HEAT EXCHANGE ARRANGEMENT

Filed May 27, 1968 5 Sheets-Sheet 1

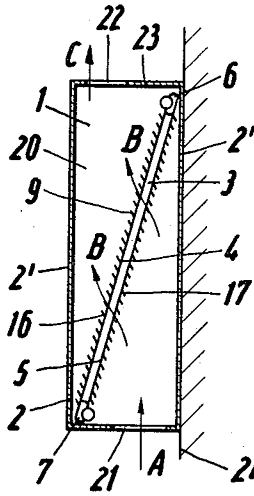

Fig. 1

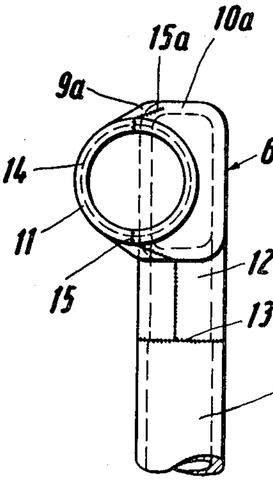

Fig. 3

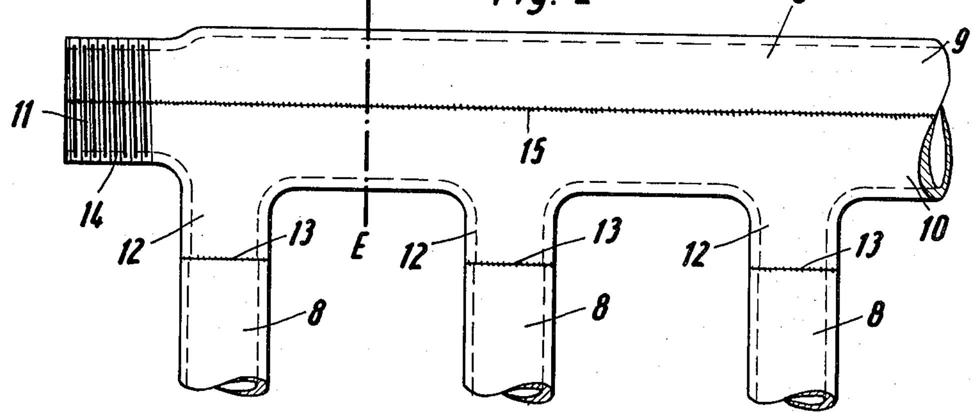

Fig. 2

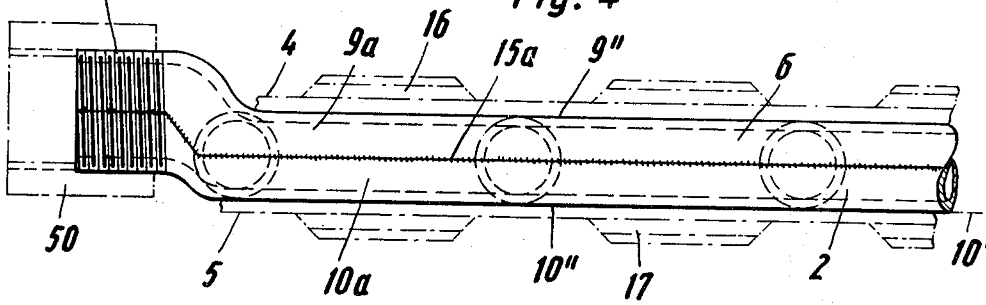

Fig. 4

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June 23, 1970 E. BENTELER ET AL 3,516,483

