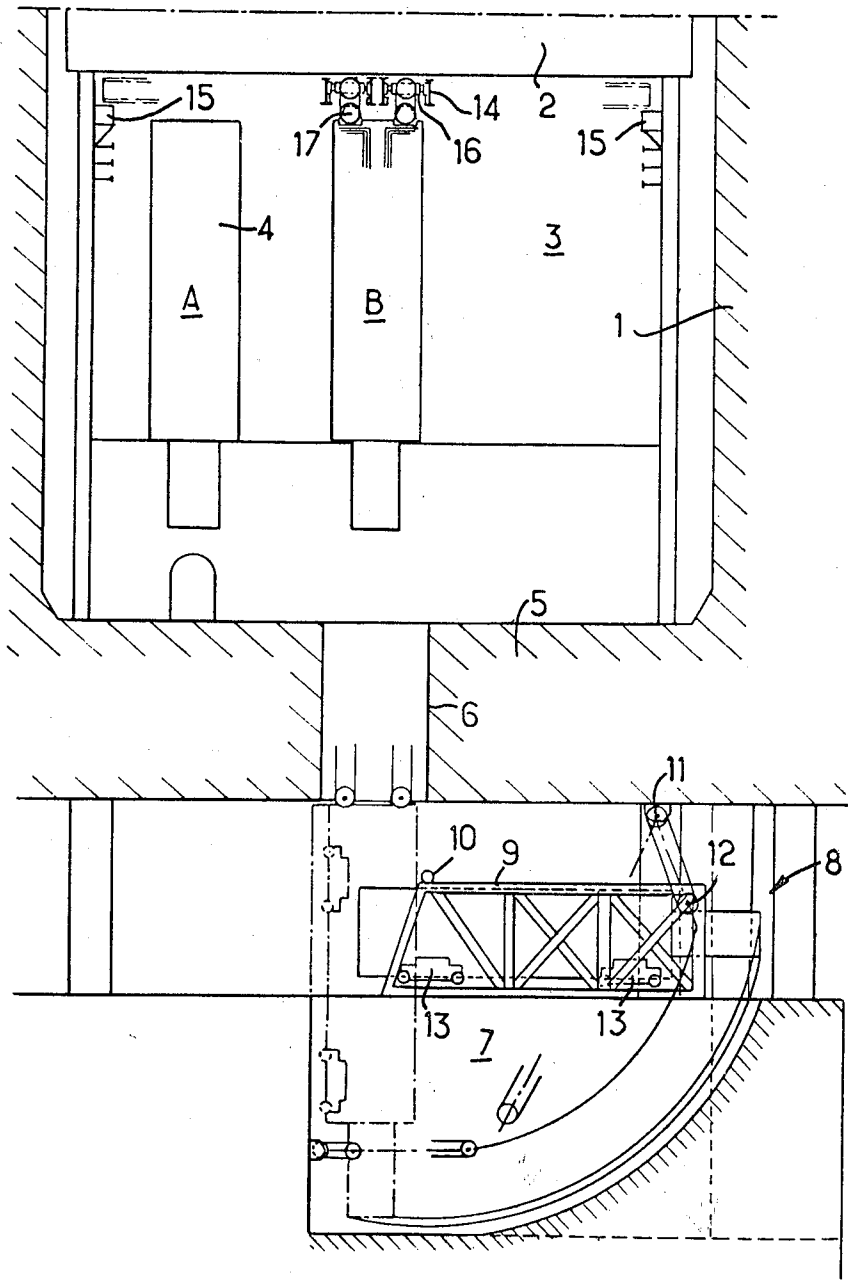


FIG. 1



INVENTORS

Pierre H. Pacault
