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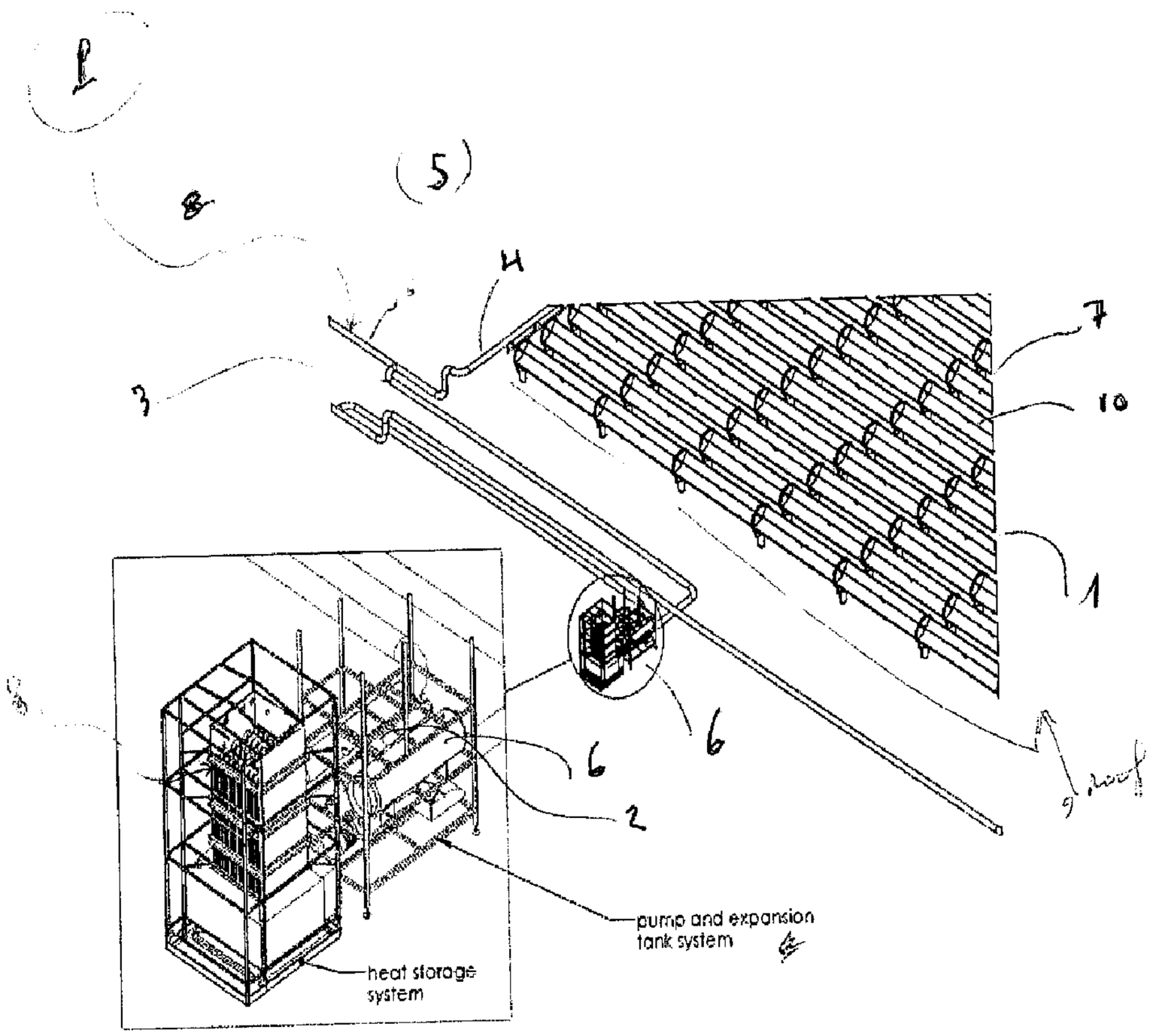
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(54) Titre : RADIATEUR/ECHANGEUR DE CHALEUR MONOBLOC EXTRUDE, SERIES ET MODULES CONNEXES ET PROCESSUS DE FABRICATION

(54) Title: ONE-PIECE EXTRUDED RADIATOR/HEAT EXCHANGER UNIT, SERIES AND MODULES THEREOF AND MANUFACTURING PROCESSES THEREOF



(57) Abrégé/Abstract:
A one-piece radiator/heat exchanger unit comprising lateral tubes and central tubes for heat exchange between a first fluid preferably flowing or not flowing inside one of said tubes and a second fluid, preferably flowing, outside one of said tubes, each of

CA 2748632 A1 2013/02/04

(21) 2 748 632

(13) A1

(57) Abrégé(suite)/Abstract(continued):
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 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. A radiator/heat exchanger series, which includes at least n of this one-piece radiator/heat exchanger units. A module consisting of a multiplicity of series of interconnected one-piece radiator/heat. Use of a one-piece radiator/heat exchanger unit for the reversible storage of heat energy. Process for the manufacturing radiator/heat exchanger.

ABSTRACT

A one-piece radiator/heat exchanger unit comprising lateral tubes and central tubes for heat exchange between a first fluid preferably flowing or not flowing inside one of said tubes and a second fluid, preferably 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 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. A radiator/heat exchanger series, which includes at least n of this one-piece radiator/heat exchanger units. A module consisting of a multiplicity of series of interconnected one-piece radiator/heat. Use of a one-piece radiator/heat exchanger unit for the reversible storage of heat energy. Process for the manufacturing radiator/heat exchanger.

0003-CA-PROV1

ONE-PIECE EXTRUDED RADIATOR/HEAT EXCHANGER UNIT, SERIES AND MODULES THEREOF AND MANUFACTURING PROCESSES THEREOF

FIELD OF THE INVENTION

The invention relates mainly the field of applied thermodynamics. The invention applies to any process involving heat transfer between different mediums, involving a radiator/heat exchanger of the invention, whether liquid, gaseous or even solid, this innovation allows to exchange heat efficiently while being simple in assembly, modular and inexpensive to manufacture.

More specifically, the invention relates a one-piece radiator/heat exchanger unit, to a radiator/heat exchanger series including a multiplicity of the one-piece radiator/heat exchanger units of the invention, as well as to module consisting of a multiplicity of series of interconnected one-piece radiator/heat exchanger.

The invention also relates to the use of a one-piece radiator/heat exchanger unit for the reversible storage of heat energy and to processes for manufacturing said radiator/heat exchanger units, series and modules.

PRIOR ART

US patent application number 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.

US patent number 5 048 602 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.

US patent number 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.

US patent number 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.

US patent application 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.

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.

Common heat exchangers transfer heat between 2 different mediums.

There was a need for a new modular approach adaptable to a multitude of applications and involving two or three fluids, this new approach being free of at least one of the drawbacks of the known modular systems.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1: represents a general perspective view of a highly efficient system (S), for recovering solar energy by solar energy concentration, wherein a module consisting of a multiplicity of series of interconnected one-piece radiator/heat exchanger according to a first embodiment of the present application is incorporated therein.

Figure 2: represents a perspective side view of the streamlined structure of a solar dish unit of the assembly as represented in Figure 1.

Figure 3: represents a perspective back view of the streamlined structure of the solar dish unit assembly according to the preferred embodiment of the parabolic solar collectors represented in Figure 2.

Figure 4: represents a side view of the streamlined isometric structure of the solar dish unit assembly according to the preferred embodiment of the parabolic solar collectors represented in Figures 1 to 3.

Figure 5: represents an aerial view of the streamlined structure of a solar dish unit assembly according to the preferred embodiment of the invention as represented in Figure 2.

Figure 6: represents a vertical cross view, in a vertical crossing the left wheel, of the streamlined structure of the solar dish unit assembly according to the preferred embodiment of the invention represented in Figures 2 and 3, this view showing 2 supporting elements ant the parabolic solar reflector.

Figure 7: represents a front view a), a side view b) and a perspective view of the structural wheel of the solar dish unit assembly represented in Figure 2.

Figure 8: is a perspective view and a detailed view of the rotating mechanism of the rotating ring inside the internal wheel represented in Figure 7.

Figure 9: is a perspective vertical side view of a calo-arm that supports the heat transfer tube represented in Figure 2.

Figure 10: represents an horizontal cross view a) and an horizontal perspective side view b) of the calo-arm represented on Figure 9.

Figure 11: represents the detailed of the calo-clam a front view a), side view b), perspective view c) and linear view d) attaching a calo-arm and a heat transfert tube according to the preferred embodiment of the invention represented in Figure 2.

Figure 12: represent a perspective view of the solar beam connected to the rotating mechanism in Figure8.

Figure 13: represents a perspective view one joint between heat transfer tubes at focal point.

Figure 14: represents the exploded view and split view of joints between 2 heat transfer tube as use in the a cross section, according

Figure 15: represents the general diagram of the highly efficient system (S) represented in Figure 1.

Figure 16: is a perspective view of a line of solar dish unit, with supporting means apparent.

Figure 17: I a perspective view of the system S mounted on the flat roof of a dairy plant.

Figure 18: represents a perspective view a) and an horizontal cross view of a one-piece radiator/heat exchanger unit according to a first preferred embodiment of the present application.

Figure 19: represents a side view of a heat exchanger series of 8 one-piece radiator/heat exchanger units according to a first preferred embodiment of the present application.

Figure 20: represents a detailed perspective vertical side view of a module constituted by 10 series of 8 interconnected one-piece radiator/heat exchanger units according to the first preferred embodiment represented on Figure 19.

Figure 21: represents a detailed perspective vertical side view of the superior part of the module represented on Figure 20.

Figure 22: represents a perspective vertical view of a one-piece radiator/heat exchanger unit according to a second preferred embodiment of the present application wherein the cross-section represents 3 circular tubes and 3 flat tubes, each of the circular tube being adjacent to 2 of the circular tubes.

Figure 23: represents the manifold used to connect units in the embodiment represented on Figure 20.

Figure 24: represents the module of Figure 20 mounted with the manifold represented on Figure 23 and positioned in a tank placed inside an assembled tank with inert gas blanket system.

GENERAL DEFINITION OF THE INVENTION

A first object of the present invention is a one-piece radiator/heat exchanger unit comprising lateral tubes and central tubes for heat exchange between a first fluid, flowing or not flowing, inside one of said 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 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.

A second object of the present invention is a radiator/heat exchanger series, which includes at least n one-piece radiator/heat exchanger units as defined in the first object of the present invention, 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.

A third object of the present invention is a module consisting of a multiplicity of series of interconnected one-piece radiator/heat exchanger as defined in the second object of the present invention, which series being connected in series or in parallel in order to increase the thermodynamic exchanges.

A fourth object of the present invention is the use of a one-piece radiator/heat exchanger unit as defined in the first object of the present invention and/or of a radiator/ heat exchanger series as defined in the second object of the present invention and//or of a module as defined in the third object of the present invention for the reversible storage of heat energy.

A fifth object of the invention is a process for manufacturing radiator/heat exchanger unit as defined in the first object of the present invention, or of a radiator/ heat series as defined in the second object of the invention or of a module as defined in the third object of the present invention, by using assembling known methods such as extrusion, welding, screwing, stamping and/or moulding.

Preferred embodiment

The following example is given as a matter of illustration only and should not be interpreted as constituting any limitation of the scope of the invention.

The invention is a radiator / heat exchanger, which includes:

- at least a radiator / heat exchanger

- at least one U-tube
- at least two pieces of connectors
- potentially assembled modules consisting of a series of interconnected heat exchangers

Said radiator / heat exchanger has 3 cavities for fluid circulation (liquid or gas). Specifically, we have two circular cavities acting as tubes and a rectangular central cavity serving as a link between the two circular cavities. Radially surrounding these three cavities, flat walls act like longitudinal fins thereby promoting direct exchange area between the metal walls and the external fluid. The said heat exchanger can be immersed in a third fluid to which we can use as a heat buffer.

Said U-tube allows the connection between two circular cavities of a single radiator / heat exchanger or radiator / or an adjacent heat exchanger. Indeed it is possible to connect the radiator / heat exchanger in series or in parallel in order to increase the thermodynamic exchanges.

Said connector allows the connection between the radiator / heat exchanger and the fluid supply manifold. It is held in position by welding the radiator / intercooler and threaded, welded or otherwise to the fluid supply manifold.

