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(54) **HEAT EXCHANGES FOR DISPENSING SUB-ZERO BEER**

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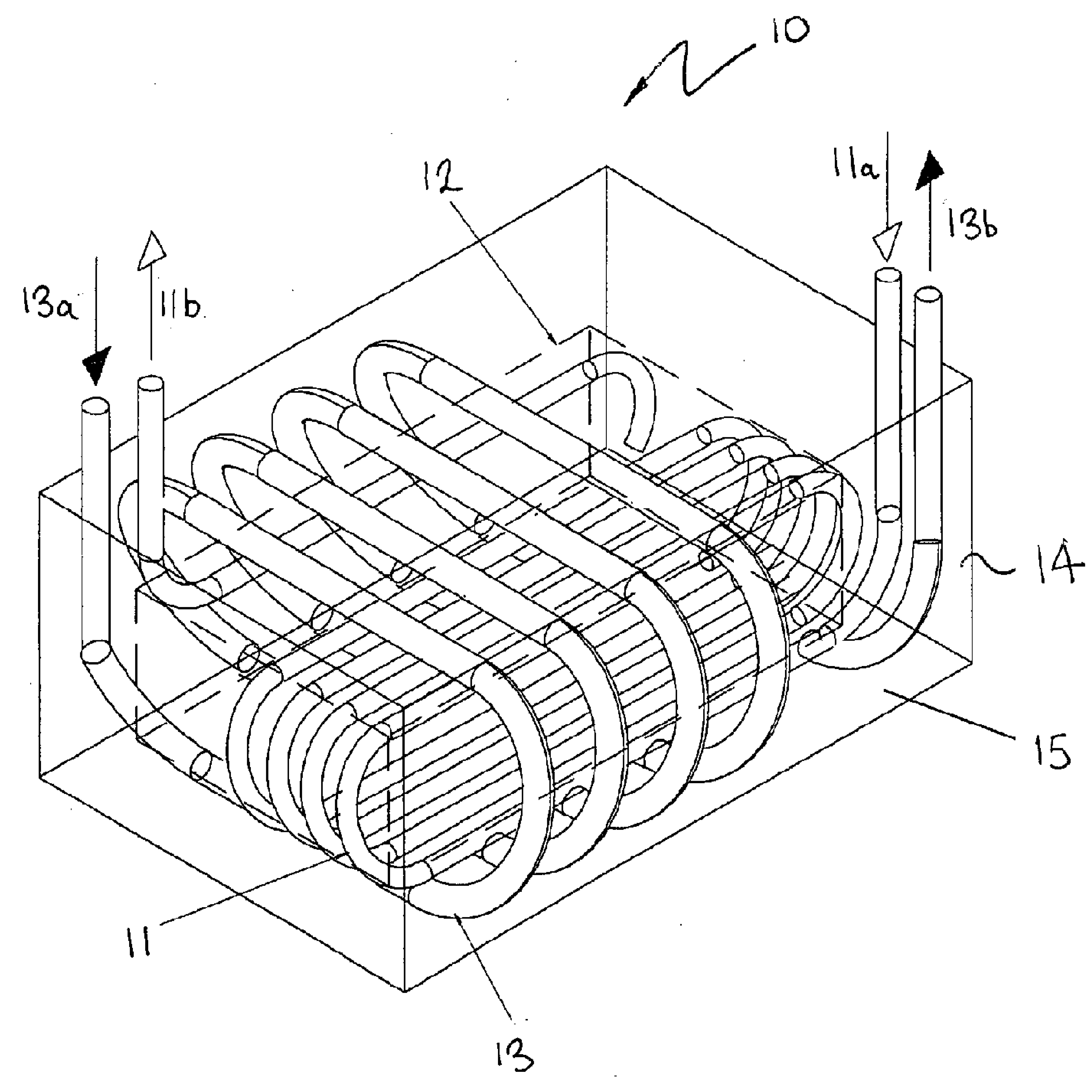
(57) **ABSTRACT**

A heat exchanger (**10**) comprises a coolant line (**11**) and a beverage line (**13**), embedded in a solid block of Aluminium (**15**). The coolant line (**11**) is in the form of a first helical coil defining a plurality of turns typically located in the centre of the block. The beverage line (**13**) is in the form of a second helical coil defining a plurality of turns extending around the first coil. The coolant line defines a cold zone (**12**), typically in the centre of the block, with the volume outside the central zone carrying the beverage line ratio defining an designated beverage cooling zone (**14**). The volume ratio of the designated zone to the cold zone is about 150:100. The heat exchanger allows for cooling of beer to precise temperatures and even temperatures close to freezing point, using direct expanded Freon refrigeration methods. The complete system including the refrigeration equipment to be packaged into a small area, such as is available under bars and dispensing counters etc., which removes the need for large installations and the associated costs and maintenance of the same. In a variant an additional beverage cooling zone may be located inside the cold zone. The positions of the coolant and beverage lines may also be reversed in certain applications.



