



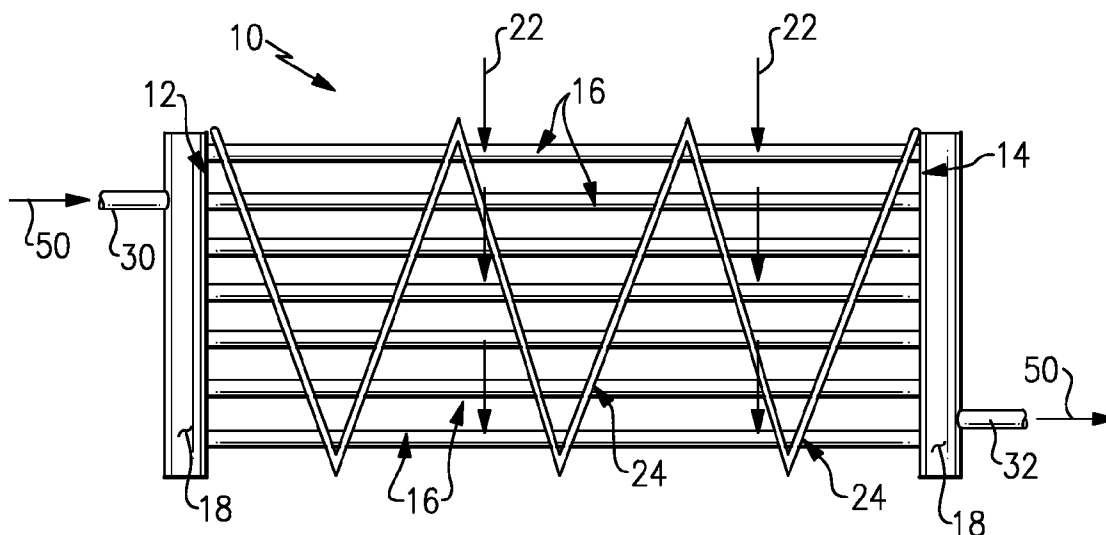
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(19) **United States**(12) **Patent Application Publication**
Baylis et al.(10) **Pub. No.: US 2008/0173436 A1**(43) **Pub. Date: Jul. 24, 2008**(54) **PLASTIC INTERCOOLER****Publication Classification**(76) Inventors: **Bobbye Kaye Baylis**, Harrow (CA);
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Haworth, London (GB)(51) **Int. Cl.**
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BIRMINGHAM, MI 48009(21) Appl. No.: **12/018,412**(22) Filed: **Jan. 23, 2008****Related U.S. Application Data**(60) Provisional application No. 60/886,152, filed on Jan.
23, 2007.(57) **ABSTRACT**

An intercooler comprises a plurality of plastic cooling tubes extending between a first end plate and a second end plate and a baffle arranged in the intercooler and extending at least partially between the first end plate and the second end plate. The baffle comprises a plurality of first openings for receiving a respective plastic cooling tube, the baffle further comprising a plurality of second openings arranged between the first openings. The second openings permit air to flow through the intercooler whilst creating turbulence in the air flow which increase the thermal transfer between the air and the tubes increasing the efficiency of the intercooler.



