(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 823 609 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
19.12.2001 Bulletin 2001/51

(51) Int Cl.[7]: **F28D 1/053**, F25B 39/04

(21) Application number: **97112993.7**

(22) Date of filing: **29.07.1997**

(54) **A condenser for air-conditioning systems for vehicles**

Kondensator für Klimaanlage für Fahrzeuge

Condenseur pour système de conditionnement d'air pour véhicules

(84) Designated Contracting States:
DE ES FR GB SE

(30) Priority: **07.08.1996 IT TO960683**

(43) Date of publication of application:
11.02.1998 Bulletin 1998/07

(73) Proprietor: **DENSO THERMAL SYSTEMS S.p.A.**
10046 Poirino (Torino) (IT)

(72) Inventor: **Parola, Andrea**
10023 Chieri (Torino) (IT)

(74) Representative: **Quinterno, Giuseppe et al**
Jacobacci & Partners S.p.A., Corso Regio Parco, 27
10152 Torino (IT)

(56) References cited:
EP-A- 0 633 435
DE-A- 4 122 904
FR-A- 380 090
US-A- 1 759 167

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 823 609 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a condenser for air-conditioning systems for vehicles.

[0002] More precisely, the invention relates to a condenser of the so-called mechanically-assembled type, comprising at least one row of tubes fixed to a pack of substantially flat fins by mechanical expansion of the tubes after they have been inserted in aligned holes in the fins.

[0003] Condensers for vehicle air-conditioning systems constitute a very special class of heat exchangers because of the severe operating conditions to which they are subject. The pressures inside the tubes may reach values of the order of 30 bars before a safety system intervenes by switching off the system. The working temperatures of the condenser reach peak values of 120-140°C. These working conditions substantially differentiate the structural characteristics of a condenser from those of other types of heat exchangers present in a vehicle.

[0004] Condensers produced by braze-welding assembly techniques use tubes having a plurality of microducts separated by walls or ribs which enable the tube to withstand severe operating conditions without undergoing permanent deformation or damages,with leakage of coolant to the exterior. Although condensers of this type have optimal performances from the point of view of heat-exchange capacity and optimal structural strength, they have the disadvantage of a very high cost.

[0005] Mechanically-assembled condensers are cheaper than braze-welded ones but generally have inferior heat-exchange efficiency. This is mainly due to the fact that the mechanical assembly technique uses tubes with circular cross-sections, the stable shape of which enables them to withstand the high pressure levels present in the system. However, the shape of the tubes greatly penalizes the heat-exchange performance of the condenser.

[0006] The Applicant's document EP-A-0 633 435 describes a mechanically-assembled condenser with tubes having oblong cross-sections. Tubes of this type considerably improve the performances of the condenser in terms of heat-exchange efficiency. However, tubes with oblong cross-sections present difficulties from the point of view of structural strength. The aforementioned document EP-A-0 633 435 solves the problem of the inferior structural strength of tubes with oblong cross-sections, in comparison with tubes with circular cross-sections, with the use of particular dimensions of the entire assembly of tubes-fins.

[0007] The structure of the heat exchanger described in this document has given optimal experimental results and can withstand the normal thermal and mechanical stresses which occur during use in a vehicle.

[0008] However, tests have shown that there are still critical points from the point of view of structural strength, particularly when the condenser is subjected to laboratory tests which produce more severe stress conditions than those which normally occur during the use of the condenser in a vehicle.

[0009] In particular, laboratory tests have shown the presence of weak points which may give way, particularly as a result of pulsed-pressure stress tests. A typical test of this type provides for the condenser to be brought to a temperature of about 100°C and for the tubes to be stressed from the interior with a pressure variable alternately between 5 and 30 bars at a frequency of the order of 0.5-3 Hz.

[0010] DE-A-41 22 904 discloses oil coolers for motor-vehicles comprising a row of flat tubes. Zigzagging heat-dissipating metal sheets are connected, for instance by brazing, between adjacent tubes of said row. On each side of said row of tubes there is provided a bridging tube which can have a circular cross-section. Said bridging tubes have a cross-section which is larger, preferably larger to a substantial extent, than the total cross-section of the whole row of flat tubes, and form an alternative circuit for bypassing said row of tubes at low temperatures, when the oil becomes so thick that is can hardly flow through the flat tubes of the row.