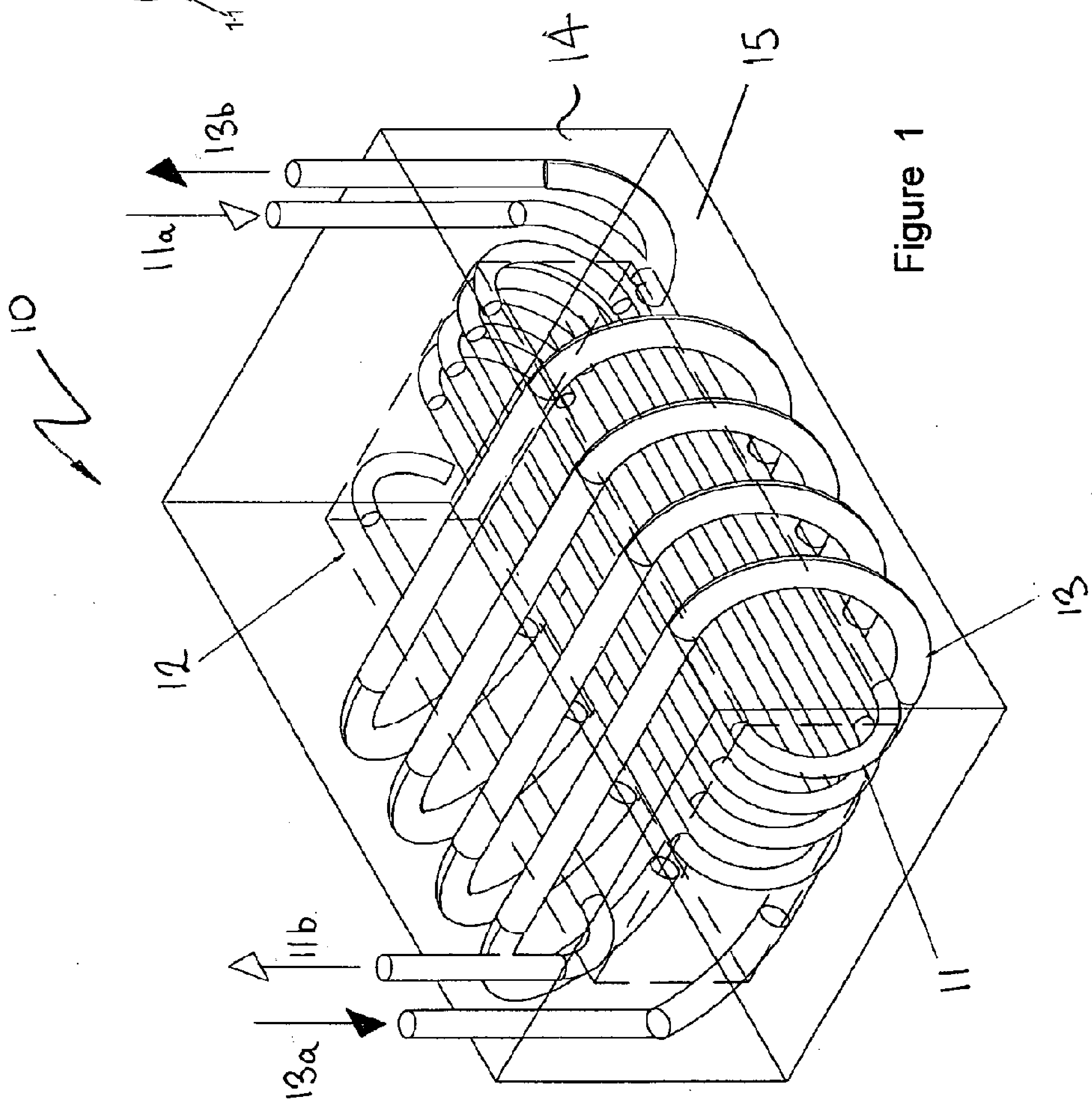


Figure 1

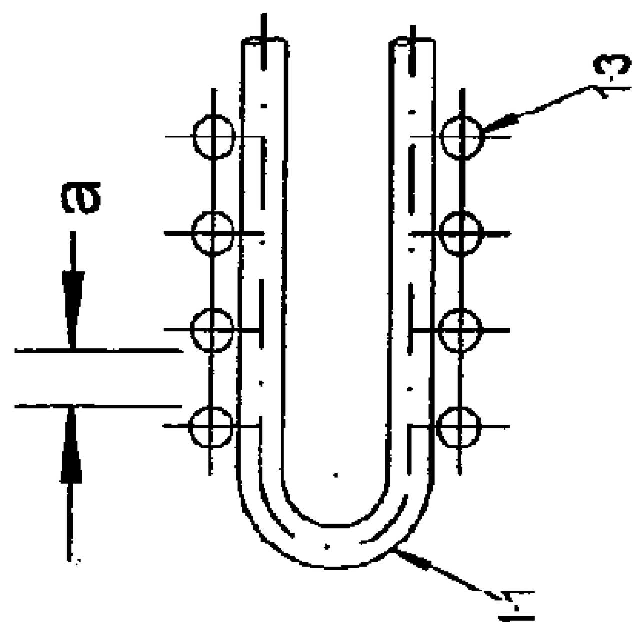


Figure 2

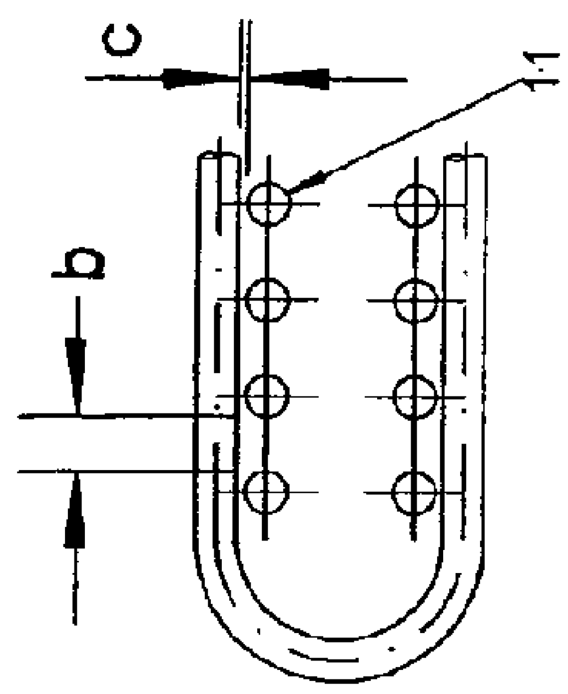


Figure 3

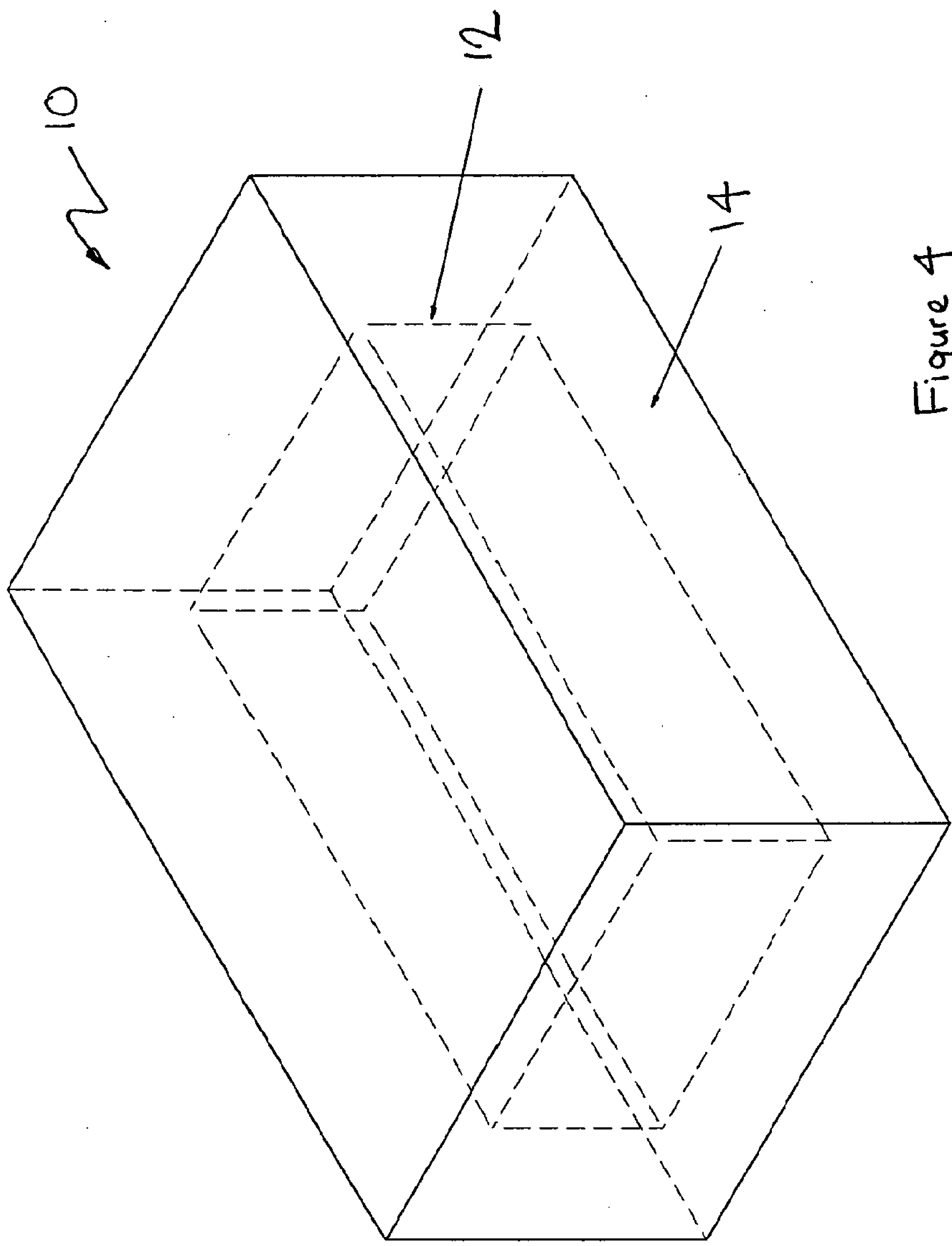


Figure 4

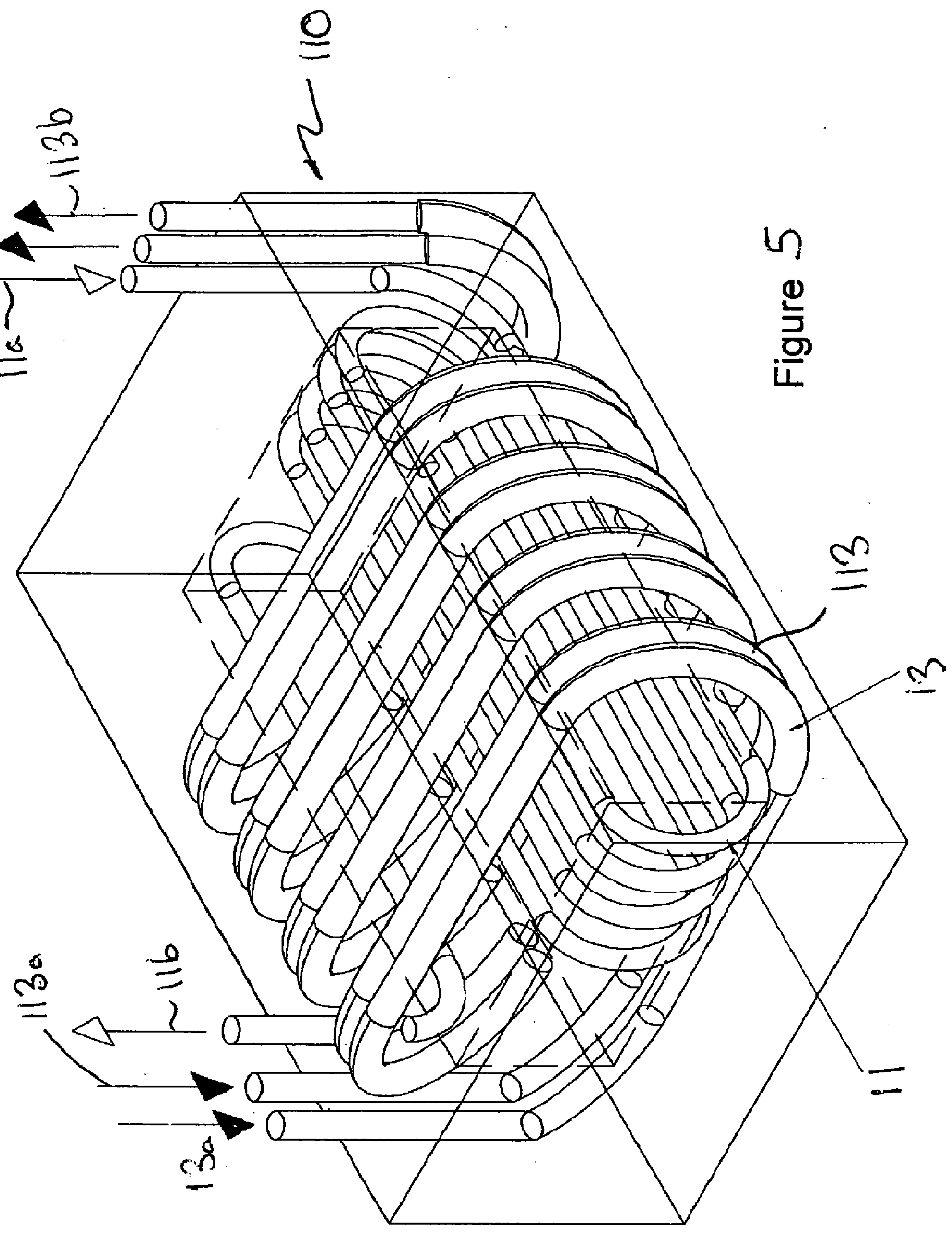


Figure 5

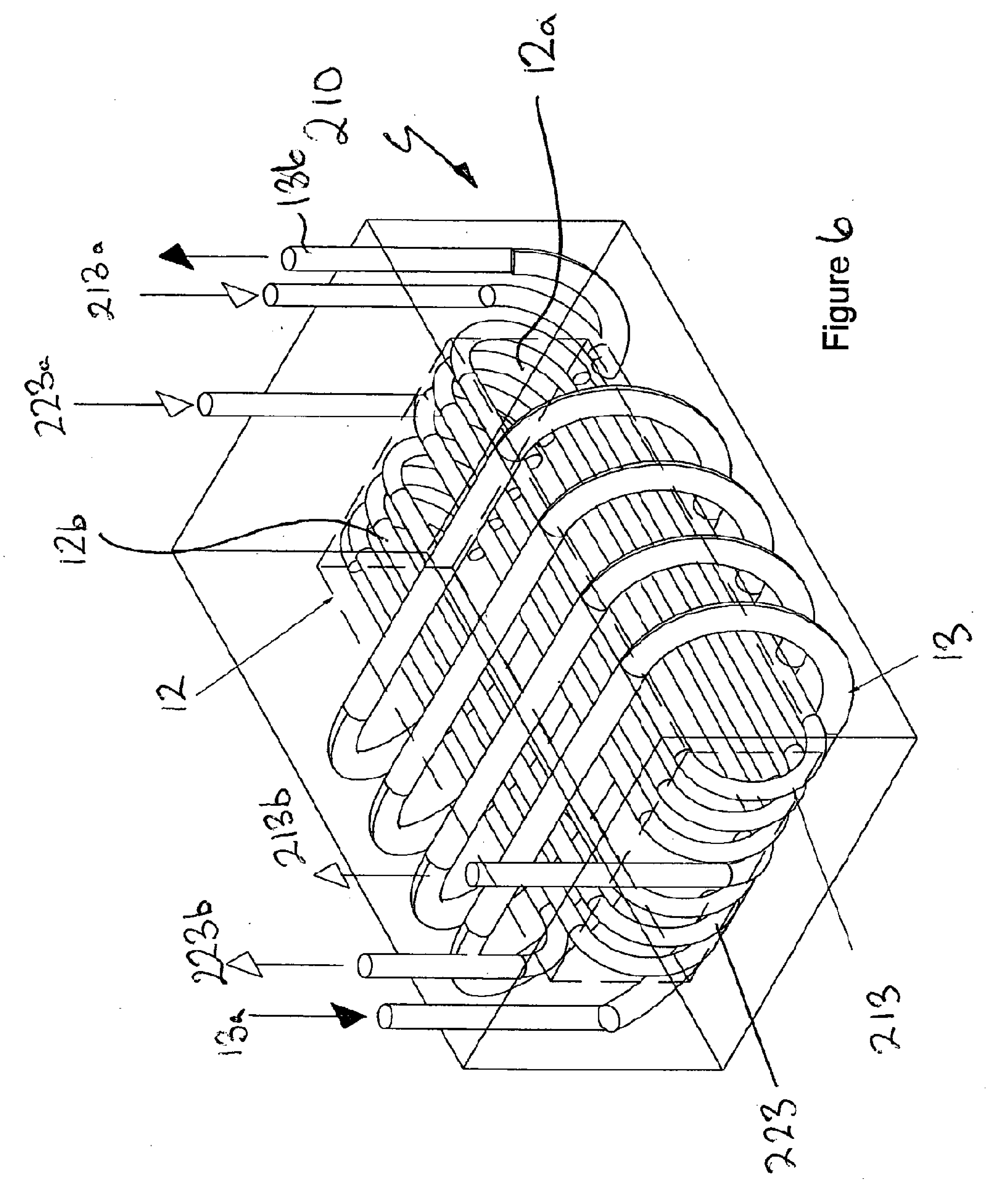


Figure 6

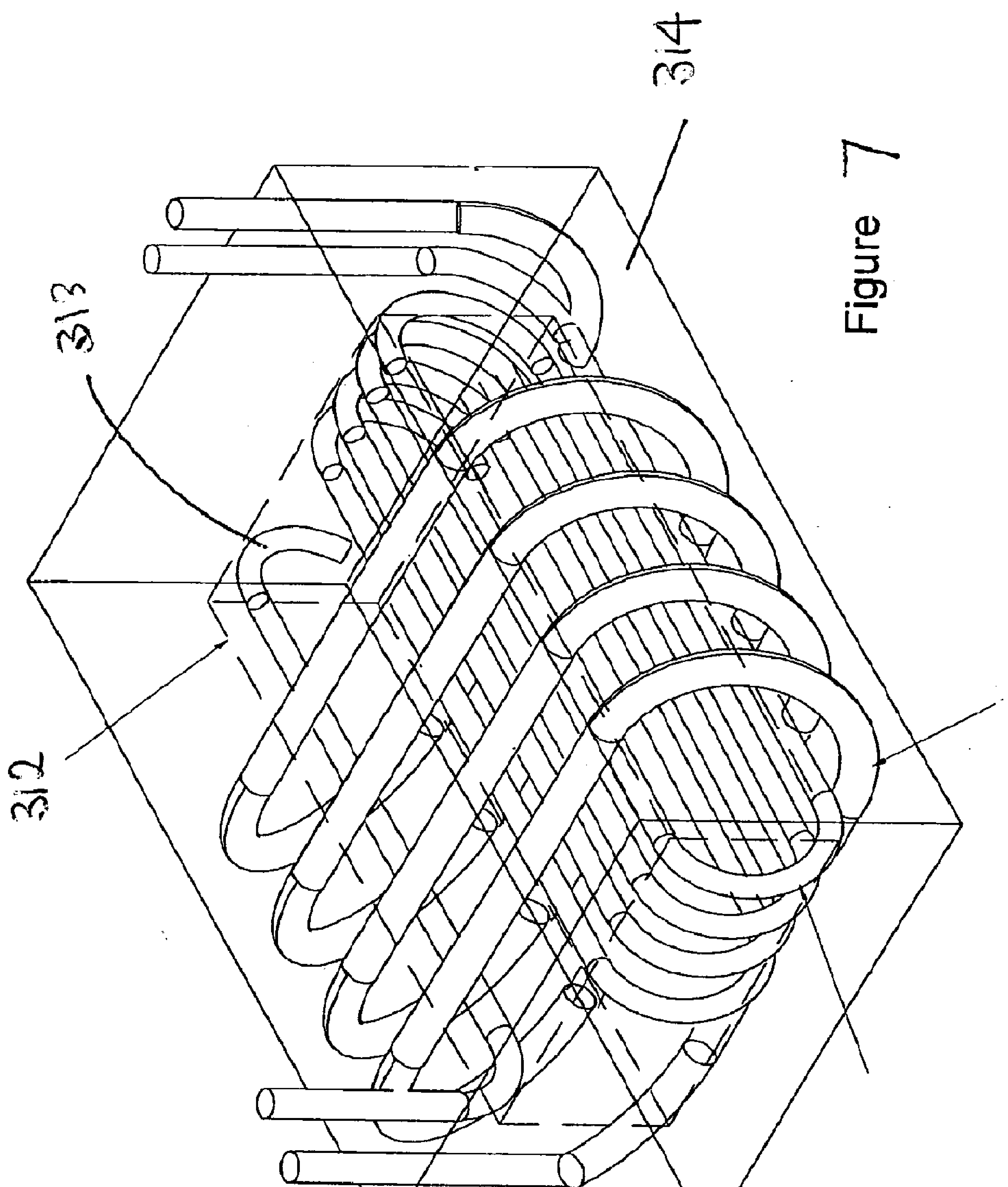


Figure 7

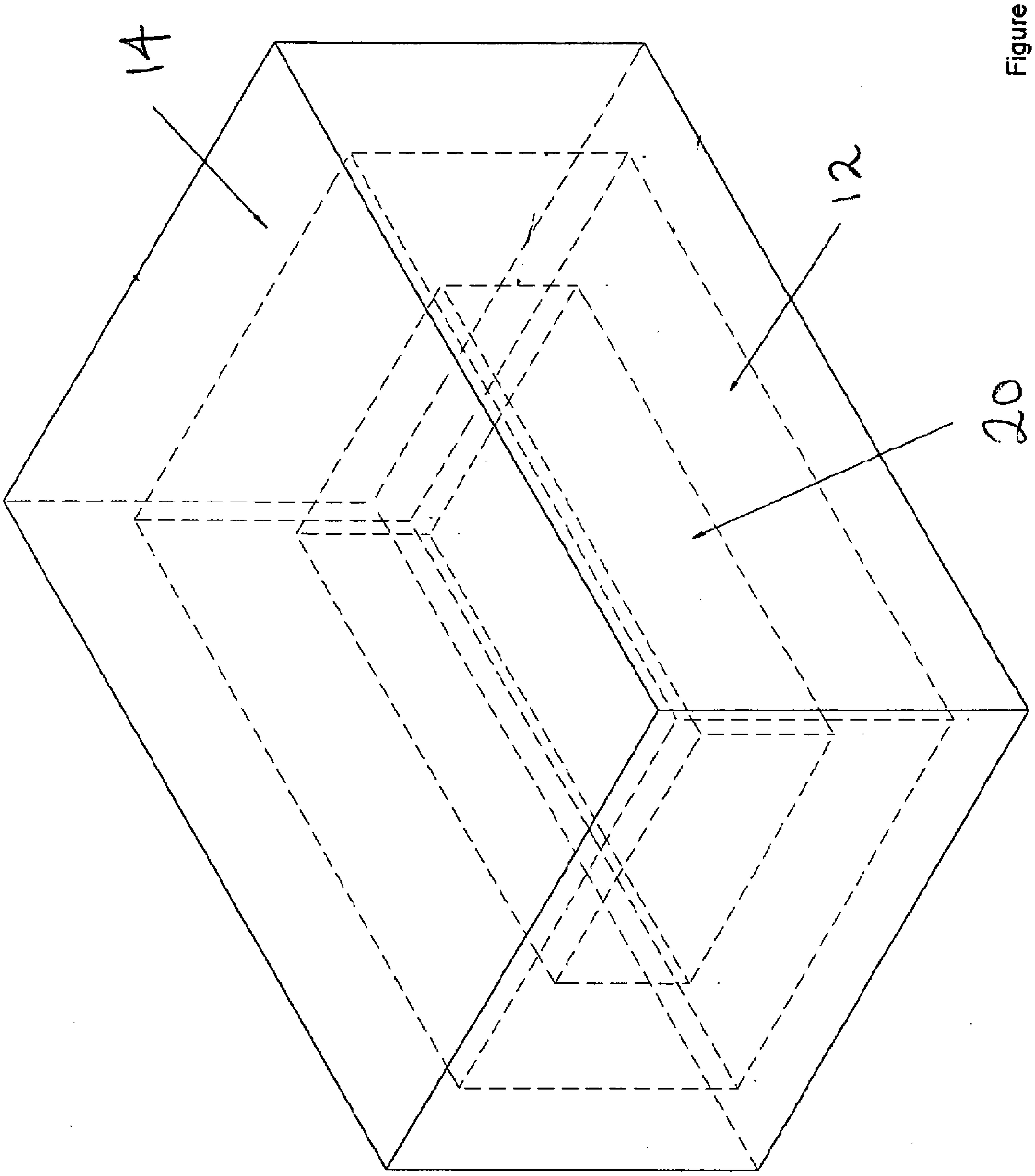


Figure 8

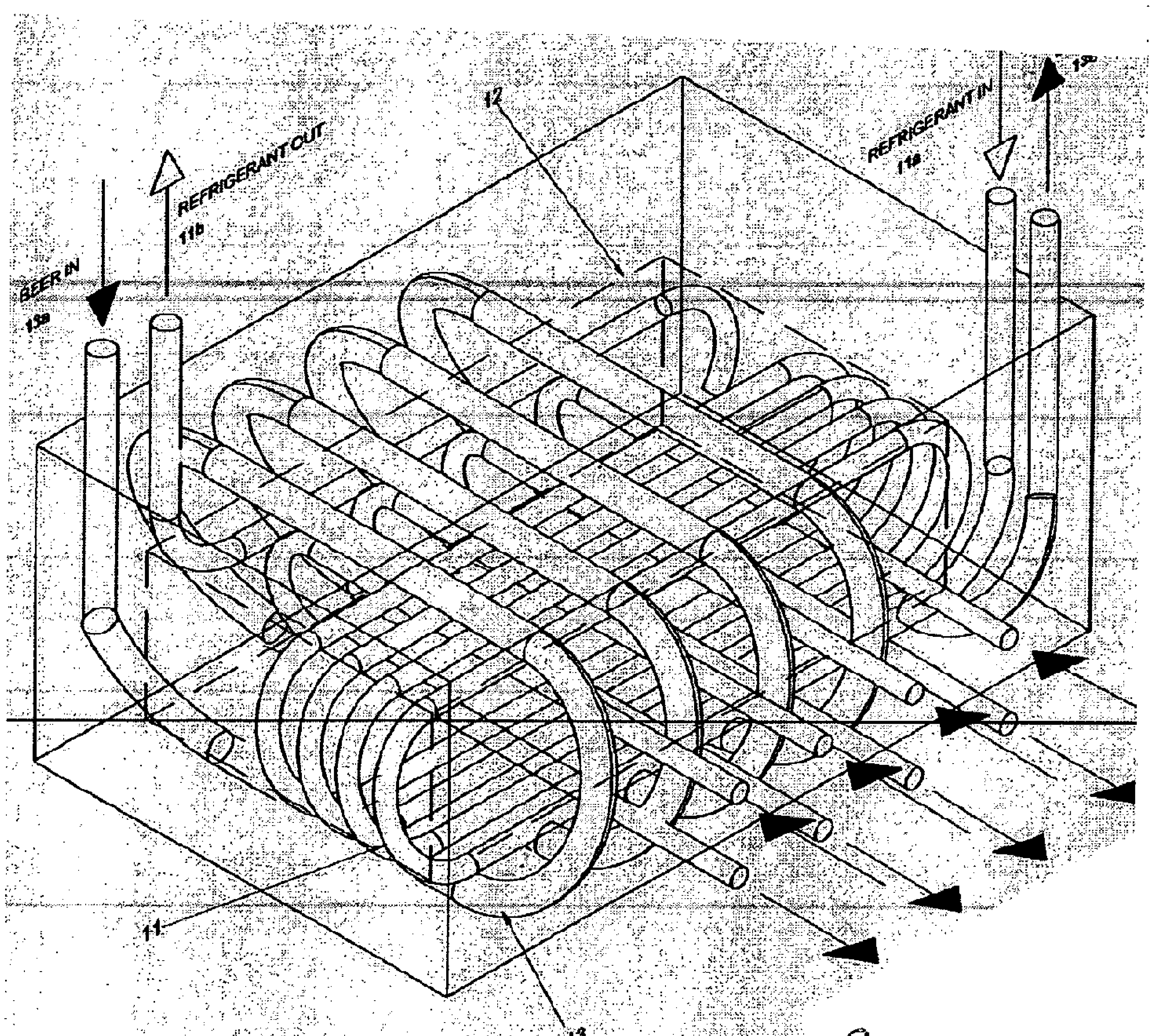


Figure 9

HEAT EXCHANGES FOR DISPENSING SUB-ZERO BEER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority from Australian Provisional Patent Application No 2008900054 filed on 4 Jan. 2008, the content of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] This invention relates to an improved apparatus for dispensing cooled fluids, in particular beverages, such as beer.

BACKGROUND OF THE INVENTION

[0003] In most commercial establishments where beer is served, the beer is supplied in barrels or kegs. The kegs are stored in a refrigerated cold room or cellar at a temperature range of between 3 and 10 degrees C. The beer is normally dispensed through beer