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CA 2843780 A1 2013/02/07

(21) 2 843 780

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2012/08/03
(87) Date publication PCT/PCT Publication Date: 2013/02/07
(85) Entrée phase nationale/National Entry: 2014/01/31
(86) N° demande PCT/PCT Application No.: CA 2012/050532
(87) N° publication PCT/PCT Publication No.: 2013/016829
(30) Priorités/Priorities: 2011/08/04 (CA2,748,635); 2011/08/04 (CA2,748,537); 2011/08/04 (CA2,748,632)

(51) Cl.Int./Int.Cl. *F28D 1/02* (2006.01), *F24J 2/24* (2006.01), *F24J 2/30* (2006.01), *F28D 7/16* (2006.01), *F28F 1/10* (2006.01)
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(54) Titre : ECHANGEUR DE CHALEUR ET SON PROCEDE DE FABRICATION
(54) Title: HEAT EXCHANGER AND METHOD OF MANUFACTURING THEREOF

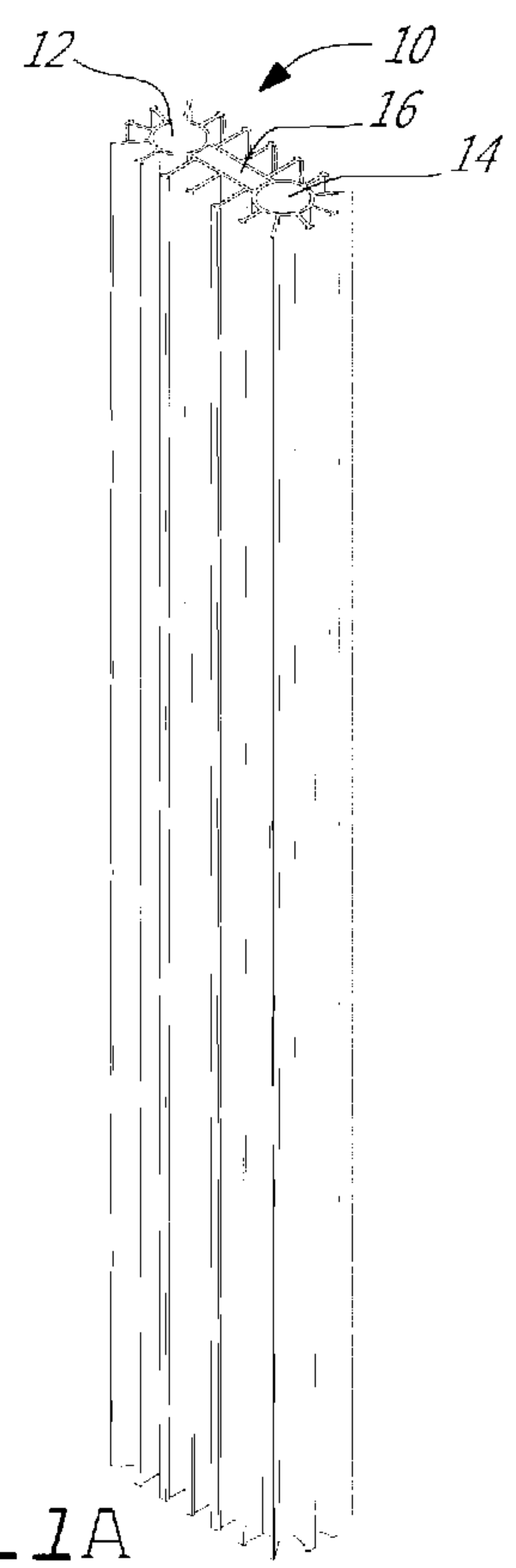

Fig-1A

(57) Abrégé/Abstract:
A heat exchanger (10) comprising at least first (12) and second (14) tubular bodies, a first fluid flowing in the first tubular body and a second fluid flowing in the second tubular body; and a bridge (16) thermally linking the first and second tubular bodies, and a

(57) Abrégé(suite)/Abstract(continued):
method for making a heat exchanger, comprising providing at least a first and a second tubular body, selecting a bridge depending on a required thermal exchange, connecting the first and second tubular bodies by the bridge and circulating a first fluid within the first tubular body and a second fluid within the second tubular body. The heat exchanger is used with a tracking type parabolic mirror solar heating system (100).

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 February 2013 (07.02.2013)

(10) International Publication Number
WO 2013/016829 A1

(51) International Patent Classification:
F28D 1/02 (2006.01) *F28D 7/16* (2006.01) *F24J 2/24* (2006.01) *F28F 1/10* (2006.01) *F24J 2/30* (2006.01)

(21) International Application Number:
PCT/CA2012/050532

(22) International Filing Date:
3 August 2012 (03.08.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

2,748,632	4 August 2011 (04.08.2011)	CA
2,748,537	4 August 2011 (04.08.2011)	CA
2,748,635	4 August 2011 (04.08.2011)	CA

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM,

[Continued on next page]

(54) **Title**: HEAT EXCHANGER AND METHOD OF MANUFACTURING THEREOF

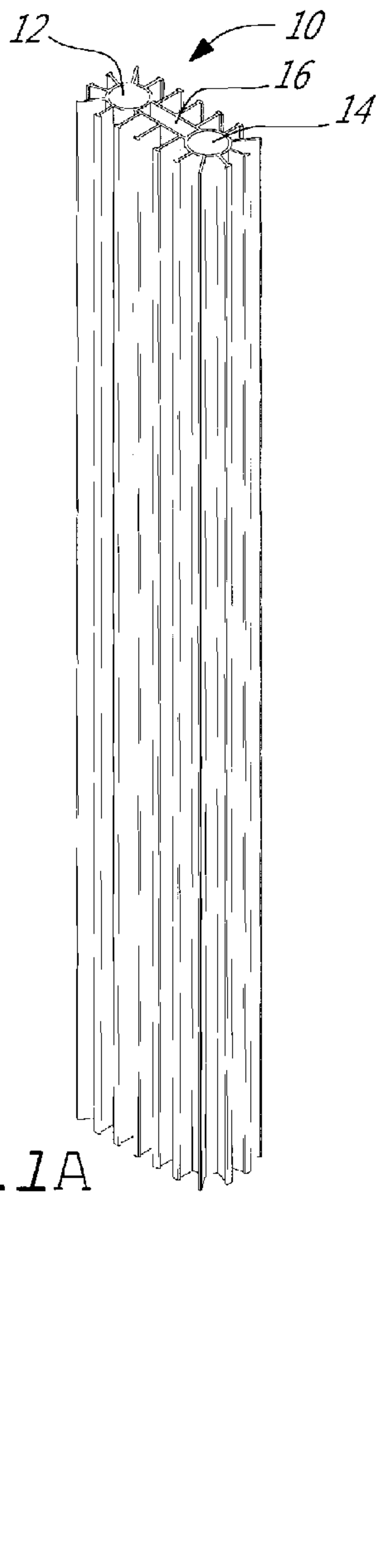


Fig-1A

(57) **Abstract**: A heat exchanger (10) comprising at least first (12) and second (14) tubular bodies, a first fluid flowing in the first tubular body and a second fluid flowing in the second tubular body; and a bridge (16) thermally linking the first and second tubular bodies, and a method for making a heat exchanger, comprising providing at least a first and a second tubular body, selecting a bridge depending on a required thermal exchange, connecting the first and second tubular bodies by the bridge and circulating a first fluid within the first tubular body and a second fluid within the second tubular body. The heat exchanger is used with a tracking type parabolic mirror solar heating system (100).

WO 2013/016829 A1

WO 2013/016829 A1

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

TITLE OF THE INVENTION

Heat exchanger and method of manufacturing thereof

FIELD OF THE INVENTION

[0001] The present invention relates to heat exchangers. More specifically, the present invention is concerned with heat exchangers and method of manufacturing thereof.

BACKGROUND OF THE INVENTION

[0002] Common heat exchangers transfer heat between two different mediums, either separated or in direct contact. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment.

[0003] US 4 080 703 describes a heat exchanger in the form of a heat radiating or absorbing panel is disclosed, which consists of an aluminum panel having a copper tube secured thereto in heat exchange relationship. The panel has at least one pair of parallel, spaced, retainer legs that have angularly inwardly extending flanges. A copper tube of circular cross section is laid into the channel formed by said retainer legs, and is then squashed by means of a die into a generally oval cross section which will be confined within the retainer legs. While so confined, fluid under pressure may be introduced into the tube to expand it into intimate contact with the panel, the retainer legs and the flanges. The assembly may then be heated during the expanding step to a temperature somewhat above the expected operating temperature of the assembly, to prevent loosening of the intimate contact between the tube and panel, which have different coefficient of expansion. Provision may be made to cause flow through the tube to be turbulent or swirling. Alternatively, the introduction of fluid under pressure, and the heating of the assembly, may be omitted, and the sum of the inside surface of the back of the panel between the flanges, the inside surfaces of the flanges, and the underside of the die between the flanges, may be made equal to the outside circumference of the tube. The exposed surface of the panel may be configured to increase its area and to provide good exposure over a wide range of angles of incidence. The heat exchange relationship between the tube and panel may be enhanced by interposing a thin layer of a synthetic resin between; and the resin may have powdered metal entrained therein. If dimensional relationships alone are relied upon to provide intimate contact between the tube and panel, a mastic-like material in a thin film may be applied to the interface between the tube and panel to improve heat transfer and seal out moisture.

[0004] US 048 602 describes a heat exchanger includes a core and a pair of headers, the core including flat tubes and corrugated fins sandwiched between the tubes, the headers having holes in which the end portions of the tubes are inserted, wherein each tube comprises a stop means for ensuring that an adequate length of the tubes become inserted in the headers.

[0005] US 6 155 340 describes a heat exchanger comprises a plurality of flat tubes for heat exchange between a first fluid flowing inside the tubes and a second fluid flowing outside the tubes. A pair of hollow headers is connected to the ends of the flat tubes. An inlet and outlet are provided in the headers for introducing the first fluid into the flat tubes and discharging it therefrom. Each header is composed of at least two parallel tubes with substantially circular cross-section, two adjacent tubes having integrated wall portions, thereby providing a substantially flat header.

[0006] US 6397931 describes a finned heat exchanger is disclosed. The heat exchanger includes a unitary fin array with a multiplicity of fin banks. Each of the fin banks include a plurality of raised, folded fins for heat transfer. The fin banks extend in a transverse direction and are spaced apart in a longitudinal direction. The fin banks are retained within the fin array by looped expansion turns. The fin array is mounted on a dielectric substrate base. A closed flow channel for directing a flow of coolant is created by adding a cap to the substrate base.

[0007] US 2011/000657 describes an extruded tube for a heat exchanger is provided that includes two at least approximately parallel outer side walls that extend in a longitudinal direction and a transverse direction of the extruded tube and that are connected by two outer narrow sides in a vertical direction of the extruded tube, wherein at least one continuous web extends between the side walls in the longitudinal direction and in the vertical direction and separates at least two ducts of the extruded tube, and wherein at least one of the outer side walls has embossings that serve to form both bulged portions that project into the ducts of the side walls and also bulged portions that extend substantially in the transverse direction of the web, wherein the bulged portions of the at least one web have a controlled orientation with respect to the transverse direction.

[0008] EP 2 273 224 describes the unit (15) has an interior duct (17) i.e. extruded duct, comprising a set of longitudinal internal channels that circulates fluid. A hollow exterior envelope (19) is hosed in the interior duct and manufactured using a strip. Two ribbed walls (19a) are arranged on either side of the interior duct to delimit another set of longitudinal channels (29) for circulating another fluid that is in contact with the interior duct and the exterior envelope. The latter set of channels is extended in parallel to the former set of longitudinal internal channels. An independent claim is also included for a method for manufacturing a heat exchange unit between two fluids.

[0009] US2010300665 relates to a heat exchange unit and corresponding heat exchanger, method Of manufacturing a heat exchange unit. The invention relates to a heat exchange unit between a first and a second fluid the heat exchange unit comprising: at least one interior duct (17) having a plurality of first longitudinal internal channels (21) for the circulation of the first fluid, a hollow exterior envelope (19) wherein is housed the interior duct (17), and at least two ribbed walls (19a) arranged on either side of the interior duct (17), in contact with the interior duct (17) and as well with the exterior envelope (19), in such a way as to delimit a plurality of second longitudinal channels (29) for the circulation of the second fluid, the second channels (29) extending substantially in parallel to the first channels (21). The invention also relates to a heat exchanger incorporating a heat exchange unit as well as a method of manufacturing such a unit.

[0010] US6155340 relates to a heat exchanger comprises a plurality of flat tubes for heat exchange between a first fluid flowing inside the tubes and a second fluid flowing outside the tubes. A pair of hollow headers is connected to the ends of the flat tubes. An inlet and outlet are provided in the headers for introducing the first fluid into the flat tubes and discharging it therefrom. Each header is composed of at least two parallel tubes with substantially circular cross-section, two adjacent tubes having integrated wall portions, thereby providing a substantially flat header.

[0011] US6397931 relates to a finned heat exchanger is disclosed. The heat exchanger includes a unitary fin array with a multiplicity of fin banks. Each of the fin banks include a plurality of raised, folded fins for heat transfer. The fin banks extend in a transverse direction and are spaced apart in a longitudinal direction. The fin banks are retained within the fin array by looped expansion turns. The fin array is mounted on a dielectric substrate base. A closed flow channel for directing a flow of coolant is created by adding a cap to the substrate base.