Albert Dostatni

BY

Maguire

ATTORNEY

FIG. 2

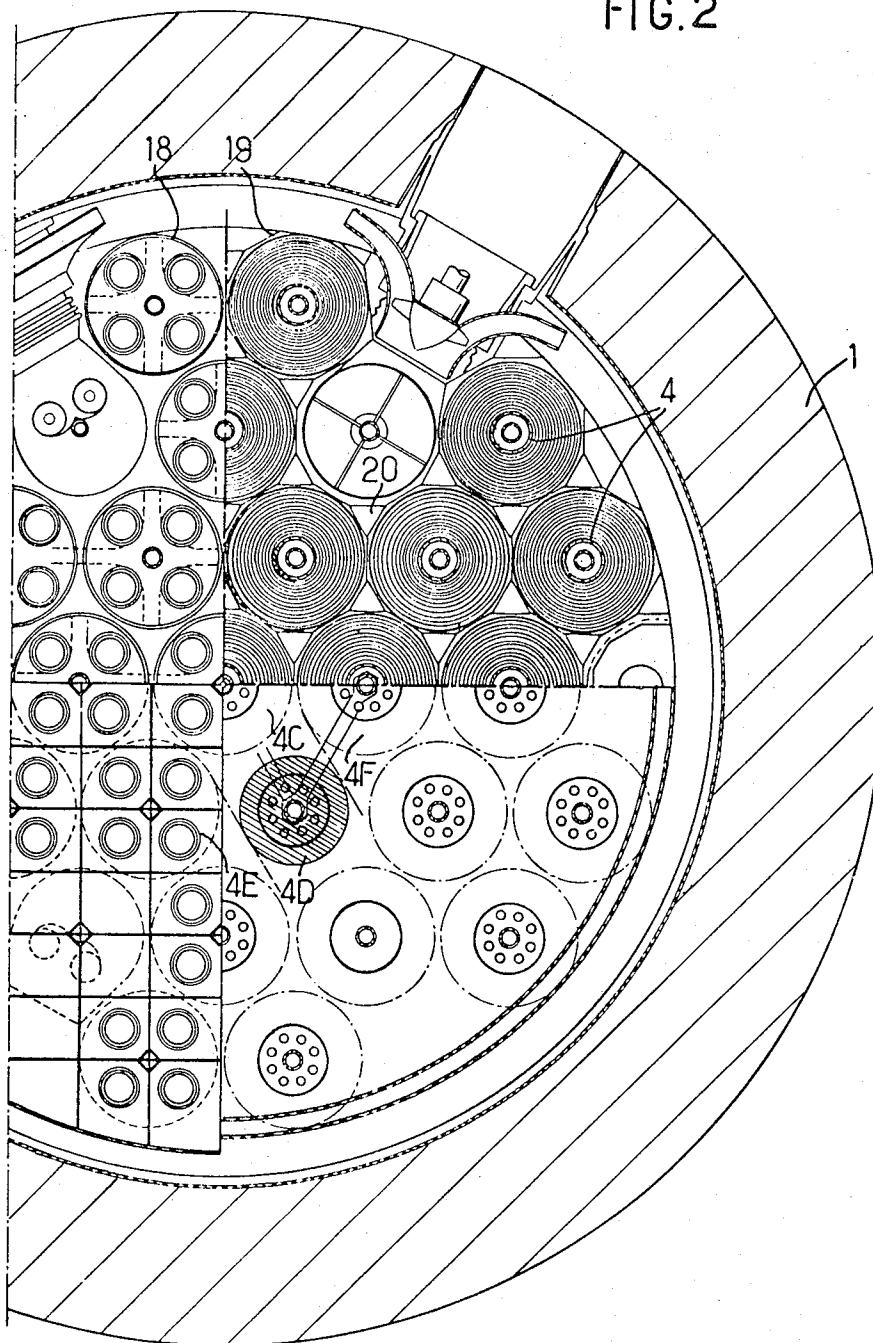


