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(54) Heat exchanger assemblies having hybrid tanks

(57) Heat exchanger assemblies, and, in particular, heat exchanger assemblies that function in high pressure and/or temperature environmental conditions, are described.

An essential feature of the heat exchanger assembly is the presence of an hybrid tank comprising both plastic or plastic like materials and metal or metal alloy materials, that provides for good structural integrity and operation of the assembly under high pressure and/or temperature conditions.

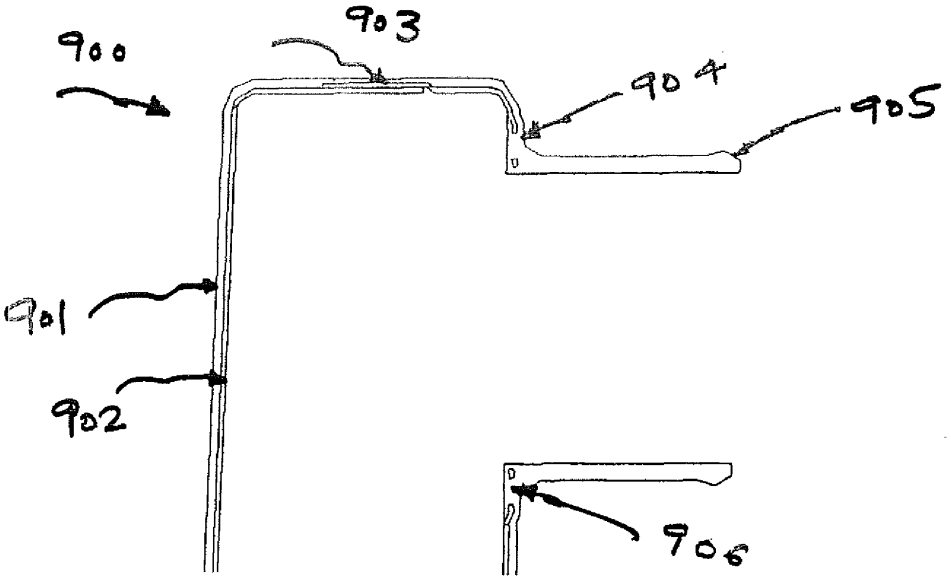


FIG. 9

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Description

[0001] This patent application is a continuation in part of US patent application No. 11/414,706 filed April 28, 2006 and claims priority thereto

FIELD OF THE INVENTION

[0002] The present invention relates to heat exchanger assemblies, and, in particular, heat exchanger assemblies that function in high pressure and/or temperature environmental conditions.

BACKGROUND OF THE INVENTION

[0003] Current tank or tanks for heat exchangers, especially high pressure and/or temperature heat exchangers such as charge air coolers, use materials such as cast aluminum for tanks subjected to high temperatures and/or pressure conditions.

[0004] JP2003314287 (A) identifies use of cast Aluminum tanks which are welded to the heat exchanger core. EP1524105 (A2, A3) identifies bonding of two material to form a structural part.

[0005] The use of cast aluminum tanks, however, means that such heat exchangers are required to have certain limitations, such as design limitations/need for complex features to provide for dimensional stability and/or part integration; additional manufacturing steps or operations to accomplish outcomes not possible using a casting aluminum process alone; higher costs due to these additional or secondary operations, welding necessary for tanks to the heat exchanger for assembly, high weight, and, in certain cases, inadequate corrosion resistance.

[0006] Heat exchangers have also used plastic tanks or manifolds ('tanks') to meet product requirements, For example, plastic charge air cooler tanks or tanks are used where the application temperature and pressure allow one to design them to meet the product requirements, Once specifications for temperature and pressure increase to a point where plastic tanks have limitations, cast aluminum tanks are often considered and used.

[0007] For cast aluminum tanks there is some machining required which, as described above, leads to higher overall costs. Also, cast aluminum tanks can be designed with heavy wall sections and its characteristics mean that the types of part designs that can be implemented do not achieve the goal of reducing overall costs enough to make them as commercially desirable as wanted.

[0008] Using of cast aluminum tanks for heat exchanger requires welding of tanks in most cases to the heat exchanger and this either requires robots and more time and quality sensitive manufacturing step in the system. With plastic tank this step is reduced by having gasket and standard crimp process.

[0009] As shown in figure 1 a tank is heat exchanger designed with cast aluminum Tank Figure 1b shows the cast aluminum tank.

SUMMARY OF THE INVENTION

[0010] In aspects of the present invention, a heat exchanger capable of functioning in high temperature and/or pressure environments, with a lower profile cost for the same or better performance than aluminum cast tanks, is provided. In addition, the strength and performance characteristics of lower temperature and/or lower pressure environment plastic tank systems are enhanced with the hybrid tanks of the present invention. Examples of high temperature environments are those where tanks for applications where temperature is higher than 220°C, and, particularly where temperatures and pressure are both at a high level. For example, at high temperatures, internal pressure is higher, for example greater than 30 psi.

[0011] Aspects of the present invention, therefore, provide for extended application ranges for hybrid tanks than either cast aluminum or plastic end tanks alone, particularly for use in an automotive vehicle, with lower weight with good performance versus cast aluminum only end tanks, and potentially lower cost (for example, through less time to manufacture and elimination of machining, welding and allowing integration of features not possible through metal casting methods) versus prior heat exchanger art tanks. Otherwise stated, aspects of the present invention allow for a larger degree of design freedom (more integration of features which can not be feasible through metal casting processes).

[0012] Various aspects of the present invention allow for a first material, for example, plastic or plastic like parts, and features of a heat exchanger to exist in conjunction with parts and features made of other, for exmple, different material (a second material). By other materials, it is meant materials that have different characteristics, such as different strength levels, stress modulus, stiffness levels, or the like. For example, an other material could be a material that has elastic like properties, or rigid properties; in the case of two different plastic based materials, for example, one the plastic or plastic part can be stiff relative to the other part, or visa versa. In an example where one material is plastic or plastic like, the other material can be another plastic or plastic like material with characteristics differing from the material, or the other material could be a metal or metal alloy based material. The plastic or plastic like parts can be formed or produced, for example, with processes such as, but not limited to, injection molded, blow molded or compression molded or plastic cast components. Produced parts, for example, do not require secondary operation at all or require minimum secondary operations after a main or principle manufacturing step in order to produce the end product. A hybrid tank, therefore, as used herein, is an end tank formed using at least two different materials. In general, the first and second materials, therefore, have different structural characteristics. As used herein, by

structurally less flexible, it is meant a material that is more stiff or rigid, and, therefore can lead to a longer lasting or higher performance versus a less stiff or rigid material.

[0013] In specific aspects of the present invention, materials such as plastic or plastic like materials and metal or metal alloy materials are used together to form the hybrid tank. For example, an end tank is made conforming to a plastic and metal hybrid design, wherein routine machining, such as in the prior art for metal end tanks, is eliminated or minimized.

[0014] Various aspects of the present invention, therefore, extend the application range possible for heat exchanger, and, especially for high temperature and/or pressure environment heat exchangers such as CACs (Charged Air Coolers) or intercoolers. By providing for combined properties of two or more materials, strengthened tanks at lower weight and cost than cast aluminum tanks or tanks, gain advantages, especially in terms of design freedom. Use of plastic or plastic like materials, in addition to metal or metal alloy materials in end tanks, as stated above, allows integration of features which are not possible through metal casting.

[0015] Tubes are present in automotive heat exchangers and heat exchanger assemblies. For example, in a heat exchanger with a plurality of tubes, the plurality of tubes can have at least one tube with a plurality of sub-passageways extending along a length of the at least one tube and wherein each of the sub-passageways of the at least one tube has a cross-sectional area perpendicular to the length of the at least one tube that is between about 0,02 mm^2 and about 1.00 mm^2.

[0016] End tanks, such as those used in the heat exchanger assemblies of the present invention, may be used in various applications where automotive fluids are handled. Particularly in high pressure and/or temperature environments, where plastic only end tanks can not meet, or with great difficulty, meet specifications, (such as EGR coolers, or charged air intake tank, or intake manifolds), hybrid tanks not only have the structural features necessary to meet such specifications, but also are light and formable enough to be used in a variety tight space packaging, as well as high temperature/pressure environments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Figure 1a is an example of prior art heat exchanger with cast aluminum tank.