Example 1- Dairy plant :

The installation partially represented in Figure 1 comprises a highly efficient system (S) for recovering solar energy by solar energy concentration by using a battery (1) of parabolic solar collectors (7) according to the present invention. The system (S) was implemented as a complementary energy system for the industrial dairy plant (P) and installed on the roof of the dairy plant as apparent on Figure 17.

The battery (1) is connected to the heat storage system (2) by means of the tubular connection (industrial piping?) (3). The tubular connection (4) feed the battery (1) of parabolic solar connectors with the cold fluid coming from the dairy plant (P). The tubular connection (5) connects the heat storage system (2) with the plant and feed the plant (P) with heated fluid.

In the case of the present example, the battery (1) comprises of 6 ranks of 120 feet of parabolic solar collectors (7) of the said elements covering 252 square meters, the parabolic solar connectors are connected in series, in 6 parallel lines, of solar collectors units.

The pump and expansion tank system (6) assures the circulation of the fluids in tubular connections (4) and (5) and absorbs the volumes expansion according to the temperature of the fluid circulating in tubular connections (4) and (5). The thermal storage system (2) comprises a radiator / heat exchanger assembly (8) positioned inside the walls of the heat storage system (2).

The parabolic solar collectors (7) are installed on the roof (9) of the dairy plant and cover a surface of 252 square meters. The collectors have an approximate efficiency of 70% so on an average sunny day, they can absorb 700 Watts of the 1 000 watts received per square meters of ground covered by the parabolic collectors. The solar energy thereby captured is then converted to thermal energy as a heat transfer fluid is circulated at the apex of the parabolic solar collectors (7) on the heat transfer tube (10).

The solar collectors (7) of the invention are mechanised in order to be able to follow the sun path as the day advances. This path fellowship is obtained by the solar beam apparatus (100) mounted on the solar concentrators in junction with a mechanical motor and drive (M) to adjust accordingly the collector's position relative to the sun.

The solar collector (7) represented on Figure 2 is 1,25 meter broad and the parallel side wheels (20) and (21) have a diameter of 1,20 meter.

The rigidity of the self-supporting structure solar collector (7) is assures by 2 rails (27) and (28), each end of a rail being connected to the internal surface on one of the two parallel side wheels (20) and (21) and by the spinal rail (26) also connecting the two side wheels.

The parabolic surface (31) is constituted by the two adjacent parabolic mirrors (21) and (22). In the present example the parabolic mirrors are made of laminated aluminum with a reflective film.

The two lateral edges of the two adjacent parabolic mirrors (21) and (22) are fixed respectively to the rails (27) and (28) of the self-supporting structure.

The rigidity of the self-supporting structure is also created by 6 diagonal supporting elements (25) (only 3 of them are apparent on Figure 2) and by 4 vertical supporting elements (34).

Each of the supporting elements (25) connecting 2 adjacent parallel vertical supporting elements (34).

Each vertical supporting element (34) connecting the spinal rail (26) with one of 2 lateral rails (27) and (28).

The heat transfer tube (29) is maintained in a predetermined fixed position above the concave part of the mirror and relative to the focus of the mirrors (22) and (23), by means of the 2 so called Calo-arms (47) and (48) perpendicularly attached respectively to the extremity (49) and to the center (50) of the heat transfer tube (29). The Calo-arms (47) and (48) being also attached, respectively to the left extremity and to the center of to the spinal rail (26).

The Calo-arms (47) and (48) are identical and represented in a more detail way in Figures 9, 10 and 11. The Calo-arms (47) and (48) is constituted by a shaft (200) with parallel guides (201) in form of structural grooves (70) and by arise (71). The connecting element (73) is made of an annular part (203) positioned around the circular section of the heat transfer heating tube (29) and ends by two flat parts (204) and (205) represented in Figures 11a, 11b, 11c and 11d.

The Solar beam sensing system (d) is of the Analogue Guy type is generally represented on Figure 2 and in details on Figure 12. The Solar beam sensing system (d) comprises a cylinder (80), 2 photovoltaic cells (82) and (83) measuring the positioning (by means of 2 reference angles), an half disc (100) assuring the presence of a shaded zone for one of the photovoltaic cells, 2 photovoltaic cells measuring the positioning (by means of 3 reference angles) of the mirror in respect of the solar beam, and a plate (81).

Globally the Solar beam sensing system (80) identify the optimal positioning of the solar beam relative to the place and comprise a calculating unit configured to send positioning instructions to the motor (M).

The solar beam sensing system detects solar potential and steer precisely the structure (via the mechanical system) towards optimal solar collection. In order to place the pair of mirrors (22) and (23) in the appropriate position respective the solar beam and for a maximum recovering efficiency during the complete period of the day wherein the system (S) is in function.

During the night, or when the intensity of the solar beam is too weak, the assembly of mirrors rotates in a protective mode wherein the heat transfer tube (29) is in under the convex part of the mirrors (22) and (23). Then, the back parts of the mirrors (22) and (23) act as protectors against rain, hail, ice or any other environmental aggressive natural element. The assembly of mirrors will return in operational mode as soon as the operational conditions are present.

The assembly of mirrors of supporting elements, of rails of heat transfer tube and of Calo-arm are connected in a solider way rotates by means of the structural wheels (20) and (21) and on the 3 contact points (61), (62) and (63) apparent on Figure 7c.

Once the heat is transferred thought the walls of the heat transfer tube (29) from the solar beam to the heat transfer fluid that in the present case is XCELTHERM® Grade 500, then the heat transfer fluid is pumped by means of pump system (6) through the thermal storage system which comprises a heat exchanger (8)of the type represented on Figure 20 and is constituted of a module of 10 series 8 one-piece radiator/heat exchanger units, with a maximum heat storage capacity of 209 kWatts for a total volume of the heat exchanger of 1,23 m^3.

The detail of the heat exchanger and of its components is represented on Figures 18 to 20.

The heat transfer fluid in the system (S) is pumped and controlled by a control system, the circulatory pump, an expansion tank positioned in pump and extension tank (6) and various types of valves and plumbing fittings.

The control system measures the thermal storage system's temperature and evaluated if the need of heat is present, if so, it sends a signal to the solar collectors (7) to verify if there is sufficient solar potential to heat and if so, it starts the pump and begin to ramp up the heat transfer fluid through the solar collectors (7) and then through the storage system (2).

In the storage system is in the case of the present example a phase-change material (in this case mannitol which is at least 99 % pure) which turn into liquid phase at temperatures around 170°C.

The metal tank of the heat storage system (s) has approximate exterior measurements as follows: 96'' x 37'' x 37'' without insulation (add 11'' thickness all around if you use mineral mats).

In this tank made of metal lays the heat exchanger/radiator which is submerged in the phase-change material. So the heat storage tank allows heat exchange between 3 fluids:

- hot heat transfer fluid;
- cold heat transfer fluid; and
- phase-change material.

ADVANTAGES OF THE INVENTION

This concept can be used as a radiator OR a heat exchanger, it allows the possibility of staged heat transfer, it can use one or two dynamic fluids in the circular cavities and another static or dynamic fluid as an immersing medium, it can enhance its thermal storage capacity by using various combinations of materials in which we immerse the radiator / heat exchanger. Additionally, the longitudinal fins give the radiator / heat exchanger robustness.

The shape of the radiator / heat exchanger with longitudinal fins allows it to be manufactured by extrusion and thus provides lower manufacturing costs as well as mass production in any size and unlimited length.

The simplicity of the assembly reduces the required mounting operations.

This concept is associated with an important potential in:

- Radiator mode: Direct Exchange from two similar fluids circulating in the circular cavity to the surrounding medium. This mode can be regarded as 100% thermal dumping or 100% thermal extraction by the same module.

- Hybrid mode: staged heat transfer between the 3 fluids within one module; between the primary fluid flowing in one of the two circular cavities and the secondary fluid flowing in the other circular cavity. Between primary and secondary fluids and the external medium.

- Direct heat exchanger mode: Direct thermal exchange between two fluids through walls connecting the two circular cavities (or tubes)

Consequently, the new system allows various possibilities of fluids internal oil, water, glycol, etc.....
The manufacturing process allows for a variety of materials to be used for the profile (metal, plastic, composite).
Various immersing material, gas, solid phase change material etc ....
Assembly in series or parallel by U-bends in order to have a multiplication of infinite possibilities (number and arrangement)

The design of the invention provides a new modular approach adaptable to a multitude of applications and involves two or three fluids.

Although the present invention has been described with the aid of specific embodiments, it should be understood that several variations and modifications may be grafted onto said embodiments and that the present invention encompasses such modifications, usages or adaptations of the present invention that will become known or conventional within the field of activity to which the present invention pertains, and which may be applied to the essential elements mentioned above.

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 the external walls of said tubes that are not common to other of said tubes are equipped with fins, that 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, 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 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 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 said 2 lateral tube, the section of the 3 lateral tubes defining the 3 edges of the triangular cross-section of said one-piece radiator/heat exchanger unit and the section of the central tubes defining the 3 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 3 walls of said central triangular tube being walls of the 3 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 claims 5 or 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 the 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 use 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 the 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 the 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 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.

14. A one-piece radiator/heat exchanger according to anyone of claims 4 to 13, wherein the width (w) 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.

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. Use of a one-piece radiator/heat exchanger unit as defined in anyone of claims 1 to 15 and/or of a radiator/ heat exchanger series as defined in anyone of claims 16 to 21 for the reversible storage of heat energy.

27. Use of a one-piece radiator/heat exchanger unit as defined in anyone of claims 1 to 15, or of a radiator/ heat series as defined in anyone of claims 16 to 21 or of a module as defined in anyone of claims 22 to 25 for the reversible storage of heat energy for example in the solar industry and/or in the food industry.

28. Process for manufacturing radiator/heat exchanger unit as defined in anyone of claims 1 to 15, or of a radiator/ heat series as defined in anyone of claims 16 to 21 or of a module as defined in anyone of claims 22 to 25, by using assembling known methods such as extrusion, melding and/or screwing.

29. A one-piece radiator/heat exchanger according to anyone of claims 1 to 5 and 7 to 15, wherein:

- the fluid circulating in the first circular tube is the same that the fluid circulating in the second tube ; or
- the fluid circulating in the first circular tube is the different of the fluid circulating in the second tube; or
- the fluid circulating in the first circular tube is the same that the fluid circulating in the second tube ; or and
- the fluid circulating in the first circular tube is the different of the fluid circulating in the second tube.

30. A one-piece radiator/heat exchanger according to claims 6, wherein:

- the fluid circulating in the first circular tube is the same that the fluid circulating in the second tube ; or
- the fluid circulating in the first circular tube is the different of the fluid circulating in the second tube; or
- the fluid circulating in the first circular tube is the same that the fluid circulating in the second tube ; or
- the fluid circulating in the first circular tube is the different of the fluid circulating in the second tube;
- the fluid circulating in the first circular tube is the same that the fluid circulating in the third tube ; or

- the fluid circulating in the first circular tube is the different of the fluid circulating in the third tube; or
- the fluid circulating in the first circular tube is the same that the fluid circulating in the third tube; or
- the fluid circulating in the first circular tube is the different of the fluid circulating in the third tube.

31. A one-piece radiator/heat exchanger according to claims 6, wherein: the fluid and its state, gaseous, liquid or solid, in the central triangular tube defined by the wall of the rectangular tubes, is the same or different from the fluid or from the state of the fluid circulating in the circular or rectangular tubes.

