

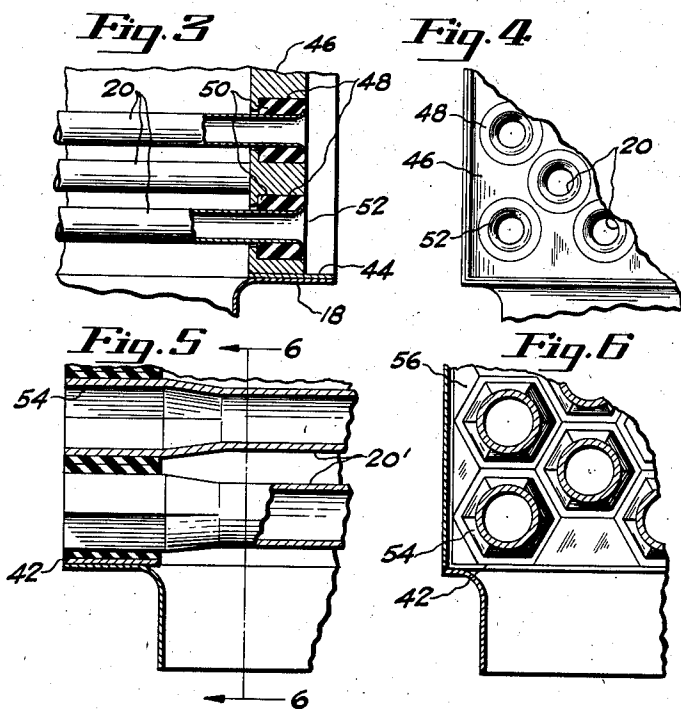
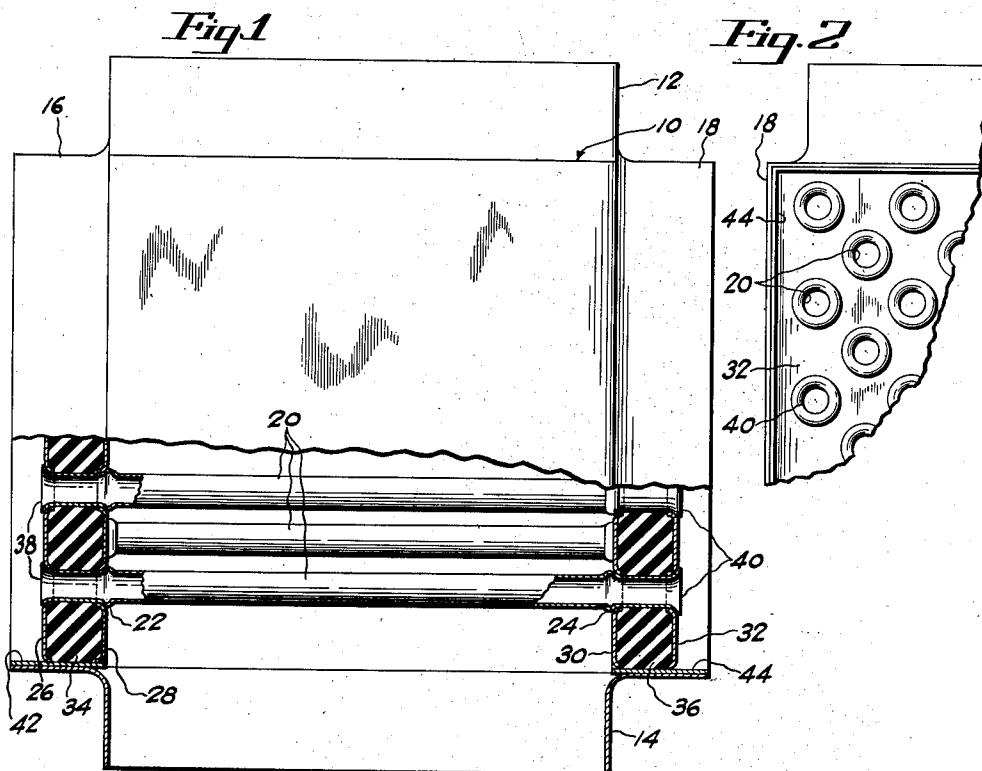
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HEAT EXCHANGER

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HEAT EXCHANGER

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This invention relates to improvements in heat exchangers and has particular reference to an improved heat exchanger such as a radiator or intake air cooler for an internal combustion engine.

An object of the invention resides in the provision of an improved radiator or heat exchanger device of the character indicated which is light in weight and resistant to engine vibrational effects.

A further object resides in the provision of an improved heat exchanger or air cooler of the character indicated in which the joints are flexibly sealed by a suitable resilient material such as rubber or a synthetic rubber product.

A still further object resides in the provision of a fluid tight heat interchanger formed of a metal such as aluminum or an aluminum alloy which cannot be readily soldered, welded, brazed, fused or a metal to metal joint otherwise effected.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawing, in which like reference numerals are used to designate similar parts throughout, there is illustrated, in three somewhat modified forms, a suitable mechanical arrangement for the purpose of disclosing the invention. The drawing, however, is for purposes of illustration only and is not to be taken as limiting the invention since it will be apparent to those skilled in the art that various changes in the illustrated constructions may be resorted to without in any way exceeding the scope of the invention.

In the drawing, Fig. 1 is an elevational view of a heat exchanger of the character indicated a portion thereof being broken away and shown in section to better illustrate the construction thereof.

Fig. 2 is an end elevational view of a fragmentary portion of the heat exchanger shown in Fig. 1.

Fig. 3 is a sectional view of a fragmentary portion of the heat exchanger shown in Fig. 1 showing a somewhat different method of sealing the cooler joints.

