United States Patent

Frost

[15] **3,688,372**

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[54] **THE METHOD OF MAKING A HEAT EXCHANGER**

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[73] Assignee: **Modine Manufacturing Company,**

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[52] **U.S. Cl.** ....**29/157.3 C,** 29/157.3 D, 29/455 LM, 113/118

[51] **Int. Cl.** **B21d 53/00,** B21k 29/00, B23p 15/26

[58] **Field of Search** ...29/157.3 D, 157.3 C, 157.3 V, 29/455 LM, 157.3 A, 157.3 AH, 157.3 B, 157.3 R; 113/118

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[57] **ABSTRACT**

A heat exchanger in which a continuous, integral, formed sheet of heat exchange material such as heat conducting metal is shaped to provide a first area and a second area spaced from each other to provide a fluid flow space and a third area in this flow space provided with displaced turbulence producing portions in the flow space.

3 Claims, 6 Drawing Figures

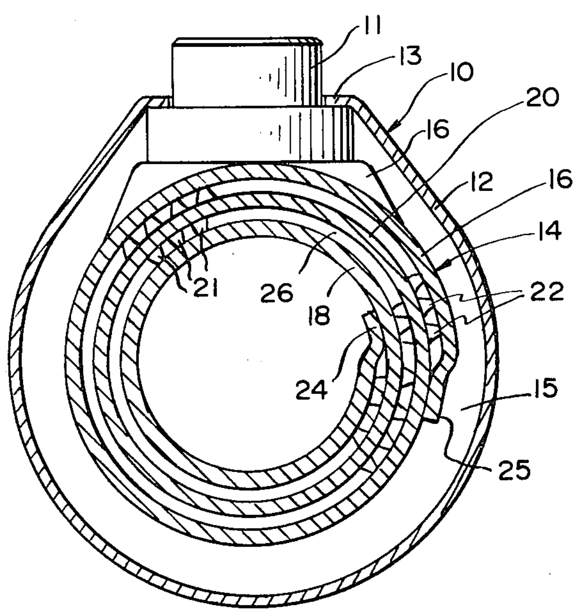


FIG.1

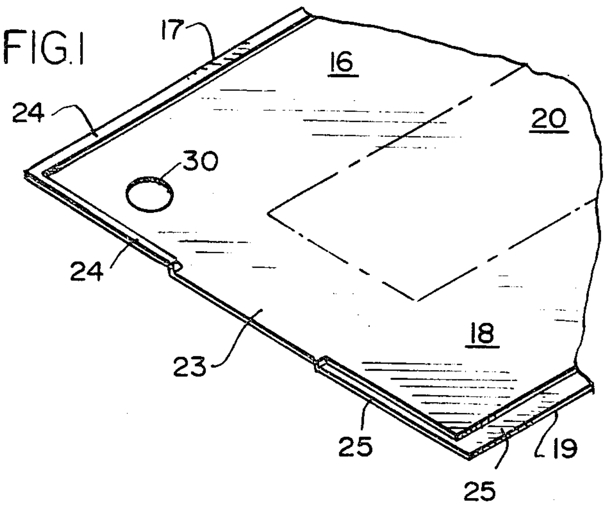


FIG.3

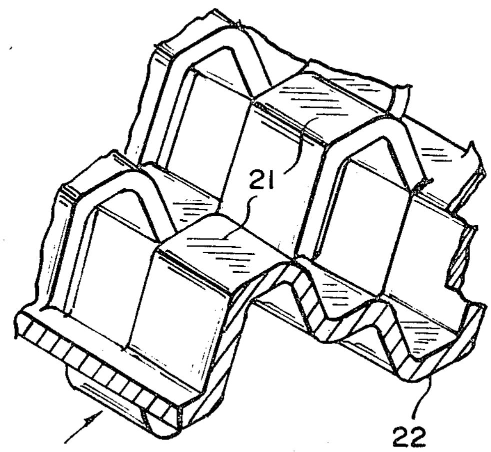


FIG.2

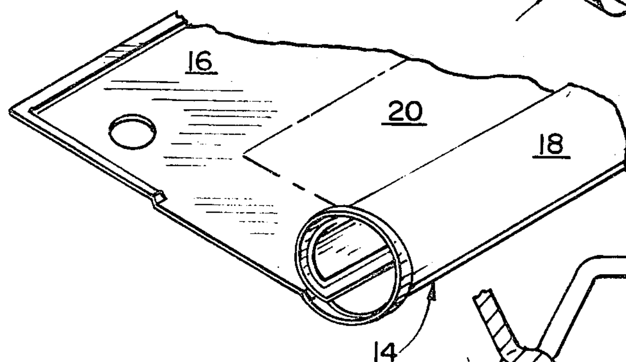


FIG.4

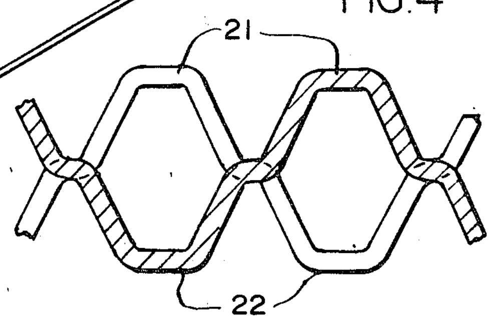
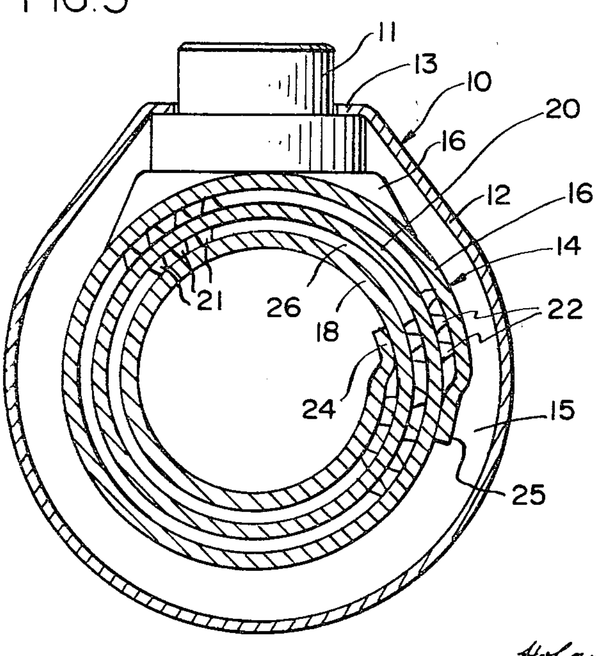


FIG.5



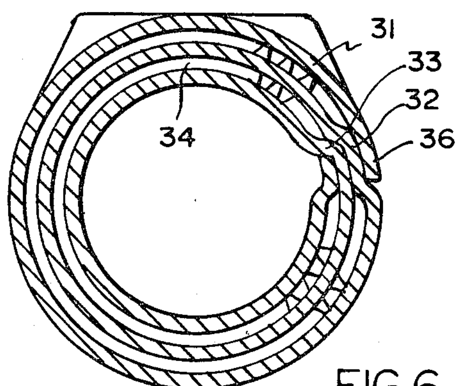


FIG.6

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THE METHOD OF MAKING A HEAT EXCHANGER

