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HEAT EXCHANGER AND METHOD OF MAKING SAME

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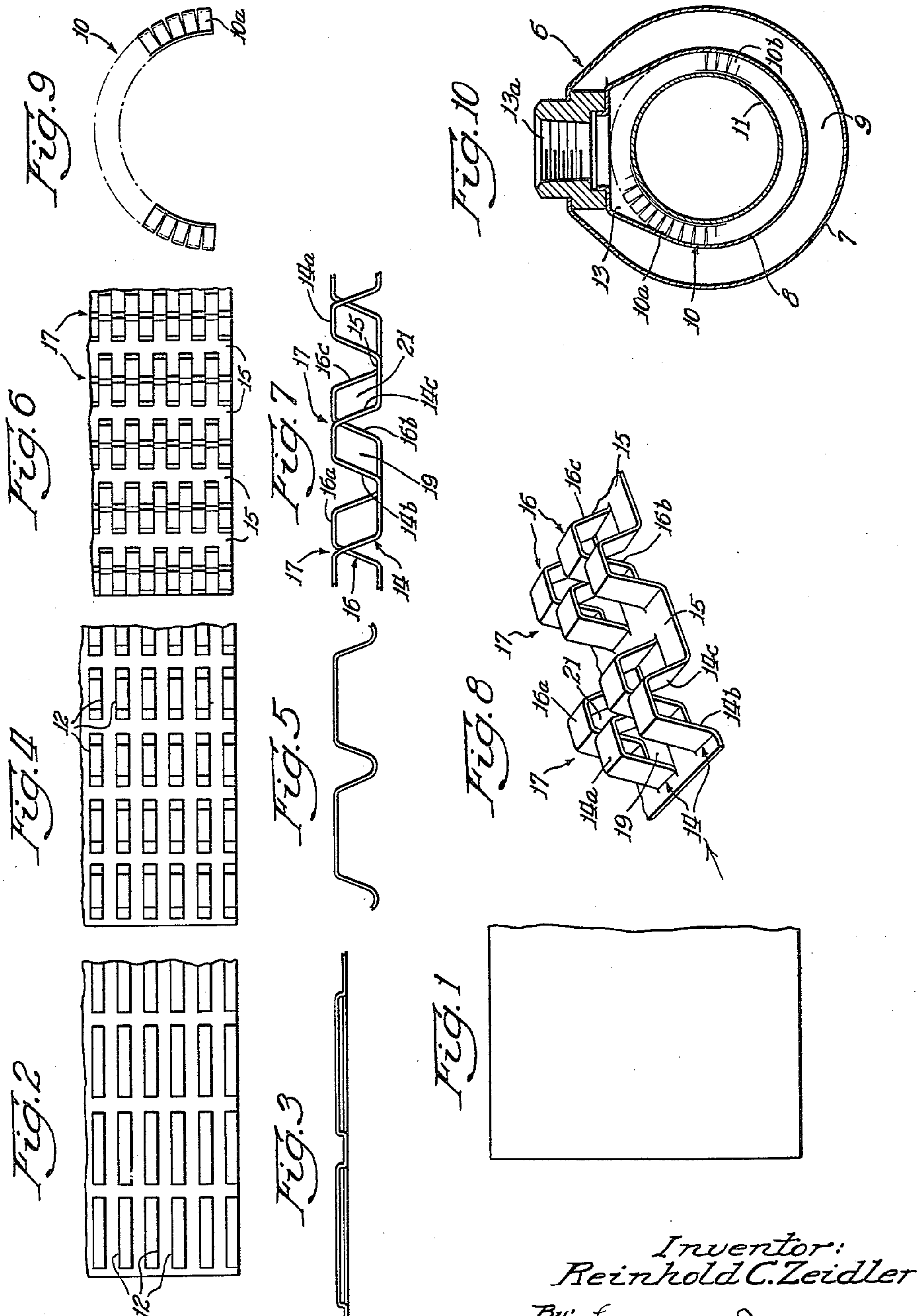

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HEAT EXCHANGER AND METHOD OF MAKING SAME

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This invention relates to heat exchangers and more particularly to a turbulizer for effecting turbulence of liquids such as oil and the like during the course of passage through a heat exchanger, and thus more effective heat dissipation. The present heat exchanger is of the tubular type and is particularly suitable for cooling the oil of torque converters in automatic transmissions for vehicles and the like where compactness is of importance.