Fig. 4 is an end elevational view of a fragmentary portion of a heat exchanger constructed in the manner illustrated in Fig. 3.

Fig. 5 is a sectional view of a fragmentary portion of a heat exchanger showing a still further modified form of sealing the heat exchanger joints, and

Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Referring to the drawing in detail, the numeral 10 generally indicates the heat exchanger casing which is provided with four duct connections as indicated at 12, 14, 16 and 18. One stream of air, such as the engine intake air, flows through the heat exchanger from the connection 16 to the connection 18 passing through the interiors of the tubes 20, and another stream of air, such as the cooling air, passes from the connection 12 to the connection 14 flowing over the exteriors of the tubes 20 as it passes through the heat exchanger. With this arrangement heat is transferred from the intake air, flowing through the tubes, through the tube walls to the cooling air, flowing over the exteriors of the tubes. It is to be understood that this arrangement is illustrative only and that the device 10 may be either an heat exchanger or a radiator so that one or both of the fluids flowing therethrough may be liquid and that the direction of flow may be in either direction through the intercooler as the exigencies of the particular installation may require. The tubes 20 may be conveniently formed from aluminum blanks by an extrusion process and the casing 10 may be formed of sheet aluminum if desired.

In the form of the invention shown in Fig. 1 the tubes are provided near their ends with extruded annular beads, as indicated at 22 and 24, and the end portions beyond these beads are passed through apertures in the spaced header plates 26, 28, 30 and 32. An apertured plate or sheet 34 of a suitable resilient material, such as rubber or synthetic rubber, such as "Neoprene," is included between the header sheets 26 and 28, and a similar plate of resilient material 36 is included between the plates 30 and 32 to provide composite tube sheets for the ends of the heat exchange tubes. After the tube ends are inserted through the composite tube sheets the ends of the tubes are expanded or flared outwardly as indicated at 38 and 40 in a manner which forces the opposed side plates of each tube sheet together and compresses the resilient material included therebetween. This compression of the resilient material in the direction of its thickness causes it to tend to expand in area thus forcing the material into close contact with the end portions of the tube passing therethrough and into close contact with the end bands 42 and 44 which surround the tube sheets and are rigidly secured by a fluid tight joint to the casing 10, thereby providing a resilient fluid tight seal between the tubes and the tube sheets

and between the tube sheets and the casing of the intercooler or radiator.

In the form of the invention shown in Figs. 3 and 4 tube sheets, as indicated at 46, are provided in the form of relatively thick plates of a light metal, such as an aluminum alloy, provided with countersunk apertures, as indicated at 48. Each aperture has an inner portion of relatively small diameter which closely encircles the tube wall and an outer portion of larger diameter in which is inserted a cylindrical bushing 50 of resilient material which fills the space between the end portion of the associated tube and the countersunk portion of the respective aperture 48. After the bushings 50 are inserted the ends of the tubes are expanded or flared, as indicated at 52, to compress the material of the bushings into close contact with the end portions of the tubes and the walls of the countersunk portions of the respective apertures. In this case the tube sheets are rigidly secured to the end band 44 to provide a fluid tight seal between the casing and the tube sheets.

In the form of the invention shown in Figs. 5 and 6 the tubes 20' are provided with expanded hexagonal end portions 54 to provide sufficient spacing between the intermediate portions of the tubes for the flow of fluid therebetween. These expanded end portions are then coated, by some suitable means such as dipping or spraying, with rubber or synthetic rubber latex. The tubes are then placed in the casing with the hexagonal end portion arranged in honeycomb fashion, as illustrated in Fig. 6, within a frame member 56 formed to fill in the spaces between the coated portions of the tubes and the end bands, one of which is indicated at 42. After the tubes are properly arranged in the end frames the entire structure is subjected to a heat treating process which vulcanizes the latex coatings on the tube ends together and thus provides integral resilient layers between all of the flat surfaces of the tube ends and between the tube ends and the frame, these layers being also vulcanized to the tube ends and to the frame to secure the tubes in proper position in the frame.

From the above description it will be observed that means have been provided for making a heat exchanger without soldered or welded joints and for resiliently securing the parts together

against fluid leakage and accidental disruption while permitting sufficient flexibility in the structure so that extremely light weight parts can be used and the structure will be resistant to vibrational effects.

While a suitable mechanical arrangement has been hereinabove described and illustrated in the accompanying drawing in three somewhat modified forms, it is to be understood that the invention is not limited to the particular forms so illustrated and described, but that various changes in the size, shape and arrangements of the various parts and of the materials thereof may be resorted to as come within the scope of the subjoined claims.

Having now described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

1. In a heat exchanger arranged for the flow of two separate fluid streams therethrough, a plurality of tubes for maintaining said fluid streams separate and exchanging heat therebetween, and a pair of end headers for said tubes, each header including a composite tube sheet comprising a pair of spaced metal plates apertured for the projection of the end portions of the tubes therethrough, and a body of resilient material between said plates also apertured for said tubes, said tubes having expansions on the opposite sides of each composite tube sheet spaced to force said plates together and compress said resilient material into fluid tight contact with said tube end portions.

2. In a heat exchange device, a plurality of tubes, a pair of end headers for said tubes, a casing having portions closely surrounding said headers, each header including a composite tube sheet comprising a pair of spaced metal plates apertured for the projection of the end portions of the tubes therethrough, and a body of resilient material between said plates also apertured for said tubes, said tubes having expansions on the opposite sides of each composite tube sheet spaced to force said plates together and compress said resilient material into fluid tight contact with said tube end portions and with the portions of said casing surrounding said headers.

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