[0011] The object of the present invention is to provide improvements to mechanically-assembled condensers having tubes with oblong cross-sections, which eliminates or reduces the risks of their giving way, even in pulsed-pressure test conditions.

[0012] According to the present invention, this object is achieved by a heat exchanger having the characteristics forming the subject of the appended claim.

[0013] More precisely, it has been noted that, during pulsed-pressure stress tests, the tubes at the ends of the row constitute the points with the greatest probability of giving way.

[0014] According to the present invention, in order to overcome this problem, tubes with circular cross-sections are used at the ends of the row and tubes with oblong cross-sections are used in the inner portion of the row.

[0015] By virtue of this characteristic, a greater structural strength of the assembly of tubes-fins is achieved at the ends of the row by virtue of the greater intrinsic resistance to radial deformation of tubes with circular cross-sections.

[0016] Further characteristics and advantages of the present invention will become clear in the course of the following detailed description, given purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a schematic, perspective view of a condenser according to the present invention,

Figure 2 is a schematic, perspective view of the condenser of Figure 1, and

Figure 3 is a plan view of an end region of the con-

denser.

[0017] With reference to the drawings, a condenser for vehicle air-conditioning systems is indicated 10. The condenser 10 comprises a row of tubes 12, each of which is fitted in a series of aligned holes 26 (Figure 3) formed through substantially flat fins 14 superposed on one another so as to form a pack. The connection between the tubes 12 and the fins 14 is achieved by mechanical expansion of the tubes after they have been inserted with slight clearance through the aligned holes of the fins. The ends of the tubes which project from the pack of fins 14 are braze-welded to respective manifolds 16 and 18.

[0018] Experimental structural strength tests have shown that the tubes disposed at the ends of the row are more exposed to the risk of breakage, particularly in the presence of pulsing internal pressure which causes fatigue stressing of the system.

[0019] According to the invention, in order to increase the structural strength of the assembly of tubes-fins, tubes 12a and 12b with circular cross-sections are used at the ends of the row. The remaining tubes 12 situated in the inner portion of the row have oblong (for example, oval) cross-sections in order to achieve good heat-exchange characteristics of the condenser.

[0020] Experimental tests have shown that the tubes with circular cross-sections do not require the assistance of the surrounding fins to withstand the internal pressure. The use of tubes with circular cross-sections instead of tubes with oblong cross-sections at the ends of the row therefore achieves the necessary strength characteristics to pass the most demanding tests without the need for additional lateral restraint systems. This solution also has the advantage of considerable stability as well as good structural strength.

Claims

1. A condenser for air-conditioning systems for vehicles, comprising at least one row of tubes (12, 12a, 12b) fixed to a pack of substantially flat fins (14) by mechanical expansion of the tubes after they have been inserted in aligned holes (26) in the fins (14), said row of tubes comprising a pair of tubes (12a, 12b) with circular cross-sections each tube situated at each end of the row and a plurality of tubes (12) with oblong cross-sections situated in the inner portion of the row.

Patentansprüche

1. Kondensator für Klimaanlagen für Fahrzeuge, umfassend mindestens eine Reihe Röhren (12, 12a, 12b), die an einer Reihe im Wesentlichen flacher Rippen (14) befestigt sind, und zwar durch mechanische Ausdehnung der Röhren, nachdem sie in fluchtende Löcher (26) in den Rippen (14) eingesetzt worden sind, wobei die Reihe Röhren ein Paar Röhren (12a, 12b) mit kreisförmigem Querschnitt, wobei sich jede Röhre am jeweiligen Ende der Reihe befindet, und eine Mehrzahl an Röhren (12) mit länglichem Querschnitt, die sich im inneren Teil der Reihe befinden, umfasst.

Revendications

1. Condenseur pour systèmes de conditionnement d'air pour véhicule, comprenant au moins une rangée de tubes (12, 12a, 12b) fixés à un empilement d'ailettes pratiquement plates (14) par dilatation mécanique des tubes après qu'ils ont été insérés dans des trous alignés (26) formés dans les ailettes (14), ladite rangée de tubes comprenant une paire de tubes (12a, 12b) de section circulaire qui sont placés chacun à chaque extrémité de la rangée, et plusieurs tubes (12) ayant des sections allongées placées à la partie interne de la rangée.