Figure 1 b is a cast aluminum tank as found in current heat exchangers.

Figure 1c is an interior view of a cast aluminum tank as in current art.

Figure 1d is a cross section of an all plastic tank which has a metal insert in the fluid connection area only.

Figure 2 is a schematic side view of a hybrid tank, in accordance with an aspect of the present invention.

Figure 3 is a schematic interior view of a hybrid tank of figure 2, in accordance with an aspect of the present invention.

Figure 4 is a schematic view of metal shell for a hybrid tank, in accordance with an aspect of the present invention.

Figure 5 is a schematic cross sectional view of metal shell for a hybrid tank, in accordance with an aspect of the present invention.

Figure 6 is a rotated sectional view of metal shell for a hybrid tank, in accordance with an aspect of the present invention.

Figure 7 is a schematic cross sectional views of hybrid tank, in accordance with an aspect of the present invention.

Figure 8 is a schematic cross sectional view of plastic-metal sections or 'joints' of a hybrid tank, in accordance of an aspect of the present invention.

Figure 9 is a schematic cross sectional view of additional plastic-metal sections or 'joints' of an hybrid tank, in accordance with an aspect of the present invention.

Figure 10 is a schematic cross sectional view of a hybrid tank, further comprising a coating on the tank, in accordance with an aspect of the present invention.

Figure 11 is an interior schematic view of hybrid tank, comprising additional structural components to improve tank performance, in accordance with an aspect of the present invention.

Figure 12 is a schematic cross sectional view of plastic-metal sections, bonded using adhesive, in accordance with an aspect of the present invention.

DESCRIPTION OF VARIOUS EMBODIMENTS OF THE PRESENT INVENTION

[0018] Heat exchanger assemblies, and, especially, heat exchanger assemblies operating in high temperature and/or pressure environments, allow increased temperature and pressures range of application of lower weight and cost tanks. Hybrid tanks, as in the various

aspects of the present invention, are therefore useful to replace cast aluminum, or even other metal tanks, such as stamped and brazed aluminum tanks.

[0019] The present invention, in one embodiment, provides for a heat exchanger for an automotive vehicle comprising: a first end tank; a second end tank opposite the first end tank; a plurality of essentially parallel tubes in fluid communication with the first and second end tanks; at least one fin contacting at least two of the plurality of tubes, with the parallel tubes and the fins being generally co-planar relative to each other; wherein at least the first end tank or the second end tank is a hybrid tank made of a first material and a second material.

[0020] When the second material of the hybrid tank is a metal or metal alloy, the metal part or parts comprising the second material of the hybrid tank are located in the hybrid tank in at least one, and, more specifically, in a plurality of areas. The metal part or parts, together referred to as the 'metal shell', is provided in one strategic area or, in a plurality of areas, or in all of areas necessary to provide the correct rigidity or stiffness for its own particular heat exchanger application, in accordance with the applicable specification. For example, for heat exchanger assemblies comprising a charge air cooler, the metal shell provides stiffness which allows areas of the hybrid tank to resist high pressures at specified temperatures. The plastic part or parts of the hybrid tank (plastic adjuncts) are formed or otherwise assembled together with the metal shell such that they have essentially leak proof seals between metal and plastic areas of the hybrid tank, thereby rendering the tank so-called 'leak tight'.

[0021] The metal shell of the heat exchanger tank may comprise metal or metal alloy derived from a sheet of metal or metal allow (sheet metal).The combination of sheet metal and plastic takes advantage of the properties of sheet metal to take large loads (sheet metal form (which is in $0.3 \geq t \leq 4$ mm thickness), versus, for example, the typical cast aluminum tanks of width or thickness which are often greater than or equal to $3 \geq t \leq 6$ mm, wherein t is the average thickness. The properties of the plastic, particularly, for example, lower densities compared to aluminum, allow for a lighter overall tank and subsequently heat exchanger and assembly weight, and ease of manufacturing of complex features on or associated with the hybrid tank.

[0022] The area of hybrid tanks at the junction of contact of metal and plastic parts is called, herein, 'plastic-metal sections'. Together, the plastic-metal sections form part of the overall tank and the tank comprises the metal shell and plastic adjuncts.

[0023] These plastic-metal sections, also referred to on occasion as mechanical joints or mechanical interface joints can be envisioned in many ways. Simplistic joint is shown where plastic flows through strategically placed perforations in the metal and thus creating a mechanical joint. The number and type of mechanical joint varied per location through out the tank and also from one tank design to other tank designs. The purpose of the mechanical joint is to allow some deformations and loads seen during the duty of the part. In various aspects, the plastic adjuncts and the metal sections can be bonded, glued, or otherwise held together, either by a general bonding process, by adhesives, or by forming an interfacial layer of a product to help form a seal. Plastic-metal sections can be bonded together.

[0024] Aspects of the present invention also provide for the use of a coating, such as thermal barrier, or thermally dissipative, coatings, that is applied to various areas of the hybrid tank. Aspects of the present invention having such coatings, means that the application range of current systems can be further expanded to cover higher heat and pressures, through improve the thermal and chemical resistance of the product. Examples of liquid coatings are numerous and are found in standard formulations and used in the art on a regular basis. One such example includes coatings such as thermal barrier type coating like IC-105 from Techline Coating. Preferred are coating that practically eliminate or highly reduce oxidation by isolating the majority of the base material from higher temperatures.

[0025] Other examples of coatings useful for applications of the present invention including thermally dissipative type coating, with or without supplemental coating substances can provide other characteristics in addition to heat management and chemical resistance. For higher temperature applications, thermally dissipative coatings can include, for example, a thermally cured heat emitting coatings, that can be combined with other materials, such as pigment, to provide corrosion protection as well as being applied as a thin film. Various coatings, and particularly those applied as thin films tend not to reduce surface area by filling in surface porosity. For example, a coating is applied on the interior or exterior or both walls of the hybrid tank. Also, essentially all or one can envision only some portion of the tank, may use such a coating. Preferred coating, in various aspects, is done on the internal or 'interior' surface of the wall of the tank.

[0026] To provide even further structural strength, at least one bridge or a number of bridges between the walls of at least one of the end tanks can be provided. The bridge or bridges span at least two walls of the hybrid end tank and provide increased structural support for the tank. The bridge or bridges are made of a material that meets the specifications required for a heat exchanger. The bridge or bridges can be made of the first material, or the second material, or as a combination of the first and second material, or of a different material altogether.

[0027] The bridge or the bridges may be integral to the end tank, i.e., can be molded as a single part along with a plastic part or can be part of a metal part, or a combination of the two, during the formation of the end tank. In various embodiments, a bridge or bridges are added in another step, i.e., formed separately from the end tank and provided during assembly for support. The bridge can be formed integral to the end tank or formed separately from the end tank and added to the end tank during

assembly.

[0028] Figure 1a, (100) is a typical heat exchanger, having tanks (101) and (102) are provided to remove and accept fluid from vehicle systems respectively. Tank (101) which is outlet tank, is typically made entirely out of plastic, particularly since outlet temperatures, usually and in some cases, also pressures, are lower. Tank (102) is inlet for fluid entering in the heat exchanger (100). For cooling heat exchangers the temperature and pressure of the fluid entering in the inlet tank 1(02) is high. Tank (102) is made of metal or materials which can withstand higher temperature or pressure. Figure 1 a has a cast aluminum tank (110). Heat exchanger (100) shows that tanks are connected by header (104) and (110). The main heat exchanger portion of the heat exchanger is called the core (103). Core (103) is made up of tubes and fins (not shown). The tubes of the core allow fluid to exchange heat with out side environment in combination with fins. Also shown are mounting features (106,107,108 and 109) (features which allow one part to attach to another part so as to retain portions of the heat exchanger to another with ascertain proximity) typical to such heat exchangers.

[0029] Figure 1 b, (160) shows a cast aluminum tank or aluminum sheet metal brazed or welded tank (not shown) also exits. Interface features such as outlet connector (161), foot area (162) and mounting features (163) and (164) are shown. Cast aluminum tank requires additional machining to finish desired for interface features especially tank foot and fluid connectors.