Heretofore, oil coolers of this type have been provided with turbulizers comprised of a pair of hollow semi-cylindrical complementary grids for reception in a correspondingly formed passage of a tubular heat exchanger to retard the flow of oil, increase turbulence and enhance the efficiency of heat transfer. These turbulizers have been formed from flat ribbon stock and have been characterized by longitudinally aligned groups of parallel slits defining staggered U-shaped portions offset from the plane of the flat stock. The material between each pair of adjacent slits in a group was positioned at opposite sides of the original plane of the sheet to form the U-shaped portions. The U-shaped portions were longitudinally spaced from each other and the adjacent staggered series of U-shaped portions so that a sinusoidal path was formed for two separate streams of oil through the annular passage. By this arrangement, stratification of the oil occurred because of the two separate paths of flow and heat transfer was diminished because of the fact that only part of the U-shaped portions were in conductive relation to the heat exchange surface.

Accordingly, a principal object of the invention is to provide a tubular heat exchanger having a turbulizer formed to the configuration of an annular chamber without decreasing the efficiency and effectiveness of the turbulizing unit.

A further object of the invention is to provide a heat exchanger of the stated type having a turbulizer which is capable of effecting a high degree of turbulence in the heat exchanger, and which is provided with relatively large conductive surfaces to facilitate the dissipation of heat.

Another object of the invention is to provide a turbulizer of the mentioned type which is characterized by radially extending longitudinally spaced groups of corrugations offset from the plane of the stock in the one direction, in which alternate series of corrugations of a group are partially offset longitudinally so that they overlap adjacent series of corrugations and thus assure turbulence in the oil during the course of flow through the annular heat exchange chamber, and in which the adjacent series of corrugations are joined on a common plane coincident with one side of the turbulizer so that forming of the unit to the required semi-annular shape is facilitated.

A further object of the invention is to devise a method for forming the turbulizer of the present invention in which a continuous strip of flat metal is provided with longitudinally spaced groups of longitudinally extending parallel slits, in which the strips defined by the slits are formed into laterally extending corrugations, in which the corrugations are reformed to offset longitudinally alternate series of strips, in which the flat grid thus formed is bent to assume a semi-annular shape in cross-section and in which the grid is severed to the required length.

A final object of the invention is to provide a turbulizer of the stated type which is characterized by ease of manufacture, facility of use, convenience in form, and improved functional characteristics.

This invention consists of the novel constructions, arrangements, and devices to be hereinafter described and claimed for carrying out the above stated objects and such other objects as will be apparent from the following description of preferred forms of the invention, illustrated with reference to the accompanying drawings, wherein:

FIGURE 1 is a plan view of a section of flat ribbon stock used to form the turbulizer of the present invention;

FIGURE 2 is a fragmentary plan view of the flat stock of FIGURE 1 after the slitting step;

FIGURE 3 is an enlarged elevational view of the stock in the stage shown in FIGURE 2;

FIGURE 4 is a plan view similar to FIGURE 2 but showing the stock in the configuration it assumes after the transverse corrugation step;

FIGURE 5 is an enlarged elevational view of the preform in the stage illustrated in FIGURE 4;

FIGURE 6 is a plan view similar to FIGURES 2 and 4 showing the stock after it has been reformed to stagger the corrugations in alternate series of strips joined together only at the base which is substantially coincident with the original plane of the stock;

FIGURE 7 is an enlarged elevational view of the preform shown in FIGURE 6;

FIGURE 8 is a greatly enlarged view in perspective of the turbulizer preform in the stage illustrated in FIGURES 6 and 7;

FIGURE 9 is an elevational view of a turbulizer section in its final configuration; and

FIGURE 10 is a sectional view of a heat exchanger embodying a pair of complementary turbulizer sections of the type shown in FIGURE 9.