HEAT EXCHANGE ARRANGEMENT

Filed May 27, 1968 5 Sheets-Sheet 2

Fig. 5

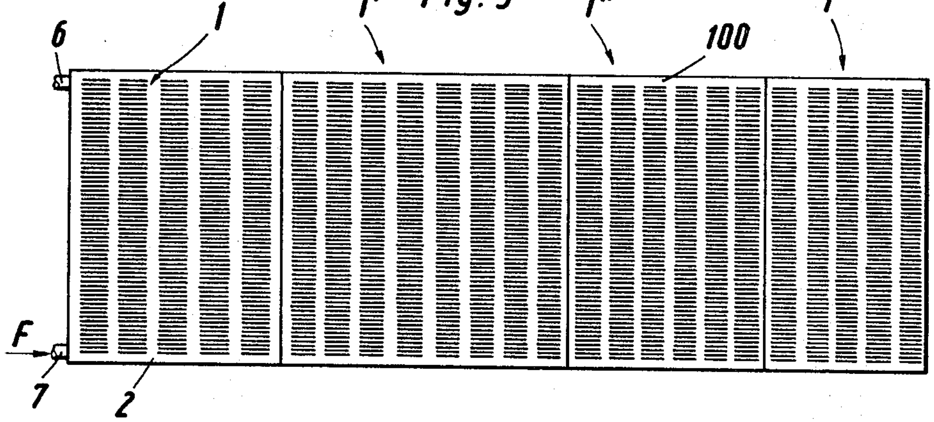


Fig. 6

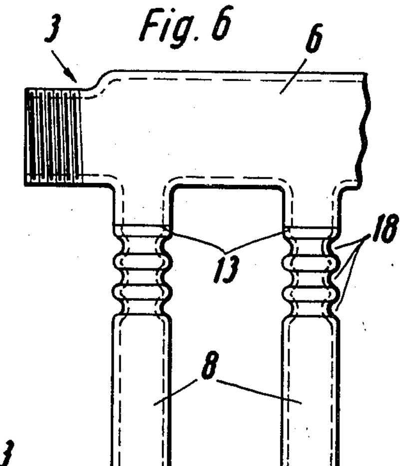
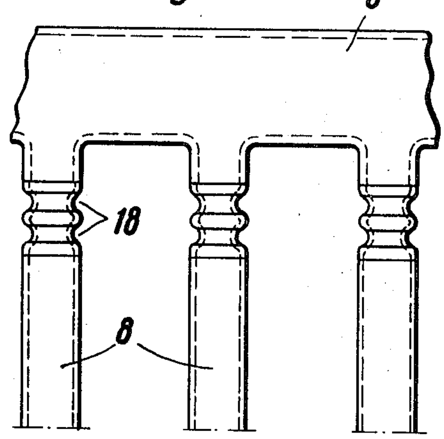