FIG. 3

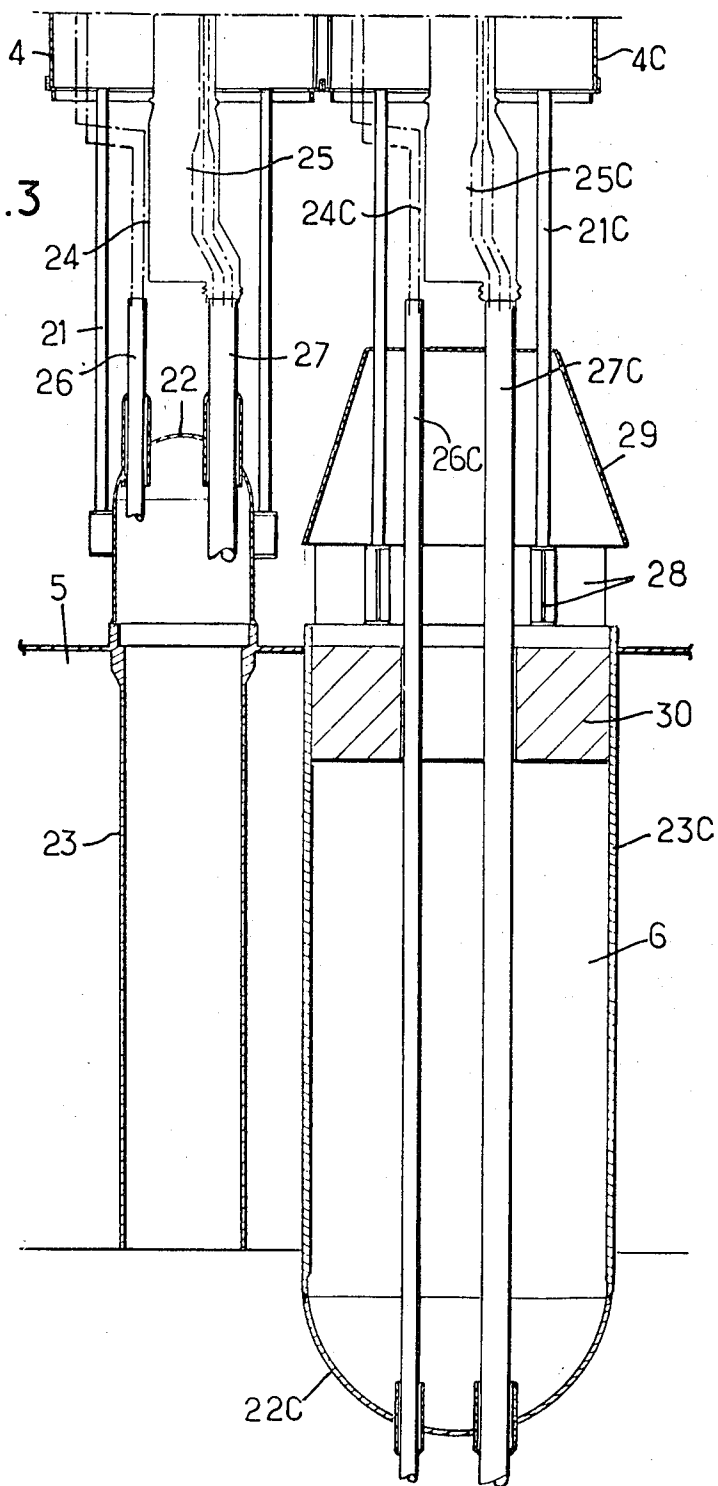


FIG. 4