[0030] Figure 1C, (180) is an inside view of the tank (160). Again shown are the features (181,182 and 183).

[0031] In figure 1 D, is the cross section view of the tank (190) made entirely out of plastic (191) where fluid connection section (193) has metal sleeve (192) inside. Sleeve (192) helps prevent creep in plastic and maintain its shape during it life cycle.

[0032] Figure 2 illustrates hybrid tank (200) is made with more than two materials. Tank (200) typically has multiple interfaces such as connector for the fluid handling (201), foot interface (202) connected to the core portion of the heat exchanger described in figure 1 a and mounting features (203) and (204).

[0033] Figure 3 illustrates hybrid tank (300) with interior view of tank (200) of figure 2. Connector (301), foot (305), mounting feature (302) is shown. Mechanical interface points (303, 304 and 306). The mechanical interface points (plastic-metal sections) are joints between sheet metal and plastic.

[0034] In figure 4, metal shell (400) is shown with details (401,402,403 and 404). Details (401, 402 and 403) are perforations provided in the metal sections for allowing plastic to flow and form a mechanical interface joint. Plastic-metal section detail (404) shows the mechanical interface joint between two sections of metal; where two separate metal sections are brought together.

[0035] Figure 5 shows a cross section (500) as shown in figure 4 at Section B-B item (405) showing further details of some of the mechanical interface joint sections. Cross section (500) illustrates two pieces are joined at location (506), sheet metal wall is shown (501). Perforations (502, 503, 504 and 505) are formed in a manner to allow plastic to flow and create a mechanical interface joint (plastic-metal section). Perforations in wall section (501) may be added (not shown) as needed by the product.

[0036] The metal shell is comprised of a part or parts found in specific areas where strength is required to be enhanced, for example, to meet product specifications. Such areas can be, for example, areas of increased load, high pressure concentration in the tank, areas exposed to increased temperatures, etc.

[0037] In figure 6, hybrid tank metal section (400) is shown in respective sections (600 and 620). Section (600) shows features of the metal sections. Spaces or perforations (602, 604) are shown for section (600). When there is more than one perforation or space, the perforations or spaces can be aligned or unaligned. Similarly, perforations (625, 623) are shown for section (620). Sections (600) and (620) form shell (400), these perforations get aligned and create a location for plastic to form a plastic-metal section. Section (600) areas (606, 608, 610, 611) and section (620) has areas (626, 627, 628, 629); when sections (600) and (620) are joined to form a shell (400), these areas create a plastic-metal section (joint) shown as item (404) or (506). The sections (600 and 620) have walls (609) and (624) respectively which can again be perforated as desired to create locations for making the joint with plastic.

[0038] Figure 7, is a cross section (700) of a finished hybrid tank (Section A-A) shown in figure 5. Cross section (700) shows plastic section (701) and metal section (702). Also shown are the interface features such as tank foot (703, 800) and fluid connecting port (708). This cross section shows plastic-metal section between plastic and metal sections at (707, 706, 704 and 705). Also shown is the area where two metal sections and plastic sections come together (709).

[0039] Figure 8, is an enlarged view (800) of the bottom section of (700), as one of the configuration which can be envisioned for joining metal and plastic. (801) is the foot area (901), plastic section (803) is and metal section (804) is shown. (802) is the plastic-metal section.

[0040] Figure 9 illustrates an enlarged view (900) of the top section of cross section (700). The plastic section (901) and similarly, metal section (902 are shown. Fluid interface connector (905) exists as a feature. Items (905) and (906) show one of the approaches to joining plastic to metal mechanically.

[0041] Figure 10 shows cross section (1000) with another variation where the hybrid tank wall is coated with a protective coating on its interior surface, which can be a corrosion resistant or thermally resistive or dissipative coating or coatings are generally used. Shown here is coating (1003) applied preferably to inside or interior surface as shown. Plastic section (1001) and metal section,

(1002) are protected by coating (1003) from fluid or environment inside the tank.

[0042] Figure 11 shows interior view of hybrid tank (1200), having bridges or tie rods (1207) and (1208) for increased structural support (bridges) between walls (1206) and (1205) respectively. Shown in this view are features (1203) for mounting, fluid connection features (1201), (1202) foot area, and location of mechanical joint between metal and plastic (1204), is provided.

[0043] Figure 12 shows the hybrid tank (1300) in a cross sectional view. Plastic section (1301) is bonded to metal section (1303) with a bonding material (1302). Plastic and metal sections can, of course, can be envisioned to be in opposite orientation to what is shown here. In cross section, plastic material section (1301) is manufactured and bonding material (1302) is applied to either a plastic section (1301) or a metal section (1303) and then plastic and metal section with one of them carrying bonding material are brought together to form the plastic-metal section. Also shown is fluid connection area (1304) where interior surface (1305) is shown, without optional metal sleeve.

[0044] It can also be envisioned that metal portions and plastic portions are separately manufactured and joined in a secondary operation v/s in the die or tool to form a shaped part. For example, ultrasonic or vibration welding processes, may be used.

[0045] The metal section (metal shell) can be manufactured in one part, in its entirety, through a deep draw process, for example, or can be in more than one piece.

[0046] Various aspects of the present invention relate to a method of manufacturing heat exchanger assemblies comprising a hybrid tank. In one such method, an hybrid tank is formed by assembly a metal shell or shells and plastic material in such a way that a fluid-tight hybrid tank comprising plastic-metal sections is made.

[0047] At least one metal portion or part is placed in the mold or die to provide the metal section, plastic material is provided in desired areas not adequately or appropriately provided by the metal section.

[0048] A hybrid tank is, preferably, assembled as part of a heat exchanger assembly, thereby providing for an heat exchanger comprising a hybrid tank, and such hybrid tank as part of the assembly. The metal shell can also be located, piece by piece, into a mold at various time intervals. For example, multiple positioning of metal sections and multiple plastic injections to form plastic sections adjuncts at various areas and at various time intervals, can be done to achieve desired product functionality in the finished hybrid tank.

[0049] In one aspect of the present invention, the metal part or parts are placed in a mold or die to provide, or form, a metal shell. Plastic adjuncts or sections are provided in the strategic areas to produce a hybrid tank of desired strength, size and weight (note that metal portion can be one or more of them). Vice versa, the plastic adjuncts can be provided to various areas of a mold or die, and metal parts can be added at strategic areas to produce an hybrid tank of desired size, strength and weight.

[0050] In various aspects, for example, the plastic section or adjunct is molded separately and also metal sections are formed separately. The plastic and metal sections are arranged in a mold or die or a fixture and are joined by injecting plastic again to join metal and plastic section using a same material or different material.

[0051] Additional structure features may also be added to the hybrid tank to improve tank, and, therefore, overall heat exchanger assembly performance. For example, tie rods, bars, structural supports, or other bridging means (herein referred to as "bridges") to support at least two areas of the tank, as provided in various aspects of the present invention. These additional structural features provide additional structural strength where desired.

[0052] In various aspects of the present invention, structural analysis of embodiments aids to define the thickness of metal sheet or portions and distribution of plastic to metal joints based on the functional requirements of the part.

[0053] In one method of manufacturing a hybrid tank for an automotive vehicle heat exchanger, the heat exchanger is made by: providing a metal shell comprising one or more metal sections for the hybrid tank; combining one or more plastic sections with the one or more metal sections; forming plastic-metal sections between the metal shell and plastic adjuncts; whereby the hybrid tank thereby produced is leak-tight and able to withstand high temperature and/or pressure conditions. In other method, a metal shell comprises sheet metal is used and/or the plastic-metal sections are formed by providing for perforations or spaces in-between metal sections of the metal shell, and flowing plastic or plastic like material by or into the perforations or spaces to form plastic-metal sections.

[0054] Unless stated otherwise, dimensions and geometries of the various structures depicted herein are not intended to be restrictive of the invention, and other dimensions or geometries are possible. Plural structural components can be provided by a single integrated structure. Alternatively, a single integrated structure might be divided into separate plural components. In addition, while a feature of the present invention may have been described in the context of only one of the illustrated embodiments, such feature may be combined with one or more other features of other embodiments, for any given application. It will also be appreciated from the above that the fabrication of the unique structures herein and the operation thereof also constitute methods in accordance with the present invention.