Application number / Numéro de demande: 2748632

Figures: 16-17-19-20-21-23
24

Pages:

Unscannable items received with this application
(Request original documents in File Prep. Section on the 10th floor)

Documents reçu avec cette demande ne pouvant être balayés
(Commander les documents originaux dans la section de la préparation
des dossiers au 10ième étage)

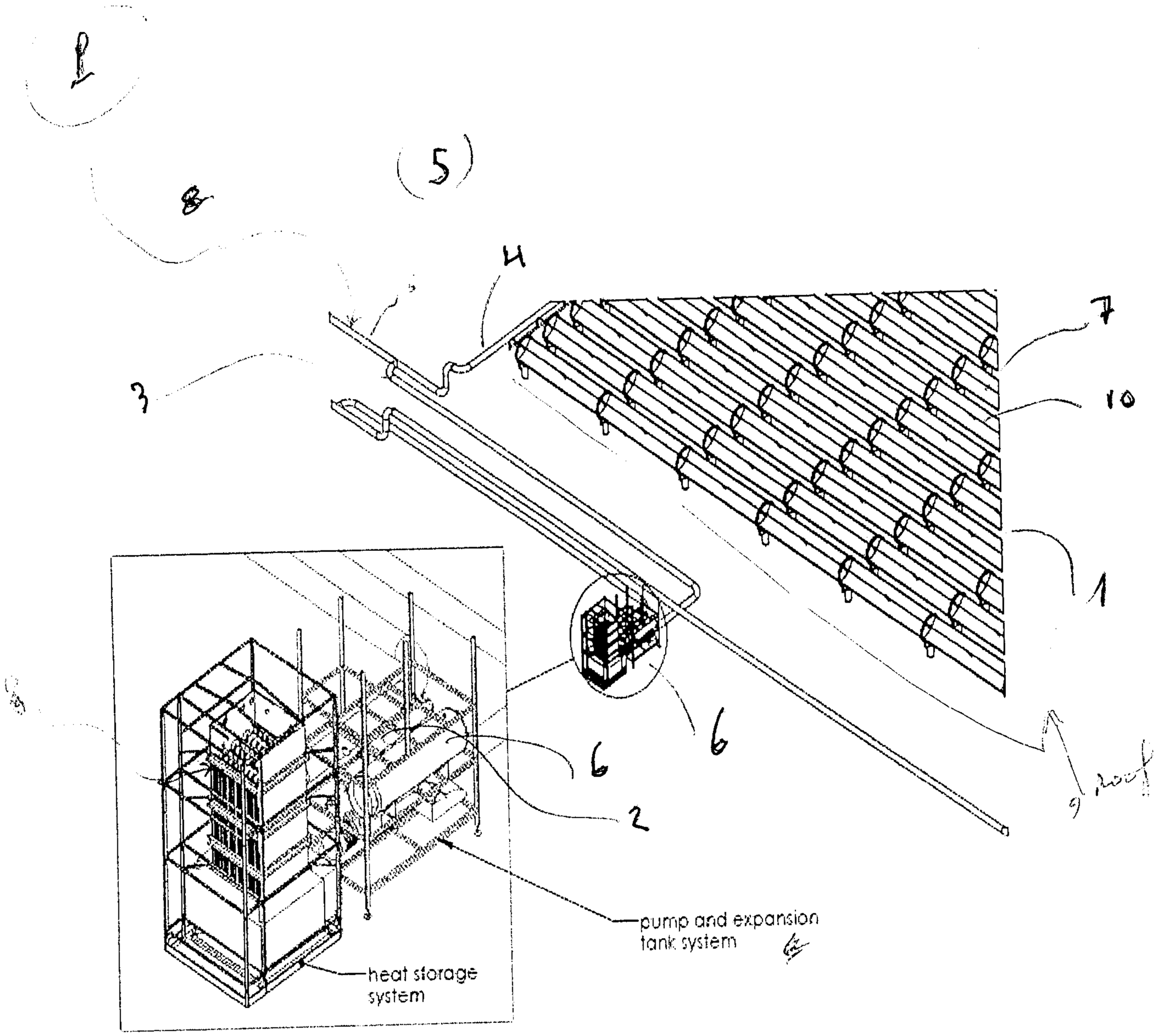


FIGURE 1

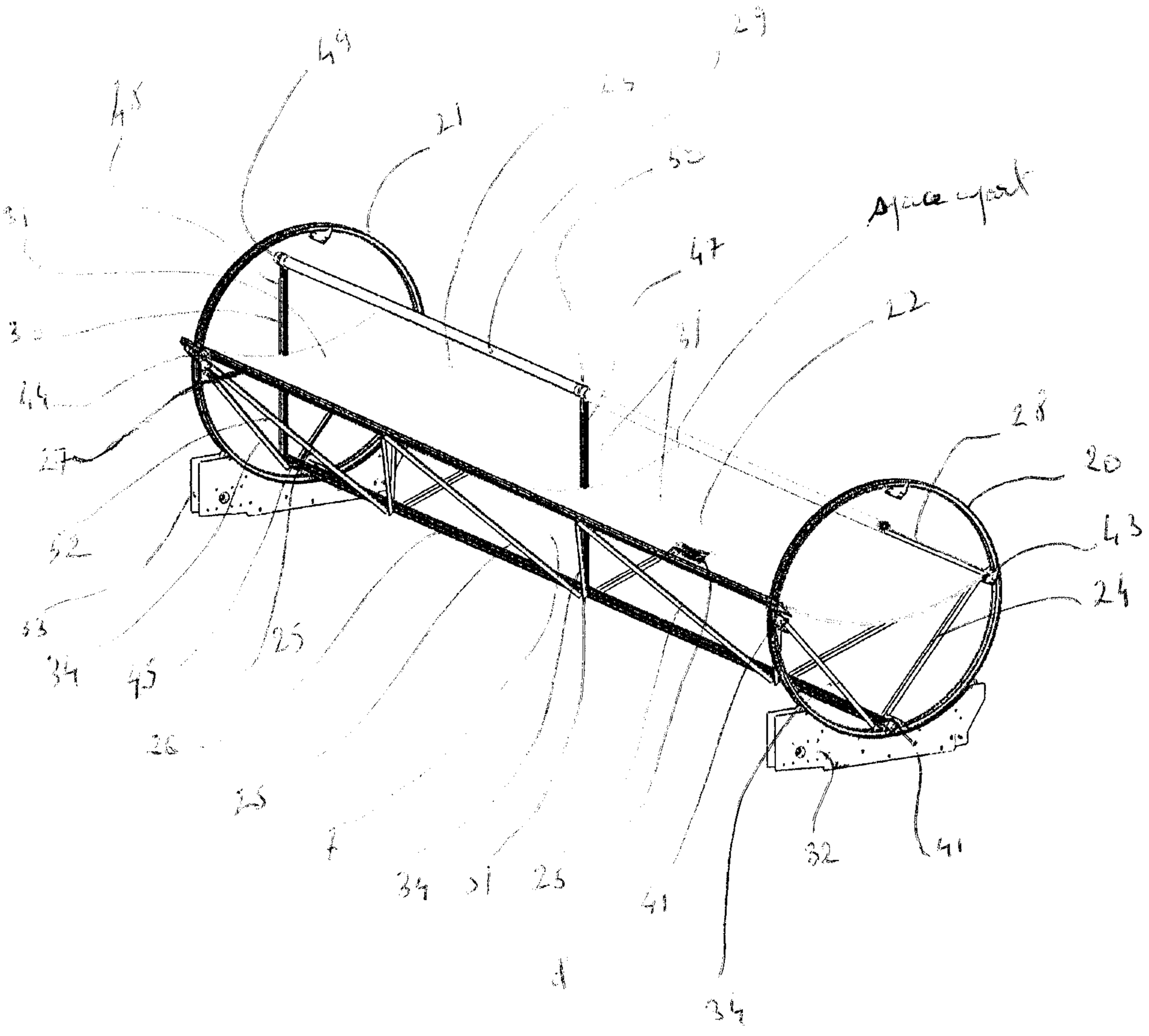

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FIGURE 2

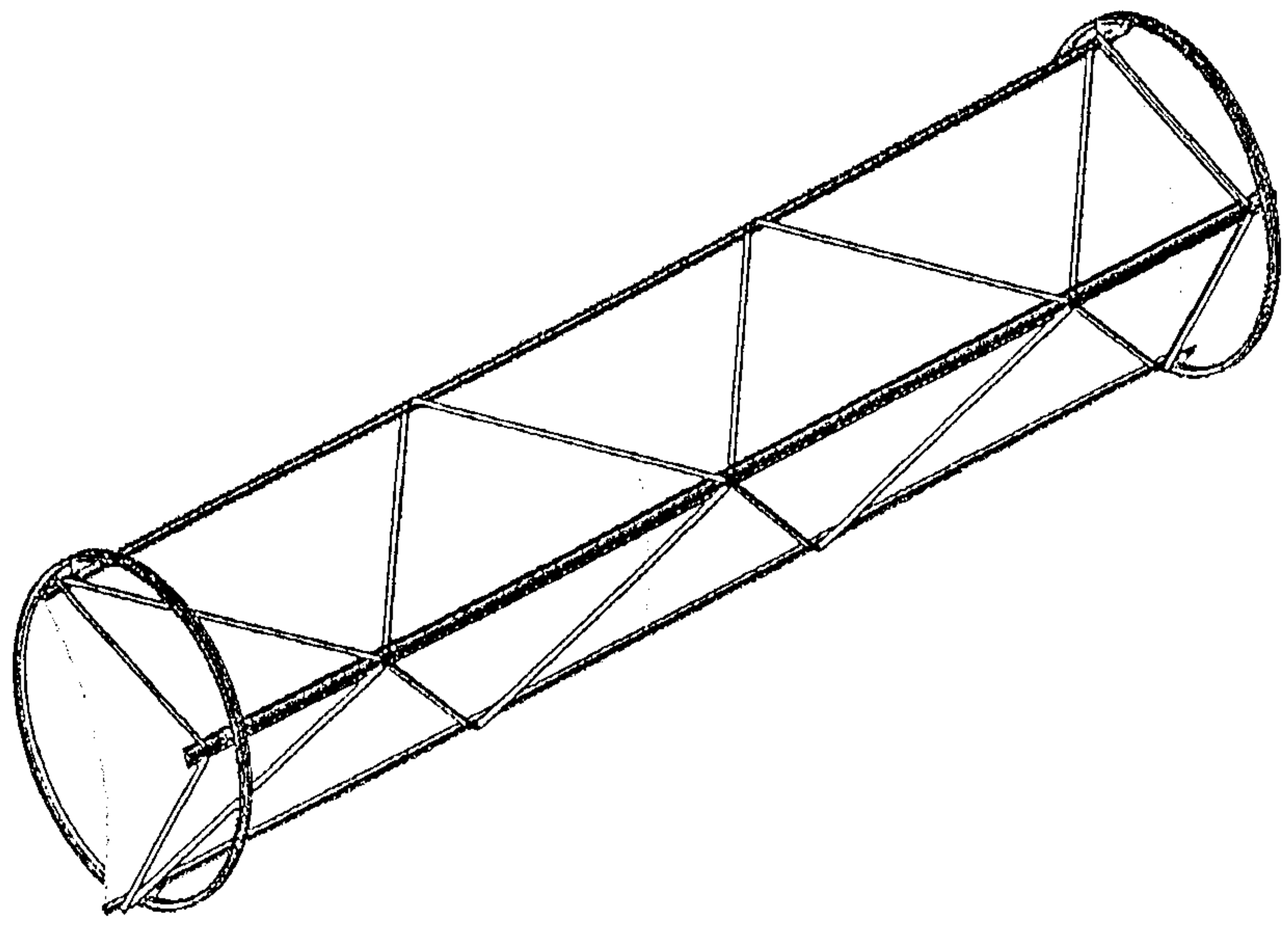


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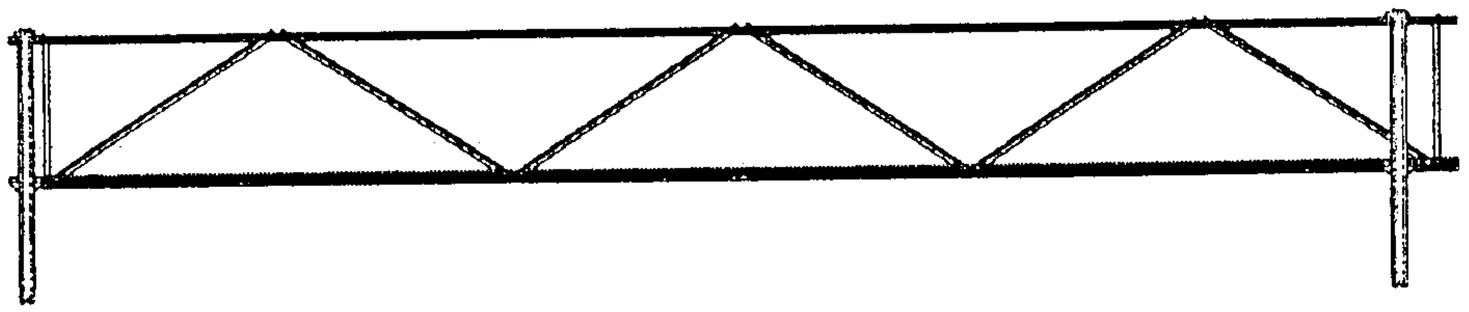