[0012] US4080703 relates to a heat exchanger in the form of a heat radiating or absorbing panel is disclosed, which consists of an aluminum panel having a copper tube secured thereto in heat exchange relationship. The panel has at least one pair of parallel, spaced, retainer legs which have angularly inwardly extending flanges. A copper tube of circular cross section is laid into the channel formed by said retainer legs, and is then squashed by means of a die into a generally oval cross section which will be confined within the retainer legs. While so confined, fluid under pressure may be introduced into the tube to expand it into intimate contact with the panel, the retainer legs and the flanges. The assembly may then be heated during the expanding step to a temperature somewhat above the expected operating temperature of the assembly, to prevent loosening of the intimate contact between the tube and panel, which have different coefficient of expansion. Provision may be made to cause flow through the tube to be turbulent or swirling. Alternatively, the introduction of fluid under pressure, and the heating of the assembly, may be omitted, and the sum of the inside surface of the back of the panel between the flanges, the inside surfaces of the flanges, and the underside of the die between the flanges, may be made equal to the outside circumference of the tube. The exposed surface of the panel may be configured to increase its area and to provide good exposure over a wide range of angles of incidence. The heat exchange relationship between the tube and panel may be enhanced by interposing a thin layer of a synthetic resin therebetween; and the resin may have powdered metal entrained therein. If dimensional relationships alone are relied upon to provide intimate contact between the tube and panel, a mastic-like material in a thin film may be applied to the interface between the tube and panel to improve heat transfer and seal out moisture.

[0013] US2006218954 relates to a heat storage apparatus includes heat storage panels having primary fluid passages formed therein; passage plates having secondary fluid passages formed therein; and heat reservoirs. The heat storage panels and the passage plates are layered alternately, and the heat reservoirs are interposed between the heat storage panels and the passage plates in such a manner that the heat reservoirs, the heat storage panels and the passage plates are adhered to one another. Protrusions are formed on surfaces of the heat storage panels in such a manner that the heat reservoirs are supported by the protrusions.

[0014] US4270523 relates to a heat storage apparatus comprising a plurality of heat exchanger elements mounted in a housing. Each element has a central portion containing a storage medium, surrounded by portions through which a first and a second heat transfer fluid can be passed in heat contact with said storage medium. Means are provided for passing the heat transfer fluids from respective supply conduits through the apparatus through the respective portions of the heat exchanger elements to respective discharge conduits.

[0015] CA1146158 relates to a phase change material heat exchanger wherein the latent heat of a substance as its physical state changes from solid to liquid, and vice versa, is utilized as a heat storage medium. Structure is also disclosed whereby a heat transfer fluid is intimately associated with the phase change material so as to accomplish the desired hear exchange between the phase change material and the heat transfer fluid. As a result of the construction utilized for the heat exchanger, the addition of homogenizing agents to the phase change material is not required.

[0016] CN201476652 discloses a heat storage two-way heat exchanger which can fully utilizes the large phase change latent heat of a phase change material to store heat energy and can also maintain the stable heat supplying temperature of a system in the heat supplying state at the same time. The heat storage two-way heat exchanger is composed of a heat storage water tank, a phase change heat storage body, a two-position three-way solenoid valve, a low-temperature heat supplying cycle pipeline and a high-temperature heat collecting cycle pipeline. A high-temperature heat collecting cycle return pipe (7) is connected with one shunt port of the two-position three-way solenoid valve (9), a heat supplying cycle water supply pipe (8) is connected with the other shunt port of the two-position three-way solenoid valve (9), and the interflow port of the two-position three-way solenoid valve (9) is connected with the inlet of the phase change heat storage body (2) in the heat storage water tank (1). The heat storage two-way heat exchanger can switch between two operating conditions of heat storage and heat liberation according to the work requirements but can always ensure that a heat exchange fluid first exchanges heat with the heat storage body filled with the phase change material.

[0017] CN201449196 relates to a radiator with heat storage capacity, which is characterized by consisting of a heat absorbing plate (1), a heat dissipating plate (2), a circumferential frame (3), a heat transferring fin (4) and phase change heat storage medium (5), wherein the heat absorbing plate (1) and the heat dissipating plate (2) are arranged at a distance, the plate surfaces of which are opposite; the peripheries of the heat absorbing plate (1) and the heat dissipating plate (2) are connected with each other by the circumferential frame (3) in a sealed manner, thus forming a sealing cavity between the heat absorbing plate (1) and the heat dissipating plate (2); the sealing cavity is internally provided with a heat transfer fin (4); one side of the heat transfer (4) is contacted and connected with the heat absorbing plate (1), and the other side thereof is contacted and connected with the heat dissipating plate (2); and the sealing cavity is divided into a plurality of spaces which are filled with phase-changing heat storage medium (5). The radiator with heat storage capacity conducts heat dissipation in an off-peak manner, thus leading the design cost of the radiator to be reduced; and as for the forced cooling and water cooling assembled by the radiator, the designed power of the air cooling and water cooling can be reduced, thus achieving the effect of energy conservation and environment protection.

[0018] JP61243286 aims to improve the heat transfer performance of the heat exchanger by inserting the group of fine tubes between flat tubes so that the group of fine tubes is contacted with the outer walls of flat tubes. CONSTITUTION: The flow path of fluid A is made by a rectangular tube and the fine tube 1 is made by a circular tube. When this heat exchanger is compared with the same having fins, whose pitch is same as the diameter of the fine tube 1, heat transfer area per unit length in the flow direction of the fluid B becomes about three times in this case, therefore, the size of the heat exchanger, capable of securing the same heat transfer area as before, may be compacted while heat transmitting coefficient becomes better in case the circular tube is employed since the equivalent diameter in the case of circular tube becomes half of a parallel flat plate model. Accordingly, the heat transfer area may be increased, works for making fin may become unnecessary and the heat transfer performance may be improved.

[0019] DE10243726 describes extruded composite profile (10), preferably made of aluminum or aluminum alloy, comprises at least two individual tubes (20, 30) having the same or different external and internal geometry. The individual tubes have a round or flat profile cross-section and consist of a profile wall (22, 32) with a wall thickness surrounding a hollow chamber (21, 31). The individual tubes are arranged next to each other and are interconnected by a tear-off strip (40) having a minimal width (b), preferably of 0.1-0.3 mm, which corresponds to the distance between two adjacent tubes. The tear-off strip has a wall thickness (w4) which is at least 20% narrower than the wall thickness of the profile wall of the adjacent tubes. Independent claims are also included for the following: (1) Heat exchanger comprising individual tubes forming a composite profile; and (2) Production of a heat exchanger.

[0020] DE10150213 describes an extruded profile, particularly for a heat exchanger, is preferably of aluminum or aluminum alloy and comprises at least two tubes (2,3) with equal or different inner and outer geometry joined to each other by ribs (4). The profile is of the compound type (1), the tubes of which have a flat profile cross-section, two parallel broad sides and arched or flat narrow sides. The tubes are connected to each other on their narrow sides.

[0021] GB2424265 describes a heat exchanger core element (300 fig 3a) has an extruded tubular body with integrally formed fin segments (308 fig 3a) on an outer surface of the tubular body. The fin segments are twisted out of alignment with the tube longitudinal axis, for at least a part of the fin length between the fin tip 408 and the fin root 410. The tubular body may have a flattened cross section, such as a rectangular profile, and may include a plurality of longitudinal passages (208 fig 2a). The passages may include internal fins or protrusions (210 fig 2a) to increase the surface area of fluid contact. The core element is formed by a shearing and deforming tool (312 fig 3g) mounted within a tool holder (302 fig 3a), which shears each extruded fin into several fin segments and then twists each segment. The core element may be made of metal, such as aluminium, and several core elements may be arranged in a heat exchanger. The elements may be stacked such that the spaces between fin segments are occupied by adjacent element fin members, and the heat exchanger may include a casing having inlets and outlets for a pair of fluids between which heat is exchanged.

[0022] JP5215482 aims to make a flowing speed of fluid uniform and to enhance a heat exchanging rate by arranging outer fins between tubes formed with a plurality of fluid passages therein, connecting both ends of the tubes to a header, and forming the passages of the tubes in a lateral circular section.

CONSTITUTION:A heat exchanger 1 to be used as a refrigerant condenser of a vehicle refrigerating cycle is composed by alternately laminating many flat tubes 2 and outer fins 3 and integrally brazing them in a state that a header 4 is connected to both ends of the tubes 2. Each tube 2 is formed of an extrusion molded form of aluminum and a plurality of fluid passages 5 for passing refrigerant therein. The plurality of the passages 5 are aligned on one row, and the section of each passage is formed in a round hole having roundness.; That is, a corner is eliminated in the passage 5, a flowing speed of fluid flowing along the inner wall of the passage 5 is made uniform, and a flowing resistance of the fluid is reduced. Thus, a high heat exchanging rate is realized.

[0023] WO0000778 relates to a heat exchanger radiating element and to a process for making such a heat exchanger by using said type of radiating element, the mentioned heat exchanger being meant to be used as cooling or heating radiators for motor vehicles with internal combustion engines, as oil radiators or coolers for motor vehicles equipped with internal combustion engines or for technological installations, such as evaporators or condensers in the air conditioning apparatuses for motor vehicles, industrial refrigerating storage rooms or installations, and as convection or central heating apparatuses for dwellings, offices, industrial spaces. According to the invention, the radiating element for heat exchangers comprises some tubes (1) bent in the shape of a "U" and some fins (2), the tubes (1) being characterized in that, in the area of the bent sides, namely in the active area of the radiating element, where they come into contact with the fins (2), they have the shape of their cross-section, other than the circular shape, namely the elliptical, oval shape.

[0024] CN20092111391U provides a solar high-temperature heat collector which comprises a parabolic mirror reflecting plate. The solar high-temperature heat collector is characterized in that a heat absorber filled with heating medium is arranged in the focal position of the parabolic mirror reflecting plate and is connected with a heat exchanger filled with heating medium through a heat transfer pipefilled with heating medium, so that the solar energy can be focused on the heat absorber in the focal position through the parabolic mirror reflecting plate. Firstly, the heating medium in the heat absorber is heated, the heat is transmitted to the heating medium in the heat transfer pipe and the heating medium in the heat exchanger in sequence mainly through a heat conduction method, then the heat absorption and the energy storage are further carried out, and finally the hot water is provided for the users after the heat exchanger performs quick heating and temperature increasing to the waterflowing through the heat exchanger. The utility model has the advantages of quick heat absorption, high heat collection efficiency, convenient heat and energy storage, long holding time and high heating speed, is free from the limitation of sunshine time, and can meet the demands of instant use for the users.

[0025] GB987521 relates to a system for the collection, storage and release of solar energy comprises a heat collector such as a parabolic mirror 2 which radiates the heat on to a boiler portion 4 of a fluid circuit 6, a heat storage device 8, and a heat exchanger 16 from which the cooled fluid is returned to the boiler portion through pump 18. In the system shown, steam generated in a coil 37 of the heat exchanger 16 supplies a turbine 39 driving generator 40 and is then condensed in condenser 44, heated in heat exchanger 48, most of the liquid returning to the exchanger 37 and the remainder passing through conduit 52 to ejector 54. A by-pass 20 by-passes the heat storage unit and is controlled by thermostatic valve 22 to keep the temperature of the input fluid to coil 14 constant. A radiator 24 in by-pass 26 which is controlled by thermostatic valve 28, disposes of excess heat. Flow through a further by-pass 30 is controlled by thermostatic valve 32. The heat storing unit 10 contains a heat absorbing liquid.

[0026] CN101825072 discloses a trough-dish combined solar thermal power generation system with a fixed focus and relates to a solar thermal power generation technology. The system comprises a trough type heat-collecting and heat-storing subsystem, a dish type heat-collecting and heat-storing subsystem and a power generation subsystem, wherein the trough type heat-collecting and heat-storing subsystem and the dish type heat-collecting and heat-storing subsystem are separately connected with the power generation subsystem; and the low temperature heat exchanger of the trough type heat-collecting and heat-storing subsystem is connected with the high temperature heat exchanger of the dish type heat-collecting and heat-storing subsystem. A parabolic dish reflecting mirror contains one dish or two dishes which can perform single-spindle automatic tracking and the focus, namely the receiver is fixed, thus facilitating the heating and heat insulation of large flow high temperature fluid. The invention adopts a trough type solar field with low investment cost to heat the low temperature section of the working medium and a dish type solar field to heat the high temperature section of the working medium, thus reducing the investment of the electric power plant under the premise of ensuring high generating efficiency.

[0027] US2011277471 relates to a method for storing heat from a solar collector CSTC in Concentrating Solar Power plants and delivering the heat to the power plant PP when needed. The method uses a compressed gas such as carbon dioxide or air as a heat transfer medium in the collectors CSTC and transferring the heat by depositing it on a bed of heat-resistant solids and later, recovering the heat by a second circuit of the same compressed gas. The storage system HSS is designed to allow the heat to be recovered at a high efficiency with practically no reduction in temperature. Unlike liquid heat transfer media, our storage method itself can operate at very high temperatures, up to 3000 DEG F., a capability which can lead to greater efficiency.

[0028] ES2193000 relates to a parabolic solar collector.The solar collector includes a parabolic reflector (1) from which the solar rays are reflected, a primary heat exchanger (8) mounted at the focal point of the parabolic reflector (5), a secondary heat exchanger (4) inside a tank of domestic hot water (9) that is to be heated and a circuit (6) connected between the said heat exchangers (8, 4) and characterised by the fact that the said parabolic reflector (1) is mounted on a rotating mounting (3) fitted with a pair of motors (2) connected to a supply and control unit (11) so that the said parabolic reflector (1) can rotate vertically and horizontally according to the position of the solar rays by means of the said supply and control panel (11).The collector makes the maximum use of the sun's light, producing optimum efficiency of the solar collector.

[0029] US4362149 relates to a thermal energy storage system and method for storing substantial quantities of heat for extended periods of time. The system includes a heat collecting fluid which is in a heat-exchange relationship with a source of heat or thermal energy, a housing containing a large volume of particulate material such as rocks for the storage of thermal energy, a heat transfer gas in a heat-exchange relationship with the rocks and means for causing the heat collecting fluid and the heat transfer gas to flow in counter-current, indirect heat-exchange relationship with one another, the means further includes provisions for reversing the direction of flow of the heat collecting fluid and gas for the introduction and removal of heat from a portion of the body of rock. There further is provided a working fluid and means for passing the working fluid and heat collecting fluid in indirect, heat-exchange relationship with one another for the transfer of heat to the working fluid, and a means operatively associated with the working fluid to extract energy therefrom. In a particularly preferred embodiment, the source of heat comprises a solar heat collector which uses a liquid alkali metal as the heat collecting fluid and the preferred heat transfer gas comprises air.