[0055] The preferred embodiment of the present invention has been disclosed. A person of ordinary skill in the art would realize however, that certain modifications would come within the teachings of this invention. Therefore, the following claims should be studied to determine the true scope and content of the invention.

Claims

1. A heat exchanger for an automotive vehicle comprising:

   a first end tank;
   a second end tank opposite the first end tank;
   a plurality of essentially parallel tubes in fluid communication with the first and second end tanks;
   at least one fin contacting at least two of the plurality of tubes, with the parallel tubes and the fins being generally co-planar relative to each other;

   wherein at least the first end tank or the second end tank is an hybrid tank made of a first material and a second material.

2. A heat exchanger as in claim 1, wherein the hybrid tank comprises a metal or metal alloy type second material and a plastic or plastic like first material.

3. A heat exchanger as in claim 2 wherein the hybrid tank comprises at least three different materials.

4. A heat exchanger, as in claim 3, wherein one of the materials is a coating.

5. A heat exchanger as in claim 4, wherein the coating comprises a thermally dissipative or barrier type coating.

6. A heat exchanger as in claim 4, wherein the coating comprises a chemically resistant or barrier type coating.

7. A heat exchanger, as in claim 4, wherein the coating comprises both a chemically resistant and a thermal barrier or dissipative type coating.

8. A heat exchanger, as in claim 4, wherein the heat exchanger is adapted to function in high internal temperature and/or pressure environments.

9. A heat exchanger, as in claim 4, wherein the heat exchanger is selected from the group consisting of charge air cooler (CAC), exhaust gas recycling cooler (EGR), and intercoolers.

10. A heat exchanger, as in claim 9, wherein the coating is selected from the group consisting of thermally dissipative, thermal barrier, chemically resistance and chemical barrier type coating.

11. A heat exchanger as in claim 10, wherein the coating is applied to the interior surface of the wall of the hybrid tank.

12. A heat exchanger, as in claim 2, wherein both the first end tank and the second end tank are hybrid tanks.

13. A heat exchanger, as in claim 2, wherein the hybrid tank comprises a metal shell.

14. A heat exchanger, as in claim 13, wherein the hybrid tank comprises at least one plastic adjunct.

15. A heat exchanger, as in claim 13, wherein the hybrid tank comprises a metal shell, and wherein at least one metal part of the metal shell and at least one plastic adjunct form a plastic-metal section.

16. A heat exchanger, as in claim 15, wherein a plurality of metal parts of the metal shell form plastic-metal sections.

17. A heat exchanger, as in claim 16, wherein the metal shell is made of sheet metal.

18. A heat exchanger; as in claim 16, wherein the plastic-metal sections are sealed by bonding, adhesives or forming of an interfacial layer at the interfaces of the plastic adjuncts and the metal shell.

19. A method of manufacturing a hybrid tank for an automotive vehicle heat exchanger comprising:

    providing a metal shell comprising one or more metal sections for the hybrid tank;
    combining one or more plastic sections with the one or more metal sections;
    forming plastic-metal sections between the metal shell and plastic adjuncts;

    whereby the hybrid tank thereby produced is leak-tight and able to withstand high temperature and/or pressure conditions.

20. A method, as in claim 19, wherein the metal shell comprises sheet metal.

21. A method, as in claim 20, wherein the plastic-metal sections are formed by providing for perforations or spaces in-between metal sections of the metal shell, and flowing plastic or plastic like material by or into the perforations or spaces to form plastic-metal sections.

22. A method, as in claim 20, wherein the metal shell comprises metal to metal mechanical interface points and plastic-metal sections.

23. A method, as in claim 20, wherein the metal portions of the metal shell are arranged such that they increase strength of the hybrid shell is specific areas.

24. A method, as in claim 21, wherein the perforations or spaces are aligned such that the majority of all of the plastic-metal sections can be formed in a one step operation.

25. A method, as in claim 19, further comprising the step of coating at least part of the interior surface of hybrid tank after the plastic-metal sections are formed.

26. A method, as in claim 25, wherein the coating is selected from the group consisting of thermally dissipative, thermal barrier, chemically resistance and chemical barrier type coating.

27. A method for forming an heat exchanger assembly by assembling the hybrid tank of claim 19 with other elements of an automotive heat exchanger, to form a heat exchanger assembly.

28. A heat exchanger as in claim 1, wherein the second is material structurally less flexible than the first material.

29. A heat exchanger as in claim 28, wherein both the first material and the second material are plastic or plastic like materials.

30. A heat exchanger as in claim 28, wherein the first material is a plastic or plastic like material, and the second material comprises sheet metal.

31. A heat exchanger as in claim 29, further comprising a third material.

32. A heat exchanger as in claim 30, further comprising a third material.

33. A heat exchanger as in claim 2, wherein the hybrid tanks have at least two internal walls and at least one structural bridge or bridges between the two wails of the hybrid tank to improve structural strength.

34. A heat exchanger as in claim 33, wherein the bridge or bridges is made of the same material as at least one of the first or second material of the hybrid tank, and at least one structural bridge or bridges is integrally part of the hybrid tank.