FIGURE 4

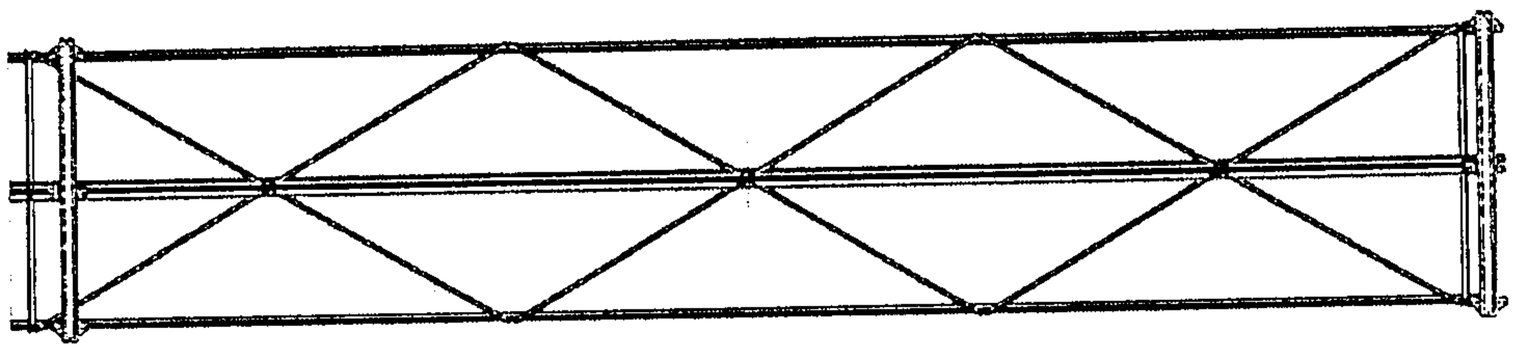


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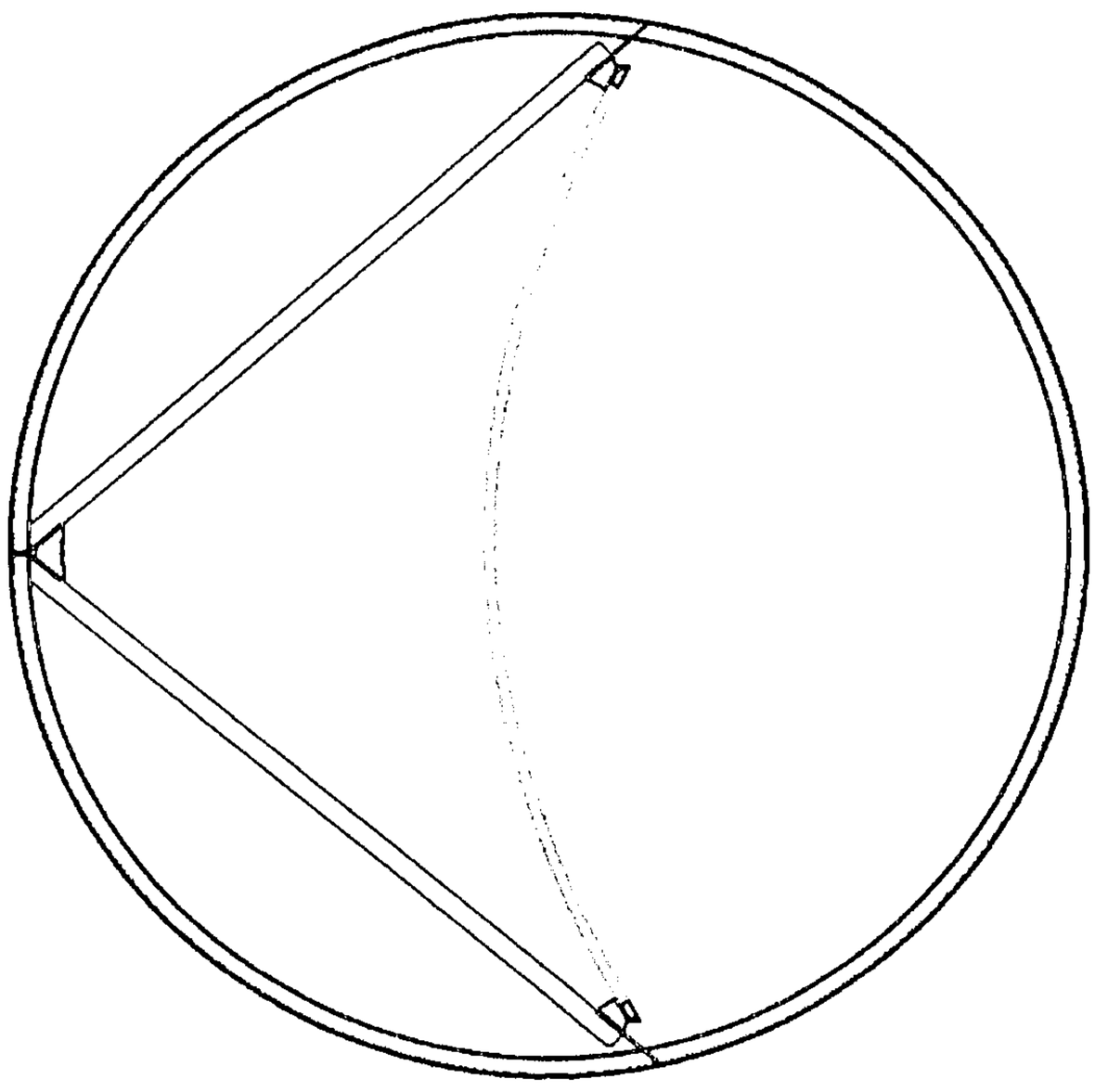


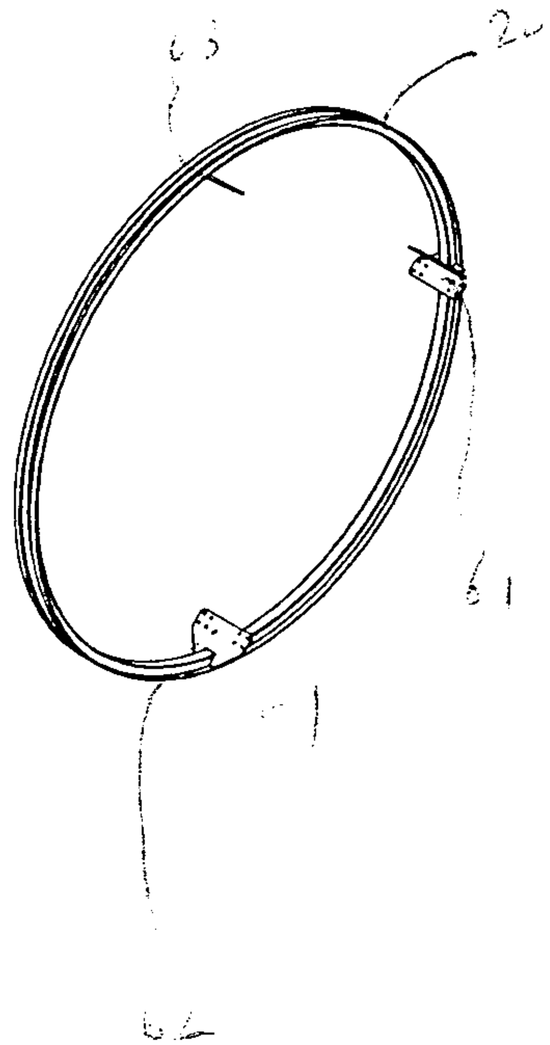
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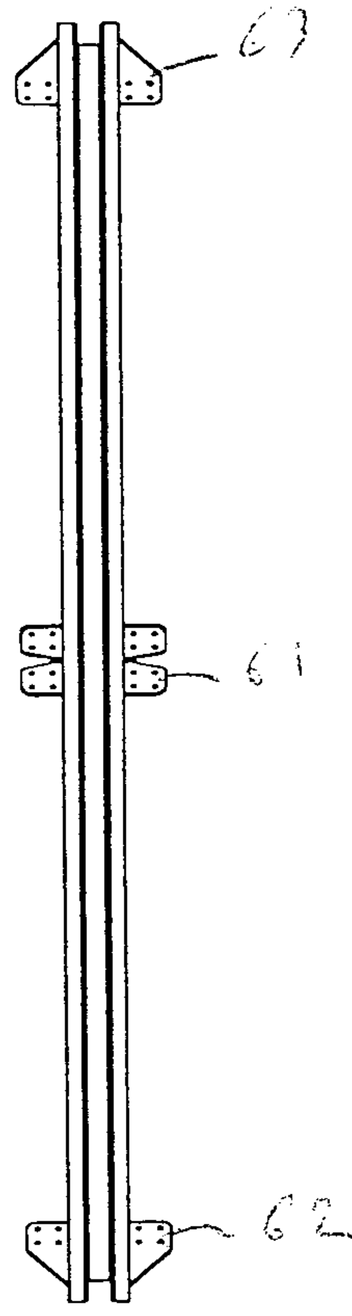
SA Roue - Wheel SA

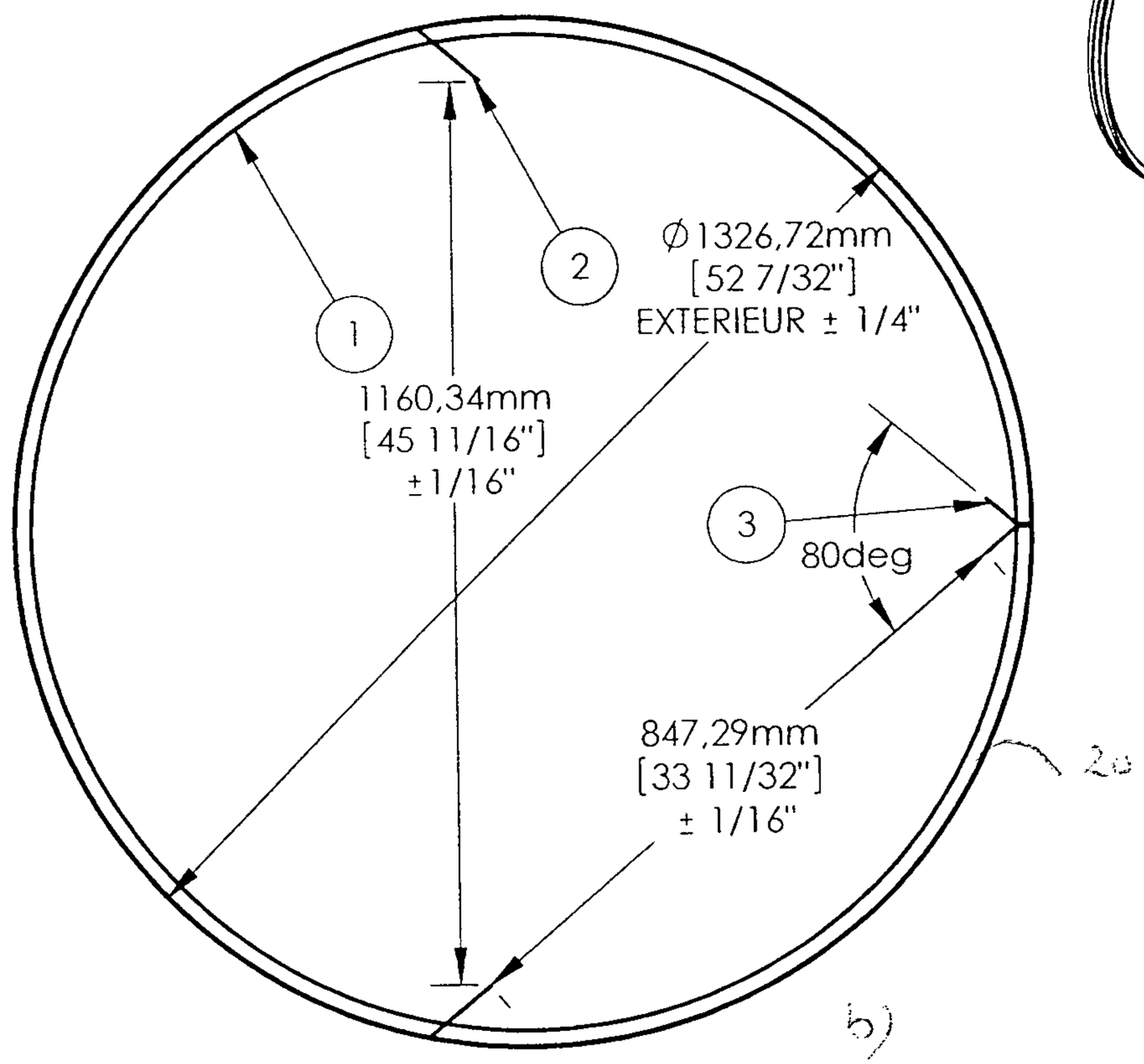
PAGE 1 DE 1 | CODE : 1400830 | QTÉ :