[0030] US7441558 relates to an active thermal energy storage system is disclosed which uses an energy storage material that is stable at atmospheric pressure and temperature and has a melting point higher than 32 degrees F. This energy storage material is held within a storage tank and used as an energy storage source, from which a heat transfer system (e.g., a heat pump) can draw to provide heating of residential or commercial buildings and associated hot water. The energy storage material may also accept waste heat from a conventional air conditioning loop, and may store such heat until needed. The system may be supplemented by a solar panel system that can be used to collect energy during daylight hours, storing the collected energy in the energy storage material. The stored energy may then be used during the evening hours to heat recirculation air for a building in which the system is installed.

[0031] There is a need for a modular, multi-mode heat exchanger adaptable to a range of applications and involving at least two fluids.

SUMMARY OF THE INVENTION

[0032] More specifically, in accordance with the present invention, there is provided a heat exchanger comprising at least a first and a second tubular bodies, a first fluid flowing within the first tubular body and a second fluid flowing within the second tubular body; and a bridge thermally linking the first and second tubular bodies.

[0033] There is further provided an assembly of heat exchangers, each comprising at least a first and a second tubular bodies, a first fluid flowing within the first tubular body and a second fluid flowing within the second tubular body; and a bridge thermally linking the first and second tubular bodies.

[0034] There is further provided a method for making a heat exchanger, comprising providing at least a first and a second tubular bodies, selecting a bridge depending on a required thermal exchange between the tubular bodies, connecting the first and the second tubular bodies by the bridge, and circulating a first fluid within the first tubular body and a second fluid within the second tubular body.

[0035] Other objects, advantages and features of the present invention will become more apparent upon reading of the following non-restrictive description of specific embodiments thereof, given by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036] In the appended drawings:

[0037] Figures 1 show a) a perspective view and b) a cross section of a heat exchanger according to an embodiment of an aspect of the present invention, and Figures 1c and 1d show cross sections of other embodiments of the heat exchanger;

[0038] Figure 2 is a diagrammatic view of operating modes of a heat exchanger according to an embodiment of an aspect of the present invention;

[0039] Figure 3 is a perspective side view of an assembly of heat exchangers according to an embodiment of an aspect of the present invention;

[0040] Figure 4 is a perspective side view of an assembly of assemblies of Figure 3;

[0041] Figure 5 is a detail of the assembly of Figure 4;

[0042] Figure 6 shows a manifold used to connect heat exchangers in the assembly of Figure 4;

[0043] Figure 7 shows the assembly of Figure 4 mounted with the manifold of Figure 6;

[0044] Figure 8 is a cross-section of a heat exchanger according to an embodiment of an aspect of the present invention;

[0045] Figure 9 is a partial perspective view of a system according to an embodiment of an aspect of the present invention; and

[0046] Figure 10 is a perspective view of the system of Figure 9 mounted on the roof of a plant.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0047] The present invention is illustrated in further details by the following non-limiting examples.

[0048] As illustrated in Figures 1, a heat exchanger 10 according to an embodiment of an aspect of the present invention comprises tubular bodies 12 and 14, adapted to receive therein a first fluid and a second fluid respectively, connected, along at least part of a length thereof, by a bridge 16, immersed in an external fluid (F).

[0049] In Figures 1a and 1b, the bridge 16 is shown as a tubular body, i.e. adapted to receive therein a third fluid, two adjacent tubular bodies sharing a common wall portion, i.e. the fluid in the tubular body 12 is separated from the fluid in the central tubular body 16 by a common wall 17, and the fluid in the lateral tubular body 14 is separated from the fluid in the central tubular body 16 by a common wall 19. The fluids within the tubular bodies are separated from the external fluid (F) by non-shared outer walls 20.

[0050] Fins 18 extending radially and outwardly from the non-shared outer walls 20 of the tubular bodies 12, 14, 16, on at least part of the length of the tubular bodies, allow an additional thermal exchange between the fluids within the tubular bodies and the external fluid (F) in which the heat exchanger 10 is immersed, in addition to a direct thermal exchange between the fluids within the tubular bodies and the external fluid (F) through the non-shared walls 20 of the tubular bodies 12, 14, 16.

[0051] In a one-piece extruded heat exchanger 10, the fins 18 extend perpendicularly to the outer walls 20, and run longitudinally along at least a length thereof, i.e. perpendicularly to a flow direction of the fluids within the tubular bodies 12, 14. These fins 18 also enhance the mechanical resistance of the heat exchanger 10.

[0052] Corrugations or protrusions on the outer walls 20 may also be used to increase the thermal exchange surface of the heat exchanger 10.

[0053] The external fluid, i.e. outside the outer walls of the heat exchanger 10, accumulates heat, as a battery. It may be a fluid, a liquid, a solid, a gas or a mixture thereof. It may be dynamic (flowing) or static (not flowing). It may be used as a heat buffer.

[0054] The fluids in the tubular bodies 12, 14 are typically flowing fluids, either similar or different. They may be heat transfer liquids.

[0055] In cases when the bridge 16 is a tubular body, as illustrated in Figures 1a and 1b, the tubular body 16 extends along the whole length of tubular bodies 12 and 14 for example. It may receive a fluid, either a liquid or a solid for example, such as a phase change material for example.

[0056] As shown in Figure 1c, the bridge 16 may be formed by a common shared wall between the tubular bodies 12 and 14, i.e. along the whole length of the tubular bodies 12, 14. The bridge 16 may also be a solid member connecting the tubular bodies 12 and 14, along part or the whole length of the tubular bodies 12, 14, as exemplified in Figure 1d. The shape of the bridge may vary as long as it provides a mechanical thermal contact between the tubular bodies 12 and 14.

[0057] The bridge 16 ensures mechanical heat conduction, through walls, between the tubular bodies 12 and 14, by providing a mechanical interface between the tubular bodies 12 and 14, in addition to the interface provided by the external fluid (F).

[0058] The form and nature of the bridge 16 is selected depending on the required thermal exchange between the tubular bodies 12 and 14 on the one hand, and with the external fluid (F) on the other hand. The length of the bridge 16 between the tubular bodies 12 and 14, i.e. the width (W) of the solid member connecting the tubular bodies 12 and 14 (see Figure 1d) or the section of the tubular body linking the tubular bodies 12 and 14 (see Figure 1b), for example, and hence the thermal exchange surface of the bridge 16 may thus be adjusted.

[0059] Figure 2 shows different operating modes of the heat exchanger 10. For example, a cold fluid may be heated through the tubular body 14 and the hot fluid cooled down in the tubular body 12, in a heat exchanger mode (see full lines), i.e. part heat extractor and part radiator. The bridge 16 may be a central tubular body with a phase-change material therein, the latent heat of the phase-change material in the central tubular body 16, at its physical change from solid to solid or liquid to solid for example, being used as a heat storage medium.

[0060] Still in this example, in the case of a same fluid, by using a valve mechanism (V), the heat exchanger 10 may also be operated as a full heat extractor (see dotted lines in Figure 2) or as a full heat radiator (see dashed lines in Figure 2).

[0061] Flowing fluids may have counterflow or parallel flows within the tubular bodies 12, 14.

[0062] The tubular bodies are generally parallel to maximize the surface area of walls between fluids while minimizing resistance to fluid flow there through. Other configurations may be contemplated.

[0063] The tubular bodies 12 and 14 are shown with generally circular sections, and the bridge 16 as a central tubular body is shown with a flattened cross section, such as a rectangular section, in Figure 1b, as these are easily extruded geometries. Other sections and shapes may be contemplated.

[0064] Although the tubular bodies 12 and 14 are shown as identical in Figure 1b, they may be of different cross sections (see Figures 1c and 1d for example).

[0065] As people in the art will now be in a position to appreciate, the present heat exchanger can be tailored and tuned according to a range of different needs, by adjusting the lengths and sections of the tubular bodies 12, 14 and of the bridge 16, by selecting different fluids, and by selecting modes of operation as described hereinabove for example.

[0066] As illustrated in Figures 3 to 5, heat exchangers 10a,10b, 10c... may be connected together in series (see for example Figure 3) or in parallel (see for example Figures 4 and 5) using U-tubes 22 for fluid circulation between the heat exchangers, for scalability of the thermodynamic exchanges depending on target applications.

[0067] In Figure 4 for example, the assembly is immersed in a phase change material (F) acting as a battery.

[0068] The heat exchanger 10, or an assembly thereof, is connected to an external circulation system by connectors 24, as shown for example in Figures 3 and 5. A fluid supply manifold 26, as shown for example in Figures 6 and 7, may be used for connection to the external circulation system.

[0069] In Figure 7, the assembly of Figure 5 is mounted with the manifold shown in Figure 6 and positioned in a tank placed inside an assembled tank.

[0070] In another embodiment illustrated for example in Figure 8, a heat exchanger 100 comprises three tubular bodies 112, 114, 116, connected two by two by bridges 118, 120, 122 shown as central tubular bodies 118, 120, 122. Again, radially surrounding fins 18 may be provided on the external walls of these cavities 112, 114, 116, 118, 120 and 122. When seen in section, as in Figure 8, the heat exchanger 100 has a triangular cross-section, the three lateral tubular bodies 112, 114, 116 defining the three edges of the triangular cross-section of the heat exchanger 100, and the bridges as central tubular bodies 118, 120, 122 defining the three sides of the triangular cross-section of the heat exchanger 100.

[0071] For example, a fluid may be flowing within the tubular bodies 112, 114, 116 and a solid-liquid phase may be partially flowing or not within the central tubular bodies 118, 120, 122.

[0072] As some phase change materials may be more efficient for heat extraction than for heat accumulation, a configuration as shown in Figure 7 allows using two lateral tubular bodies for accumulating heat and one lateral tubular body for extracting heat, thereby achieving a desired performance.

[0073] Flowing fluids may have counterflow or parallel flows within the lateral tubular bodies.

[0074] Other embodiments of a heat exchanger comprising for example four lateral tubular bodies connected two by two by thermal bridges may be contemplated, for ease of manufacturing and / or to increase the thermal exchange with the external fluid and/or to accommodate higher flow rates.

[0075] The heat exchanger is a one-piece unit. It may be made of extruded aluminum or aluminum alloy for example.

[0076] Assemblies formed by one-piece heat exchangers of the present invention or interconnected assemblies thereof may be used in a number of applications, for example in systems recovering heat from industrial processes.

[0077] An application in systems for recovering solar energy by solar energy concentration, for example, is illustrated in relation to Figures 9 and 10.

[0078] Figure 9 shows an installation comprising a system (S) for recovering solar energy by solar energy concentration, with a battery of parabolic solar collectors 70, as a complementary energy system for an industrial dairy plant (P) for example, and installed on the roof of the plant (Figure 10).

[0079] The battery of parabolic solar collectors on the roof is connected to a heat storage system 200 by means of tubular connection 300 (see insert Figure 9). The heat storage system 200 comprises a module 80 of heat exchanger units of the present invention as described hereinabove.

[0080] A tubular connection 40 feeds the battery of parabolic solar connectors with cold fluid coming, in this example, from the plant (P). A tubular connection 50 connects the heat storage system 200 with the plant (P) and feeds the plant (P) with heated fluid.

[0081] A pump and expansion tank system 60 ensures the circulation of the fluids in the tubular connections 40 and 50 and absorbs volumes expansion according to the temperature of the fluids circulating in tubular connections 40 and 50.

[0082] There is provided a one-piece radiator/heat exchanger unit comprising of lateral tubes and central tubes for heat exchange between a first fluid, flowing or not flowing inside one of the lateral or central tubes, and a second fluid, flowing or not flowing, outside one of said tubes, each of the tubes having a cross-section, walls and a pair of ends, the lateral tubes being symmetrically positioned adjacent to the central tubes, the axis of each the tubes being about parallel and positioned about the same plan or positioned in about parallel plans, each of the lateral tubes sharing a common wall with at least one of the central tubes and the lateral tubes being, at least two by two, connected by the walls of the central tubes that are not shared with the lateral tubes.

[0083] The one-piece radiator/heat exchanger unit comprises lateral tubes are configured for the circulation or for the non-circulation of a liquid and/or for the circulation or for the non-circulation of a solid and/or for the circulation or for the non-circulation of a gaseous phase, and the central tube is configured for the circulation or for the non-circulation of a gaseous and/or for the circulation or the non-circulation of a fluid phase and/or for the circulation or the non-circulation of a solid phase.

[0084] Parts of the external walls of the tubes that are not common to other of the tubes are equipped with fins, which may be symmetrically distributed on the surface of the external wall of the tubes.

[0085] The cross-section of the lateral tubes is about circular and the cross-section of the central tube is about rectangular.

[0086] The one-piece radiator/heat exchanger unit may comprise 3 tubes for heat exchange between a first fluid, flowing or not flowing, inside the tubes and a second fluid, flowing or not flowing, outside the tubes, each of the tubes having a cross-section and a pair of ends, 2 of the tubes (the lateral tubes) being symmetrically positioned adjacent to the 3 third tube (the central tube), the 3 tubes having axes that are about parallel and positioned about the same plan, each of the 2 lateral tubes sharing a common wall with the central tube and the 2 opposite lateral tubes being connected by the 2 walls of the central tube that are not shared with the 2 lateral tubes; for example the 2 lateral tubes are configured for the circulation of a fluid and the rectangular tube is configured for the partial circulation or non-circulation of a solid liquid-phase.

[0087] The one-piece radiator/heat exchanger unit may comprise 6 tubes for heat exchange between a first fluid, flowing or not flowing, inside the tubes and a second fluid, flowing or not flowing, outside the tubes, each of the tubes having a cross-section and a pair of ends, 3 of the tubes (the lateral tubes) being symmetrically positioned adjacent to 2 of the other 3 tubes (the central tube), the 6 tubes having axes that are about parallel and positioned in parallel plan, each of the 3 lateral tubes sharing a common wall with each of the 2 adjacent central tubes and 2 opposite lateral tubes being connected by the 2 walls of the central tube that are not shared with the 2 lateral tube, the section of the 3 lateral tubes defining the 3 edges of the triangular cross-section of the one-piece radiator/heat exchanger unit and the section of the central tubes defining the 3 sides of the triangular cross-section of the one-piece radiator/heat exchanger unit. The heat exchanger unit comprises a central triangular tube, the 3 walls of the central triangular tube being walls of the 3 rectangular tubes directed in direction of the center of the triangular section of the one-piece radiator/heat exchanger unit. The common shared wall may be curved.