dispensing valves/taps located away from the cold room. A heat exchanger or some form of extra cooler is also normally included in the system to further cool the beer in line between the cold room and the tap.

[0004] The beer is delivered to the taps from the kegs through a conduit containing the beer delivery lines. The conduit also contains coolant transfer lines for recirculation of cold water or water containing a percentage of antifreeze components such as glycol. In practice, the beer is moved through the beer delivery lines by means of CO_2 gas pressure applied to the barrel or keg.

[0005] Recently, due to changes in customer preferences and fashions, it has become desirable to serve beer at temperatures below 0 degrees C.

[0006] Existing systems using heat exchangers installed in line between the cold room and the beer dispensing tap, have relied on an external cold source being supplied to circulate coolant at closely controlled temperatures through the conduit and heat exchanger to cool the beer to the sub zero temperature.

[0007] These systems have high maintenance costs associated with the external cold source and a high initial installation costs involving extensive site alterations to the beer system.

[0008] The present invention seeks to provide a lower cost and preferably more efficient beverage cooling system.

[0009] Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

SUMMARY OF THE INVENTION

[0010] According to a first aspect of the present invention there is provided a heat exchanger comprising a coolant line and a beverage (typically beer) line embedded in a solid block of a material having a high thermal conductivity (most preferably aluminium, although other materials having high conductivity could be used) with the coolant line in the form of a first coil defining a plurality of turns located in the block and the beer line in the form of a second coil defining a plurality of coils extending around the first coil.

[0011] The location of the coolant line typically in the centre of the aluminium block and the physical arrangement of the coolant line in the form of a coil provides a cold core or central cold zone in the solid block.

[0012] The resultant outer area provides a designated beverage cooling zone in which the beer/beverage line is located.