Fig. 7



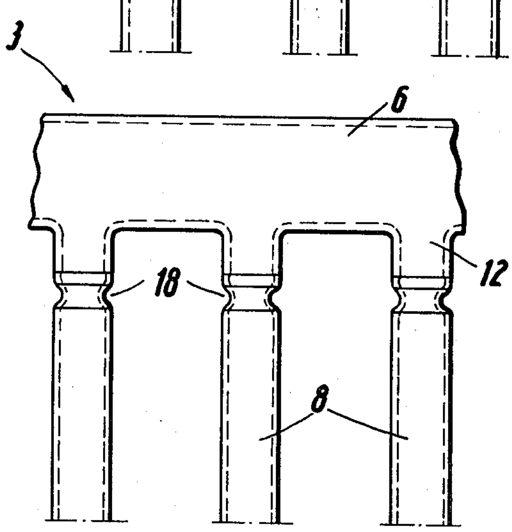


Fig. 8

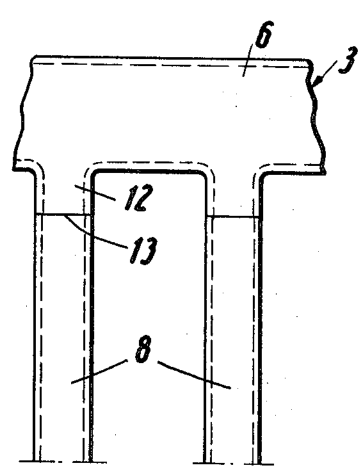


Fig. 9

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Fig. 10

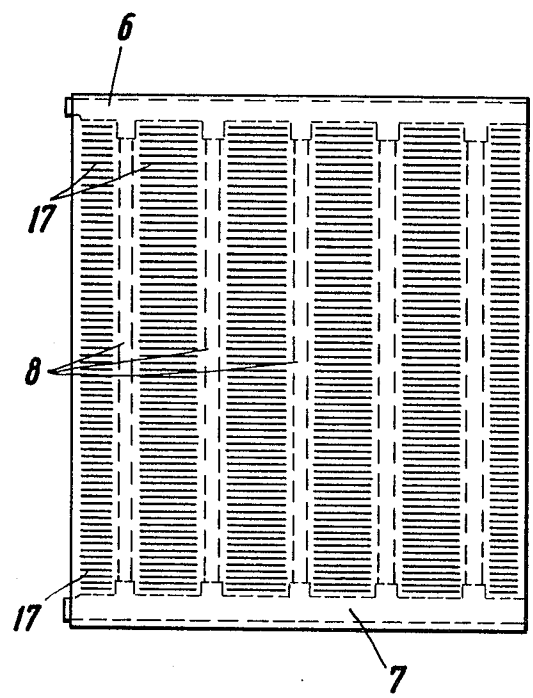

Fig. 11

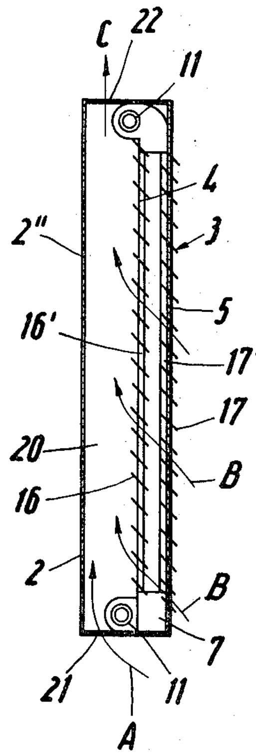

Fig. 12

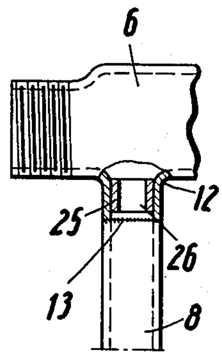

Fig. 13

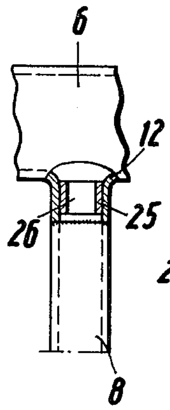

Fig. 14

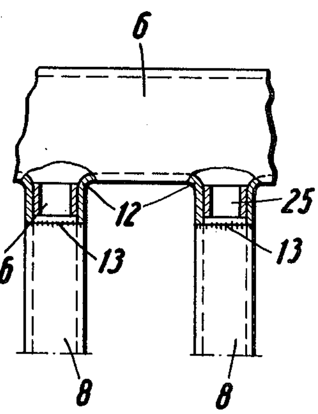

Fig. 15

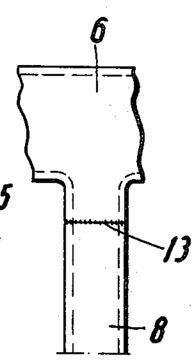

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Fig. 16

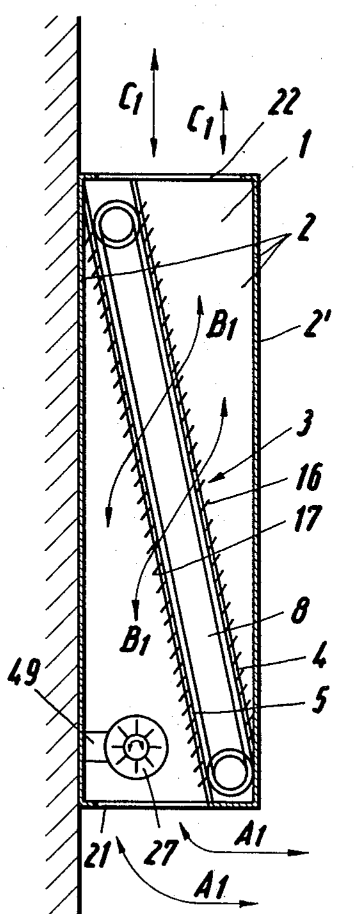

Fig. 17

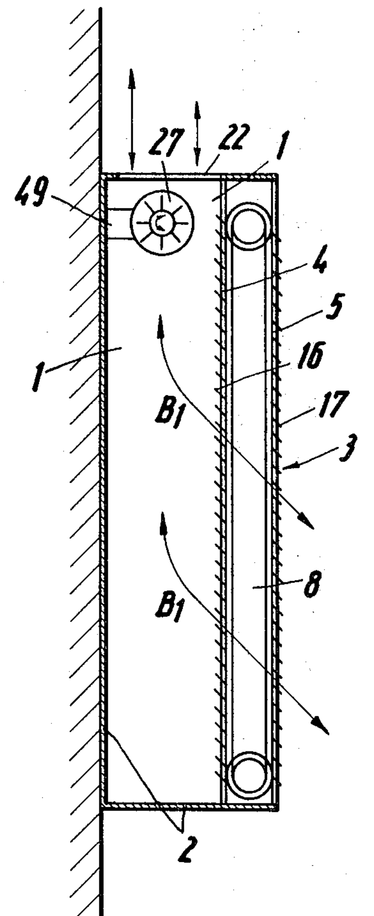

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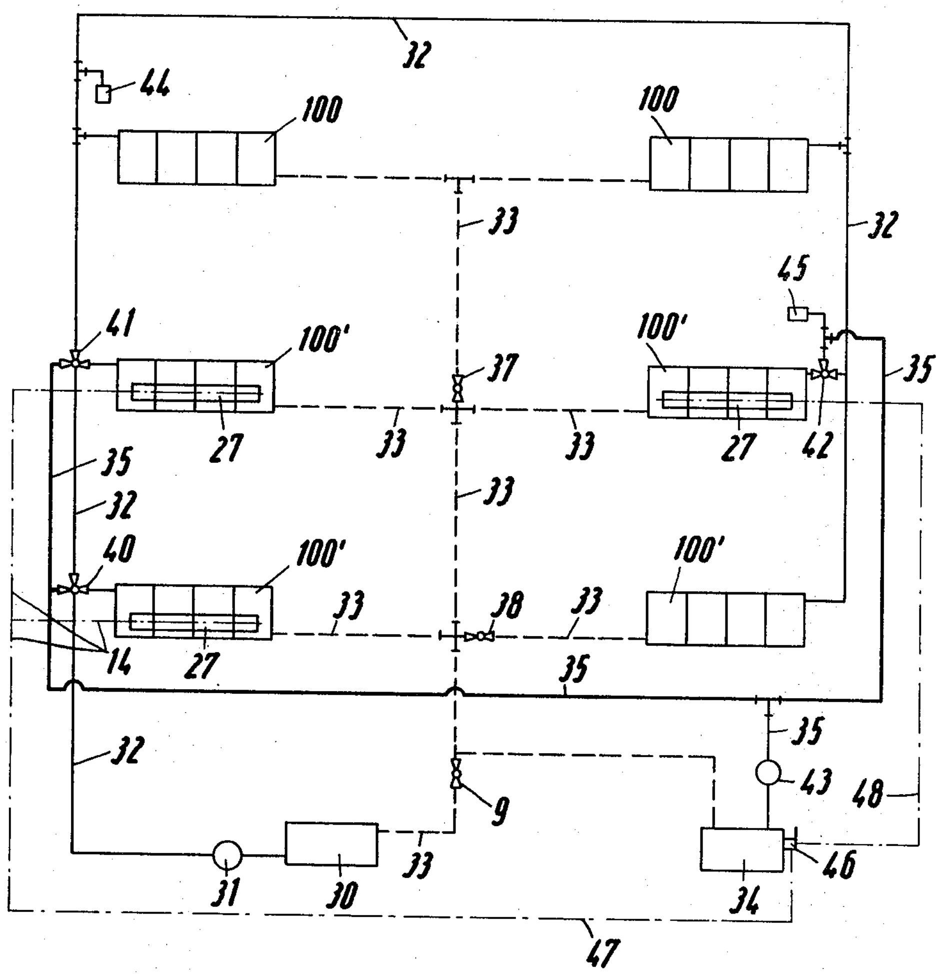
Fig. 18