Because all of these areas are parts of one integral sheet a preferred embodiment of the heat exchanger is the tubular concentric type in which the first and second areas are formed as concentric cylinders and the third area also has a curved cross section and occupies the space between these two areas. This invention also includes a method of making a heat exchanger of the tubular type in which a metal sheet is provided with spaced apart first and second areas and an intermediate third area having turbulence promoting projections and then rolling the sheet upon itself to form a tube of at least three concentric parts in which the inner and outer parts are solid and spaced from each other to provide an annular flow space and the third part is located in this space and contains the turbulence promoting projections to comprise a turbulator.

Heat exchangers of this general type are disclosed in U.S. Pat. No. 2,752,128 assigned to the same assignee as the present application and in U.S. Pat. No. 3,083,662. These tubular heat exchangers are widely used as transmission oil coolers and particularly for cooling the oil of torque converters in automatic transmission vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary perspective view of a metal sheet used in making the heat exchangers of this invention.

FIG. 2 is a view similar to FIG. 1 but illustrating an intermediate arrangement in the method of manufacturing the exchanger.

FIG. 3 is a fragmentary perspective view of a portion of the turbulence producing third area **20**.

FIG. 4 is a fragmentary sectional view through the turbulence producing portions taken along line 4—4 of FIG. 3.

FIG. 5 is a transverse sectional view through one embodiment of the completed tubular heat exchanger.