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No. ARTICLE	NUMERO DE PIECE	DESCRIPTION	1400830/QTE
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2	1003230	Plaque de fixation latérale - grande roue	2
4	1201130	Plaque de montage pliée du dos de la grande roue	2







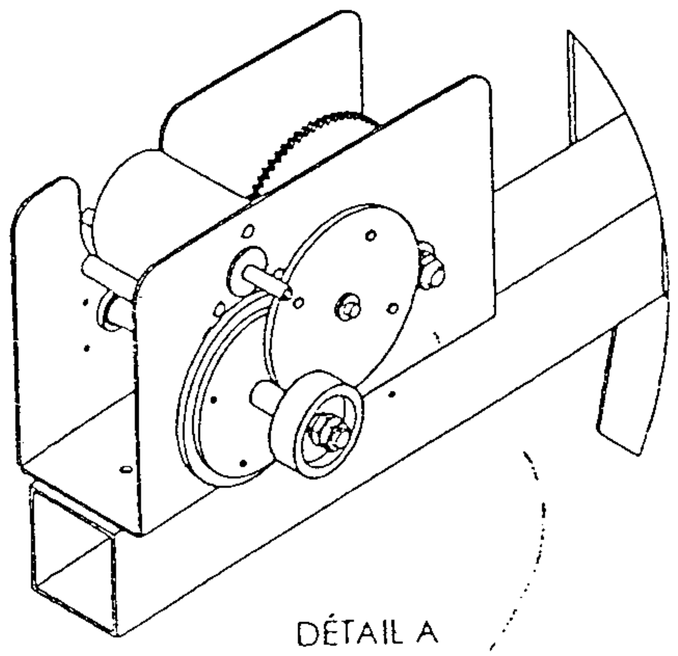
ASSEMBLAGE SELON GABARIT

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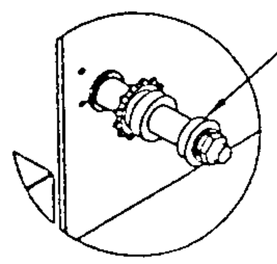
Rackam Design	PAR	DATE	MATÉRIEL : Aluminium
	S Baribeau	40576	REVISION : 1 Cotes de vérification ajoutées
141 Wellington Sud. Sherbrooke (Qué) J1H 5C9 tel 819-348-0101 net rackamd.com			Tolérances : X = ±1mm X.X = ±0.03mm X/X = ±1/32" X.XX" = ±0.015" X.XXX" = ±0.005" ANGLES = ±1°

Figure 7

CA 02748632 2011-08-04

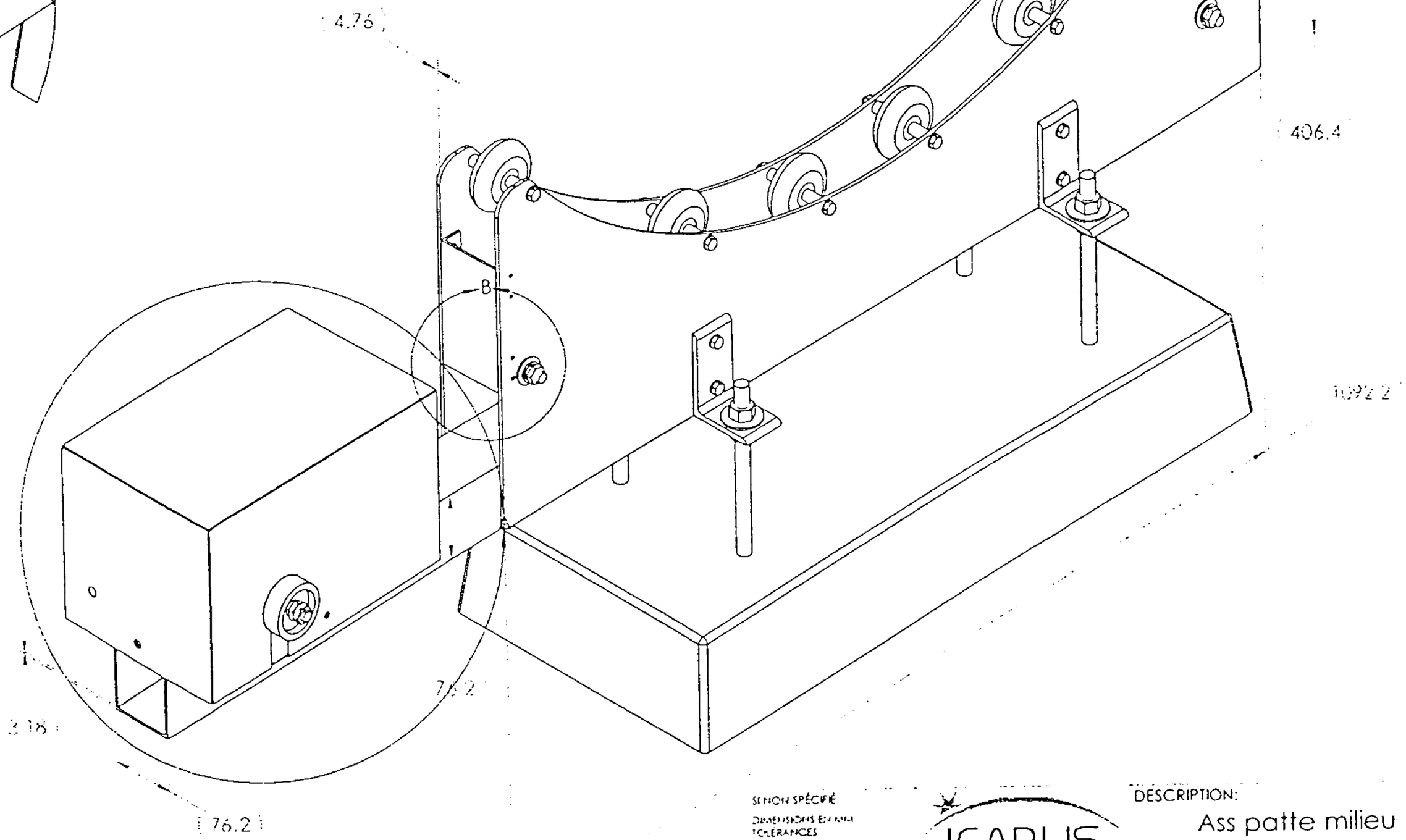


DÉTAIL A



DÉTAIL B

Roulement à bille



Tous les boulons sont des M-8
Les tiges filletées qui vont dans le ciment sont des 5/8-13
Les rivest sont tous des 3/16"

LES INFORMATIONS CONTENUES DANS CE DESSIN SONT LA PROPRIÉTÉ DE ICARUS HEAT TOUTE REPRODUCTION INTERDITE

SI NON SPÉCIFIÉ
DIMENSIONS EN MM
TOLÉRANCES
ANGLE : ± DEG
X.X : 0.3
X.XX : 0.10
MATÉRIAU
Matériau
MISE EN FORME
Mise en Forme
FOURNISSEUR
Fournisseur

ICARUS HEAT

DESCRIPTION:
Ass patte milieu

FOR. NO. DESSIN: B 1000
REV: A
DATE: 2010-11-22
ÉCHELLE : 1:5
FEUILLE 1 DE 1

Figure 8

CA 2748632 2011-08-04

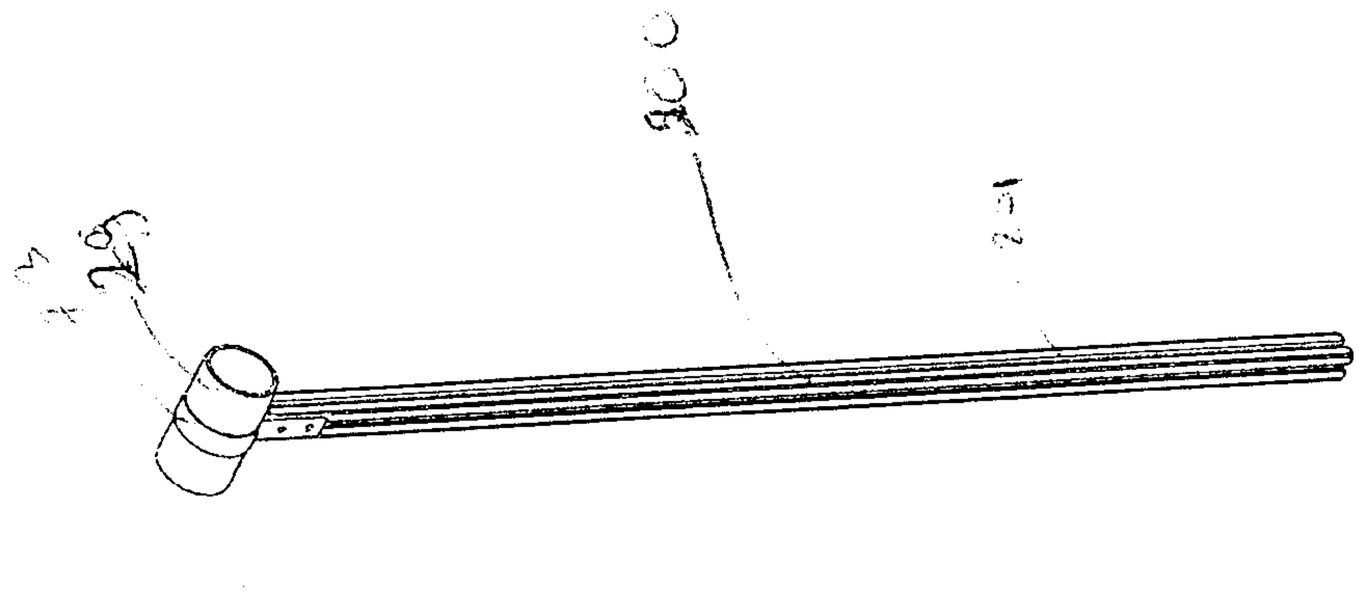
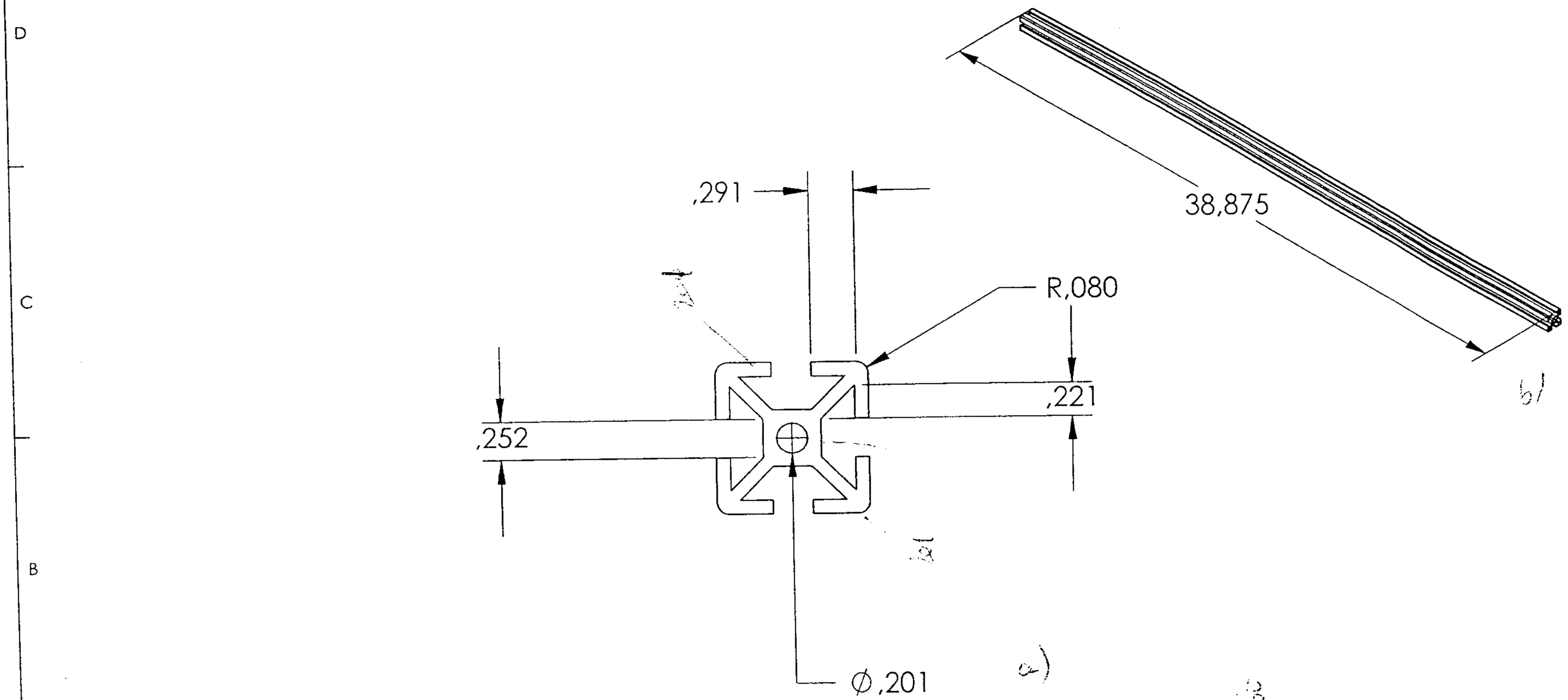