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HEAT EXCHANGE ARRANGEMENT

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Int. Cl. F28f *1/00*
U.S. Cl. 165—22 15 Claims

ABSTRACT OF THE DISCLOSURE

A heat exchange arrangement includes a heat exchange unit having a housing, a fluid inflow manifold tube and a fluid outflow manifold tube respectively arranged in an upper and lower portion of the housing, and a plurality of upright tubes connecting the inflow and outflow manifold tubes. In accordance with the invention each of the manifold tubes consists of two hollow elongated shell sections having opposite ends and together constituting the respective manifold tube, these shell sections being formed intermediate their opposite ends with first projections extending transversely of the elongation of the shell sections and together constituting first tubular sockets to which the upright tubes are to be connected, and at their opposite ends with respective second projections together constituting second tubular sockets extending axially of the respective manifold tube and being laterally offset to one side of the longitudinal axis of the same to such an extent as to assure that a tubular component which is connected to the respective second sockets surrounding the same is substantially flush with the manifold tube at the opposite side thereof from the one side.

BACKGROUND OF THE INVENTION

The present invention relates to a heat exchange arrangement, and more particularly to a heating and cooling arrangement for air conditioning purposes.

Heat exchange arrangements of this type, namely of the type utilizing manifold tubes and connecting tubes extending between the inflow and outflow manifold tubes, are known. They are, however, relatively expensive to manufacture and the necessity to provide lateral connections on the manifold tubes for the connecting nipples and other elements makes the width of assemblies consisting of manifold tubes and connecting tubes quite significant. Furthermore, such connecting nipples project laterally as already indicated, and make it impossible for the manifold tubes to be located closely adjacent the walls of the housing of the heat exchange arrangement, thus increasing the size requirements and reducing the effectiveness of the arrangement for heating and/or cooling purposes.

It is therefore a general object of the present invention to overcome these disadvantages.

A more particular object of the invention is to provide a heat exchange arrangement comprising an assembly including inflow and outflow manifold tubes and connecting tubes, which assembly is simple and inexpensive to manufacture, requires relatively little space, and permits

positioning of the manifold tubes closely adjacent the walls of the housing.

SUMMARY OF THE INVENTION

In accordance with one feature of our invention we provide, in a heat exchange arrangement of the type here under discussion, a heat exchange unit comprising a housing having an upper and a lower portion, a fluid inflow manifold tube and a fluid outflow manifold tube each of which is arranged in one of these portions, and a plurality of upright tubes connecting the inflow and the outflow manifold tubes. Each of the manifold tubes comprises, in accordance with the invention, two hollow elongated shell sections having opposite ends and together constituting one of the manifold tubes. The shell sections are each formed intermediate their opposite ends with a plurality of first projections which extend transversely of the elongation of the shell sections and which together constitute first tubular sockets adapted for connection of the upright tubes thereto. At their opposite ends the shell sections are provided with respective second projections which together constitute second tubular sockets extending axially of the respective manifold tube and being laterally offset to one side of the longitudinal axis of the manifold tube to an extent which substantially corresponds to the wall thickness of a tubular component which is adapted to be connected to the respective second sockets surrounding the same. Thus, such tubular component is substantially flush with the respective manifold tube at the opposite side of the latter from the aforementioned one side and at this opposite side the manifold tube can be located closely adjacent to a housing wall or the like.