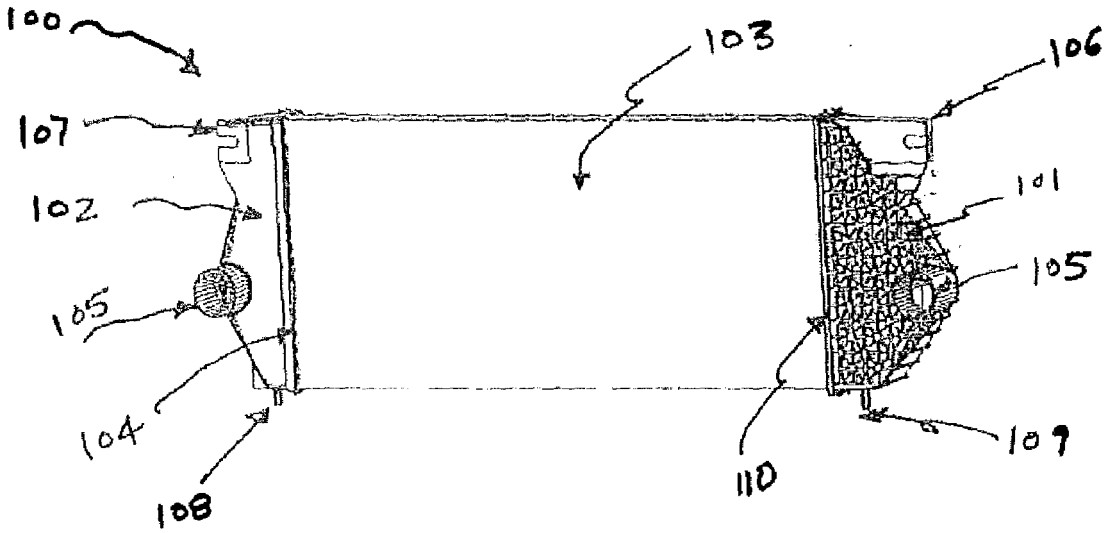


FIG. 1a

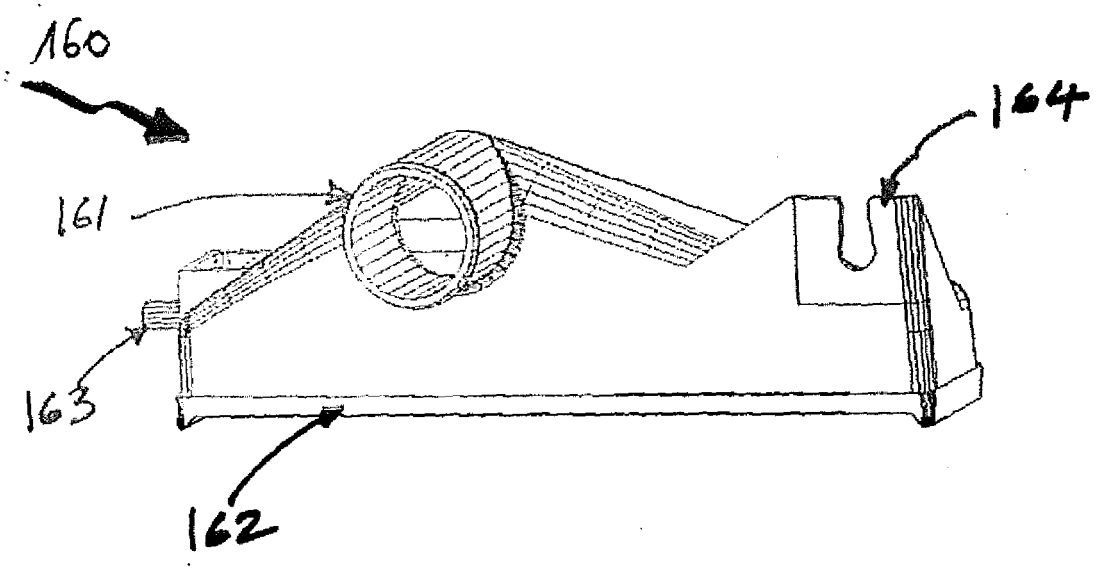


FIG. 1b

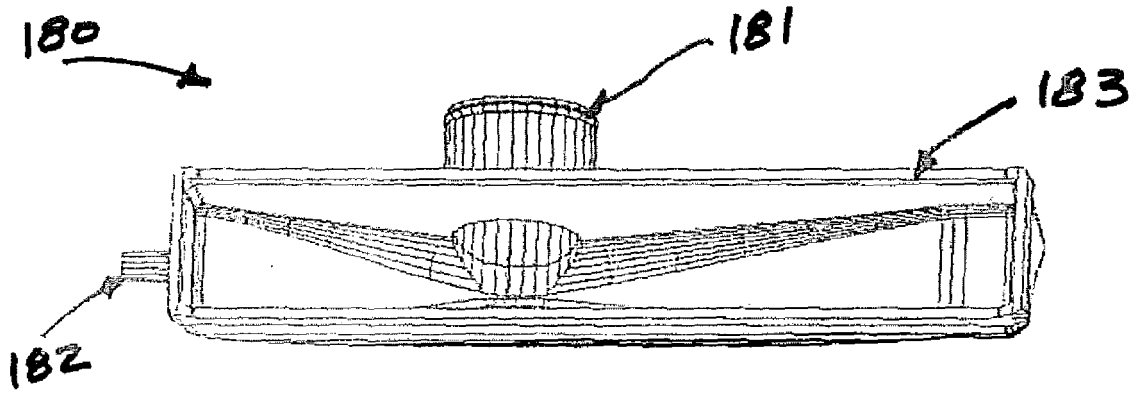


FIG. 1c

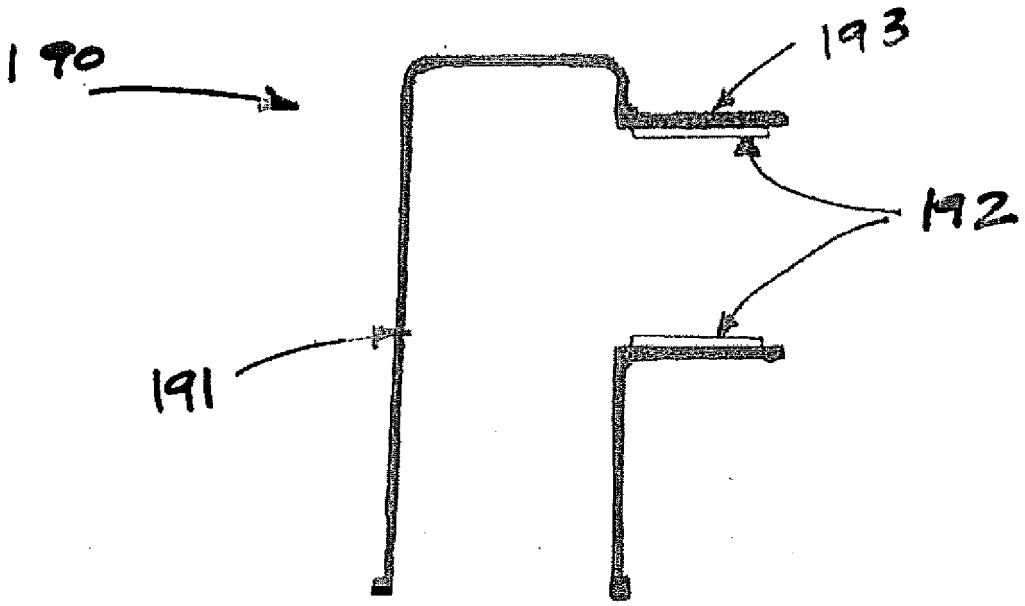


FIG. 1d

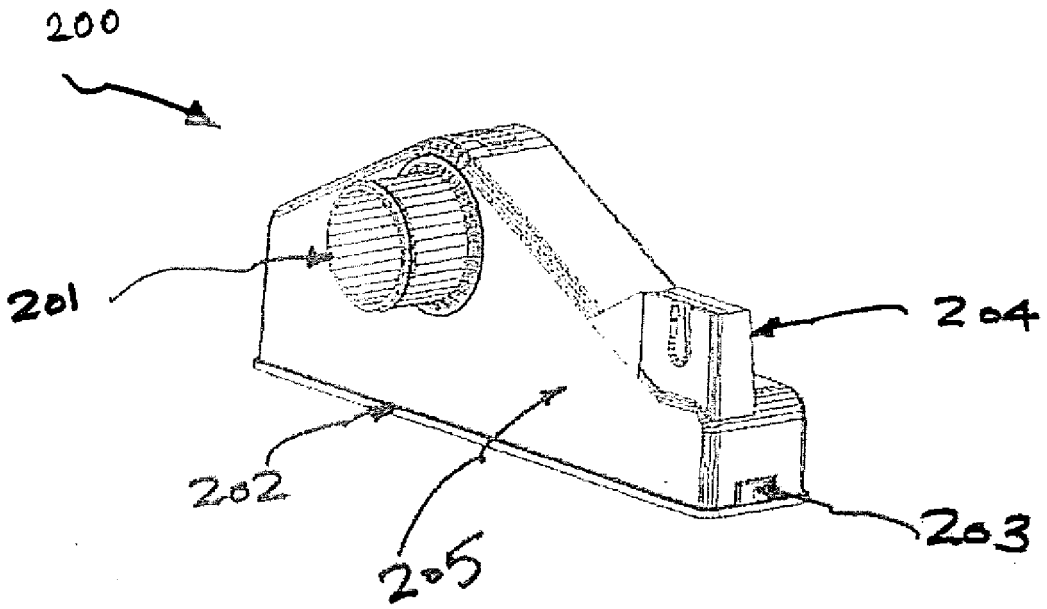