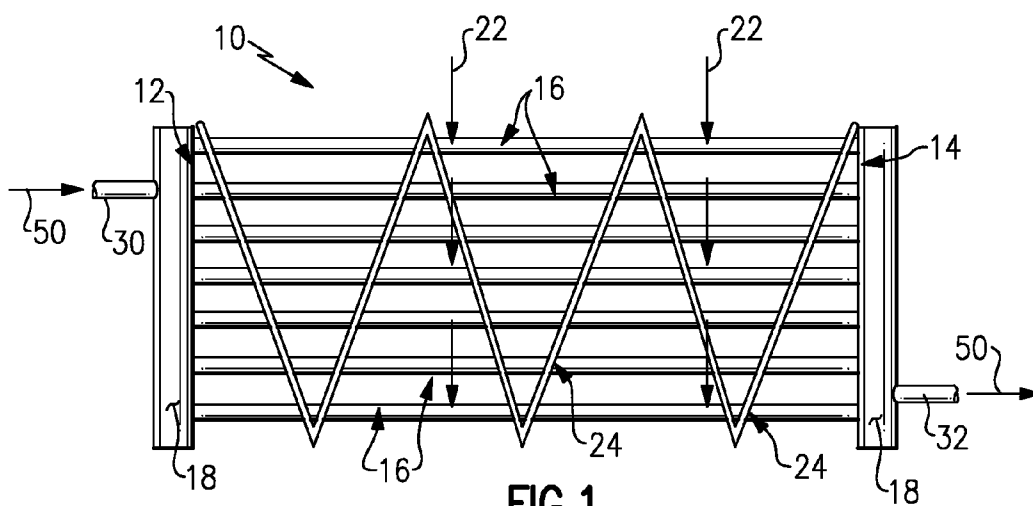


FIG. 1

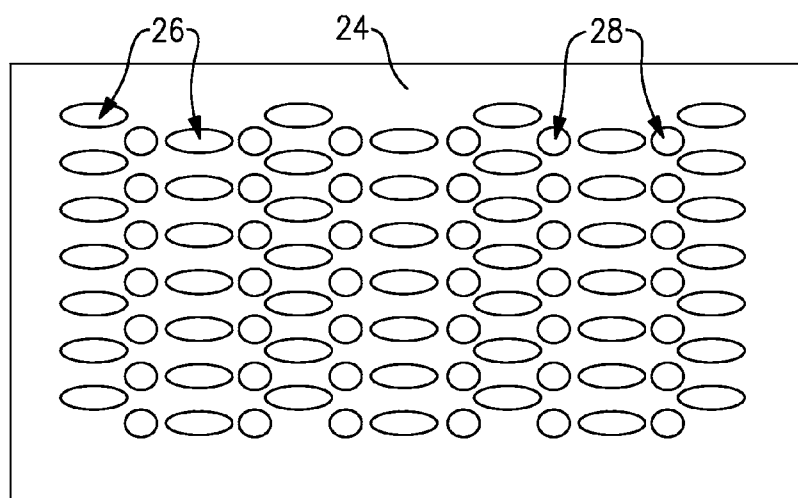


FIG. 2



FIG. 3A



FIG. 3B

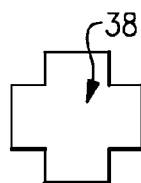


FIG. 3C

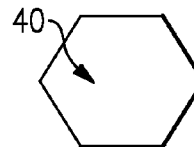


FIG. 3D

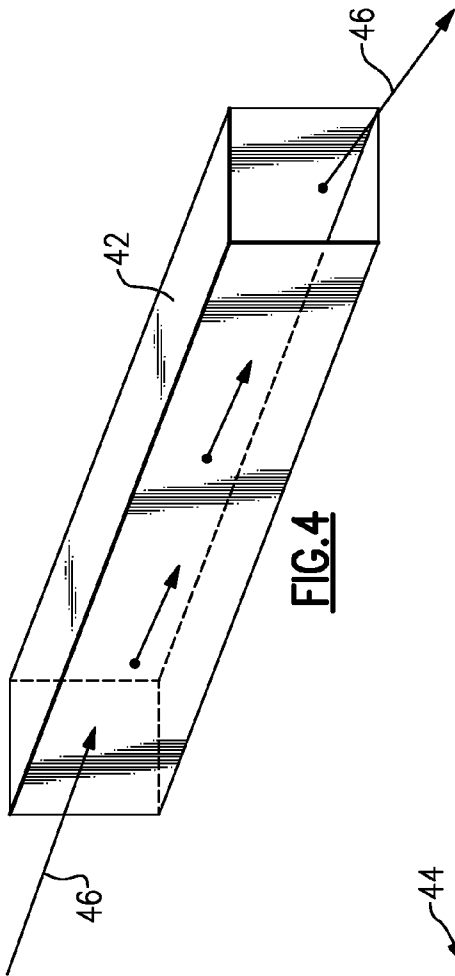


FIG. 4

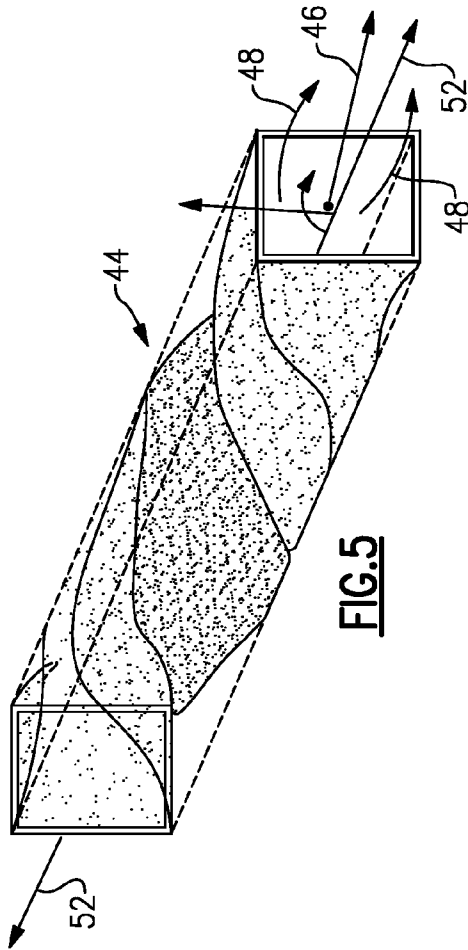


FIG. 5

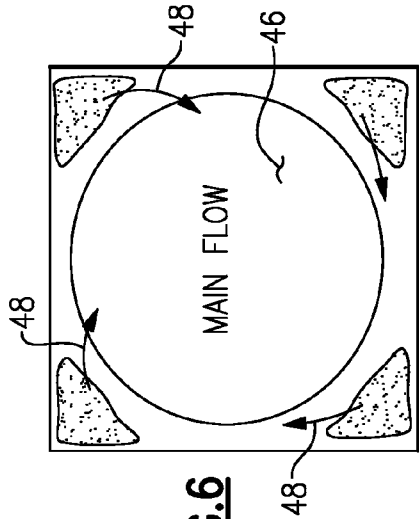


FIG. 6

PLASTIC INTERCOOLER

CROSS REFERENCE TO RELATED APPLICATION

[0001] The application claims priority to U.S. Provisional Application No. 60/886,152 filed on Jan. 23, 2007.

BACKGROUND OF THE INVENTION

[0002] This invention generally relates to an intercooler for use in a motor vehicle. More particularly, this invention relates to a plastic intercooler.

[0003] An intercooler is a heat exchanger for transferring heat from one fluid to another fluid that is not physically in contact. One example application of an intercooler is for cooling the charge air exiting the compressor of an air charging device such as a turbocharger. An intercooler is desired to cool to and reduce the volume of the charge air so that more air can be introduced into the cylinders of an engine. The hot charge air is directed through a plurality of tubes over which cooling air flows.

[0004] A conventional intercooler includes a plurality of tubes that span between manifolds or tanks on each end. The tanks typically comprise an open internal volume in communication with an open end of the plurality of tubes. The tanks include an inlet to provide for a single inlet or outlet for air flow through the intercooler. The tubes are typically formed from metals such as aluminium, copper or brass that are welded or brazed to end plates. The end plates are in turn attached to the tanks to provide the desired inlet and outlet for the intercooler.

[0005] Disadvantageously, metal tube construction and fabrication provide a relatively heavy and cumbersome device. Further, the use of metal tubes limits the configuration of the intercooler. The constraints on devices installed within vehicles are becoming more demanding as related to cost, weight and flexibility of design. Therefore it has been considered to produce an intercooler from plastic whereby the weight of the intercooler can be reduced whilst offering improved design flexibility. A disadvantage of using plastic as a material for the intercooler is that the heat transfer from plastic to air is relatively low compared to the heat transfer between metal and air. Therefore the efficiency of a plastic intercooler is lower than that of an equivalent metal intercooler.

[0006] Accordingly, it is desirable to design a plastic intercooler with an improved heat transfer between the cooling medium and the medium to be cooled.