Referring to the drawings and more particularly to FIGURES 9 and 10, the heat exchanger of the present invention is indicated generally by reference numeral **6** and may comprise an outer housing **7**, an inner casing **8** within the housing **7** and defining therebetween a substantially annular passage **9** for flow of a suitable coolant, and a tubular conduit **11** in spaced relation to the casing **8** and defining therebetween a substantially annular passage **13** for the oil to be cooled. The housing **7** may be omitted and the casing **8** may be arranged in the bottom tank of a radiator or in a tubular conduit such as a hose connection between the vehicle engine and the radiator. In cases where the housing **7** is utilized the coolant may flow in parallel through the conduit **11** as well as through the passage **9**. The passage **13** may be closed at each end by any suitable means and the oil may be introduced through an inlet **13***a* and discharged through a suitable outlet (not shown). It will be understood that the present heat exchanger is characterized by compactness and that the axial extent of the passage is limited. Thus, it is important to retard the rate of flow of the oil and bring the oil into intimate contact with the surfaces of the wall of the conduit **11** and the casing **8** so that maximum heat transfer may be effected. This result is accomplished by a turbulizer **10** which, in the present instance, comprises two complementary sections **10***a* and **10***b* extending substantially the full length of the chamber **13**. The turbulizer **10** is in the form of a grid providing a tortuous passage for the oil to be cooled and is formed from flat metal stock which, as will be hereafter apparent, is shaped to provide a series of obstacles to the oil flow. The shaping of the obstacles, according to the present invention, is accomplished in such a manner as to facilitate the forming of the turbulizer to the shape shown in FIGURES 9 and 10.

Referring now to FIGURE 8, the turbulizer **10** is shown fragmentarily in that figure on a greatly enlarged scale, in the shape it assumes just prior to forming to the configuration of the chamber **13.** The turbulizer **10** has a base **15** and a plurality of longitudinally spaced groups **17** of substantially U-shaped corrugations extending in one direction from the plane of the base **15.** These groups **17** extend transversely of the blank or flat stock during formation and radially outwardly from the base **15** when the turbulizer section is shaped as in FIGURES 9 and 10. Each of the groups **17** includes a series of spaced corrugations **14** and an alternate series of longitudinally offset corrugations **16.** The several corrugations **14** and **16** are joined only to the base **15** and thus when the preform shown in FIGURE 8 is shaped as in FIGURES 9 and 10, the portions of the base **15** connecting the several longitudinally spaced corrugations **14** and the portions of the base **15** connecting the several longitudinally spaced corrugations **16** form joined chords of such limited dimension that a high degree of heat conduction is afforded through the turbulizer and through the wall of the conduit **11.** To effect efficient heat conduction through the casing **8** each of the corrugations is preferably shaped so that a substantial area is in contact with the casing. To this end, each of the corrugations has a substantially flat top panel **14***a* while each of the corrugations **16** has a substantially flat top panel **16***a*.

The offset arrangement and shape of the corrugations **14** and **16** provides for effective turbulization and the prevention of stratification of the oil along the heat conductive surfaces. Each of the corrugations **14** has a sloping upstream panel **14***b* and a sloping downstream panel **14***c* while each of the corrugations **16** has a sloping upstream panel **16***b* and a sloping downstream panel **16***c*. Assuming flow of oil in the direction of the arrow in FIGURE 8, the oil impinges against the panel **14***b* of the several corrugations **14** and thence passes therebetween into engagement with the leading or upstream panel **16***b* of the several corrugations **16.** The oil then flows through openings **19** between the upstream panels of the several series of corrugations, thence into contact with the inner surface of each downstream panel **16***c*, and thence out through openings **21** between the downstream panels of the corrugations of adjacent series. It will be apparent that the above cycle is repeated when the next group of corrugations is reached and that the oil traverses a series of substantially right angle turns during the course of its passage through the several groups of corrugations. These sudden changes of course of the oil provides an efficient scouring action which precludes the formation of film of cold oil on the surfaces of the casing **8** and the wall of the conduit **11.**