FIG. 2

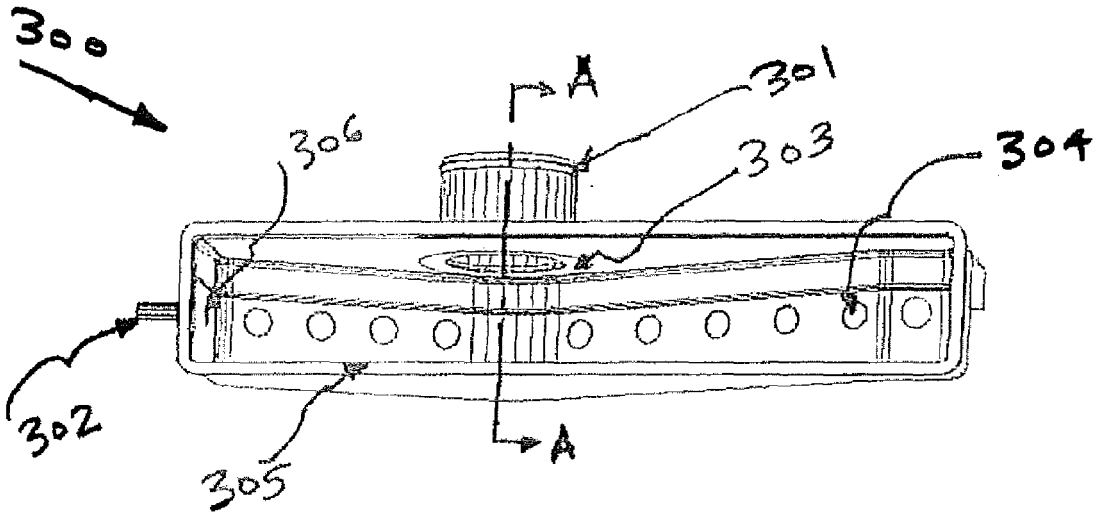


FIG. 3

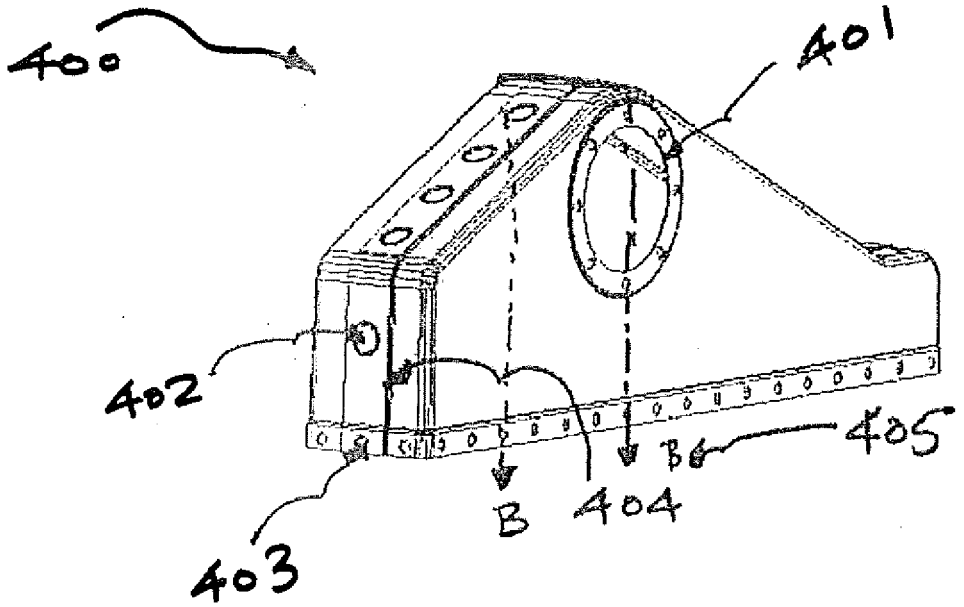


FIG. 4

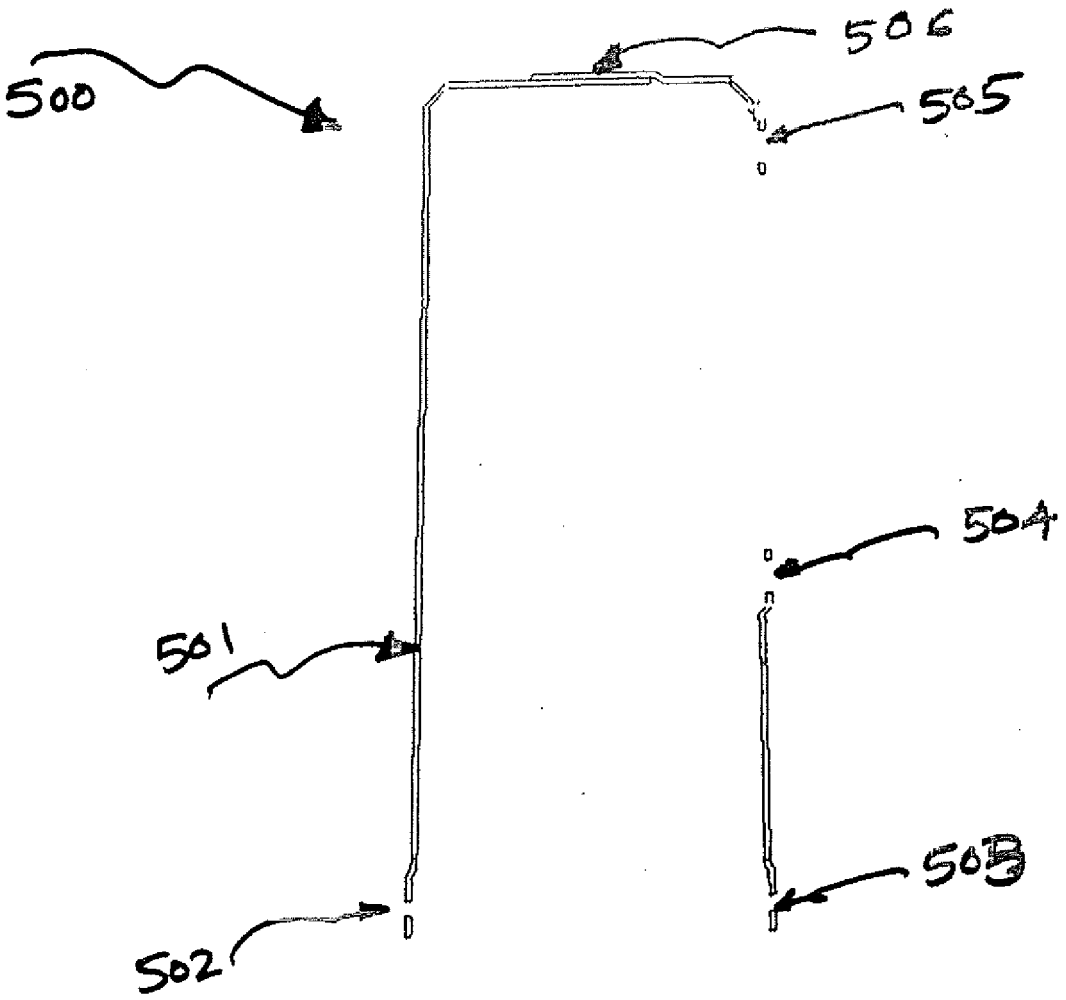


FIG. 5

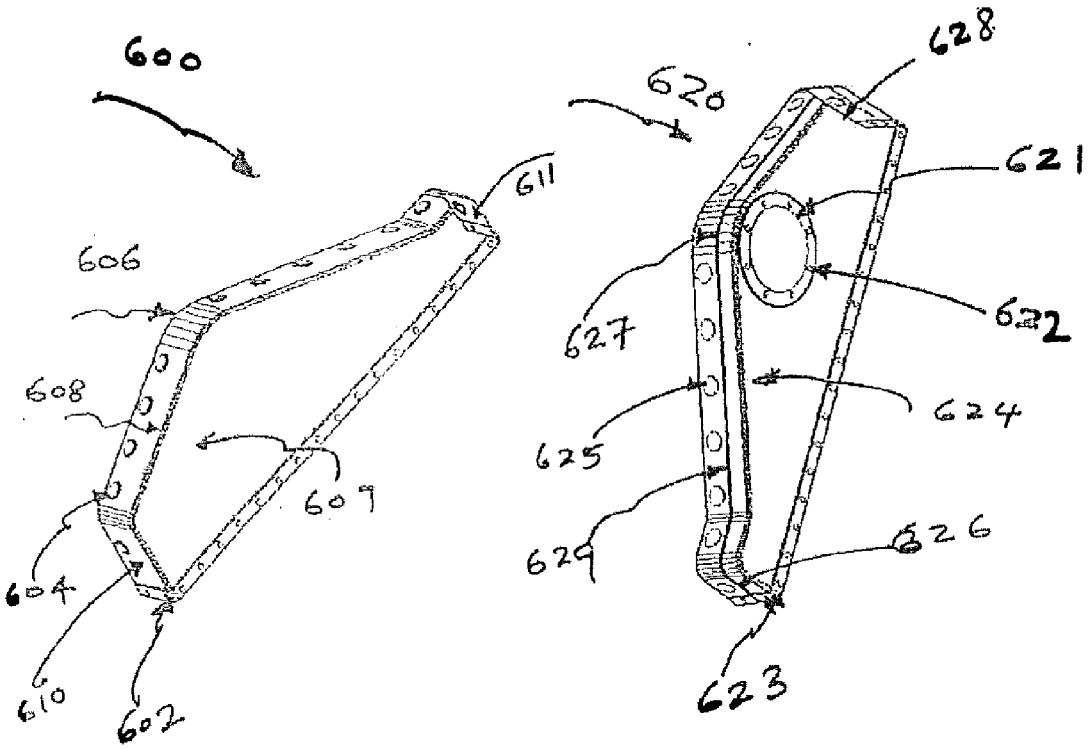