SUMMARY OF THE INVENTION

[0007] A plastic intercooler assembly includes a plurality of plastic tubes that extend between plastic end plates. A baffle is arranged in the intercooler which extends across the flow path of the air flowing over plastic tubes. The baffle includes openings which allow the air to flow through the baffle and over the plastic tubes. The baffle introduces turbulence into the air flow and disrupts the boundary layer on the outside of the tube walls. By disrupting this boundary layer the heat transfer between the fluid inside the tubes and the air flowing over the tubes can be improved. The baffle can also serve as a support for the tubes.

[0008] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic view of an example intercooler assembly.

[0010] FIG. 2 is a schematic view of an intercooler baffle.

[0011] FIGS. 3A-3D are schematic views of shows example shapes for openings in the intercooler baffle.

[0012] FIG. 4 is a schematic view of an example square tube.

[0013] FIG. 5 is a schematic view of an example twisted square tube.

[0014] FIG. 6 is a schematic cross-section of the twisted square tube.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] Referring to FIG. 1, an intercooler assembly 10 includes a first end plate 12 and a second end plate 14. Extending between the end first end plate 12 and the second end plate 14 are a plurality of plastic tubes 16. The plastic tubes 16 are secured to the end plates 12, 14 to provide the desired seal between the end plates 12, 14 and the ends of the tubes 16. This can be achieved by laser welding or another suitable method.

[0016] A first tank 18 is attached to the first end plate 12 and a second tank 20 is attached to the second end plate 14. The first tank 18 includes an inlet opening 30 providing an inlet for a cooling fluid 50 and the second tank 20 includes an outlet opening 32 providing an outlet of the cooling fluid 50. The cooling fluid 50 follows a path through the first tank 18, the plastic tubes 16 and the second tank 20.

[0017] The air which is to be cooled (or charge air) flows over the plastic tubes 16 in a direction indicated with arrows 22 perpendicular to the fluid flowing through the tubes 16. As the charge air flows over the plastic tubes 16 heat is transferred through the plastic tubes 16 to the cooling fluid 50 inside the tubes 16. In order to improve the heat transfer between the fluid 50 inside the plastic tubes 16 and the air flow over the plastic tubes 16 a baffle 24 is introduced into the intercooler 10. The baffle 24 extends preferably between the endplates 12, 14 of the intercooler. The baffle 24 has preferably a concertina form, which extends through multiple rows of tubes 16. The concertina form provides for the baffle 24 to be angled relative to both charge air flow 22 and the plastic tubes 16. The specific angle of the baffle parts is provided to disrupt air flow 22, but not generate back pressure or reduce desired air flow.

[0018] Referring to FIG. 2, a portion the baffle 28 is shown with oval shaped openings 26 which each accommodate a corresponding one of the plurality of plastic tubes 16. The plastic tubes 16 have a circular cross section. It is however also possible for the tubes 16 to have a non-circular cross section, e.g. oval or square, in order to increase the surface area of the tube and therefore improve the heat transfer between the cooling fluid and the charger air.

[0019] Between the oval shaped openings 26, turbulence generating openings 28 are provided in the baffle 24. The turbulence generating openings 28 allow the air flowing over the plastic tubes 16 in the direction 22 to flow past the baffle 24 and, in doing so, the air flow is disturbed. The disturbed air

creates turbulence that disrupts the boundary layer flow on the outer surface of the plastic tubes 16. Through disturbing the boundary layer flow the heat transfer between the plastic tubes 16 and the charge air flowing over the plastic tubes 16 can be increased.

[0020] The area of the baffle 24 with turbulence generating openings 28 is large enough that no considerable back pressure is created within the intercooler 10 which would significantly reduce the air flow volume through the intercooler 10 and consequently adversely affect the cooling efficiency. The example baffle 24 can be a mesh e.g. a wire mesh whereby the plastic tubes 16 are inserted through openings in the wire mesh and openings adjacent to the plastic tubes serve as the turbulence generating openings.