According to the method of the present invention, the turbulizer **10** may be formed from a continuous ribbon of flat stock, such as shown in FIGURE 1, and is initially subjected to a slitting step, as shown in FIGURES 2 and 3. This slitting step may be effected by passing the ribbon stock through a rotating slitter (not shown) having suitably positioned cutting elements to afford longitudinally spaced groups of transversely extending parallel elongated slits **12.** The strip material between adjacent pairs of slits **12,** as will be apparent is subsequently utilized to form the corrugations **14** and **16.** As the slits **12** are formed, the longitudinally spaced groups or sections are separated by a series of depressed zones which facilitate the forming of the turbulizer during the subsequent steps into the finished product.

Referring now to FIGURES 4 and 5 the stock is then passed through a corrugation step in which the corrugations **14** and **16** are offset from the plane of the stock in one direction. During this step the stock is subjected to suitable forming apparatus, such as supplementary forming rolls (not shown) having circumferentially spaced lands for corrugating the stock in a manner that the corrugations **14** and **16** are in transverse alignment.

The preform shown in FIGURE 5 is then subjected to a reforming step in which the series of corrugations **16** is offset longitudinally from the series of corrugations **14.**

The flat preform shown in FIGURES 6, 7 and 8 may be shaped to the final form shown in FIGURES 9 and 10 on a mandrel of suitable diameter about an axis parallel to the corrugations. In this connection, it will be noted that the several corrugations of the adjacent series **14** and **16** are joined only at one plane, i.e. the base **15.** By this arrangement, the formation of the preform of FIGURES 6–8 to the final form shown is facilitated and the several segments of the base **15** are maintained in good heat exchange relation with the surface of the conduit **11.** The flat top panels of the corrugations **14** and **16** are at the same time in good heat exchange relation with the inner surface of the casing **8.**

The stock may be severed to the desired length either before or after the forming of the blank into an arcuate shaped section.

The present heat exchanger provides a turbulizer which is characterized by an efficient and effective turbulizing action as well as providing a planar base section for efficient dissipation of heat through the coolant flowing through the conduit **11** and flat top panels for effective heat conduction through the casing **8** to the coolant passing through the passage **9.** Furthermore, the longitudinal offset arrangement of one circumferential series of corrugations of a group with respect to the adjacent circumferential series of corrugations provides the highest possible turbulence.

It is to be understood that my invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be understood to those skilled in the art that changes may be made without departing from the principles of the invention.

I claim:

1. A method for forming a turbulizer for a heat exchanger comprising the steps of slitting a continuous ribbon of flat stock to form a plurality of longitudinally spaced transversely extending groups of contiguous strips, corrugating the said groups of strips to fashion a preform having a plurality of longitudinally spaced groups of corrugations, reforming said corrugations to form alternate series of corrugations offset longitudinally from each other, shaping said stock about an axis parallel to said strips so that it assumes an arcuate configuration and severing said stock to the required length.

2. A method for forming a turbulizer comprising the steps of slitting a continuous ribbon of flat stock to form a plurality of longitudinally spaced transversely extending groups of contiguous strips, corrugating the said groups of strips to fashion a preform having a plurality of longitudinally spaced groups of corrugations joined only at a base, reforming said corrugations to form alternate series of corrugations offset longitudinally from each other, shaping said stock about an axis parallel to said strips so that it assumes an arcuate configuration and severing said stock to the required length.

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