[0013] In a second related aspect, the invention provides a heat exchanger comprising a coolant line and a beverage line embedded in a solid block of a material having a high thermal conductivity with the beverage line in the form of a first coil having a plurality of turns being located in the centre of the block and defining a designated beverage cooling zone and the coolant line in the form of a second coil defining a plurality of turns and extending around the first coil and defining a cold zone.

[0014] The ratio of the volumes of these two distinct zones within the solid is an important relationship when dispensing beer at critical temperatures, often as low as −2 degrees C. In a preferred embodiment the volume ratio of the designated zone to the cold zone is about 150:100.

[0015] The cold zone acts as a thermal storage of energy. This thermal storage is used to maintain controlled beverage outlet temperatures and avoid the fluctuations that are typical with existing heat exchangers.

[0016] The coil is typically in the form of a helical coil. As used herein "helical" is not to be taken as inferring that the coils of each turn of the helical coil need be circular. The coils may be any shape and will typically comprise semi-circular curved ends separated by straight lengths of tubing.

[0017] The coolant used is typically a Freon refrigerant, however the invention can easily be adapted for use with recirculating glycol.

[0018] The coolant tubes are arranged in a helical pattern through the cold zone. The distance between the tubes is varied to control the rate of heat transfer from the coolant into the solid material of the cold zone. In the preferred embodiment the distance between adjacent tubes is between 3 and 10 mm.

[0019] The diameter of the coolant tubes used in the cold zone for transfer of cold from the coolant to the cold zone is selected based on the energy requirement of the system. Typically the range of tube diameters would be from 6 to 13 mm.

[0020] The distance between the tubes/coils in the beverage line is varied to control the rate of heat transfer from the designated zone into the beverage. In the preferred embodiment the distance between adjacent tubes is from 3 to 8 mm.