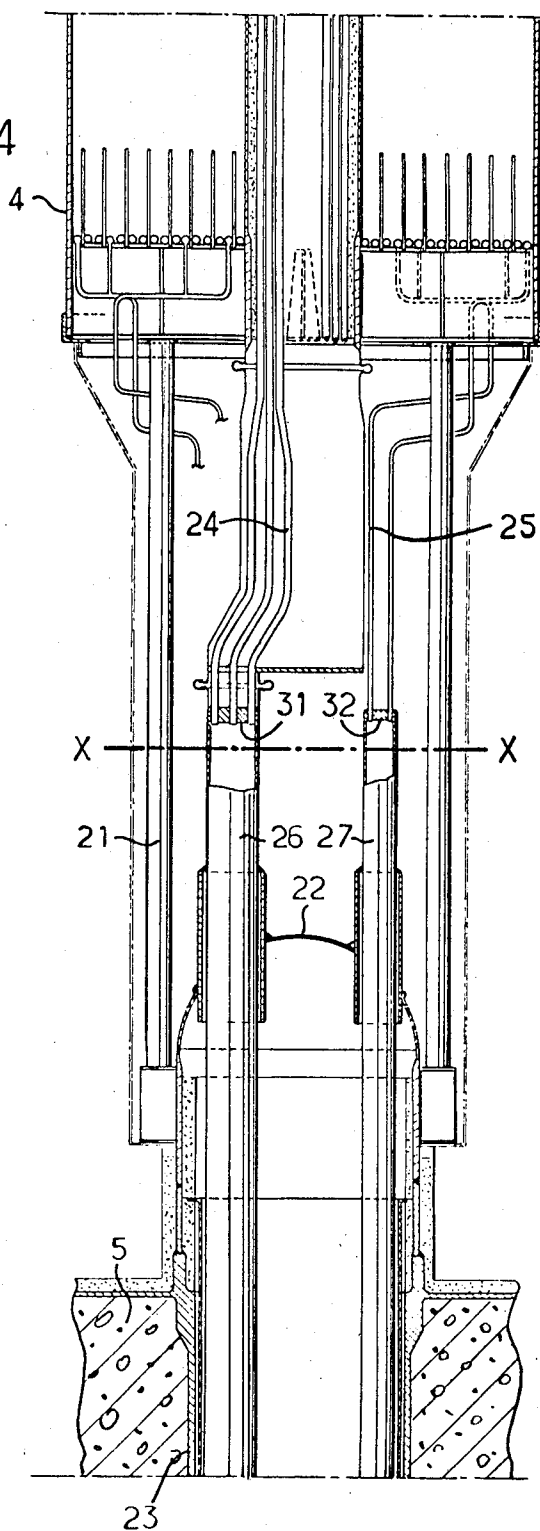
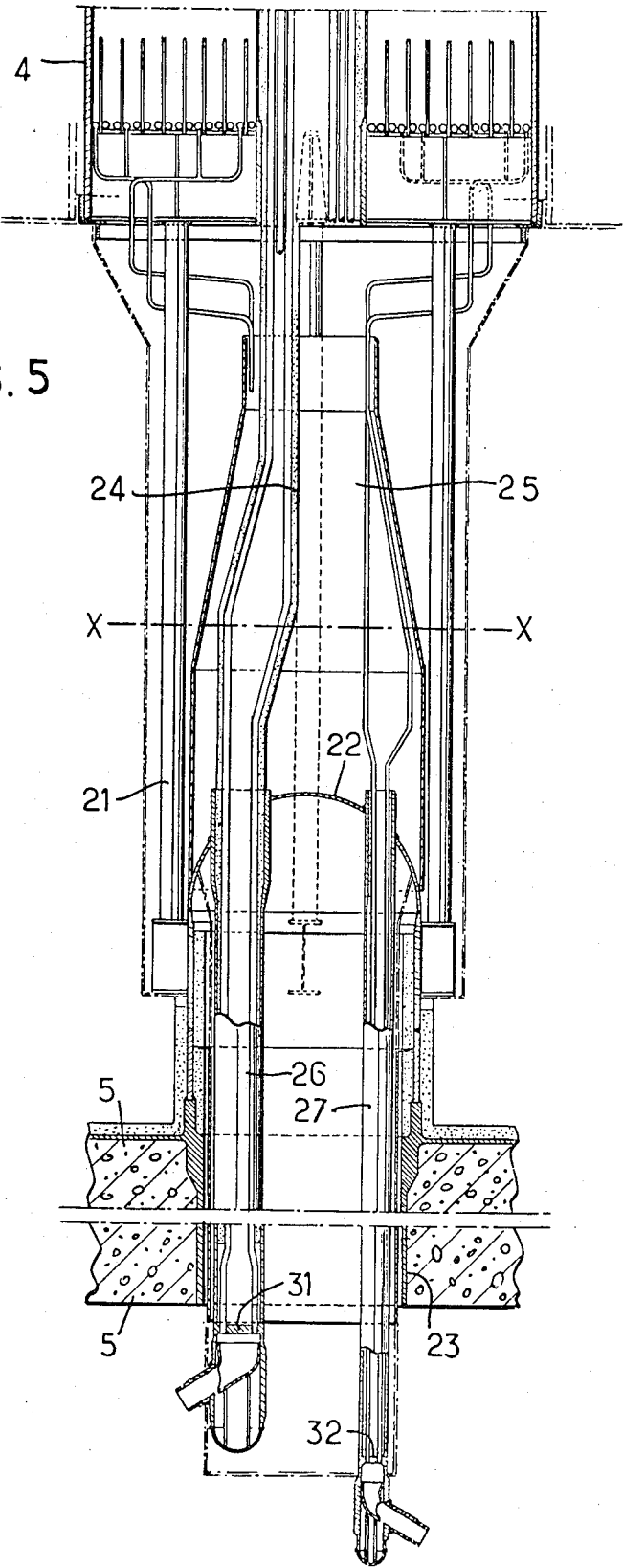