Of course, the construction of the manifold tubes from two hollow shell sections greatly simplifies the manufacturing problems involved and therefore decreases the expense. Furthermore, it permits the production of manifold tubes having configurations which were heretofore not possible.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic vertical section through a heat exchange unit embodying the invention;

FIG. 2 is a fragmentary front-elevational view of one manifold tube consisting of two sections which abut one another in a substantially horizontal plane of separation;

FIG. 3 is an end-elevational view of a manifold tube corresponding to that shown in FIG. 2 but consisting of two shell sections abutting one another along a substantially vertical plane of separation;

FIG. 4 is a top-plan view of the embodiment shown in FIG. 3 with louvre members added thereto;

FIG. 5 is an exemplary front-elevational view of a composite arrangement comprising several of the novel heat exchange units;

FIGS. 6–9 are all fragmentary front-elevational views of different manifold tubes for use in the embodiment of FIG. 5;

FIG. 10 is a front elevational view of an individual heat exchange unit according to the present invention;

FIG. 11 is a schematic vertical section through the embodiment shown in FIG. 10;

FIGS. 12–15 are each fragmentary front-elevational views of manifold tubes for use in the embodiment of FIG. 5;

FIG. 16 is a schematic vertical section through a further heat exchange unit according to the invention;

FIG. 17 is a view similar to FIG. 16 but illustrating yet an additional heat exchange unit according to the invention; and

FIG. 18 is an installation diagram illustrating, by way of example, a complete heat exchange arrangement installation.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing now the drawing in detail it will be seen that in the various figures identical components have been identified with identical reference numerals.

The schematic illustration in FIG. 1 shows that a heat exchange unit **1** comprises a housing **2** which in conventional manner may consist of metal or other suitable material. An assembly **3** consisting of a plurality of tubes, as will be discussed below, is arranged in the housing **2** in an inclined condition as shown in FIG. 1. Louvre members **4** and **5** are secured to the assembly **3** at the opposite sides thereof. The housing **2** is provided with an inlet **21** in the bottom wall thereof and with an outlet **22**. The flow of air into the housing **2** is indicated with the arrow A, and it will be seen that in the housing the air flows through the assembly **3**, guided by the louvre members **4** and **5**, in the direction of the arrows B to thereupon leave the housing in the direction of the arrow C through the outlet **22**. The top wall of the housing is identified with reference numeral **23**. The entire unit may be secured or simply placed against a wall **24** with its housing side wall **2″** while the other housing side wall **2″** remains exposed.

While FIG. 11 will be discussed in more detail subsequently it is already pointed out that instead of a completely enclosed housing, which is merely provided with an inlet and an outlet, the housing may also have an open side, that is one of the side walls **2′** or **2″** may be missing, and the assembly **3** itself will in effect replace the missing side wall. This is shown in FIG. 11.

Returning to FIG. 1 it is to be noted that the assembly **3** consists of two manifold tubes **6** and **7** which are respectively arranged in the upper and the lower portion of the housing, with the manifold tube **6** being located closely adjacent the sidewall **2″** and the manifold tube **7** being located closely adjacent the sidewall **2′**. The manifold tubes serve for inflow and outflow of heat exchange fluid, that is heated or cooled fluid, and they are connected in a manner which will be discussed presently by a plurality of upright tubes **8** which, as is more clearly seen in FIGS. 2–4, extend substantially normal to the elongation of the respective manifold tubes and extend in substantial parallelism with one another.

In accordance with the present invention the manifold tubes **6** and **7** each consist of two hollow shell sections **9** and **10** which are provided intermediate their opposite ends with tubular projections **12** constituting tubular sockets to which the upright tubes **8** are connected, for instance by welded seams as illustrated in FIG. 2 where the seams are designated with reference numeral **13**. In FIG. 2 the sections **9** and **10** are different from one another in that it is only the section **10** which is provided with the tubular projections **12**. At their respective opposite ends, which only one is shown for each of the sections in FIG. 2, both sections **9** and **10** are provided with additional projections which together constitute

tubular sockets **11** (one shown). The tubular sockets **11** are provided with screw threads **14** so that connecting nipples **50** or analogous elements may be threadedly secured thereto as shown in FIG. 4.

The sections **9**, **10** are advantageously produced in a pressing operation and, while FIG. 2 shows that the sections may be made so as to abut in a substantially horizontal plane of separation to be secured to one another by a welded seam **15**, FIGS. 3 and 4 show that the sections which are here identified with reference numerals **9*a*** and **10*a***, may also be constructed so as to abut one another in a substantially vertical plane of separation. The welded seam is here identified with reference numeral **15*a***. It will of course be appreciated that in the embodiment of FIGS. 3 and 4, which otherwise is similar to that of FIG. 2, it will be both of the sections **9*a***, **10*a*** which will be provided with the projections which together constitute the tubular sockets **12**, as compared to FIG. 2 where only the section **10** was provided in this manner.

The cross-sectional configuration of the main body portions of the manifold tubes constructed in this manner, that is the body portions other than the tubular sockets **11**, is most clearly shown in FIG. 3 where it will be seen that it may be of substantially rectangular outline, although it may of course be of other outline such as oval, generally polygonal or the like.