[0021] Alternate example shapes of the openings 28 are shown in FIGS. 3A-3D. FIG. 3A illustrates a star shaped cross-section 34. FIG. 3B illustrates a triangle shaped tube cross-section 36. FIG. 3C illustrates a cross shaped cross-section 38. FIG. 3D illustrates a pentagon shaped cross-section 3D. Other shapes which produce a large turbulence of the air flowing past the baffle 24 can also be used. It is particularly preferable for the shape to have a large edge length to surface area ratio.

[0022] Referring back to FIG. 1, the baffle 24 can be used as a support for the plastic tubes 16 at the same time as providing the turbulence producing effect. This simplifies the manufacture in that the tubes can be maintained together in a block using the baffle 24 as a support whilst the endplates 12, 14 are being attached. The example baffle 24 is shown to have five folds. It would however also be possible for the baffle 24 to be longer or shorter and to have more or less folds dependent on the size or shape of the intercooler 10. The baffle 24 can also be used as a conductor to conduct heat from the charge air to the cooling fluid. The baffle 24 can be made from any suitable material including metal, plastic or card.

[0023] Due to the low heat transfer between air and plastic it is preferable to have a liquid as the cooling liquid flowing through the plastic tubes 16. It is however possible in applications where no cooling liquid is available to have the charge air flowing through the plastic tubes 16 and the cooling air flowing in the direction of the arrows 22 over the plastic tubes 16. In the case where the charge air is flowing through the plastic tubes 16 it is advantageous to create turbulence within the plastic tubes 16. This can be achieved by producing non-circular shaped twisted tubes.

[0024] Referring to FIGS. 4-6, a plastic tube 42 with a square cross section can be produced e.g. by extrusion. By then twisting the square tube 42 along its length and about the axis 52 a twisted tube 44 is provided. The twisted tube 44 provides that the cross-sectional shape is twisted about the axis 52 at least once along a length between the endplates. The twisted tube 44 generates an internal air flow that follows the twists in the corners 48 (FIG. 6). Much of the airflow will try to continue straight down a middle flow area 46 of the twisted tube 44 and creates turbulence where it interfaces with the air 48 from the corners which is twisting.

[0025] Although a preferred embodiment of this invention has been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

What is claimed is:

1. An intercooler comprising:
 - a plurality of plastic cooling tubes extending between a first end plate and a second end plate; and
 - a baffle arranged in the intercooler and extending at least partially between the first end plate and the second end plate, the baffle comprising a plurality of first openings for receiving a respective plastic cooling tube and a plurality of second openings arranged between the first openings.
2. The intercooler according to claim 1, wherein the baffle has one or more folds to form a concertina shape.
3. The intercooler according to claim 1, wherein the cross section of the plastic tubes is substantially circular and the first openings in the baffle for receiving the plastic tubes are oval shaped.
4. The intercooler according to claim 1, wherein the plastic tubes have a non-circular cross section.
5. The intercooler according to claim 14, wherein the tubes furthermore have a twisted form along their length.
6. The intercooler according to claim 1, wherein the second openings in the baffle are circular.
7. The intercooler according to claim 1, wherein the baffle is made from plastic, metal or card.
8. An intercooler comprising:
 - a first tank including a first end plate;
 - a second tank including a second end plate; and
 - a plurality of plastic tubes extending between the first and second end plates and in communication on distal ends with each of the first tank and the second tank, the plastic tubes including a non-arcuate cross-sectional shape.
9. The intercooler as recited in claim 8, wherein the cross-sectional shape comprises a rectangle.
10. The intercooler as recited in claim 8, wherein the cross-sectional shape comprises a square.
11. The intercooler as recited in claim 9, wherein the cross-sectional shape is twisted at least once between the first end plate and the second end plate.
12. The intercooler as recited in claim 11, wherein the cross-sectional shape is disposed along an axis and is rotated at least once about the axis.
13. The intercooler as recited in claim 8, including a baffle for disrupting fluid flow over the plurality of plastic tubes.
14. The intercooler as recited in claim 13, wherein the baffle includes a first plurality of openings through which extend the first plurality of tubes, and a second plurality of openings through which fluid flows.
15. The intercooler as recited in claim 8, wherein the baffle is disposed at an angle relative to the direction of fluid flow over the plurality of plastic tubes.

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