FIG. 5



HEAT EXCHANGER ARRANGEMENT

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to a heat exchanger arrangement, such as can be used in various types of integrated power-producing installations.

In integrated power-producing installations such as those which derive their power from nuclear reactors, the heat exchangers are commonly arranged in an enclosure, generally of very thick prestressed concrete, and these enclosures are often formed by heavy and awkward prefabricated units that are not easy to shift or remove to make the reactor elements or the heat exchanger units accessible for servicing and/or replacement.

With some prior art installations, servicing and replacement operations are so difficult to execute that for reasons of safety as well as economy of operation, it is necessary to provide separate access from outside the enclosure to each of the numerous heat exchanger tubes, or at least to small groups of individual tubes in order to facilitate inspection servicing and replacement.

The present invention has as aim improvements allowing the manipulation of the exchangers to be facilitated, to render them more easily accessible, and to allow of simple and rapid exchange operations while providing possibilities of access to the individual tubes or groups of tubes, without penetrating into the inside of the enclosure.

In accordance with one of these improvements, there is provided under the floor of the enclosure a skeleton structure forming a basculating bridge that is pivotably moveable from a vertical position, situated on the vertical axis of a passage provided in the floor, in order to receive through the passage a heat exchanger unit normally stationed within the enclosure, to a horizontal or inclined position, in order to remove the unit from the enclosure.

It is advantageous to provide on the basculating bridge means for holding the exchanger unit to be transferred, and travelling carriages for removing the unit from the bridge.

The floor passage, is of a cross section greater than that of a standard modular heat exchanger unit and, is surmounted by a supporting element, for example, a grating, adapted to receive vertical posts or props which support a heat exchanger unit installed coaxially with the floor passage and to permit the removal and replacement of the exchanger tubes, thus allowing maximum utilization of the space situated inside the enclosure.

The importance of using the available space to the greatest possible extent leads to the exchangers being placed in substantially mutual contact. When the exchanger bodies are cylindrical, it is advantageous to arrange them in a center spacing network formed of equilateral triangles and to have them mutually imbricated or adjoining. Arranged in this way, they cannot become accidentally displaced into the floor passage.

The invention provides for an installation in which the circular exchanger units are mutually imbricated, with the exception of at least one unit adjacent to the one aligned with the axis of the floor passage.

The bases of the cylindrical exchanger unit casings are advantageously provided with polygonal lower flanges which are welded to each other to form the ceiling of a suction chamber. According to the present invention, these flanges are in the form of regular dodecagons; when they are placed in contact with each other, between them they delimit triangular openings adapted to receive obturating or closure plates which can be removed in order to reach the exchanger units from the suction chamber.

The invention also provides a revolving bridge placed above the exchangers, in a diametrical position, and pivoting for example as it moves at its extremities along a circular track. This bridge is provided with a carriage, whose radial movements, combined with the angular movements of the bridge, make it possible to serve any desired point inside the exchanger

chamber, and to hoist up the exchanger units there in order to move them to the outlet passage.

In order to avoid the harmful effects of the temperature whilst facilitating the operations of removal and replacement, the invention provides for a method of installation according to which the revolving bridge is kept permanently inside the enclosure, but without the carriage or mechanical or electrical equipment which is only put into place during the period during which the bridge is in service.