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FIG. 6

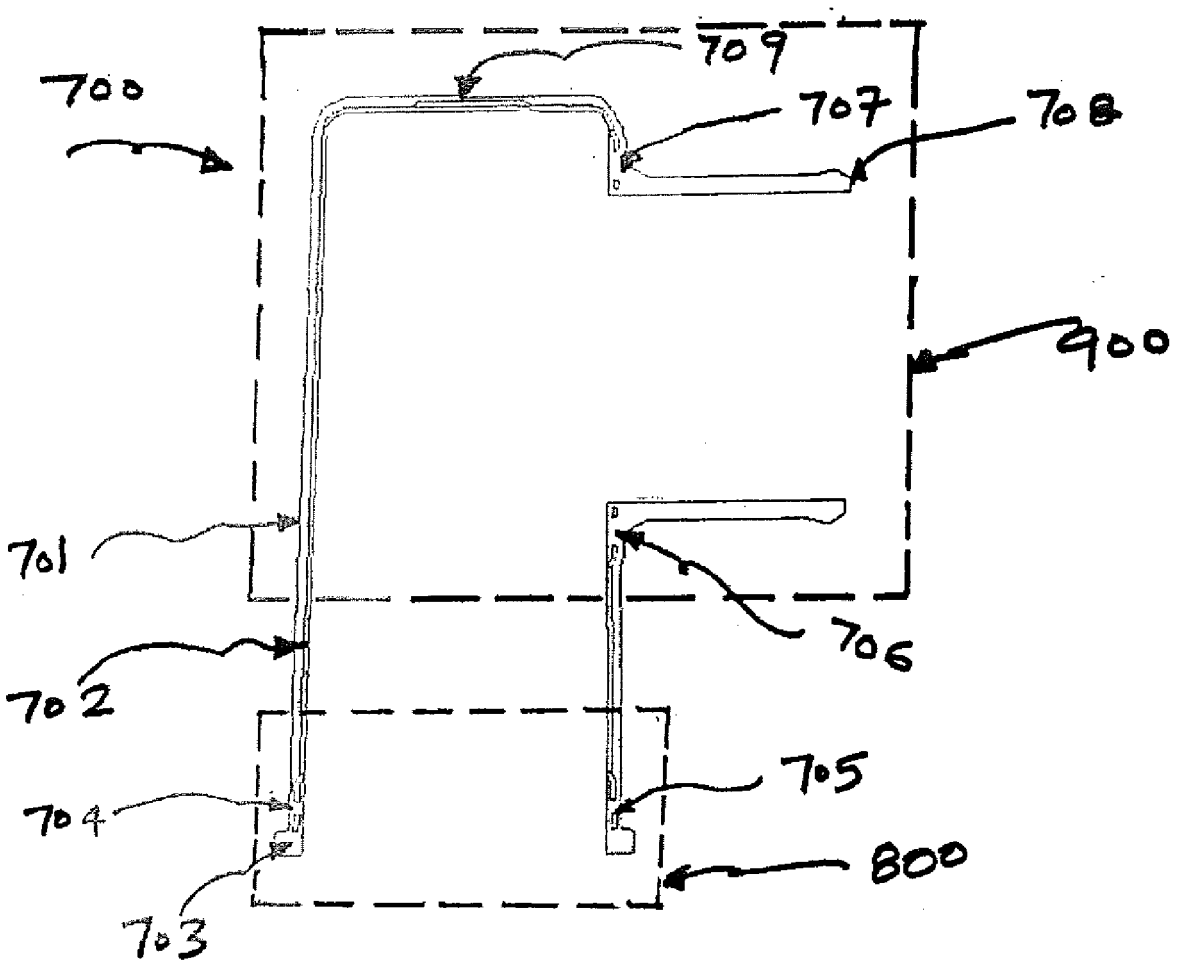


FIG. 7

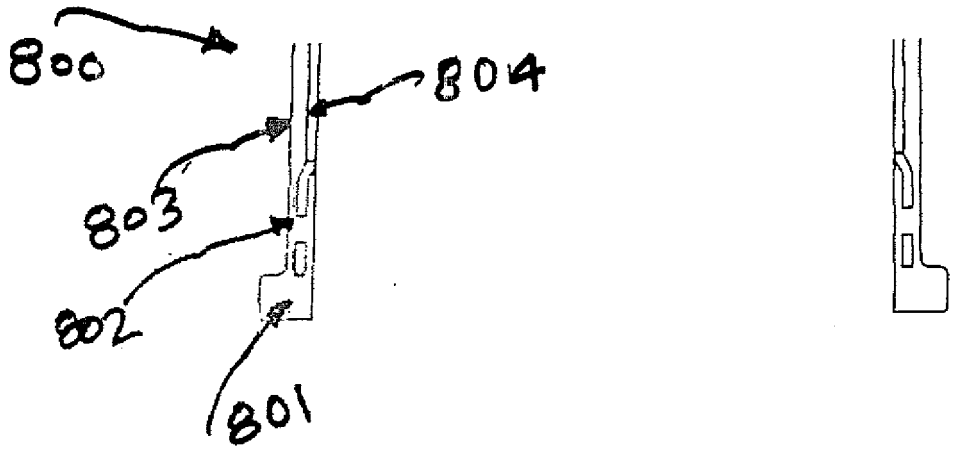


FIG. 8

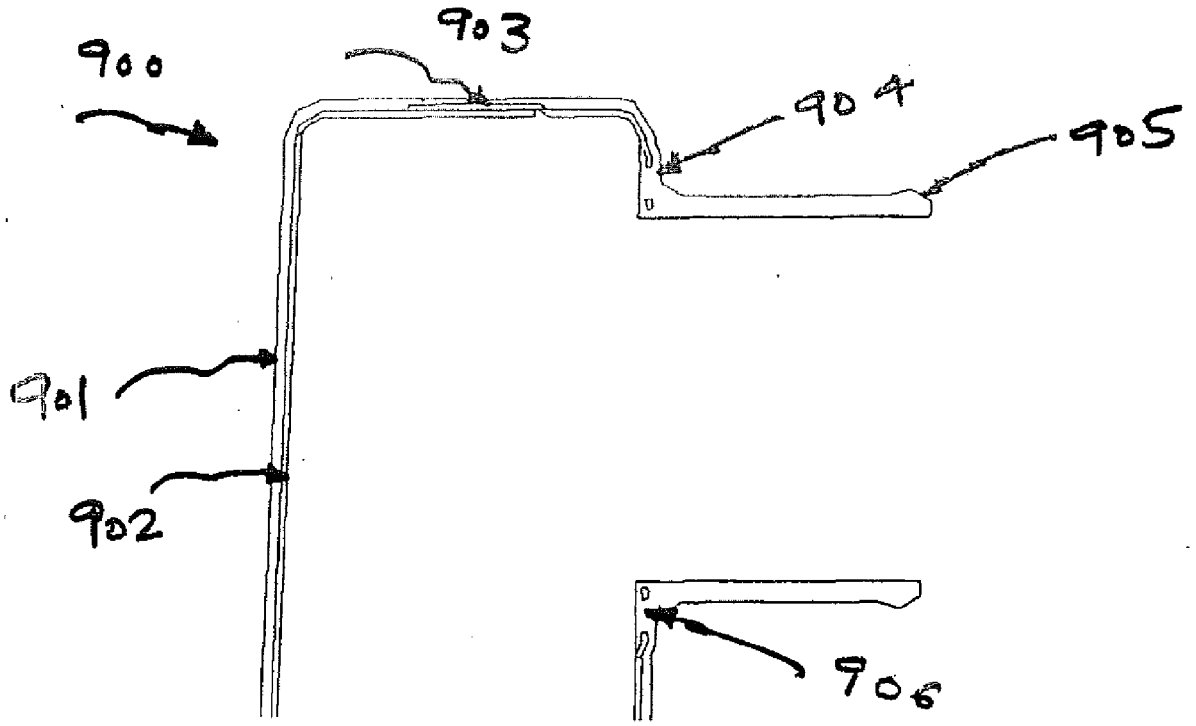


FIG. 9

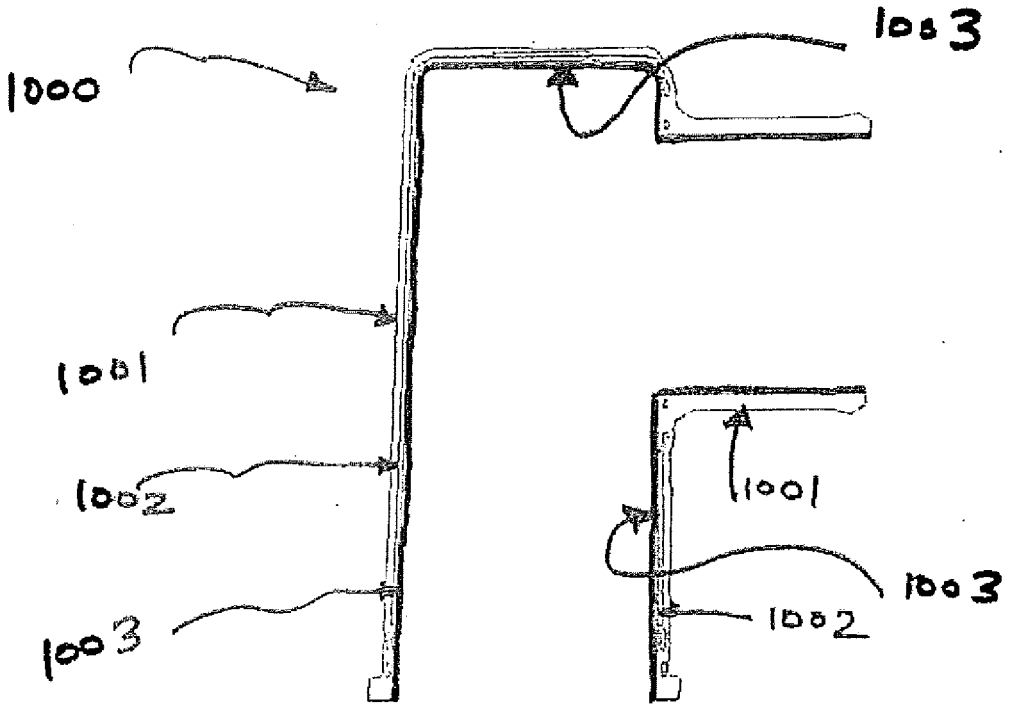