FIGURE 9

Extrusion Calo-Arm	PAGE 1 DE 1	CODE : 8000530	QTÉ :

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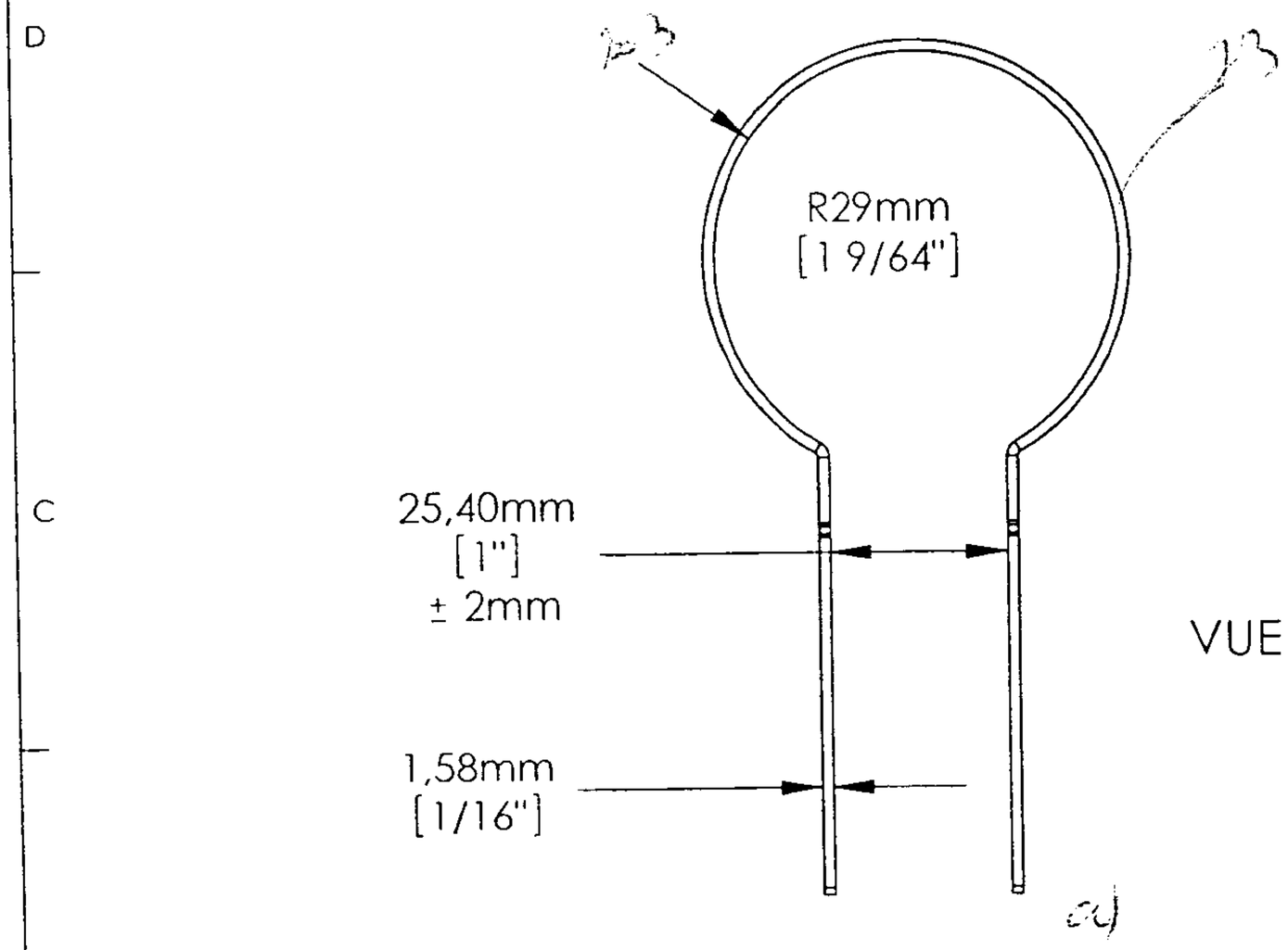
Rackam Design	PAR A. Daley	DATE 0	MATÉRIEL : Aluminium REVISION : 0 0	8000530
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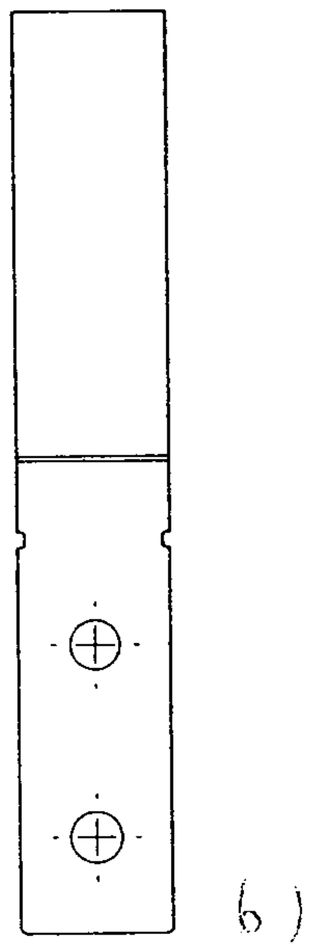
FIGURE 10

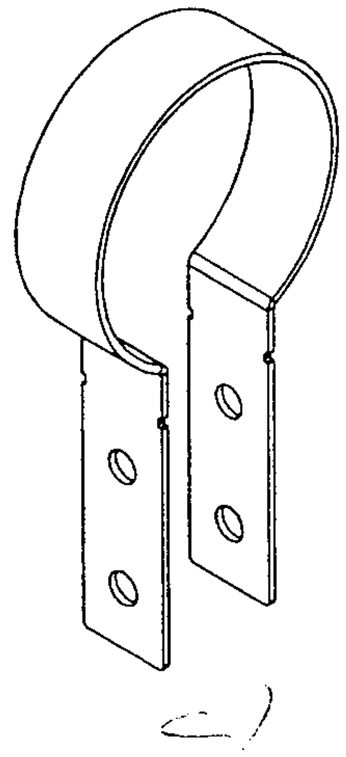
Calo-Clamp Plié

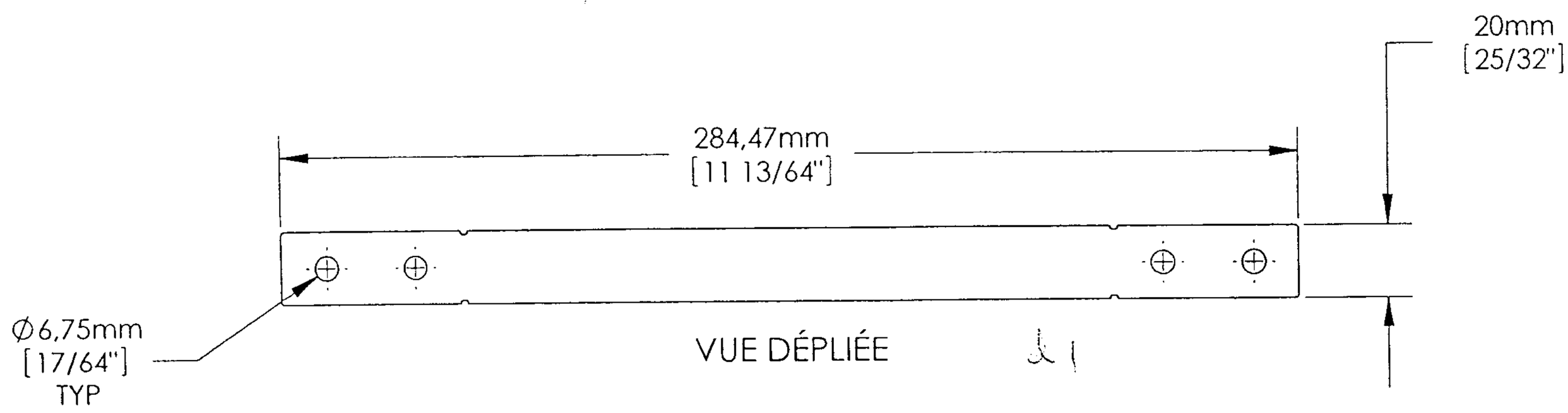
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1 DE 1		

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Rackam Design	PAR: S Baribeau	DATE: 2011-02-02	MATÉRIEL : Alu 6061-T6 x 0.063"	1200630
			REVISION : 0 Na	
141 Wellington Sud, Sherbrooke (Qué) J1H 5C9 tel 819-348-0101 net rackamd.com			Tolérances : X = ±1mm X.X = ±0.03mm X/X = ±1/32" X.XX" = ±0.015" X.XXX" = ±0.005" ANGLES = ±1°	