According to a process of removal and replacement of an exchanger body, the latter is sectioned at a suitable level above the lower flooring, for example in a horizontal plane, it is evacuated by appropriate means, it is replaced by an exchanger body whose tube-nests are provided with tube plates situated above the plane of section, the latter are connected to collector ducts which are extended to the outside of the enclosure, through the lower flooring, and suitable means of support are provided for the new exchanger. This process makes it possible to get to individual tubes and to the tube plate of a tube-nest, along the collector duct which serves as guide, without its being necessary to extend the tubes to the outside of the enclosure, which would require multiple and delicate operations of welding individual tubes.

The exchanger body to be replaced may have tube-nests which are extended to outside the enclosure, inside a duct terminated at its lower part by a tube plate situated below the lower flooring. In that case, the process in accordance with the invention consists in removing the exchanger parts situated above the plane of section as well as the exchanger tubes and plates which are below this plane, the tube plates of the new tube-nests being to advantage equipped with sections of duct which it suffices to connect to the end of the existing ducts, inside the enclosure.

The invention also extends, by way of new industrial product, to an exchanger body for an integrated power-producing installation, comprising tube-nests terminated by tube plates inside the enclosure, the latter being connected to ducts which, extending to the outside of the enclosure, play the part of collectors and guides, and thus facilitate the inspection, the supervision and the maintenance of the tubes, tube-nests and tube plates.

The invention can best be summarized as a heat exchanger arrangement wherein a plurality of cylindrical modular heat exchanger units are placed upright in side-by-side relation within an enclosure having a floor with a passage therethrough that allows the units to be transferred into and out of the enclosure volume one at a time. To transfer any selected heat exchanger unit out of the enclosure, the unit is detached from its base, hoisted by an overhead travelling crane into a position overlying the floor passage, and then lowered vertically into a basculating bridge underneath the floor. The bridge is then tilted into a horizontal attitude for discharging the unit. Transfer of a heat exchanger unit into the enclosure can be achieved by following the aforementioned procedure in reverse order. It should be noted that where a heat exchanger unit is normally stationed in coaxial alignment with the floor passage such central unit need only be lowered through the passage, which is done first before any other units are passed therethrough.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawing and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In these drawings:

FIG. 1 is a schematic partial view, in vertical section, of an installation for the production of power, equipped with a heat

exchanger arrangement in accordance with a preferred embodiment of the invention;

FIG. 2 is a partial view in horizontal section of the heat exchanger arrangement shown in FIG. 1;

FIG. 3 is a detail vertical section view of typical heat exchanger units shown in FIG. 2;

FIG. 4 is a vertical section view showing the details of the lower part of a typical heat exchanger unit used in the arrangement of the invention;

FIG. 5 is a vertical section view, similar to that of FIG. 4 and illustrating another form of heat exchanger unit that can be used in the arrangement of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

As exemplified by FIG. 1, the invention provides a concrete enclosure 1 located underneath a floor 2, which a concrete enclosure 1 located underneath a floor 2, which supports a source of heat such as a nuclear reactor, and surrounds a hollow chamber containing a plurality of modular heat exchanger units 4, of which plurality only one is shown in the drawing in two different positions designated by A and B. The lower floor 5 of the enclosure 1 is provided with a passage 6 aligned with the central axis of the enclosure 1.

A chamber 7, provided underneath the floor 5, and provided with an outlet 8, contains a basculating bridge 9, which can pass by pivoting around a point 10 from the horizontal position, shown in the FIGURE, to a vertical position, this by any suitable means, such as, for example, a drive by winch and pulley-blocks 11, 12. The bridge 9 is equipped with travelling carriages 13.

A revolving bridge 14, placed underneath the floor 2, in a diametrical position, rests by its ends on a circular track 15. The revolving bridge 14, which it is advantageous to mount during the work of constructing the installation, is adapted to receive, at the moment for an operation of removing and replacing exchangers, a carriage 16 with hoisting pulley-blocks 17. The combined operation of the bridge 14 and the carriage 16 enables the latter to come into position vertically above a give exchanger body, occupying for example the position A, to hook the exchanger to the carriage 16, to free it from the elements attaching it to the installation, to move it to position B, to make it descend through the passage 6 by operating the pulley-blocks 17, and to receive it into the skeleton of the basculating bridge 9.