[0021] The diameter of the beverage tubes used in the designated zone for transfer of heat from the beverage to the solid material is also selected based on the energy requirements of the system. Typically, the diameter may be between 7 to 11 mm.

[0022] The distance between the coolant tubes located in the cold zone and the beverage tubes located in the designated zone affects the heat flow between the two defined solid areas. The preferred distance is from 2 to 6 mm.

[0023] This allows for predetermined heat transfer effects with in the solid to facilitate the heat transfer from the coolant to the solid and then across the solid and into the beverage.

[0024] The relationship between the plane of the beverage tube coils and the coolant tube coils ("the angle between the tubes") is important in maximising the heat transfer rate across the solid.

[0025] Adjusting the angle controls the heat transfer rate across the solid. In a preferred embodiment this angle is between 80 and 110 degrees, however the angle is adjustable between 15 and 120 degrees.

[0026] The angle provides three dimensional heat flux within the solid areas and acts as a means of inducing turbulence to the heat flow through the solid areas and maximising the available transfer of cold through the system.

[0027] The efficiency control that is available through the present invention allows for cooling of beer to precise temperatures and even temperatures close to freezing point, using direct expanded Freon refrigeration methods.

[0028] The present invention allows for a complete system including the refrigeration equipment to be packaged into a small area, such as is available under bars and dispensing counters etc., which removes the need for large installations and the associated costs and maintenance of the same.

[0029] The present invention may also eliminate or ameliorate the problems associated with freezing of subzero beverages which has limited the dispensing of low alcohol beverages at temperatures less that 0 degrees C. using existing heat exchanger systems.

[0030] There may be a plurality of beverage lines in the designated zone. There may also be a plurality of coolant lines in the cold zone. The cold zone may include more than one coolant line, for example two coolant lines in parallel, or two coolant lines in series.

[0031] In one embodiment one or more additional lines may pass through the first coil. The additional lines may include one or more lines for cooling glycol. Alternatively the additional lines may include one or more lines for pre-chilling soft drinks, soda or the like.

[0032] The additional lines are generally located in a central zone inside the inner cold zone. The ratio of the central zone to the inner cold zone to the outer zone is typically about 150:100:150.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] A specific embodiment of the present invention will now be described, by way of example only, and with reference to the accompanying drawings, in which:

[0034] FIG. **1** is a schematic view of an embodiment of a solid block heat exchanger embodying the invention;

[0035] FIG. **2** is a schematic view of part of the heat exchanger illustrating the gaps between the tubes in the beverage lines;

[0036] FIG. **3** is a schematic view of part of the heat exchanger illustrating the gaps between the tubes in the coolant lines;

[0037] FIG. **4** is a schematic view illustrating the concepts of the inner cold zone and the designated zone;

[0038] FIG. **5** is a schematic view illustrating a variant of the heat exchanger of FIGS. **1** to **4** in which there are two parallel beverage lines;

[0039] FIG. **6** is a schematic view illustrating a yet further embodiment of a heat exchanger in which there are two coolant lines in series;

[0040] FIG. **7** is a schematic view of a variant of the solid block heat exchanger of FIGS. **1** to **4** in which the locations of the cold zone and cooling zones are reversed.

[0041] FIG. **8** is a schematic view illustrating a variant of the heat exchanger of FIGS. **1** to **4** in which there is and additional cooling zone; and

[0042] FIG. **9** is a schematic view of part of the heat exchanger of FIG. **8**.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0043] Referring to the drawings FIG. **1** shows a solid block heat exchanger **10** comprising a first coolant line or tube (typically formed from stainless steel) in the form of a "helical" coil arrangement **11** having a plurality of turns/coils. As shown the coils are generally rectangular in plan view having semi-circular curved ends separated by straight lengths of tubing. However other coil shapes could be used.

[0044] This coil arrangement locates generally within an cold zone **12** of the heat exchanger **10** within a rectangular box shaped volume also shown in FIG. **4**. In this embodiment, the coil **11** is an inner coil as, extending around the outside of the coil arrangement **11** is a second "helical" coil arrangement **13** (also typically formed from stainless steel tubes) which in use carries beverage, typically beer, or other carbonated alcoholic drink of a similar alcohol content to beer.

[0045] As shown, the coils are generally rectangular in plan view having semi-circular curved ends separated by straight lengths of tubing. Again, other coil shapes could be used.

[0046] This "outer" coil arrangement locates in a zone **14** (the designated cooling zone) outside of the cold zone **12** of the heat exchanger and between that cold zone **12** and the exterior of the heat exchanger.

[0047] The heat exchanger **10** is formed by locating the coils **11** and **13** in a rectangular mould in the arrangement shown and pouring molten aluminium over the coils to form a solid block **15**. Such casting techniques are well known for forming solid block heat exchangers and accordingly will not be described in detail herein. When cast, the open ends of the coils **11** and **13** form coolant inlets **11***a* and coolant outlets **11***b,* and beverage inlets **13***a* and beverage outlets **13***b,* respectively.

[0048] The ratio of the volume of the two zones **12**, **14** within the solid block is an important relationship when dispensing beer at critical temperatures, often as low as −2° C. In a preferred embodiment the volume ratio of the designated beverage cooling zone **14** to the cold zone **12** is about 150:100.

[0049] In use, the cold zone **12** or core acts as a thermal storage of energy. This thermal storage is used to maintain controlled beverage outlet temperatures to avoid the fluctuations that are typical with the heat exchangers described in the prior art.

[0050] The distance between the coils of the coolant coil arrangement may be varied to control the rate of heat transfer from the coolant into the solid core. With reference to FIG. **3**, in the preferred embodiment the distance "b" between the exteriors of the tubes is between 3 and 10 mm.

[0051] The diameter of the tubes used in the coolant coil for transfer of cold from the coolant to the cold zone is selected based on the energy requirement of the system. Typically, the diameter range would range between 6 and 13 mm.

[0052] With reference to FIG. **2**, the distance "a" between the tubes in the beverage coil arrangement **13** is varied to control the rate of heat transfer from the beverage into the defined cold zone **12**. Typically the distance between the tubes is from 3 to 8 mm.

[0053] The diameter of the tubes used in the designated cooling zone for transfer of cold from the solid to the beverage is also selected based on the energy requirement of the system. Typically the diameter range for the beverage line tubes would be between 7 and 11 mm.