FIGURE 4

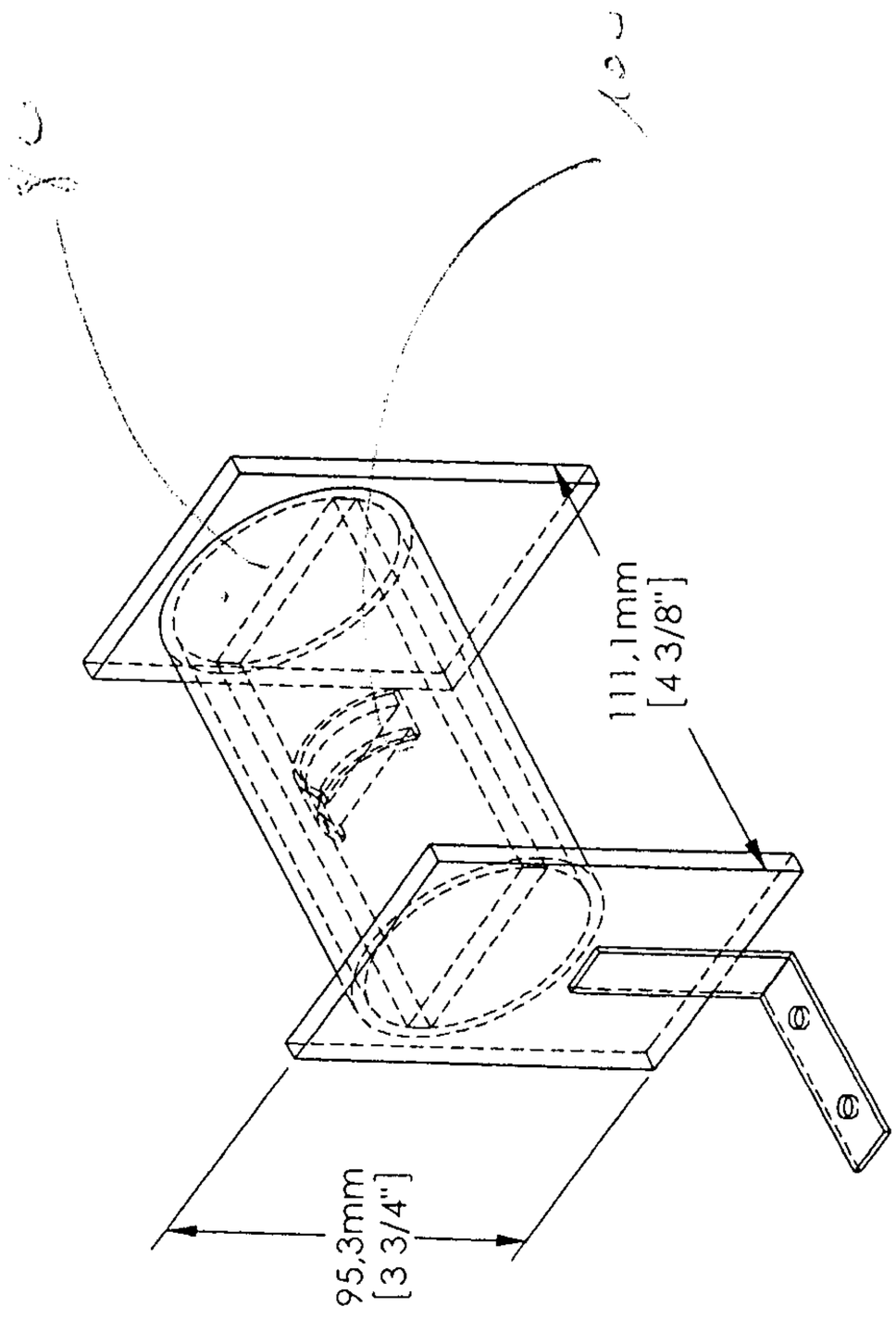


FIGURE 1

D C B A

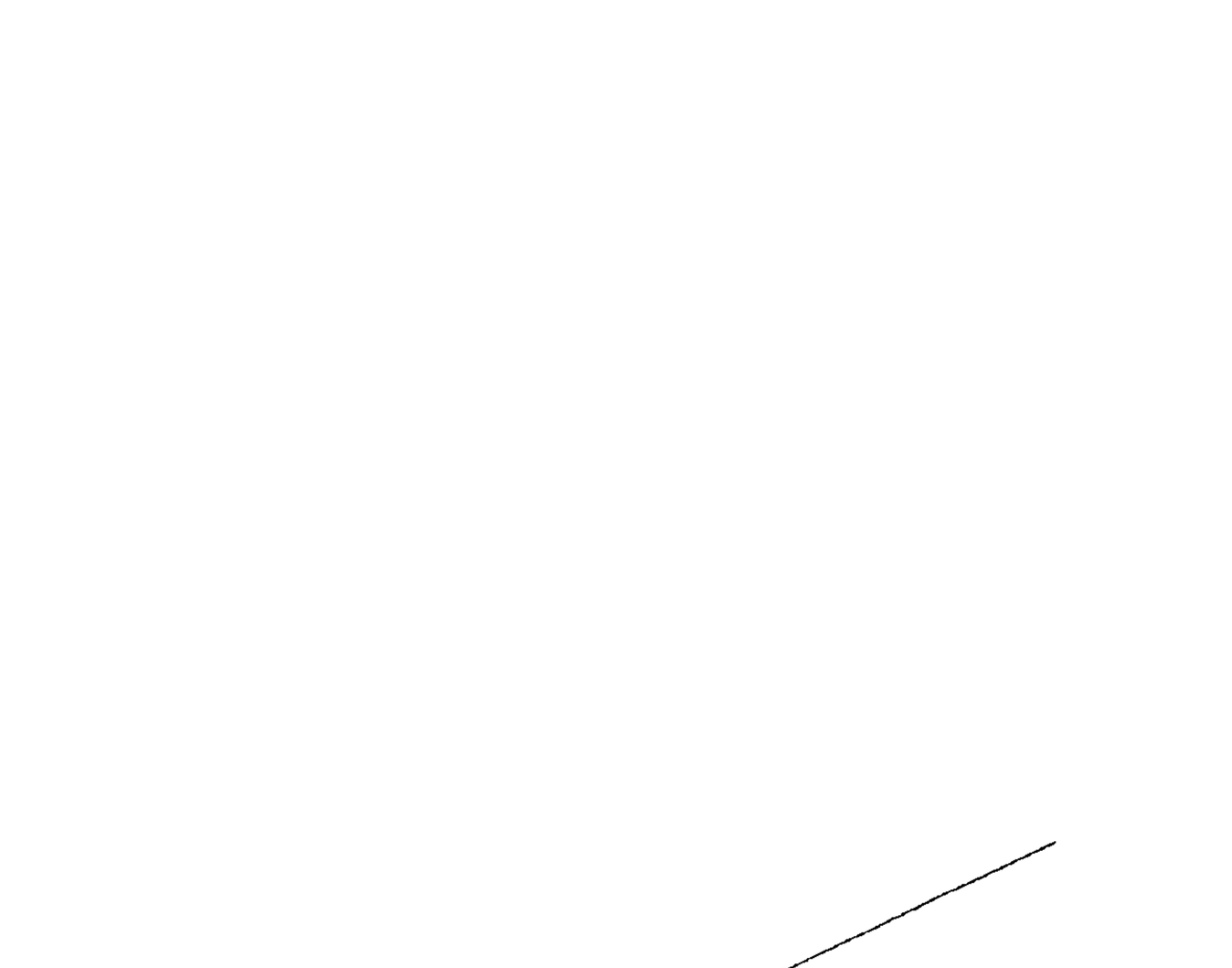


FIGURE 13

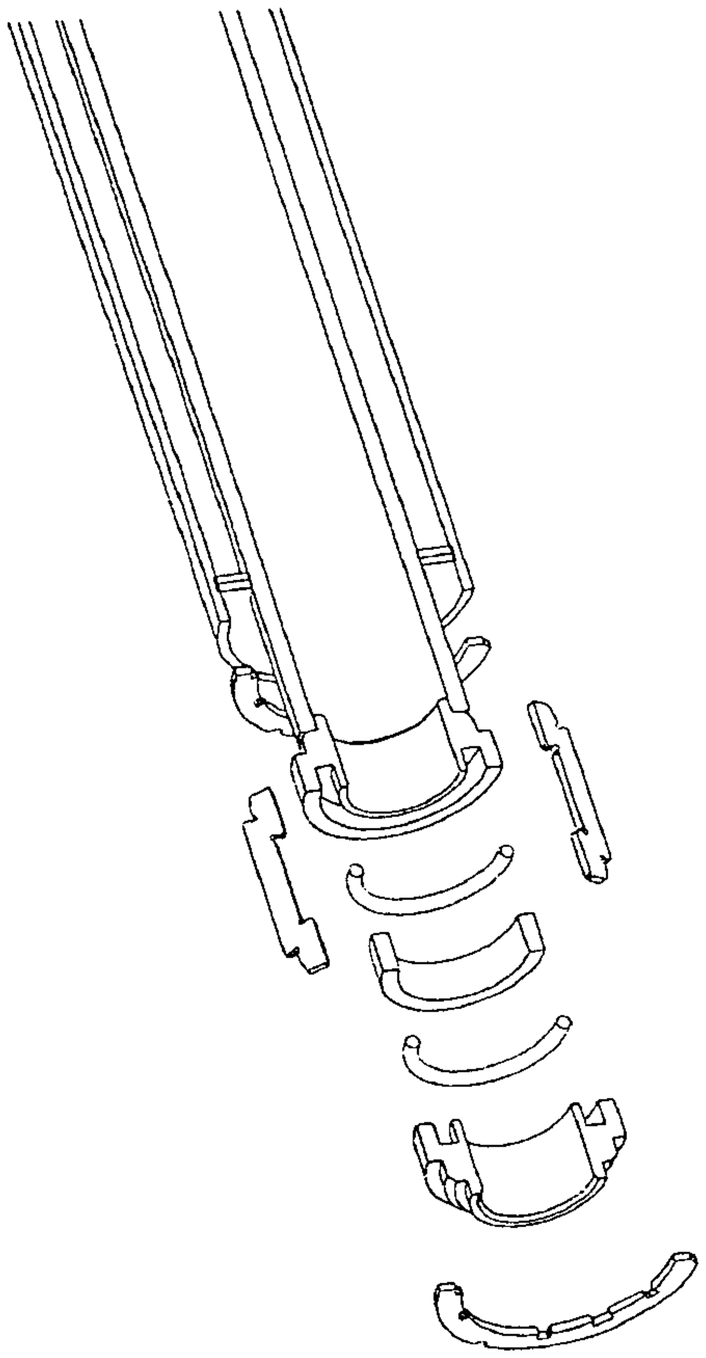
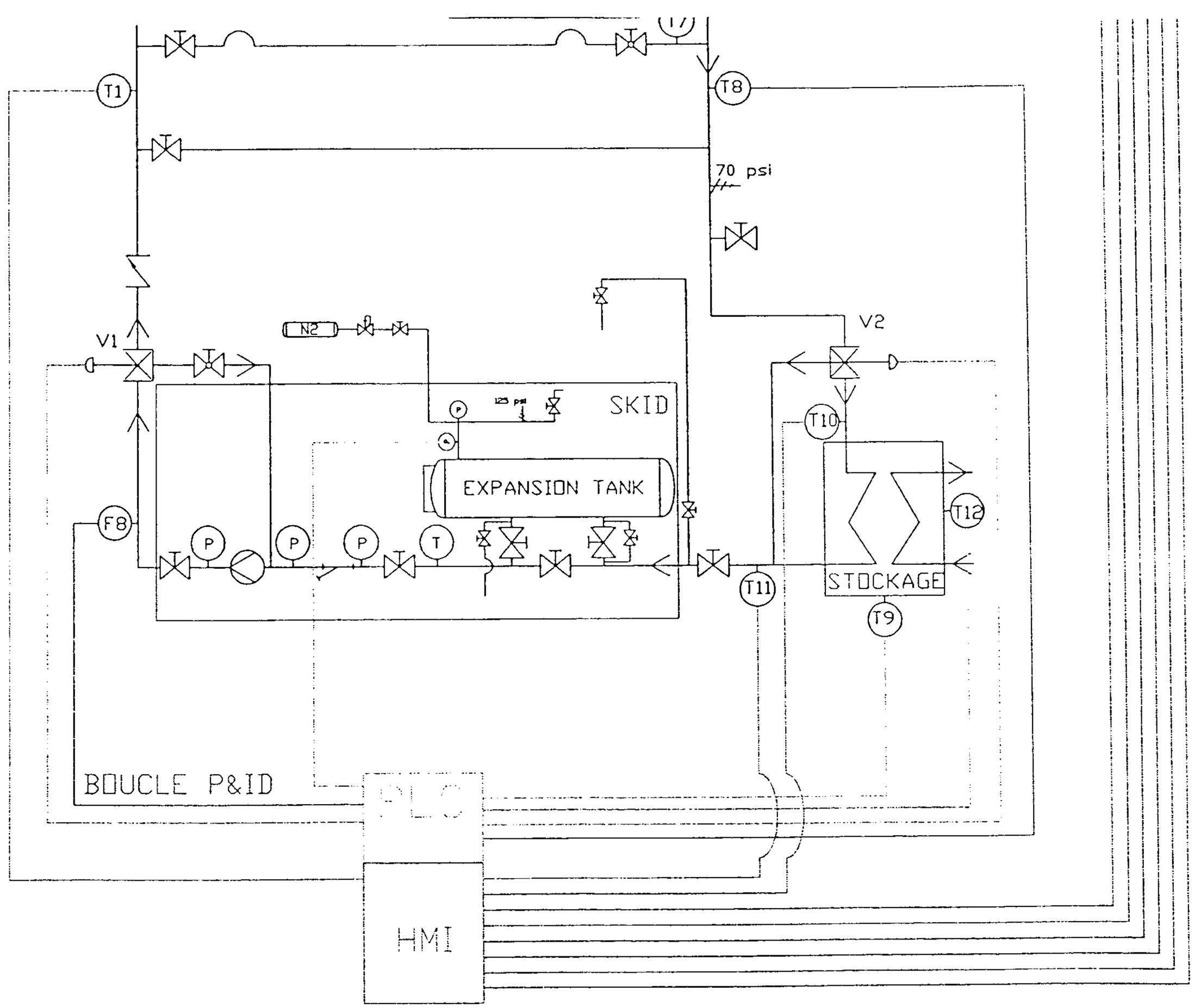