[0088] Flat walls surrounding the at least three cavities, that are perpendicular to the external surfaces of each tube to which they are connected with, act like longitudinal fins thereby promoting direct exchange area between the walls that are metal walls and the fluid circulating outside the walls of the radiator / heat exchanger. The radiator/heat exchanger may be immersed in a third fluid that may be used as a heat buffer.

[0089] For extrusion purposes, at least the width W of the rectangular section of the central tube may represent about 1,5 to 2,5 the diameter of the circular section of each of the at least 2 lateral tubes; the width of the rectangular section of the central cavity may represent about half the diameter of the circular section of each of the 2 lateral cavities; the width of the flat walls surrounding the at least three cavities, are about the diameter of the circular section of each of the at least 2 lateral cavities and/or the width of the flat walls surrounding the at least three cavities, are about 1 to 1.5 the width of the rectangular section of the central cavity.

[0090] The heat exchanger unit may be made of extruded aluminum.

[0091] Radiator/heat exchanger series are provided, which include at least n one-piece radiator/heat exchanger units, wherein each of the one-piece radiator/heat exchanger units being connected with two other adjacent one-piece radiator/heat exchanger units, at the exception of each of the 2 end one-piece radiator/heat exchanger units assuring the connection with an external circulation system. The connection between two adjacent one-piece radiator/heat exchanger units may be performed by connecting the ends of the external tubes, by a U-tube for example; or by the volume defined by the external walls of the radiator/heat exchanger units and the wall of a tank in which the radiator/heat exchanger series are positioned.

[0092] The fluid circulating in a lateral tube may be a heat transfer liquid, the fluid present in the bridge may be a component such as a polyol, for example mannitol, presenting a solid-liquid phase transition under the use conditions, and the fluid outside the external wall of each one-piece radiator/heat exchanger units may be a component such as a polyol, for example mannitol, presenting a solid-liquid phase transition under the use conditions; the fluid in the rectangular tubular bridge may be the same as the fluid outside the external wall of each one-piece radiator/heat exchanger units and, the tubular bridges and the volume outside the external wall of each one-piece radiator/heat exchanger units may communicate.

[0093] In a series, the one-piece radiator/ heat exchanger units are positioned side-by-side.

[0094] Series of interconnected one-piece radiator/heat exchangers may be assembled in modules of a multiplicity of series, the series being connected in series or in parallel in order to increase the thermodynamic exchanges.

[0095] The radiator/ heat exchanger series are maintained in contact by using connecting means such as connecting road.

[0096] A connector may be used for the connection between the radiator/heat exchanger module and a fluid supply such as XCELTHERM® Grade 500 type.

[0097] The radiator/ heat exchanger series may be held in position by welding and/or threading and/or by a manifold connecting the radiator/ heat exchanger series to the fluid supply.

[0098] The one-piece radiator/heat exchanger unit and/or a radiator/ heat exchanger series and/or a module of radiator/ heat exchanger series may be used for the reversible storage of heat energy, for example in the solar industry and/or in the food industry.

[0099] The radiator/heat exchanger unit may be made by using as extrusion, melding and/or screwing.

[00100] As people in the art will appreciate, the heat exchanger of the present invention may be used as a scalable and tunable radiator / heat exchanger. It may use one or two dynamic fluids and another static or dynamic fluid as an immersing medium. Its thermal storage capacity is adjustable by using various combinations of immersing medium in which it is immersed, bridges and tubular bodies. It allows staged heat transfer.

[00101] A heat exchanger of the present invention with longitudinal fins may be manufactured by extrusion, at reduced manufacturing costs, and allowing mass production in a range of sizes and

lengths.

[00102] The simplicity of the heat exchanger and assemblies of units results in a reduced number of required mounting operations.

[00103] The present heat exchanger may be used for the reversible storage of heat energy, for example in the solar industry and/or in the food industry.

[00104] In a radiator mode, the present heat exchanger allows direct thermal exchange from two similar fluids circulating in tubular bodies with a surrounding medium. This mode can be regarded as 100% thermal dumping or 100% thermal extraction by the same unit.

[00105] In a direct heat exchanger mode, the present heat exchanger may be used for a direct thermal exchange between fluids in tubular members, through walls connecting the tubular members.

[00106] In a hybrid mode, the present heat exchanger may be used for a staged heat transfer between three fluids for example, i.e. between a primary fluid flowing in a first tubular body and a secondary fluid flowing in a second tubular body, and between the first and second fluids and the external medium.

[00107] As people in the art will now be in a position to appreciate, the present heat exchanger may be operated with a range of fluids, including for example oil, water, glycol, etc..... Various immersing materials, gas, solid phase change material etc ... may be used.

[00108] The present heat exchanger may be made in a range of materials, including for example metal, plastic and composite.

[00109] The present heat exchanger can be used with a solar concentrator.

[00110] The scope of the claims should not be limited by the embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

CLAIMS

1. A one-piece radiator/heat exchanger unit comprising of lateral tubes and central tubes for heat exchange between a first fluid, flowing or not flowing inside one of said lateral or central tubes, and a second fluid, flowing or not flowing, outside one of said tubes, each of the tubes having a cross-section, walls and a pair of ends, the said lateral tubes being symmetrically positioned adjacent to the said central tubes, the axis of each said tubes being about parallel and positioned about the same plan or positioned in about parallel plans, each of the lateral tubes sharing a common wall with at least one of the central tubes and the lateral tubes being, at least two by two, connected by the walls of the central tubes that are not shared with the said lateral tubes.

2. A one-piece radiator/heat exchanger unit according to claim 1, wherein :
- the lateral tubes are configured :
  - for the circulation or for the non circulation of a liquid and/or
  - for the circulation or for the non circulation of a solid and/or
  - for the circulation or for the non circulation of a gaseous phase, and
- the central tube is configured for the circulation or for the non circulation of a gaseous and/or for the circulation or the non circulation of a fluid phase and/or for the circulation or the non circulation of a solid phase.

3. A one-piece radiator/heat exchanger unit according to claims 1 and 2, wherein the parts of walls of said tubes that are not common to other of said tubes are equipped with fins, which are preferably symmetrically distributed on the surface of said external wall of said tubes.

4. A one-piece radiator/heat exchanger unit according to anyone of claims 1 to 3 wherein the cross-section of the lateral tubes is about circular and the cross-section of the central tube is about rectangular.

5. A one-piece radiator/heat exchanger unit according to anyone of claims 1 to 4, comprising 3 tubes for heat exchange between a first fluid, flowing or not flowing, inside the tubes and a second fluid, flowing or not flowing, outside the tubes, each of the tubes having a cross-section and a pair of ends, the lateral tubes being symmetrically positioned adjacent to the

central tube, the 3 tubes having axes that are about parallel and positioned about the same plan, each of the 2 lateral tubes sharing a common wall with the central tube and the 2 opposite lateral tubes being connected by the 2 walls of the central tube that are not shared with the said 2 lateral tubes; preferably the 2 lateral tubes are configured for the circulation of a fluid and the rectangular tube is configured for the partial circulation or non circulation of a solid liquid-phase.

6. A one-piece radiator/heat exchanger unit according to anyone of claims 1 to 4, comprising six tubes for heat exchange between a first fluid, flowing or not flowing, inside the tubes and a second fluid, flowing or not flowing, outside the tubes, each of the tubes having a cross-section and a pair of ends, three lateral tubes being symmetrically positioned adjacent to two of three central tubes, the six tubes having axes that are about parallel and positioned in parallel plan, each of the three lateral tubes sharing a common wall with each of the two adjacent central tubes and two opposite lateral tubes being connected by the two walls of the central tube that are not shared with the said two lateral tube, the section of the three lateral tubes defining the three edges of a triangular cross-section of said one-piece radiator/heat exchanger unit and the section of the central tubes defining the three sides of the triangular cross-section of said one-piece radiator/heat exchanger unit.

7. A one-piece radiator/heat exchanger unit, according to claim 6, comprising a central triangular tube, the three walls of said central triangular tube being walls of the three rectangular tubes directed in direction of the center of the triangular section of said one-piece radiator/heat exchanger unit.

8. A one-piece radiator/heat exchanger unit according to any one of claims 5 and 6, wherein the common shared wall is curved.

9. A one-piece radiator / heat exchanger according to anyone of claims 3 to 8, wherein flat walls surrounding at least three cavities, that are preferably perpendicular to the external surfaces of each tube to which they are connected with, act like longitudinal fins thereby promoting direct exchange area between the walls that are preferably metal walls and the fluid circulating outside the walls of said radiator / heat exchanger.

10. A one-piece radiator/heat exchanger according to claim 9, wherein said radiator/heat

exchanger can be immersed in a third fluid that may be used as a heat buffer.

11. A one-piece radiator/heat exchanger according to anyone of claims 4 to 10, wherein at least the length (L) of a rectangular section of the central tube represents about 1,5 to 2,5 the diameter (d) of the circular section of each of the at least 2 lateral tubes.

12. A one-piece radiator/heat exchanger according to anyone of claims 4 to 11, wherein the width of a rectangular section of the central cavity represents about half the diameter of the circular section of each of the 2 lateral cavities.

13. A one-piece radiator/heat exchanger according to anyone of claims 4 to 12, wherein the width of flat walls surrounding the at least three cavities, are about the diameter of the circular section of each of at least 2 lateral cavities.

14. A one-piece radiator/heat exchanger according to anyone of claims 4 to 13, wherein the width (w) of flat walls surrounding the at least three cavities, are about 1 to 1.5 the width of the rectangular section of a central cavity.

15. A one-piece radiator/heat exchanger according to anyone of claims 1 to 14, made of extruded aluminum.

16. A radiator/heat exchanger series, which includes at least n one-piece radiator/heat exchanger units as defined in anyone of claims 1 to 15, wherein each of the one-piece radiator/heat exchanger units being connected with two other adjacent one-piece radiator/heat exchanger units, at the exception of each of the 2 end one-piece radiator/heat exchanger units assuring the connection with an external circulation system.

17. A radiator/heat exchanger series according to claim 16, wherein the connection between two adjacent one-piece radiator/heat exchanger units is performed by :
    - connecting the ends of the external tubes, the connection being preferably a U-tube; and
    - the volume defined by the external walls of said radiator/heat exchanger units and the wall of a tank wherein said radiator/heat exchanger series are positioned.

18. A radiator/heat exchanger series according to anyone of claims 13 to 17, wherein the fluid circulating in the left lateral tube is a heat transfer liquid, the fluid present in the central tube being a component (preferably a polyol, more preferably mannitol) presenting a solid-liquid phase transition under the use conditions, and the fluid outside the external wall of each one-piece radiator/heat exchanger units is a component, preferably a polyol, more preferably mannitol, presenting a solid-liquid phase transition under the use conditions; preferably the fluid in the rectangular tube is the same as the fluid outside the external wall of each one-piece radiator/heat exchanger units and, more preferably, the rectangular tubes and the volume outside the external wall of each one-piece radiator/heat exchanger units communicate.

19. A radiator/ heat exchanger series according to anyone of claims 16 to 18, wherein the one-piece radiator/ heat exchanger units are positioned side-by-side.

20. A radiator/ heat exchanger series according to claim 19, wherein the one-piece radiator/ heat exchanger units are positioned side-by-side as represented on Figure 19.

21. A radiator/ heat exchanger series according to claim 17, which includes 5 radiator/ heat exchanger units positioned side by side.

22. A module consisting of a multiplicity of series of interconnected one-piece radiator/heat exchanger as defined in anyone of claims 16 to 21, which series being connected in series or in parallel in order to increase the thermodynamic exchanges.

23. A module according to claim 22, wherein the radiator/ heat exchanger series are maintained in contact by using connecting means such as connecting road.

24. A module according to claims 22 or 23, wherein a connector allows the connection between the radiator/heat exchanger module and a fluid supply that is preferably of the XCELTHERM® Grade 500 type.

25. A module according to anyone of claims 22 to 24, wherein the radiator/ heat exchanger series are held in position preferably by welding and/or threading and/or by a manifold

connecting said the radiator/ heat exchanger series to the fluid supply.

26. A system for recovering solar energy by solar energy concentration, comprising at least one parabolic solar collector connected to at least one heat exchanger unit of claim 1.

27. The system of claim 26, comprising:

- a concentrating solar dish unit assembly having a rotational axis, which solar dish unit assembly comprises at least:

- one rigid parabolic self-supporting solar collector system comprising at least one solar mirror, at least one heat transfer collector positioned above the concave part of said supporting solar collector and to receive light reflected from said parabolic solar collector, said heat transfer collector being connected, preferably in a rigid way, to the said parabolic self-supporting solar collector,

- one structural rotational system configured for positioning, by rotation around said rotational axis, the rigid parabolic self supporting solar collector system in an optimised positioning relative to the positioning of the solar beam at the place; and

- preferably one solar beam detection system configured to analyse the specification, such as the positioning and such as the intensity, of the solar beam at the place and to send optimised positioning parameters to said structural rotational system, said solar beam detection system being preferably positioned on a edge of the lateral side solar mirror;

- a heat storage system configured to receive, store and provide, when required, the heat energy collected through a thermal fluid circulating through said heat transfer collector; and

- means for circulating the heat transfer fluid from said at least one heat transfer collector to the said heat storage system unit and/or means for circulating a heat transfer fluid heated in the said heat storage system to an exterior element to be heated; the heat transfer fluids being preferably the same.

28. The system of claim 26, comprising a rigid self-supporting solar collector comprising at least one parabolic reflector and at least one heat collector rigidly supported above a reflective surface of said parabolic reflector; wherein said parabolic reflector comprises a first outer metallic sheet coated with a reflective layer on an outer surface thereof, an inner layer, and a second outer metallic sheet, said outer metallic sheets and said inner layer being assembled together and shaped into a unitary parabolic shape and reinforced with

longitudinal and lateral rails.