Once the exchanger body is suitably fixed to the basculating bridge 9, the latter is placed in the horizontal position and the exchanger is removed through the opening 8 by moving it on the carriages 13.

According to FIG. 2, the installation comprises exchangers 4 having circular-based cylindrical casings, closely imbricated in each other. The removal and replacement of the central exchanger 4C only requires a simple vertical movement inside the enclosure. To remove the other exchanger units necessitates previous horizontal movements towards the outlet passage 6. In order to allow such movements, according to the invention an exchanger body 4D, next to the exchanger 4C, is given a reduced diameter, smaller than the space between the exchangers 4E and 4F.

The size of the exchanger 4D is indicated by the hatched surface in the drawing.

Once the evacuation of the exchangers 4C and 4D has been accomplished, that of all the other exchangers becomes possible.

In FIG. 2, the cylindrical casings 18 of the exchangers are provided at their lower part with flanges 19 in the shape of regular dodecagons, which enter into contact with each other, leaving between them triangular openings which are obturated with elements 20, to form a sealed ceiling of a suction chamber. In order to get to any point of the exchanger chamber from the suction chamber, it suffices to take down one of the elements 20, without touching the exchanger

bodies proper, or, in the case of a new installation, to leave the corresponding triangular opening free and not to close it until the last moment.

In FIG. 3, a standard exchanger 4 is supported by props 21 resting on a sealing bulb 22, connected at the upper end to a sheath 23 passing through the floor 5. Nests 24, 25 of exchanger tubes pass through the bulb 22, inside ducts 26, 27 which are connected to the bulb with a sealed joint, and are extended to outside the enclosure, inside the sheath 23.

The neighboring exchanger 4C is the one situated in the axis of the passage 6 provided in the floor. The passage 6, appreciably wider than those delimited by the ordinary sheaths 23, to allow of the exit of the exchangers 4, is provided with a sheath 23C, which ends in a lower sealing bulb 22C, connected by sealed joints to ducts 26C, 27C lodging tube-nests 24C, 25C.

The exchanger 4C rests by props 21C on a grating of angle-irons 28 placed across the opening 6 and resting on the edges of the sheath 23C.

An antidust umbrella 29 protects the passage 6, and a biological protection screen 30 is arranged at the top of the latter.

FIG. 4 shows, in vertical section, the lower part of an exchanger incorporating improvements in accordance with the invention. In this figure, the tube-nests 24, 25 of the exchanger 4 are terminated by tube plates 31, 32 which are connected to the ducts 26, 27 above the points of penetration of the latter into the bulb 22. The ducts, prolonged in a straight line to outside the enclosure, do duty as collectors and also serve as means of guidance which facilitate the inspection, the supervision and the maintenance of the tube plates and tubes and, if necessary, access to these elements, without having to penetrate into the enclosure.

In order to replace the exchanger 4, it is sectioned under the tube plates 31, 32 along plane XX, which implies the cutting of the ducts 26, 27 and the props 21, and the assembly situated above the plane XX is replaced by an equivalent assembly, which is welded to the prop and duct parts which have remained in place. Thus, having to section and weld the numerous exchanger tubes is avoided.

This process of removal and replacement is also applicable to an exchanger of the type shown in FIG. 5, whose tube-nests 24, 25 are terminated by tube plates 31, 32 situated outside the enclosure, under the lower floor, and welded to the lower end of the ducts 26, 27. In this latter type of exchanger, replacements are effected by sectioning along plane XX, removing the exchanger part situated above this plane, withdrawing the tube plates 31, 32 also, as well as the parts of tube-nests which are attached to them, putting into place an exchange assembly with tube plates situated above the plane XX, similar to the one described with reference to FIG. 4, and carrying out the welding to the joints of the props and ducts.