FIG. 6 is a view similar to FIG. 5 but showing a portion only of a second embodiment of a heat exchanger.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The completed oil cooler **10**, as illustrated in cross section in FIG. 4, comprises a pair of end fittings **11** of which only one is illustrated but with these end fittings being provided at opposite ends of the exchanger to provide oil inlet and outlet passages. The completed oil cooler **10** comprises an outer housing **12** that is tubular with a flat top **13** through which extends the pair of fittings **11**.

Located within the outer housing **12** is a heat exchanger **14**. This exchanger **14** is spaced from the housing **12** to provide an annular passage **15** for the liquid coolant.

In making the heat exchanger **14** itself there is provided a continuous, integral sheet of metal **23** as illustrated in FIGS. 1 and 2 with this sheet having a first area **16** at one longitudinal edge **17** and a second area **18** adjacent the opposite longitudinal edge **19**. These areas **16** and **18** are imperforate and are spaced apart so as to provide an intermediate third area **20** between them. This third area is provided with laterally projecting turbulence producing portions **21** and **22** that are in staggered rows with the projections extending from opposite sides of the sheet **23**. These projections are formed by slits in the sheet so that the oil during its flow through the cooler passes over, around and under them. Such an arrangement is illustrated in greater detail in the above U.S. Pat. No. 2,752,128.

The sheet **23** also contains opposite edge and end flanges **24** and **25** that are adjacent the edges **17** and **19**, respectively. As can be seen in FIG. 1 these flanges are of generally right angular cross section so that the outer parts are generally parallel to the flat sheet **23**.

In forming the heat exchanger **14** the sheet **23** is rolled upon itself as illustrated during a preliminary stage in FIG. 2. This forms a tube comprising the inner area **18**, the turbulator intermediate area **20** and the outer area **16**. As illustrated in FIG. 4 these areas **16** and **18** are spaced apart to provide the fluid flow space **26** in which is substantially centrally located the perforated turbulator third area **20**. The projections **21** that provide the turbulence extend inwardly in the illustrated embodiment while the other projections **22** extend outwardly. Both sets of projections **21** and **22** have flat peaks **27** and **28** which engage the adjacent surface of the corresponding tubular areas **16** and **18**. In sealing the sides of the heat exchanger **14** the above described edge flanges **24** and **25** are bonded to the rolled up tube as illustrated in FIG. 4.

As illustrated, the fitting **11** at each end of the cooler extends through the housing **12** and is held in an opening **30** at an end of the metal sheet first area **16**.

FIG. **5** is similar to FIG. **4** but illustrates a second embodiment of the invention. Both embodiments are quite similar with the principal difference being the use of a flat edge **36** on the outer area **31** of the metal sheet and locating transversely curved portions **32** and **33** adjacent this flat edge to provide the flow and turbulator space **34**.

After the tube has been rolled as described into the concentric portions as illustrated in FIGS. 4 and 5 the assembly is bonded together at contacting areas by any desired well known method.

The heat exchanger of this invention is adaptable to very high speed assembly and with greater accuracy in the mass production of the exchanges so that the cost of producing them is reduced. In producing the exchanger it is convenient to roll the sheet of metal **23** from a continuous coil of stock into a press where the sheet is formed and prepared for the rolling as illustrated in FIG. 2. After rolling the ends of each exchanger portion **14** and the longitudinal seams are sealed by a process which may be induction welding. The fittings **11** are then added before assembling within the housing **12** to make the oil cooler **10**. It is not necessary to expand the inner diameter to provide a proper contact between the parts as this contact is achieved in the rolling process, as described.

Having described my invention as related to the embodiments shown in the accompanying drawings, it is my intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the appended claims.

I claim:

1. The method of making a tubular heat exchanger having a turbulator therein, comprising: providing a continuous, integral metal sheet having spaced apart

first and second areas and an intermediate third area having turbulence promoting projections; and rolling said sheet upon itself to form a tube in which said first and second areas are substantially concentric to each other on opposite sides of said third area to provide an annular flow space between the first and second areas that is occupied by said third area.

2. The method of claim **8** wherein said projections are spaced apart, extend from opposite sides of said third area and the method further comprises bonding said projections to said first and second areas.

3. The method of claim **9** wherein said method further comprises forming angled flanges on said sheet edges at the sides of said first and second areas, and bonding said flanges to said sheet to enclose said third area after the rolling.

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