In accordance with the invention the tubular sockets **11** are laterally offset to one side of the axis of the respective manifold tube **6** or **7**. This is most clearly shown in FIGS. 3 and 4 and the offsetting is of such magnitude as to correspond substantially to the well thickness of a connecting nipple **50**—or other member, such as an additional tube—which is to be secured to the respective tubular socket **11** surrounding the same externally. The purpose is to assure that, as seen in FIG. 4, such nipple **50** or similar component is substantially flush with the outermost line **10′** (compare FIG. 4) of the respective manifold tube that is flush on that side which is opposite the side towards which the tubular sockets **11** are offset. This makes it possible, as shown clearly in FIG. 1, to place the manifold tubes **6** and **7** with the nipples **50** or analogous components connected thereto in the manner as shown in FIG. 4, closely adjacent to the respective side walls **2′**, **2″** oft he housing **2**, thus making it impossible for air passing through the housing **2** to seek a path between the respective side walls and the respective manifold tubes towards the outlet without passing through the actual body of the heat exchange assembly. Evidently, this significantly increases the effectiveness of the heat exchange unit.

The sheet-like louvre members **4** and **5** can be readily secured, for instance by spot welding, to the surface facets **9″**, **10″**, and these facets **9″**, **10″** provide a proper abutment and support for the louvre member **4**, **5** while at the same time making it possible for the latter to be in contact with the upright tubes **8** over the entire height of the latter so that a direct heat exchange takes place between the tubes **8** and the louvre members **4**, **5**. The latter, incidentally, are provided with inclined guide portions **16**, **17** and with air openings **16′**, **17′**, respectively, associated with these guide portions **16**, **17** in such a manner that the guide portions **16** are inclined upwardly towards the outlet **22** whereas the guide portions **17** are inclined downwardly towards the inlet **21** to thereby guide air coming from the inlet **21** into the air openings **17′**, from the same to and outwardly beyond the air openings **16′** and thence to the outlet **22**. This is particularly clearly shown in FIG. 11.

As shown in FIG. 5, a plurality of the heat exchange units which have been diagrammatically illustrated in FIG. 1 may be connected into a composite unit **100**. The construction of the individual units, here identified with reference numerals **1**, **1′**, **1″** and **1‴**, is similar to that discussed in the description of FIGS. 1–4 and it will be appreciated that the individual manifold tubes **6** and **7** of the respective units are connected to one another. Such assembly of different units into a composite unit makes it possible to accommodate the size and heat exchange capabilities of the composite unit precisely to the area wherein air is to be conditioned. The individual housings of the various units **1–1'''** are identified with reference numeral **2** and abut one another, being connected by screws, bolts, or in other suitable manner. The incoming heat exchange medium passes in the direction of the arrow F through the manifold tube **7**. Of course, it will be appreciated that it could be introduced through the manifold tube **6** instead although, if, for example, hot water is involved, the convection phenomenon will provide for circulation of the same in the tubes **8**, if the water is introduced through tube **7** and a weaker pump can be utilized under the circumstances than would be possible otherwise.

In any case, it is clear that in a composite unit **100** as shown in FIG. 5 the heat exchange intensity is to be equal everywhere along the length of the unit. To assure this the inner cross-sectional area of the tubes **8** or the sockets **12** in the individual units **1–1'''** differs. Specifically, the tubes **8**, or the sockets **12** in the unit **1** which is closest to the inlet for the heat exchange fluid, have the smallest minimum cross-sectional area whereas those of the unit **1'''**, which is farthest removed from the fluid inlet, have the largest. This can be obtained in various different ways. In FIGS. 6, 7 and 8 the upright tubes **8** themselves are provided with constrictions **18**, of which there may be one or several provided, whereas in FIG. 9 no such constrictions will be seen. The view shown in FIG. 6 is of upright tubes **8** associated with unit **1** closest to the heat-exchange fluid inlet, the view in FIG. 7 is of similar tubes which are, however, used in the unit **1'**. It is clearly shown that in FIG. 6 the upright tubes **8** are provided with three of the constrictions **18** whereas in FIG. 7 they are provided with only two of these constrictions. In FIG. 8, which shows the upright tubes **8** of the unit **1''**, each of the tubes **8** has only one of the constrictions **18** whereas in FIG. 9 the tubes **8** of the unit **1'''** have no constrictions whatsoever and thus correspond to the embodiment illustrated in FIGS. 2 and 3, for instance. The difference in flow resistance is of course obvious and need not be further explained. As shown in FIGS. 12–15 there are other ways of providing the desired flow resistance, eliminating the need for the constriction **18**. FIG. 18 corresponds to the showing of FIG. 6, FIG. 13 to that of FIG. 7, FIG. 14 to the showng of FIG. 8 and FIG. 15 to the showing of FIG. 9. The difference in FIGS. 12–15 as opposed to those labeled as FIGS. 6–9 is that in FIGS. 12–15 the upright tubes **8** are of constant cross section in all units, and that the different flow resistance is obtained by introducing sleeve-shaped inserts **25** into the tubular sockets **12**. This is advantageously accomplished before the two shell sections **9***a*, **10***a* are secured to one another, and it will be seen that in FIG. 12 the opening in the insert **25**, identified with reference numeral **26**, has a smallest cross-sectional area, that in FIG. 13 the opening **26** has a somewhat larger cross-sectional area, that in FIG. 14 the opening **26** has a still larger cross-sectional area and that in FIG. 15 the insert **25** is omitted.