As can be appreciated by the artisan from the foregoing, the invention can be defined generally as a heat exchanger arrangement which comprises wall means 1 defining a hollow enclosure 3 having a generally horizontal floor 5 and a passage 6 extending downwardly through said floor; a plurality of heat exchanger units 4, 4C, 4D, 4E, 4F, and overhead crane, defined by elements 14, 15, 16 and 17; and a basculating bridge means 9. The heat exchanger units 4, 4C-4F are modular cylindrical units and are disposed upright within the enclosure volume 3 in side-by-side relation to one another, with each of these units having a base support by the floor 5. The overhead crane 14-17 is positioned for movement in overlying relation to the heat exchanger units 4, 4C-4F and is capable of hoisting any one unit at a time and transporting it from its original position within the enclosure volume 3 to a position overlying the floor passage 6. The basculating bridge 9 is disposed in underlying position to the floor passage 6, is pivotably moveable between a vertical attitude position, as shown in phantom by FIG. 1 and a horizontal attitude position (as shown in full outline in FIG. 1), to respectively receive whatever heat exchanger unit 4, 4C-4F is passed through floor

passage, and to discharge such unit for removal through the underpassage 8.

For maximum utilization of the enclosure volume 3, one heat exchanger unit 4C is normally situated within enclosure 3 in overlying relation to the floor passage 6. Also, for conserving space and to facilitate transfer of heat exchanger units 4, 4C-4F into and out of the enclosure volume 3, the units 4, 4C-4F are positioned in an equilateral triangular center spacing pattern, one of the units 4D is smaller in diameter than the others 4, 4C, 4E and 4F, to establish a predetermined clearance space within the enclosure 3 to facilitate transfer of the units into and out of the enclosure 3.

While in accordance with the provisions of the statutes there is illustrated and described herein a specific embodiment of the invention, those skilled in the art will understand that changes may be made in the form of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of the other features.

What is claimed is:

1. A heat exchanger arrangement which comprises means defining a hollow enclosure having a generally horizontal floor and a passage extending downwardly through said floor; a plurality of cylindrical modular heat exchanger units disposed upright within said enclosure in side-by-side relation to one another, each of said units having a base supported by said floor; and overhead crane positioned for movement in overlying relation to said units to hoist any one unit at a time and transport same from its original position within the enclosure to a position overlying said floor passage, and to lower said unit through said passage in a generally vertical attitude; and a basculating bridge means disposed in underlying relation to said floor passage, said bridge being pivotably moveable between a vertical attitude and a horizontal attitude to respectively receive said unit and discharge same.

2. A heat exchanger arrangement according to claim 1 wherein one of said heat exchanger units is normally disposed within said enclosure in overlying relation to said floor passage.

3. A heat exchanger arrangement according to claim 1 wherein said heat exchanger units are positioned in an equilateral triangular center spacing arrangement and one of said units is smaller in diameter than the others to establish a predetermined clearance space within said enclosure to facilitate transfer of said units into and out of the enclosure.

4. A heat exchanger arrangement according to claim 1 including a sealing bulb member disposed within the base of each of said heat exchanger units to establish a fluid pressure-tight seal between said base and the upper portion of the unit, and header means extending through said base and sealing bulb member for communication with a tube bundle in the upper portion of the unit.

5. A heat exchanger arrangement according to claim 1 wherein the base of each heat exchanger unit has a dodecagonal flange positioned for contact with said floor and for edgewise adjoining engagement with the flanges of adjacent unit bases to define triangular openings between groups of adjoining flanges, and including a plurality of triangular plates matching said openings and disposed therein to seal same.

6. A heat exchanger arrangement according to claim 2 wherein said enclosure is cylindrical and said floor passage is centrally located with respect to the lateral boundaries of the enclosure.

7. A heat exchanger arrangement according to claim 6 wherein the heat exchanger unit overlying said floor passage has a sheath extending through said passage in circumferentially contiguous relation therewith, and a seal member connected to said sheath to define a fluid pressure-tight closure therefor.

8. A heat exchanger arrangement according to claim 7 including biological shielding means disposed within said sheath.

9. A heat exchanger arrangement according to claim 4 wherein said heat exchanger units each have a tubular sheath extending through said floor and said header means extends through said sheath.

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