29. The system of claim 26, comprising a rigid self-supporting solar collector comprising at least one parabolic reflector and at least one heat collector rigidly supported above a reflective surface of said parabolic reflector; wherein said parabolic reflector comprises a first outer metallic sheet coated with a reflective layer on an outer surface thereof, an inner layer of a honey comb structure, and a second outer metallic sheet, said outer metallic sheets and said inner layer of a honey comb structure being assembled together and shaped into a unitary parabolic shape and reinforced with longitudinal and lateral rails.

30. The system of claim 26, comprising a solar concentrator, comprising:

at least one rigid self-supporting solar collector comprising at least one parabolic reflector and at least one heat collector rigidly supported above a reflective surface of said parabolic reflector; and

a positioning unit configured for positioning said solar collector into an operational position for reception of solar beams by said parabolic reflector, said parabolic reflector focusing the solar beams onto the heat collector, and into a rest position in which said reflective surface of said parabolic reflector and said heat collector are at least partly under cover of a back surface of said parabolic reflector.

31. The system of claim 30, wherein said positioning unit comprises wheels mounted on supports for rotation on at least 180°.

32. The system of claim 30, wherein said positioning unit comprises wheels mounted on supports for rotation on at least 210°.

33. The system of any one of claims 30 to 32, wherein said parabolic reflector comprises a first outer metallic sheet coated with a reflective layer on an outer surface thereof, an inner layer, and a second outer metallic sheet, said outer metallic sheets and said inner layer being assembled together and shaped into a unitary parabolic shape and reinforced with longitudinal and lateral rails.

34. The system of claim 33, wherein said inner layer has a honeycomb structure.

35. The system of claim 33, wherein said inner layer is made in a polymer.

36. The system of any one of claims 30 to 35, wherein said positioning unit comprises wheels and said parabolic reflector is supported by bow arms extending across said wheels.

37. The system of any one of claims 31, 32 and 36, wherein said supports comprise adjustable side arms to modify orientation and height of the wheels.

38. The system of any one of claims 30 to 37, wherein said heat collector is a tubular member made in a thermally conductive structural material, resistant to pressures of at least 80 bars, with a high absorbency/low emissivity surface.

39. The system of claim 38, wherein said heat collector is a stainless steel tube with a metallic coating of absorbance of about 0.95 and emissivity of about 0.15.

40. The system of any one of claims 30 to 39, wherein said heat collector comprises an inner tube for fluid circulation and an outer tube, vacuum being maintained between said inner tube and said outer tube.

41. The system of any one of claims 30 to 40, wherein said heat collector is maintained on the focal line of the parabolic reflector by at least one supporting arm.

42. The system of claim 41, wherein said supporting arm is connected to the heat collector at a first end thereof by a connecting member comprising a ring part adapted to be positioned about the heat collector and tabs adapted to be secured on sides of the supporting arm.

43. The system of any one of claims 41 and 42, wherein said supporting arm is connected to the heat collector at a first end thereof and to the parabolic reflector at a second end thereof.

44. The system of claim 43, wherein the supporting arm is further held into position by cables tensioned between its first end and edges of the parabolic reflector.

45. The system of any one of claims 30 to 44, wherein said heat collector comprises at least two heat collector members connected in series using a joint, said joint comprising:

a first tubular fitting receiving an extremity of a first tubular member and a second tubular fitting receiving an extremity of a second tubular member, said first and said second fittings coming into abutment;

half rings clipping around said abutting first and second tubular fittings; and

a sleeve, said sleeve maintaining a clipping engagement of the half rings about said abutting first and second tubular fittings and tubular members.

46. The system of claim 456, wherein said joint allows a coaxial movement of said heat collector within said sleeve.

47. The system of claim 46, wherein said supporting arm is connected to said heat collector by a connecting element engaging said sleeve.

48. The system of any one of claims 31 and 32, wherein longitudinal edges of the parabolic

reflector are reinforced by longitudinal rails connected at a back of the parabolic reflector to a spinal rail, said longitudinal and said spinal rails connecting together said wheels, and said heat collector is rigidly connected to the parabolic reflector by supporting arms attached to the heat collector and to the spinal rail.

49.The system of claim 48, wherein said spinal rail is connected to said longitudinal rails at the back of the parabolic reflector by vertical members connected together by diagonal members.

50. The system of any one of claims 30 to 49, further comprising a control unit controlling said positioning unit, said control unit comprising a solar tracker and a processor configured to send positioning instructions to a motor powering said positioning unit.

51. The system of any one of claims 30 to 49, further comprising a control unit controlling said positioning unit, wherein said control unit comprises a processor configured to receive sun position data from a remote database and to send positioning instructions to a motor powering said positioning unit.

52. The system of any one of claims 30 to 49, further comprising a control unit controlling said positioning unit, wherein the control unit comprises a solar tracker and a processor configured to receive sun position data from a remote database and from said solar tracker, and to send positioning instructions to a motor powering said positioning unit.

53. The system of any one of claims 26 to 52 comprising an assembly of heat exchangers.

54. The system of any one of claims 26 to 52 comprising a battery of parabolic solar collector.

55. A heat exchanger, comprising:

at least a first and a second tubular bodies, a first fluid flowing within said first tubular body and a second fluid flowing within said second tubular body; and

a bridge thermally linking said first and second tubular bodies;

wherein said bridge is a third tubular body, said first and said third tubular bodies having a common wall therebetween, said second and said third tubular bodies having a common wall therebetween, and

wherein said first and second tubular bodies have generally circular cross sections and said third tubular body has a generally flattened cross section.

56. A heat exchanger, comprising three lateral tubular bodies and three bridges, said brides being central tubular bodies thermally linking said lateral tubular bodies two by two,

wherein said lateral tubular bodies have generally circular cross sections and said central tubular bodies have generally flattened cross sections.