It will be appreciated that instead of providing a composite unit **100** as shown in FIG. 5, a single heat exchange unit can be made to the rather large dimensions of the composite unit of FIG. 5. In this case the inner cross-sectional area of the various upright tubes **8** may differ for the same reason and in the same pattern as discussed with respect to FIGS. 6–9 and 12–15. The manner in which the difference in providing the cross-sectional area is accomplished, may also be the same as shown in FIGS. 6–9 or FIGS. 12–15. Parenthetically it should be pointed out that it is not essential precisely where in the tubes **8** or in the tubular sockets **12** the restriction of the cross-sectional area is provided.

The embodiment illustrated in FIG. 16 is largely similar to that shown in FIG. 1. As mentioned before, identical reference numerals identify identical components. In FIG. 16, however, the airflow is identified with arrows and with the letters A1, B1 and C1. In this embodiment and air circulating means **27**, which advantageously is in form of a well known blower, is secured to the housing side wall by means of a bracket or similar expedient **49** and is arranged above and closely adjacent to the air inlet **21**. As in the embodiment of FIG. 1, the outlet **22** is again located at the opposite side of the assembly **3** from the air inlet **21**.

The embodiment of FIG. 17 differs from FIG. 16 in that the assembly **3** is not inclined but rather is vertical and replaces one side wall of the housing **2**. This has already been discussed with reference to FIG. 11. A further difference is that in FIG. 17 there is no specific air inlet at the bottom of the housing **2**. There is, however, the air outlet **22** and the air circulating means **27** is arranged in the housing closely inwardly of the air outlet **22** so that air is aspirated through the assembly **3** by operation of the air circulating means **27** and will then issue from the outlet **22**.

Of course, the various embodiments illustrated and described, including those of FIGS. 16 and 17, can be provided for heating purposes as well as for cooling purposes. It will be noted that in FIGS. 16 and 17 the arrows indicating the air flow are double-headed, to indicate that the air flow may be in opposite directions, depending upon the operation of the air circulating means **27**, it being clear that if cooling is to be effected, the air circulating means **27** is made to aspirate air through the outlet **22** from the room whose air is to be conditioned.

Coming, finally, to FIG. 18, it will be seen that here there is shown a diagram illustrating how a heat exchange arrangement may be installed. It is assumed that a plurality of composite heat exchange units **100** are provided, corresponding to those shown in FIG. 5, and a further plurality of composite heat exchange units **100'** are also provided. The ones identified with reference numeral **100'** are assumed to be capable of both cooling and heating functions and it will be appreciated that neither the units **100** nor the units **100'** need be of identical size and heat exchanging capacity, as is suggested ni FIG. 18, but may be different from what is illustrated in this figure.

A boiler **30** of any well known type is provided and this may utilize solid, liquid or gaseous fuel for heating a heat exchange fluid. A feed pump **31** is associated with the boiler **30** and is connected with conduits **32**, of which the inflow portions are shown in solid lines whereas the return flow portions are shown in broken lines, with the individual heat exchange units, **100**, **100'**. The return flow conduits are identified with reference numeral **3**. A cooling device **34** is arranged parallel to the boiler **30** and its inflow conduits **35** are connected with the heat exchange units **100'**. The return flow conduits **33** which are associated with the heat exchange units **100'** serve for the return flow both of a heating medium and of a cooling medium and suitable valves **37**, **38**, **39** are interposed in these return flow conduits **33**. A branch **36** is directly connected with the cooling device **34**.

In the exemplary installation each of the heating and cooling heat exchanging units **100'** is provided with a multiple-flow valve **40**, **41**, **42** and is connected thereby to the inflow conduits **42** as well as to the inflow conduits **35** so that it can be selectively connected with the boiler **30** or with the cooling device **34** which latter is also associated with a pump **43** which is arranged in the inflow conduit **35**.

Thermostats **44**, **45** are provided in the inflow conduits **32** and **35** and can be set so as to control the operation of the boiler **30** and of the cooling device **34**, as well as of the pumps **31** and **43**.