FIG. 10

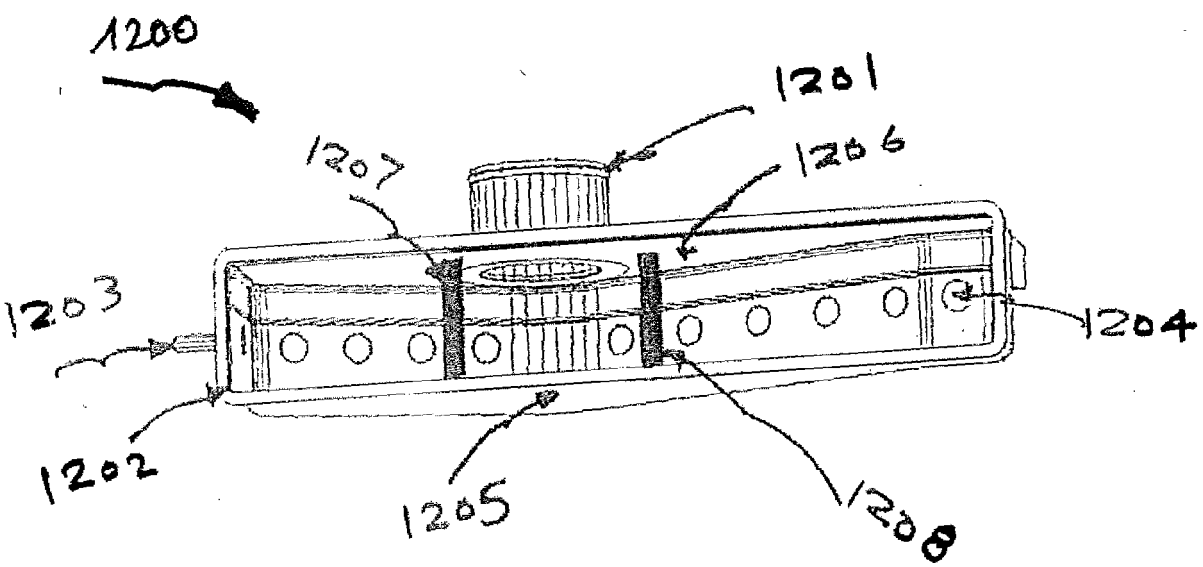


FIG. 11

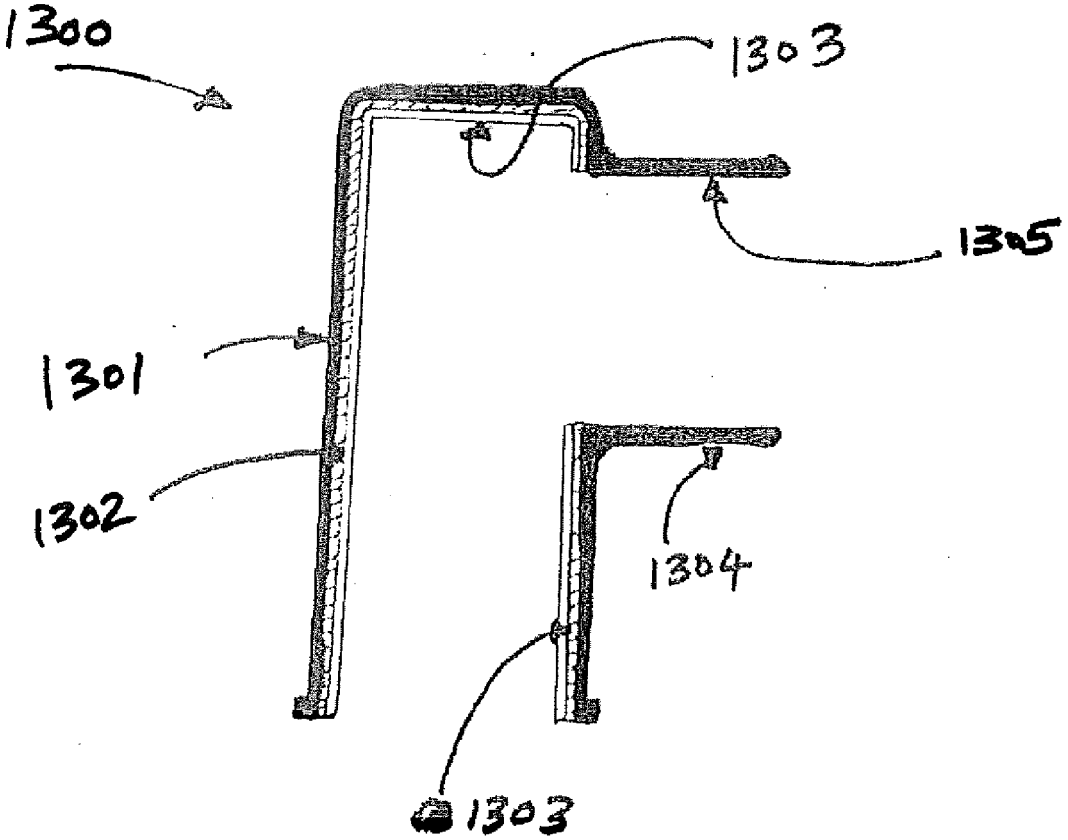


FIG. 12

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- JP 2003314287 A **[0004]**
- EP 1524105 A **[0004]**