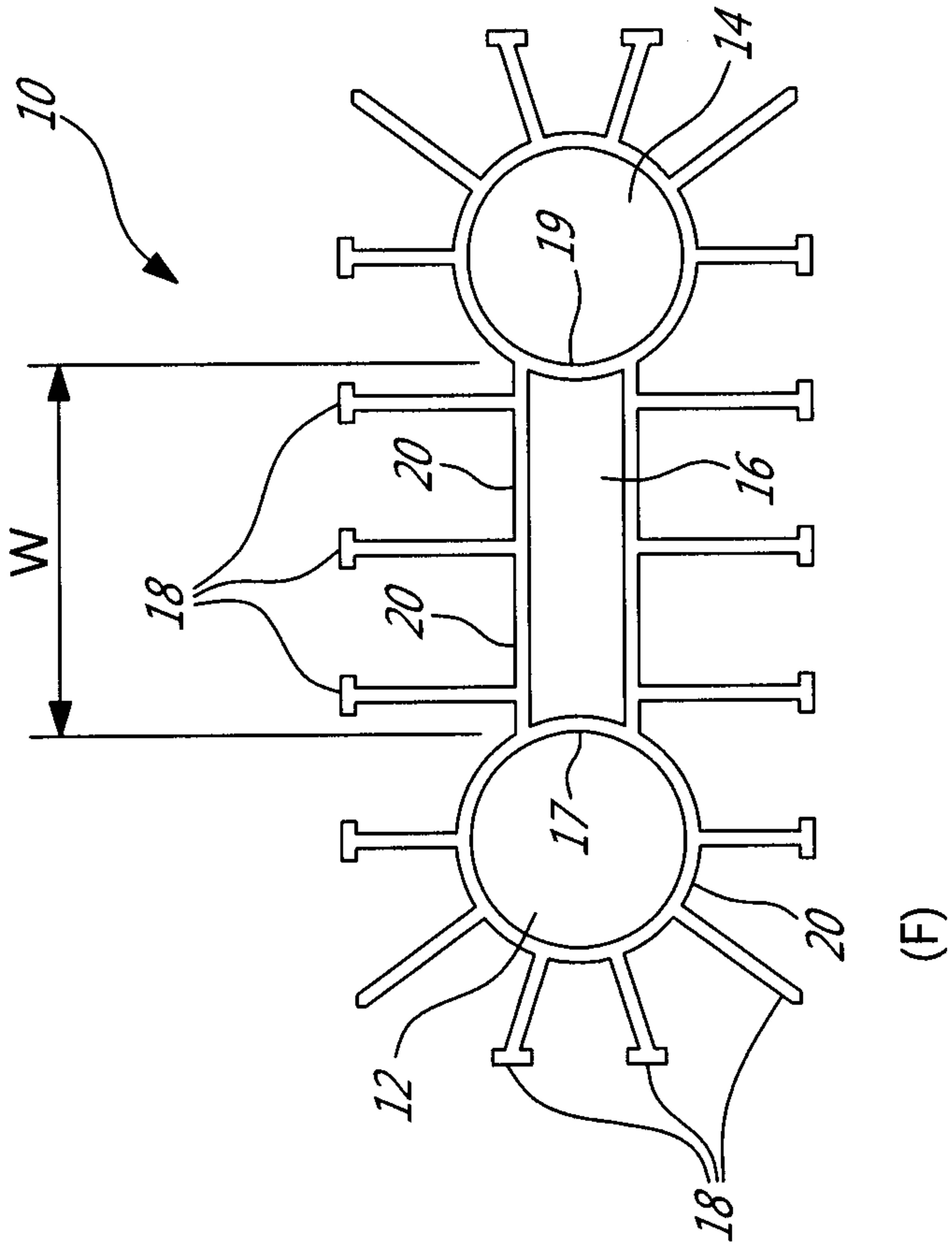


Fig-1B

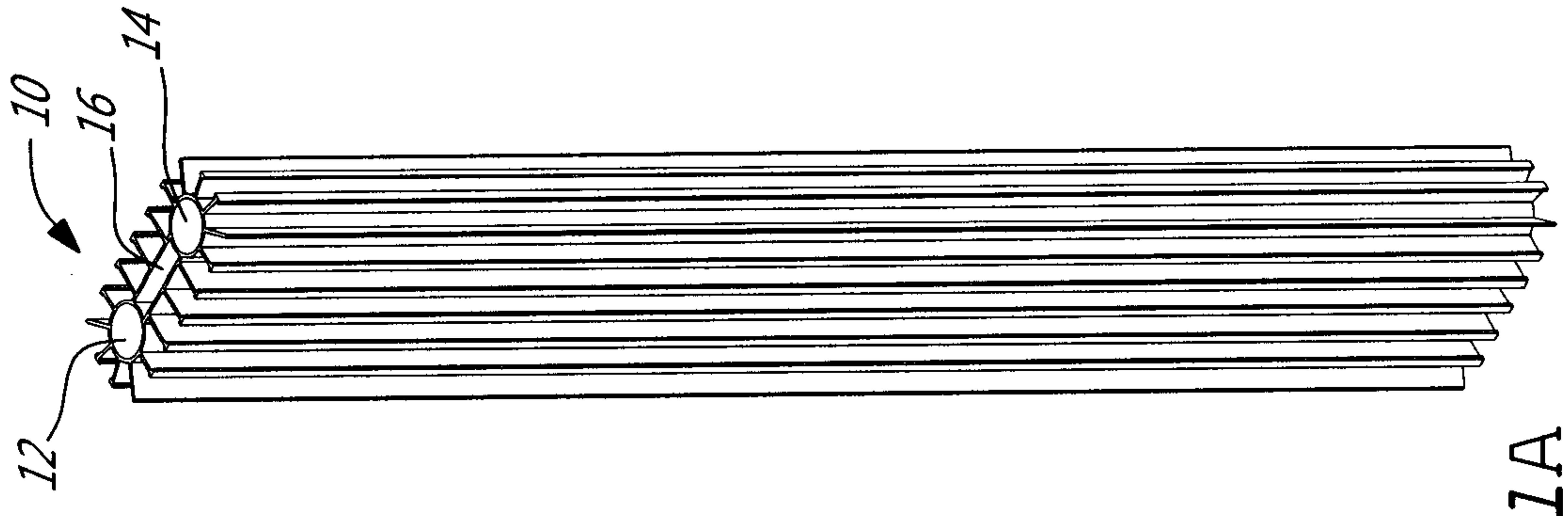


Fig-1A

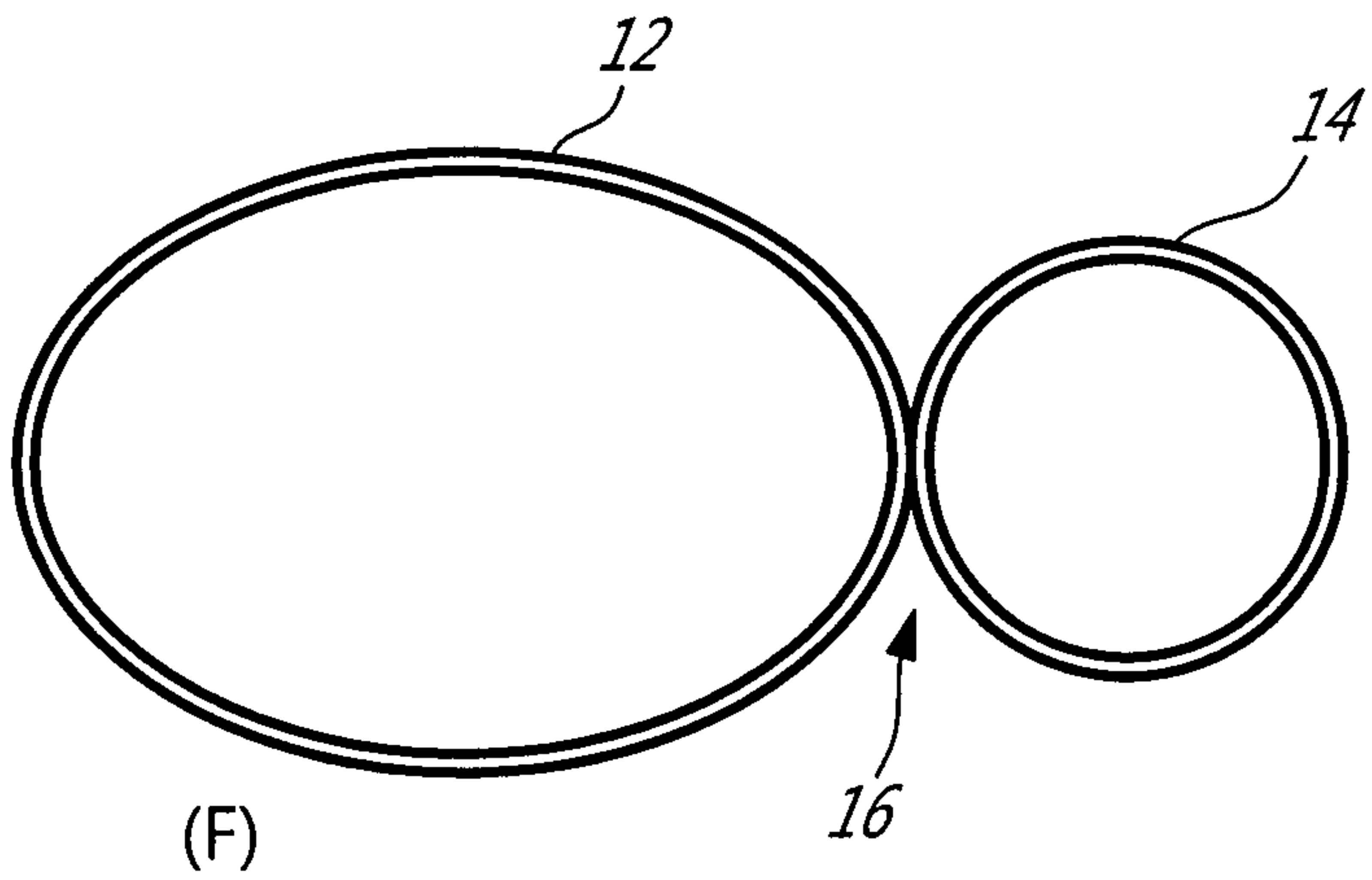


Fig-1C

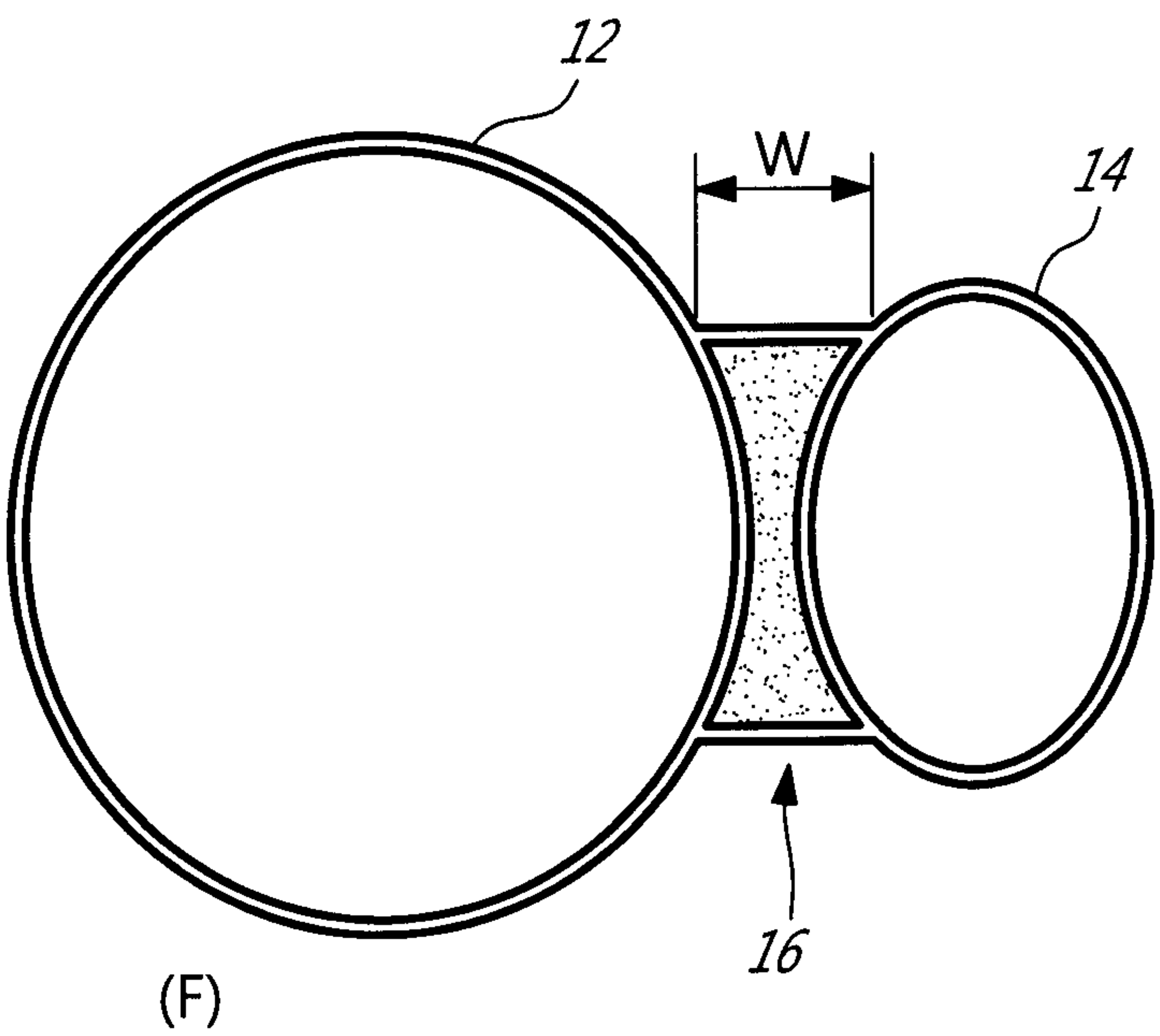


Fig-1D

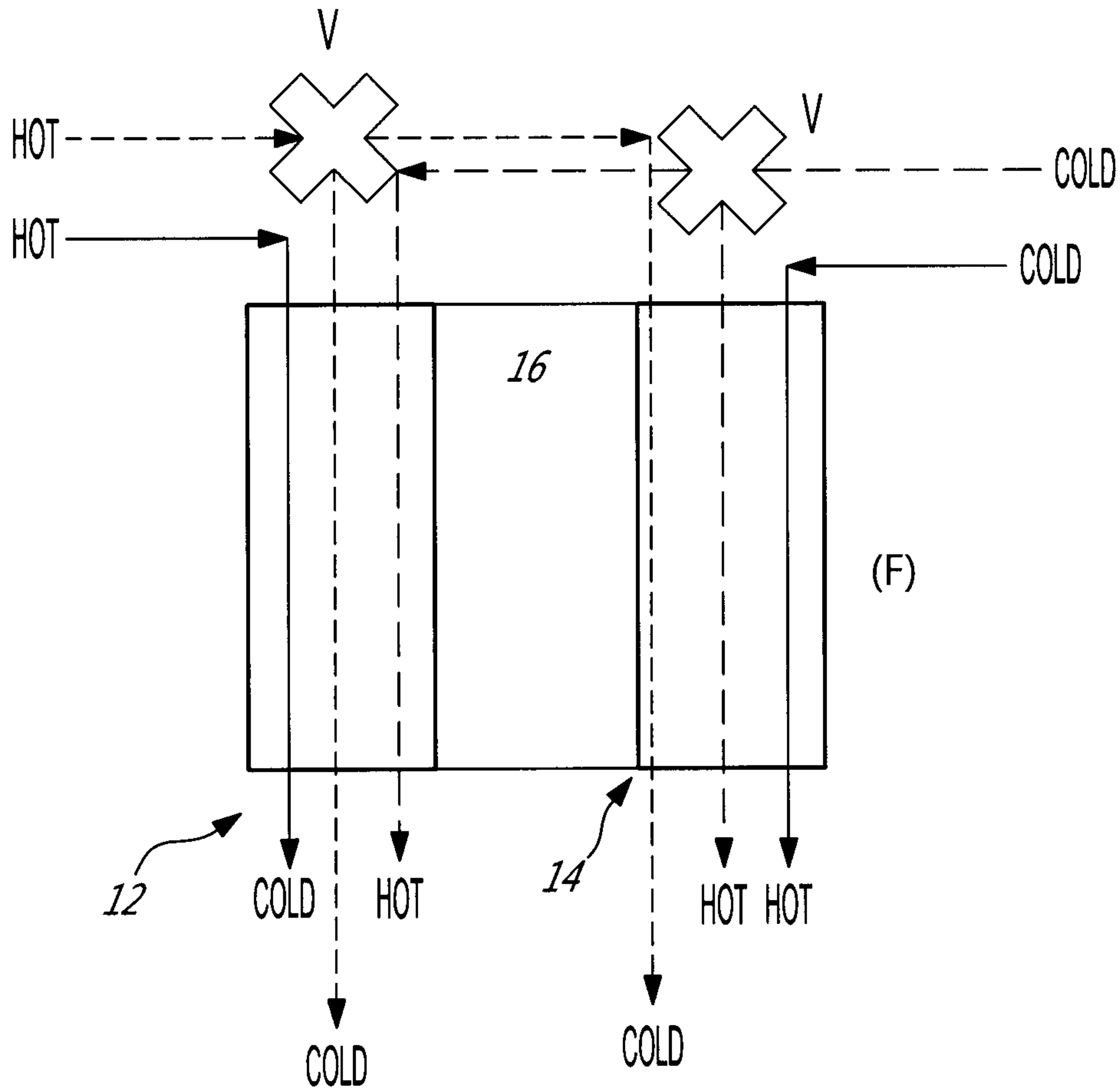