A regulating device **46** of any well known type is associated with the cooling device **43** and connected via the dot-dash line electrical conductors **47** and **48** with the air circulating means **27** in the units **100'**. When the cooling device **34** is actuated, the air circulating means **27** are thus automatically started. However, suitable switching arrangements are provided for making it possible to start operation of the air circulating means even if only a heating function is desired. Advantageously, the air circulating means **27** will be of the rotary flow type comprising a rotatable cyclindrical member which extends over substantially the entire length of the units **100**. Suitable switching means may be provided for reversing the direction of operation of the air circulating means **27**, for the purposes indicated in the discussion of FIGS. 16 and 17.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in a heat exchange arrangement, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

1. In a heat exchange arrangement, a heat exchange unit comprising a housing having an upper and a lower portion and two transversely spaced sidewalls; a fluid inflow manifold tube and a fluid outflow manifold tube each arranged in one of said portions adjacent a respective one of said side walls, each of said manifold tubes comprising two hollow elongated shell sections having opposite ends and together constituting one of said manifold tubes, at least one of said shell sections being formed intermediate its opposite ends with a plurality of first projections arranged lengthwise of and extending transversely to the elongation of said shell sections and constituting first tubular sockets, and said shell sections being formed at their opposite ends with respective second projections together constituting second tubular sockets extending axially of the respective manifold tube and being laterally offset to one side of the longitudinal axis of the manifold tube to an extent substantially corresponding to the wall thickness of a tubular component adapted to be connected to the respective second sockets surrounding the same, so that such tubular component is substantially flush with the respective manifold tube at the side of the latter which is opposite said one side; a plurality of upright tubes connected to said first tubular sockets of said inflow and outflow manifold tubes so as to establish communication between the latter, said upright tubes extending in a row transversely of said housing intermediate said sidewalls of the same; and louvre members at opposite sides of said row intermediate the same and the respective sidewall, said louvre members extending from one to the other of said manifold tubes and being rigidly secured thereto.

2. In a heat exchange arrangement as defined in claim **1**, wherein each of said manifold tubes comprises an outer peripheral face including at least one substantially flat facet, said louvre members being spot-welded to respective facets.

3. In a heat exchange arrangement as defined in claim **1**, wherein said second tubular sockets are of substantially circular cross section and tapped, and wherein said manifold tubes are of other-than-circular cross section intermediate the respective second tubular sockets.

4. In a heat exchange arrangement as defined in claim **3**, wherein said manifold tubes are of substantially oval cross section intermediate the respective second tubular sockets thereof.

5. In a heat exchange arrangement as defined in claim **1**, said louvre members comprising a first member and a second member located at said opposite sides, said first and second members each being provided with a plurality of registering apertures and a plurality of inclined louvres respectively associated with said apertures and operative for guiding air from the apertures of one of said members towards and out of the apertures of the other of said members.

6. In a heat exchange arrangement as defined in claim **5**, said first and second members being spaced from one another, and said louvres being located between said first and second members in the space between the same.

7. In a heat exchange arrangement as defined in claim **1**, said heat exchanger having an inlet and an outlet for heat exchange fluid; and further comprising at least one additional heat exchange unit similar to the first-mentioned heat exchange unit, the respective first manifold tubes and the respective second manifold tubes being connected with one another and one manifold tube of one of said heat exchange units being connected with said inlet; and wherein the upright tubes of said one unit have a predetermined minimum inner cross-sectional area and the upright tubes of the other unit have a predetermined minimum inner cross-sectional area longer than that of the upright tubes of said one heat exchange unit.

8. In a heat exchange arrangement as defined in claim **7**, said upright tubes of said one and said other heat exchange unit being provided with respective radially inwardly extending constrictions, and wherein the constrictions in the tubes of said upright tubes of said one unit are deeper than the constrictions in the tubes of said other unit.

9. In a heat exchange arrangement as defined in claim **1**, said heat exchanger having an inlet and an outlet for heat exchange fluid; and further comprising at least one additional heat exchange unit similar to the first-mentioned heat exchange unit, the respective first manifold tubes and the respective second manifold tubes being connected with one another and one manifold tube of one of said heat exchange units being connected with said inlet; and wherein some of said upright tubes have a minimum inner cross-sectional area different from the corresponding area of the others of said upright tubes.

10. In a heat exchange arrangement as defined in claim **1**; further comprising fluid inlet means associated with one of said manifold tubes adjacent one end thereof and fluid outlet means associated with the other of said manifold tubes adjacent the opposite end thereof; and wherein the upright tubes closer to said inlet means have a smaller inner cross-sectional area and the upright tubes closer to said outlet means have a larger cross-sectional area.

11. In a heat exchange arrangement as defined in claim **10**; further comprising conduit means including a supply conduit connecting supply means with said heat exchange unit; and further comprising thermostatic means associated with said conduit and with the associated supply means and being operative for controlling operation of the latter in dependence upon the temperature of the fluid in the former.

12. In a heat exchange arrangement as defined in claim **7**, the housings of said heat exchange units having respective end walls abutting each other and secured to one another.

13. In a heat exchange arrangement as defined in claim **7**; and further comprising tubular inserts disposed in the respective upright tubes, the tubular inserts in the upright tubes of said one unit having an inner cross-sectional area smaller than that of the tubular inserts in the upright tubes of the other of said units.

14. In a heat exchange arrangement as defined in claim **7**; and further comprising tubular inserts disposed in the respective first sockets, the tubular inserts in the first sockets of said one unit having an inner cross-sectional area smaller than that of the tubular inserts in the first sockets of the other of said units.

15. In a heat exchange arrangement as defined in claim **1**, said housing having an open side, and said manifold tubes, said upright tubes and said lower members together constituting an air permeable assembly located in and closing said open side.

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