FIGURE 14



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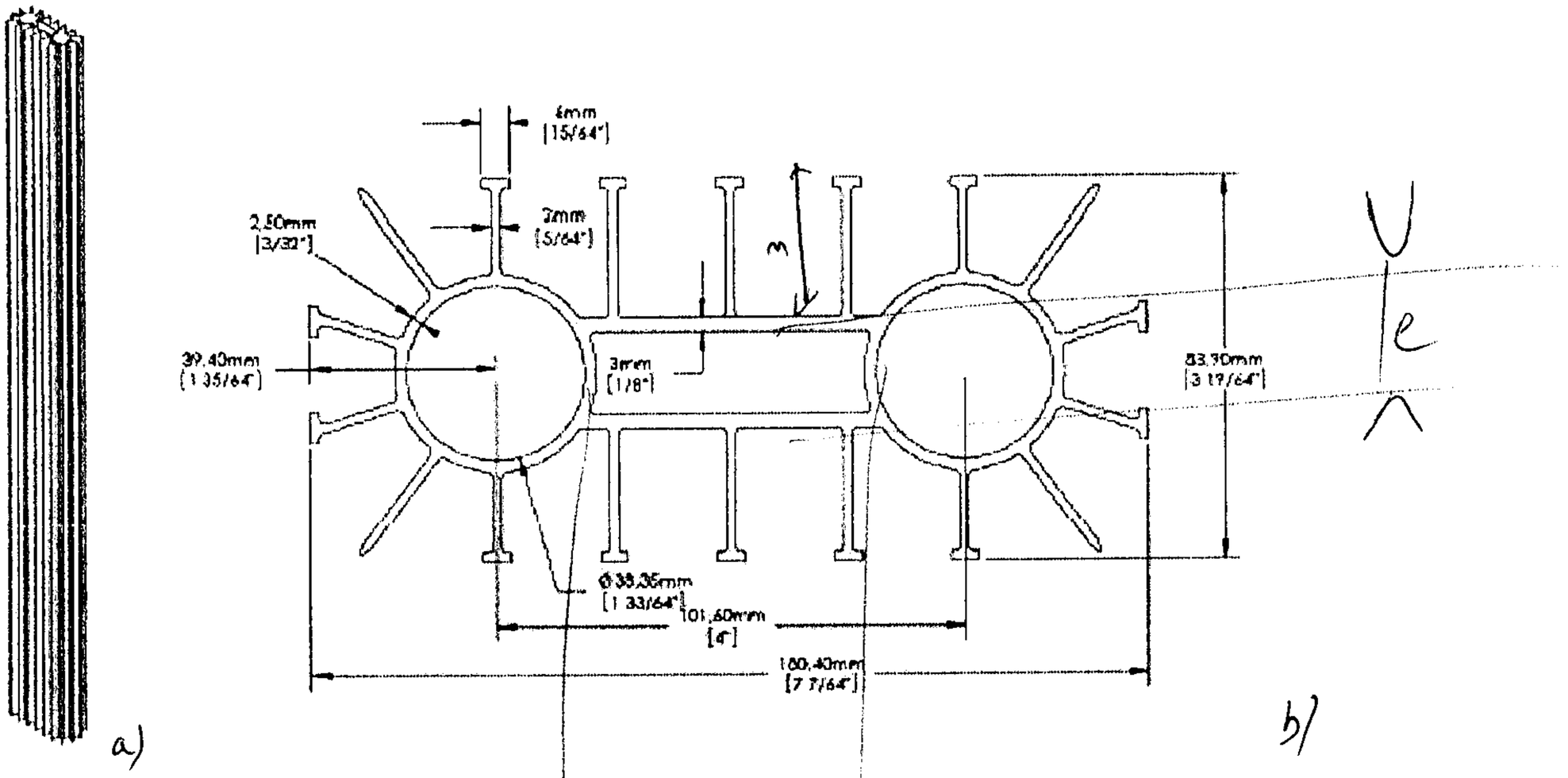
	PAR	DATE	RACKAM DESIGN-ICARUS HEAT
	R Lavabre	2011-04-12	

141 Wellington Sud, Sherbrooke (QC) J1H5C9 tel: 819-348-0101 Web: rackamd.com

FIGURE 15

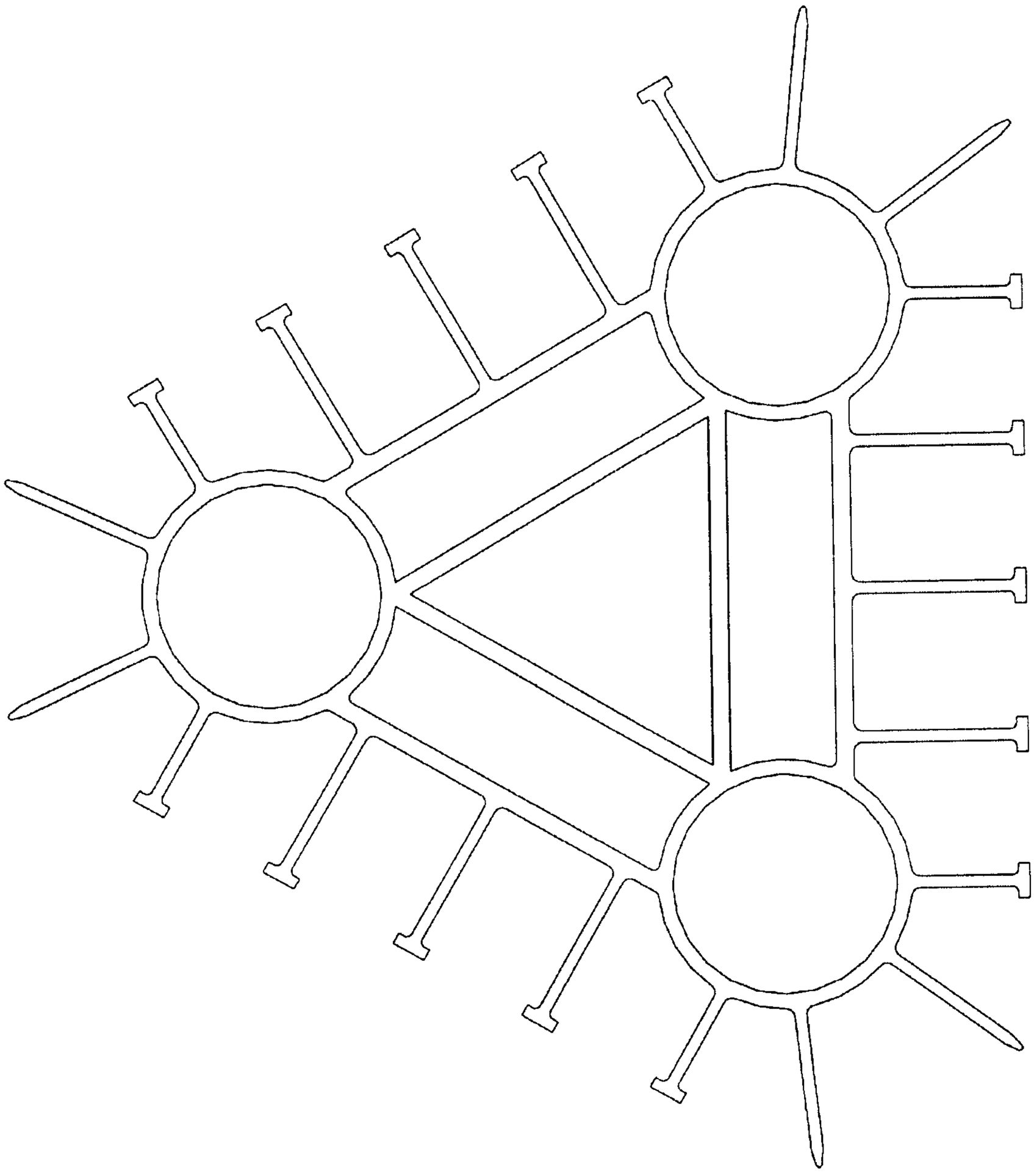
CA 02748632 2011-08-04

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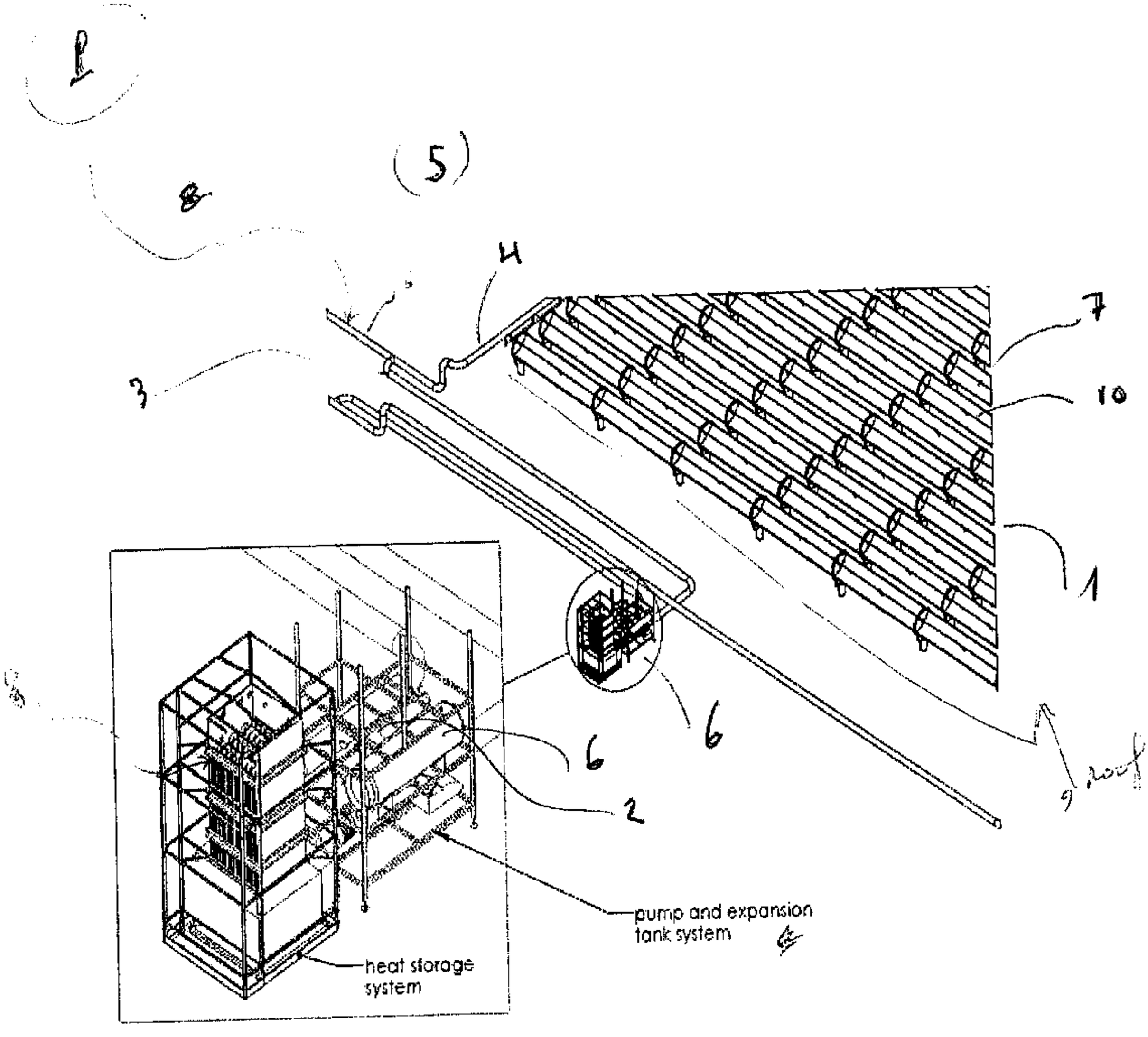


10 **Figure 1 extruded shape and profile**

Figure 1B



– Figure 22 –


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heat storage system
pump and expansion tank system