Fig-2

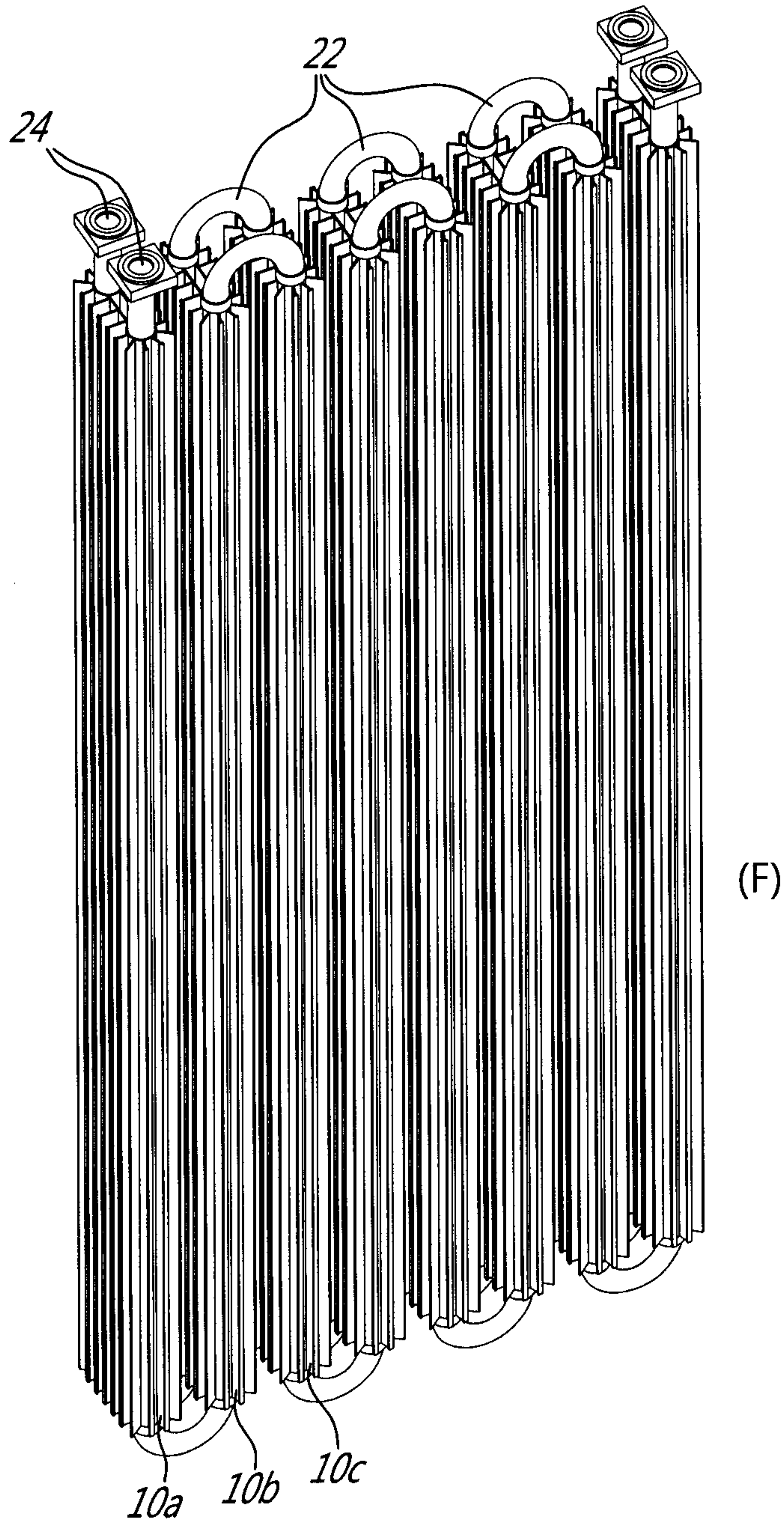


Fig-3

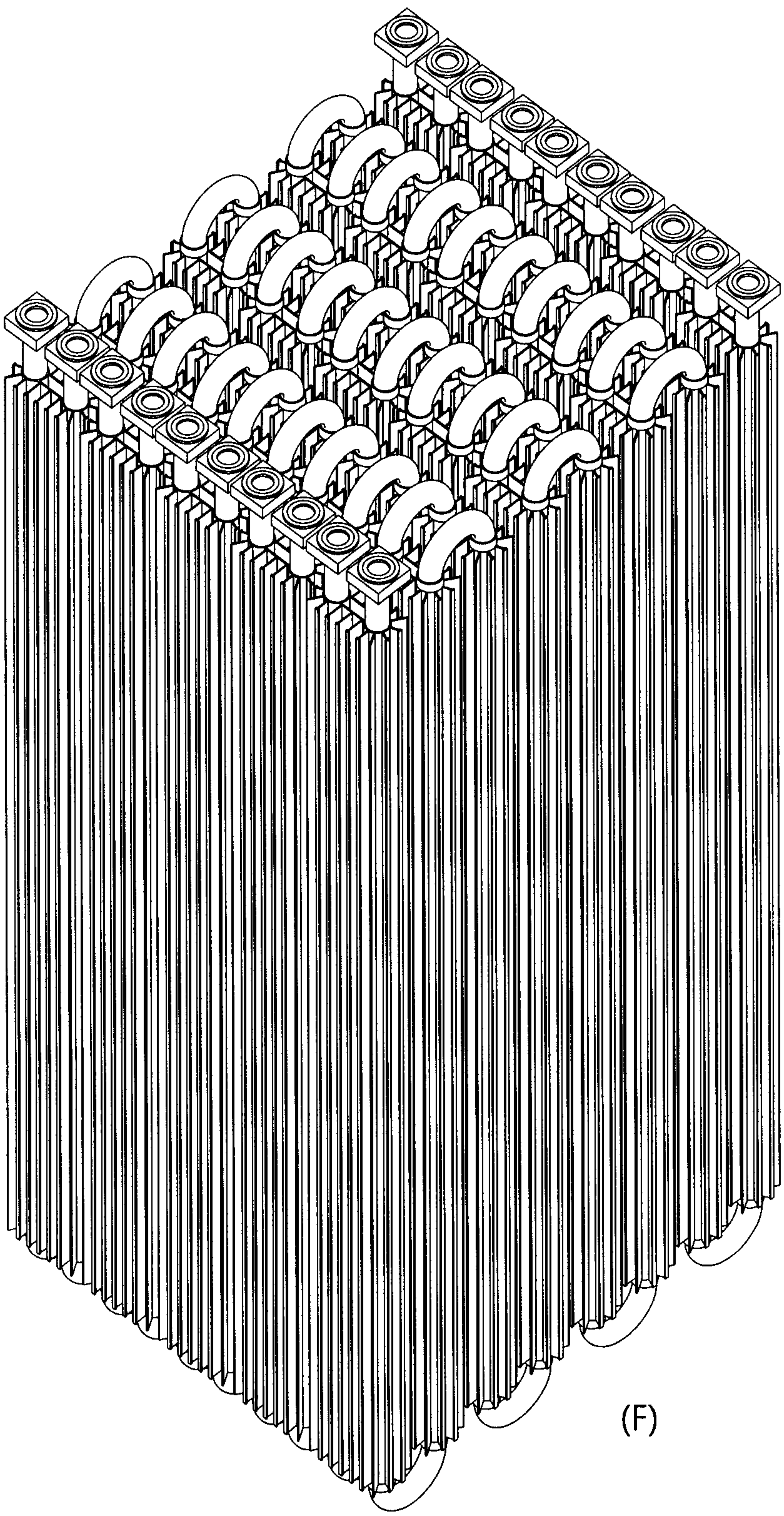


Fig-4

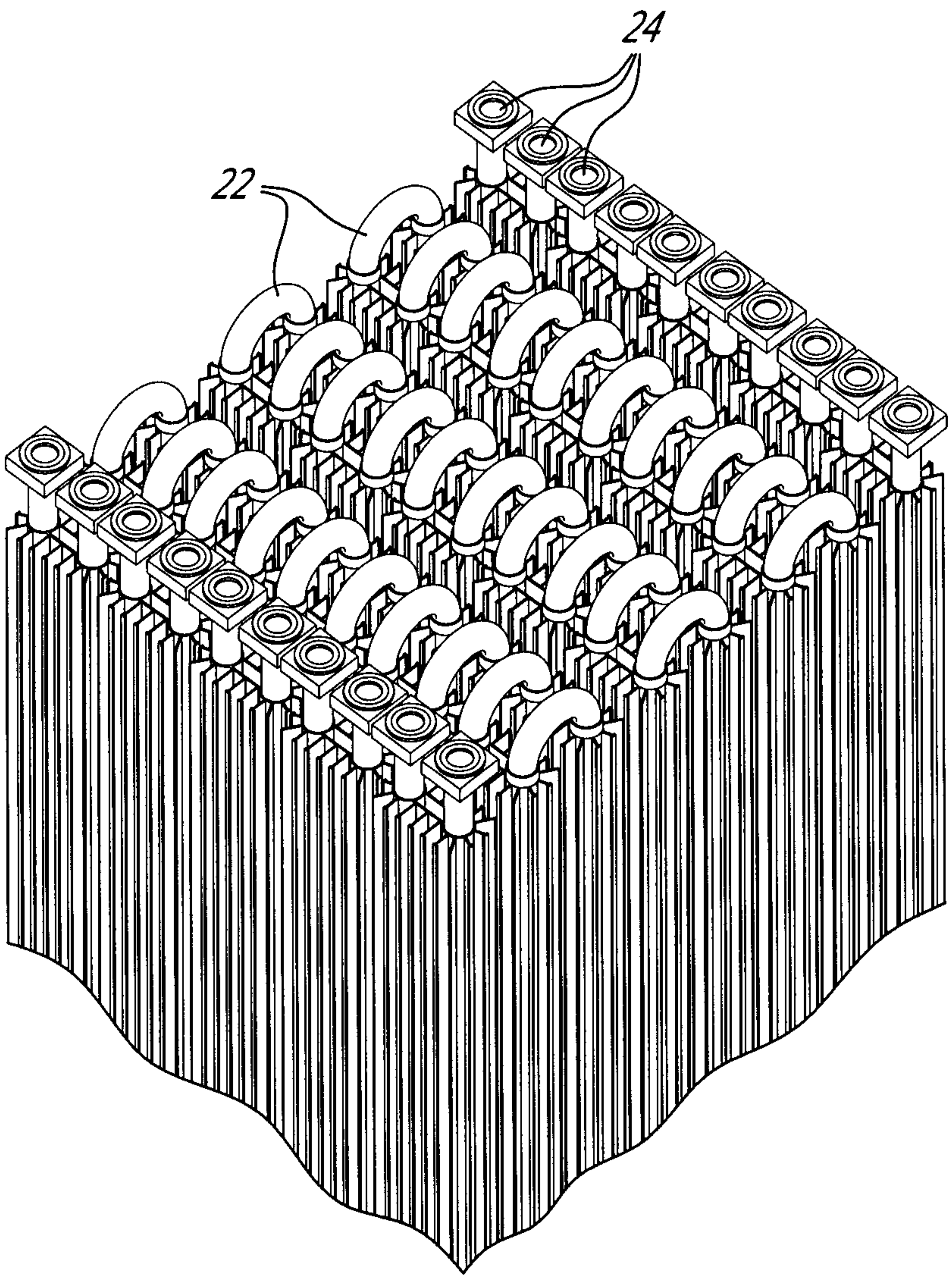


Fig- 5

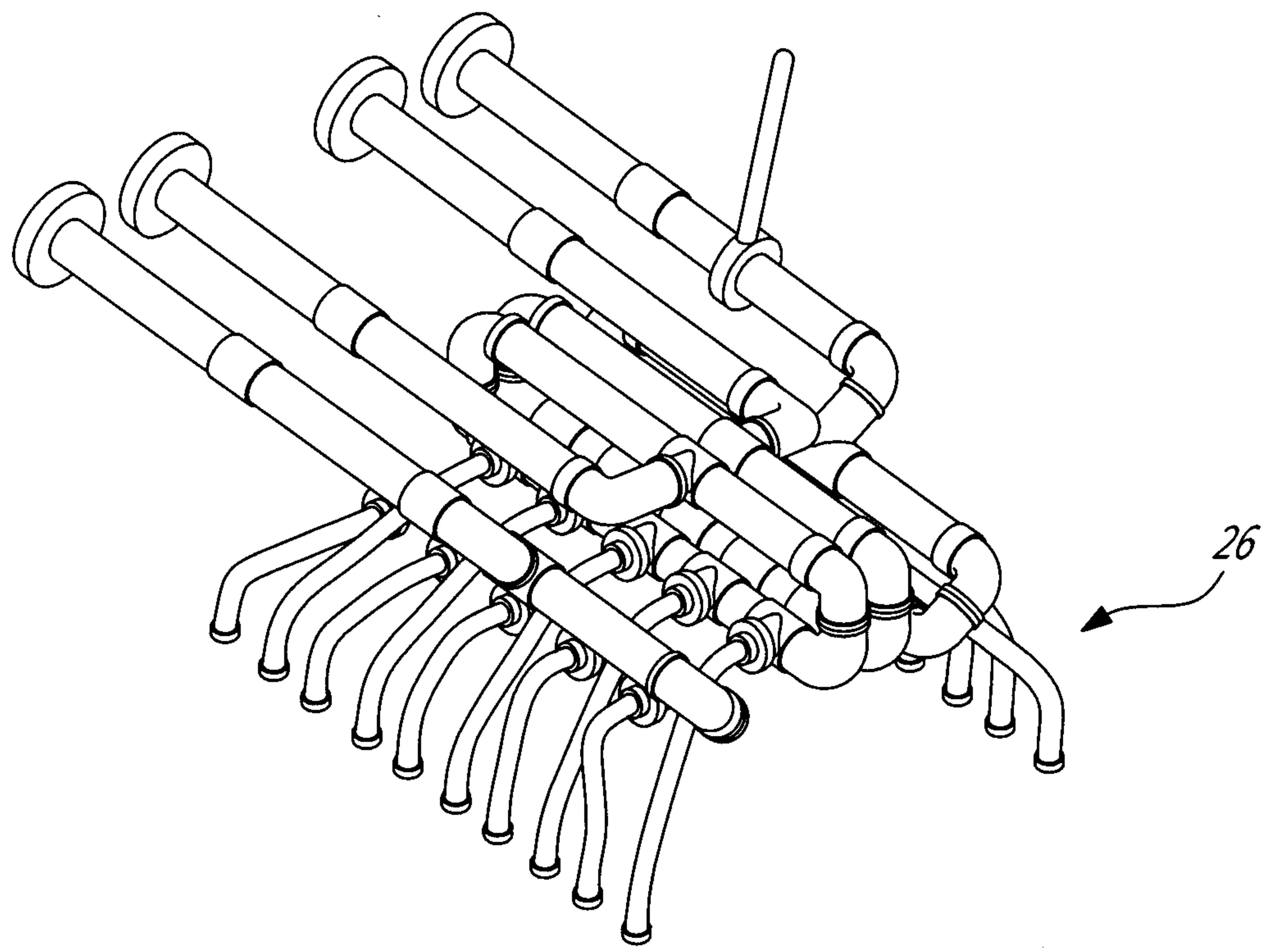


Fig- 6

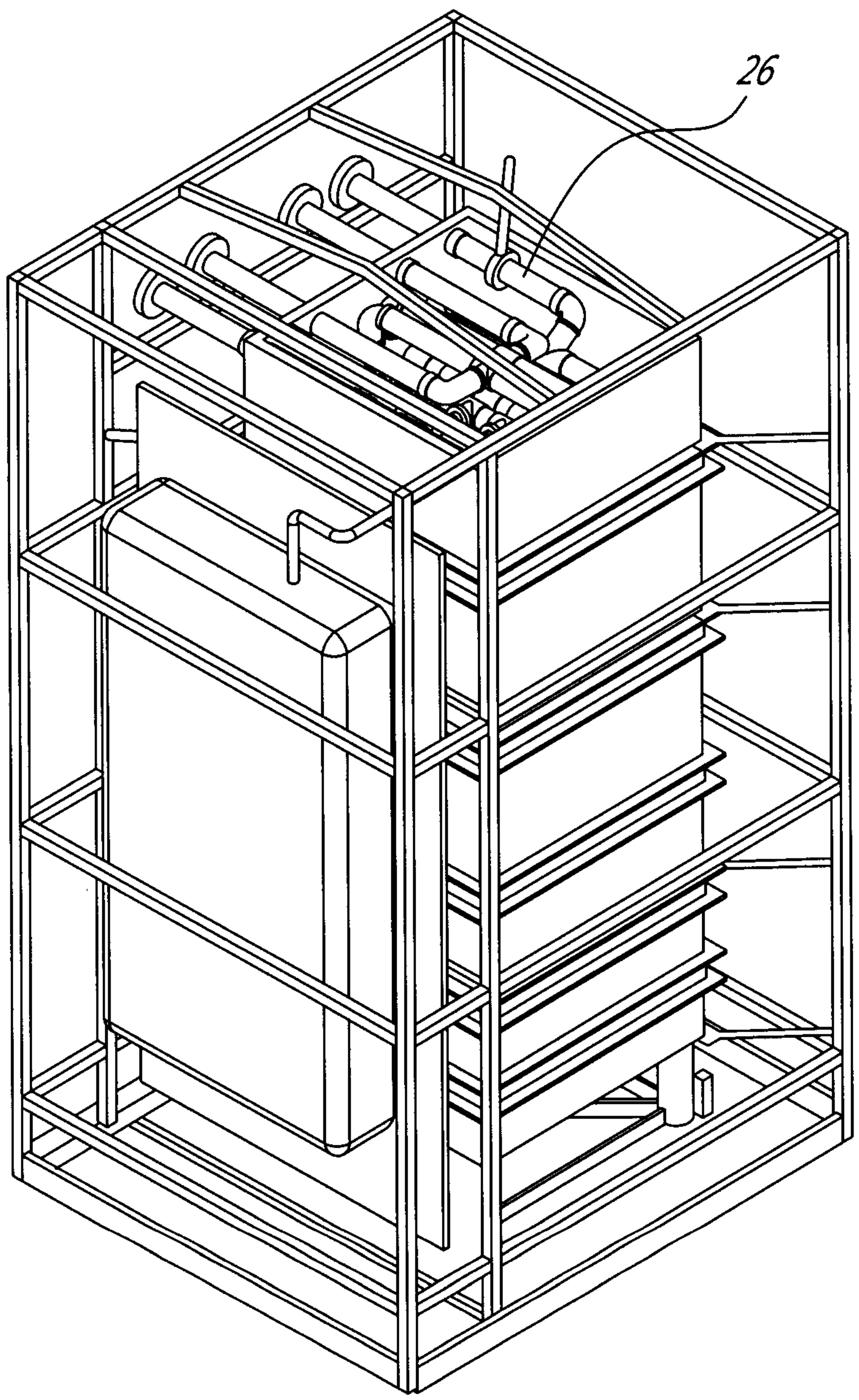