[0054] The distance between the coolant tubes located in the cold zone and the beverage tubes located in the designated zone is a significant factor in determining the heat flow between the two defined solid areas. With reference to FIG. **3**, the preferred distance "c" is between 2 and 6 mm.

[0055] This allows for predetermined heat transfer effects within the solid to facilitate the heat transfer from the cold zone **12** to the coolant and also from the beverage into the solid.

[0056] The relationship between the plane of the beverage tube coils and the coolant tube coils ("the angle between the tubes") is important in maximising the heat transfer rate across the solid.

[0057] Adjusting the angle controls the heat transfer rate across the solid. As shown in the described embodiment the angle between the plane of the coils in the coolant coil and the beverage coil is 90°. It is preferred that the angle is between 80 and 110 degrees, however the angle may be anywhere between 15 and 120 degrees.

[0058] The angle provides three dimensional heat flux within the solid areas and acts as a means of inducing turbulence to the heat flow through the solid areas and maximising the available transfer of cold through the system.

[0059] Although the foregoing describes the beverage being dispensed as being alcoholic, it will be appreciated that the system may also be used to dispense other beverages, particularly soft drinks, such as sodas and the like.

[0060] Although the above describes a heat exchanger having a single beverage line, and single coolant line, it will be appreciated that more than one beverage line may be provided in the designated cooling zone **14** and more than one coolant line in the cold zone **12**.

[0061] For example, FIG. **5** shows a variant **110** of the heat exchanger of FIGS. **1** to **4** in which there is a second beverage line **113** running parallel to the first beverage line **13**.

[0062] FIG. **6** shows a further variant **210** in which there are two coolant lines "in series" defining the (inner) cold zone **12**. A first coolant line **213** comprises a helical coil and a coolant inlet **213*a*** and a coolant outlet **213*b*** and defines one part **12*a*** of the inner cold zone **12**. A second coolant line **223** following on in series from the first coolant line, comprises a helical coil and a coolant inlet **223*a*** and a coolant outlet **223*b*** and defines the other part **12*b*** of the inner cold zone **12**. The coolant inlet **223*a*** is on the opposite side of the block **210** to the coolant outlet **213*b*** of the first coolant line.

[0063] Although in the preferred embodiment, as described above, the cold zone **12** is inside the designated beverage cooling zone **14** which has the beverage lines passing through it, it is possible to manufacture a heat exchanger in which the location of the coolant tube coils **311** and beverage line **313** coils are reversed, so that the cold zone **312** lies outside the beverage coils **313**. In this embodiment, the ratio of the volume of the cold zone **312** to the beverage line zone **314** remains 100:150, and the coolant and beverage pipe dimensions and spacings remain in the ranges described above as does the relationship between the plane of the beverage tube coils and the coolant tube coils. In a typical embodiment the angle is 90° as shown in FIG. **7**, although this angle can be varied between 80 and 110 degrees, even between 15 and 120 degrees.

[0064] It is also possible for additional lines to be present in the centre of the cold core block forming a third or central zone. This is illustrated in FIGS. **8** and **9**, where the central zone is referenced **20** and shown as rectangular parallelepiped in broken lines. With reference to FIG. **6** also, the central zone is used for cooling as is the outer designated zone. It may have one or more lines **22** passing through it—see FIG. **6**. In one embodiment the line **22** may be a glycol line for cooling glycol, used to cool a beer transfer conduit, and/or beer font or the like. In an alternative application there may be up to twenty additional lines **22** for pre-chilling e.g. soda or soft drinks.

[0065] As shown in FIGS. **8** and **9**, where the central zone is present and used for cooling, the volume ratio of the central zone **20** to the inner cold zone **12** to the outer zone **14** is typically about 150:100:150.

[0066] It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

1. A heat exchanger comprising a coolant line and a beverage line embedded in a solid block of a material having a high thermal conductivity with the coolant line in the form of a first coil defining a plurality of turns, and the beverage line in the form of a second coil defining a plurality of turns and extending around the first coil.

2. A heat exchanger as claimed in claim **1** wherein the coolant line defines a cold zone in the centre of the block, with the volume outside the zone carrying the beverage line defining a designated beverage cooling zone.

3. A heat exchanger comprising a coolant line and a beverage line embedded in a solid block of a material having a high thermal conductivity with the beverage line in the form of a first coil having a plurality of turns being located in the centre of the block and defining a designated beverage cooling zone and the coolant line in the form of a second coil defining a plurality of turns and extending around the first coil and defining a cold zone.

4. A heat exchanger as claimed in claim **1** wherein the volume ratio of the designated zone to the cold zone is about 150:100.

5. A heat exchanger as claimed in claim **1** wherein the coils are in the form of helical coils.

6. A heat exchanger as claimed in claim **5** wherein the coolant line comprises tubes arranged in a helical pattern and wherein the distance between adjacent turns in the coolant line is between 3 and 10 mm.

7. A heat exchanger as claimed in claim **1** wherein the coolant line comprises tubes having a diameter between 6 to 13 mm.

8. A heat exchanger as claimed in claim **1** wherein tubes forming the beverage line are arranged in a helical pattern and wherein the distance between adjacent tubes in the beverage line is from 3 to 8 mm.

9. A heat exchanger as claimed in claim **8** wherein the diameter of the tubes used in the beverage line is from 7 to 11 mm.

10. A heat exchanger as claimed in claim **8** wherein the distance between the coolant tubes located in the cold zone and the beverage tubes located in the designated zone is from 2 to 6 mm.

11. A heat exchanger as claimed in claim **1** wherein the angle between a plane defined by the beverage tube coils and a plane defined by coolant tube coils is between 80 and 110 degrees.

12. A heat exchanger as claimed in claim **1** wherein the coolant line carries a Freon refrigerant.

13. A heat exchanger as claimed in claim **2** wherein there are a plurality of beverage lines in the designated zone.

14. A heat exchanger as claimed in claim **2** wherein there are a plurality of coolant lines in the cold zone.

15. A heat exchanger as claimed in claim **1** when dependent on claims **1** or **2**, wherein one or more additional lines pass through the first coil.

16. A heat exchanger as claimed in claim **15** wherein the additional lines include one or more lines for cooling a secondary cooling media.

17. A heat exchanger as claimed in claim **15** wherein the additional lines include one or more lines for cooling soft drinks, soda or the like.

18. A heat exchanger as claimed in claim **15** wherein the additional lines are generally located in a central zone inside the cold zone.

19. A heat exchanger as claimed in claim **18** wherein the volume ratio of the central zone to the cold zone to the designated zone is about 150:100:150.

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