Fig-7

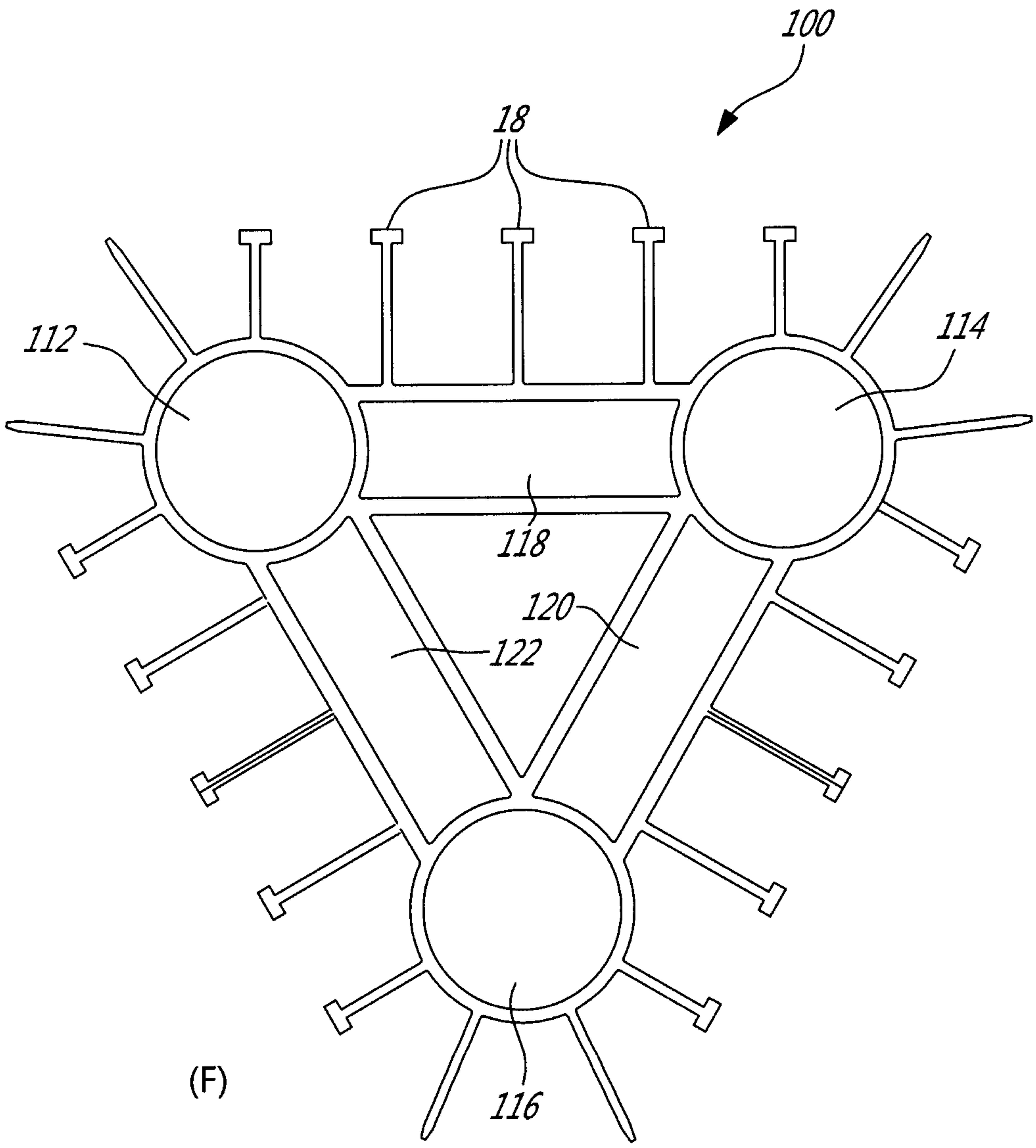
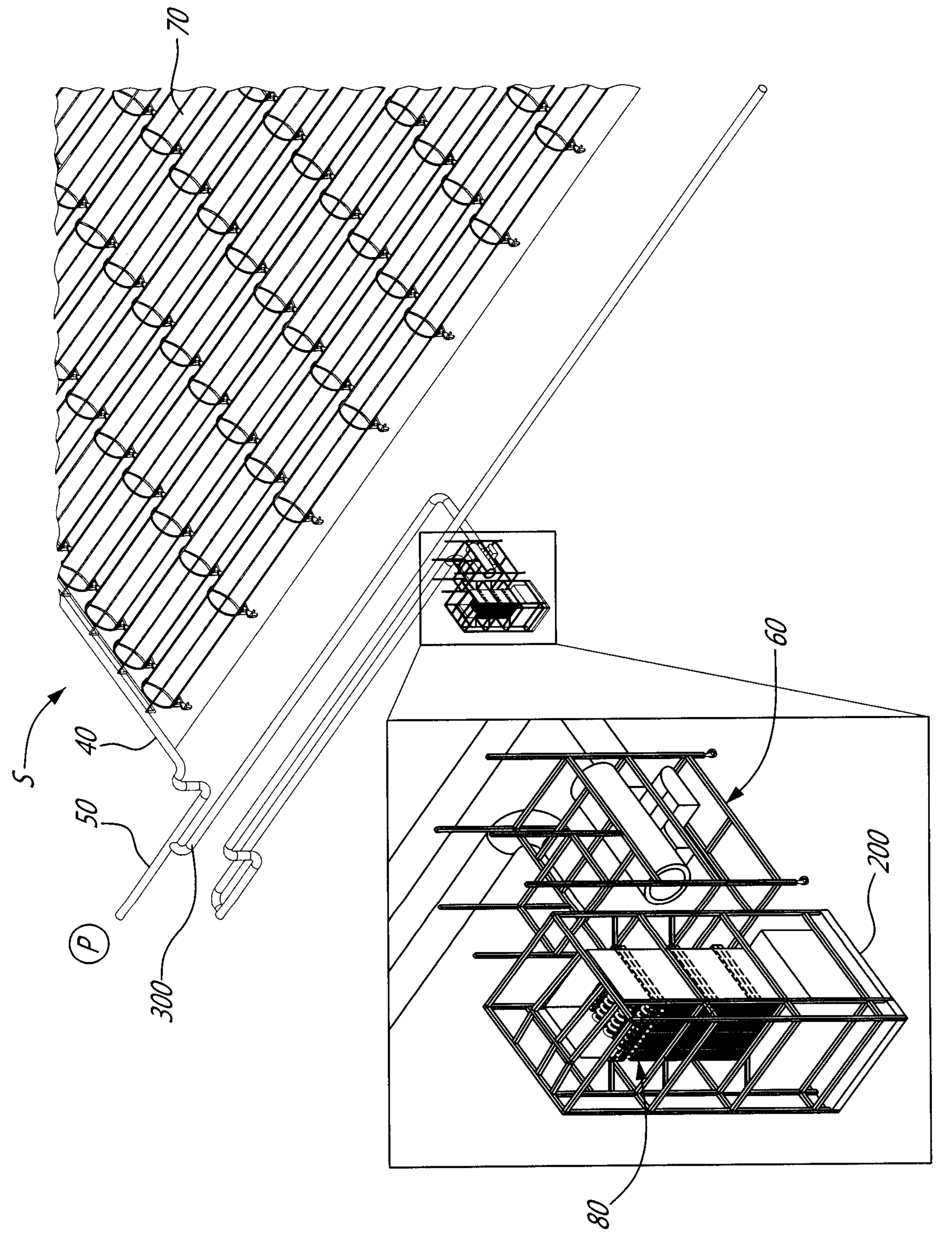


Fig. 8


70
60
S
40
50
P
300
200
80

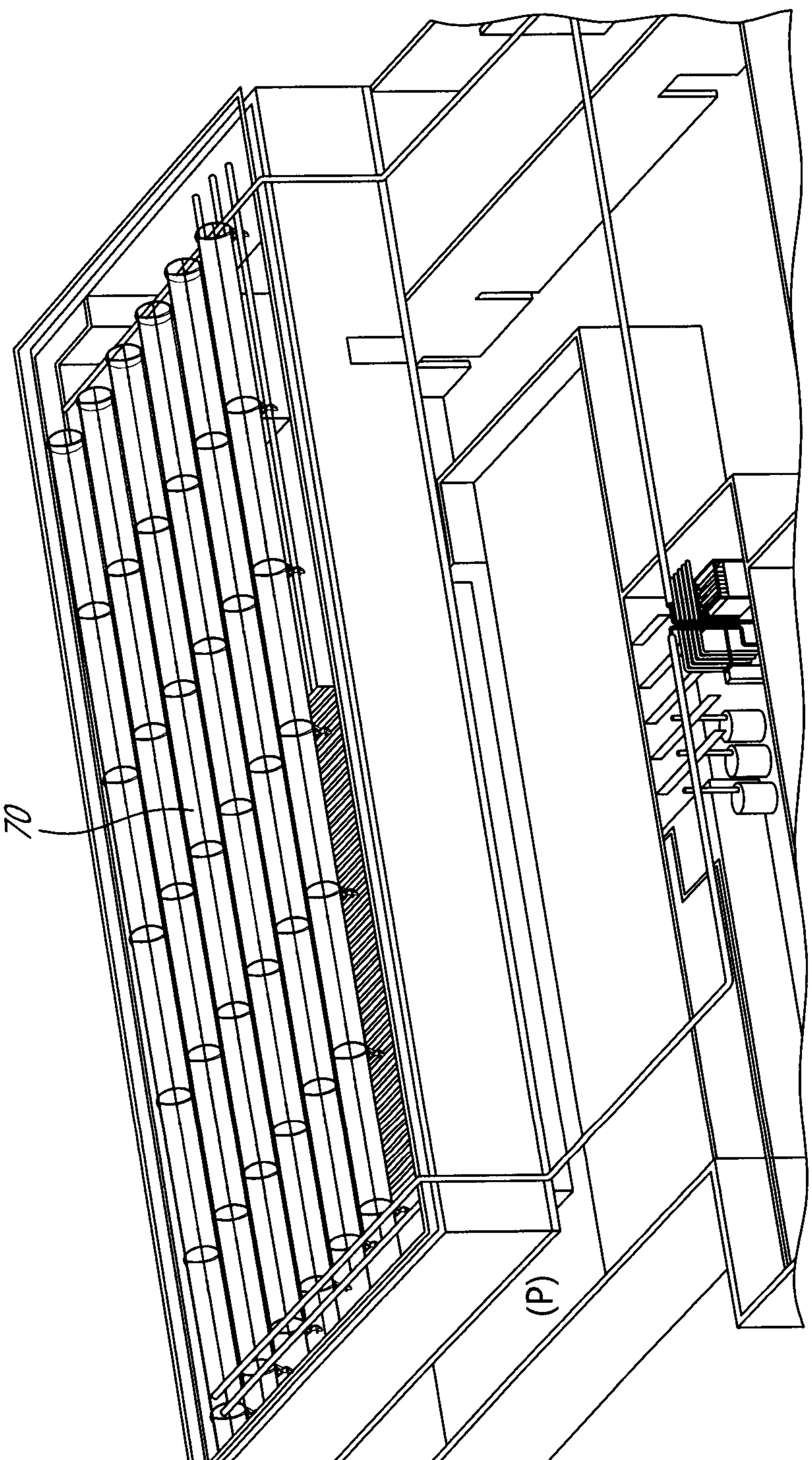


Fig-10

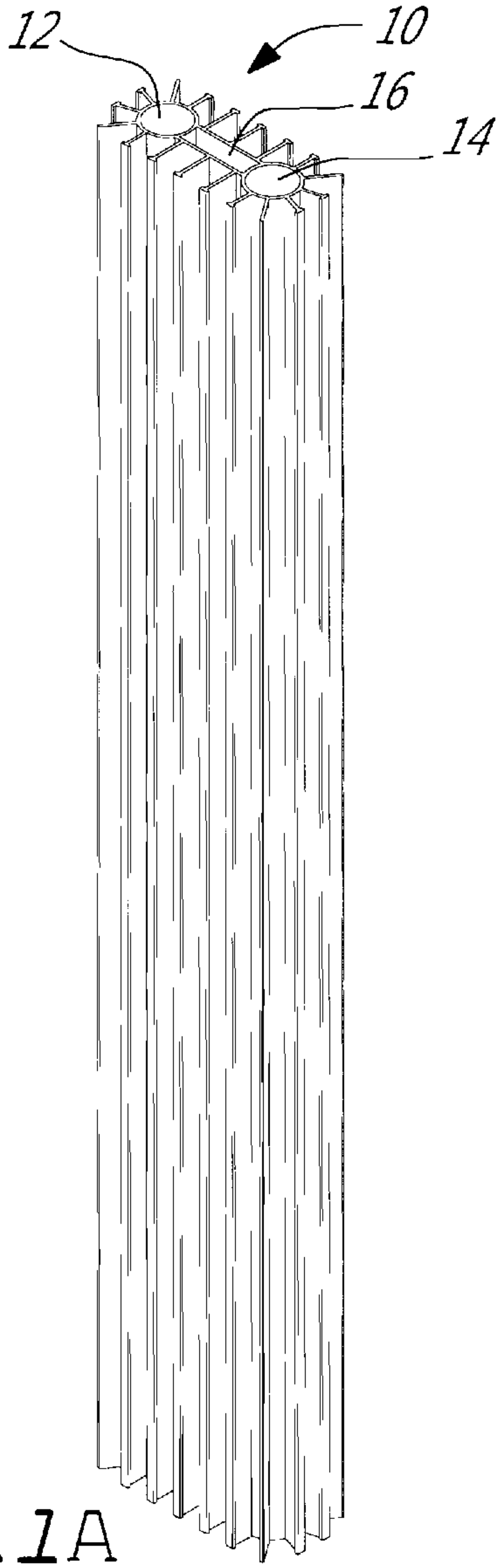


Fig-1A