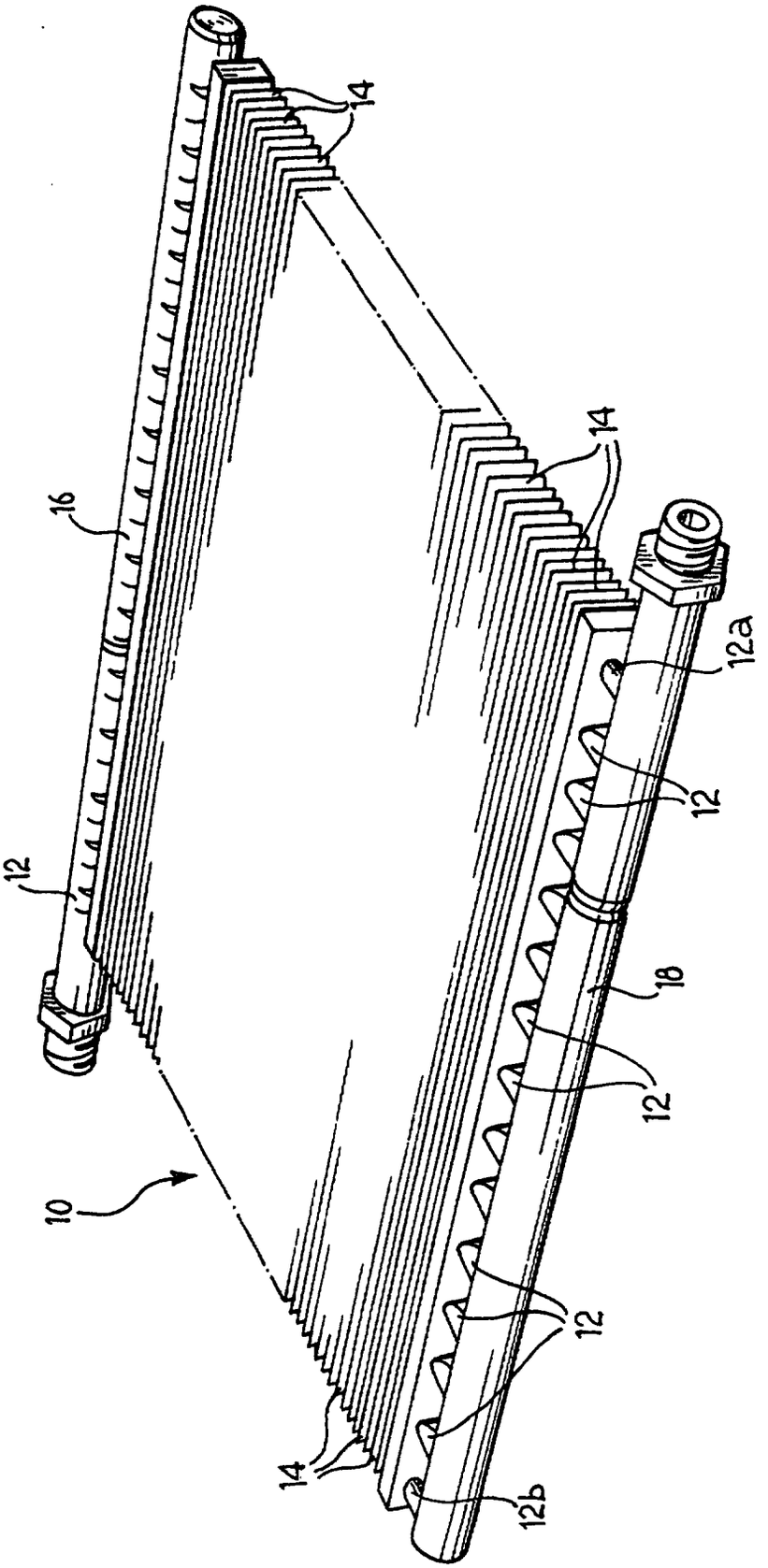


FIG. 1

FIG. 2

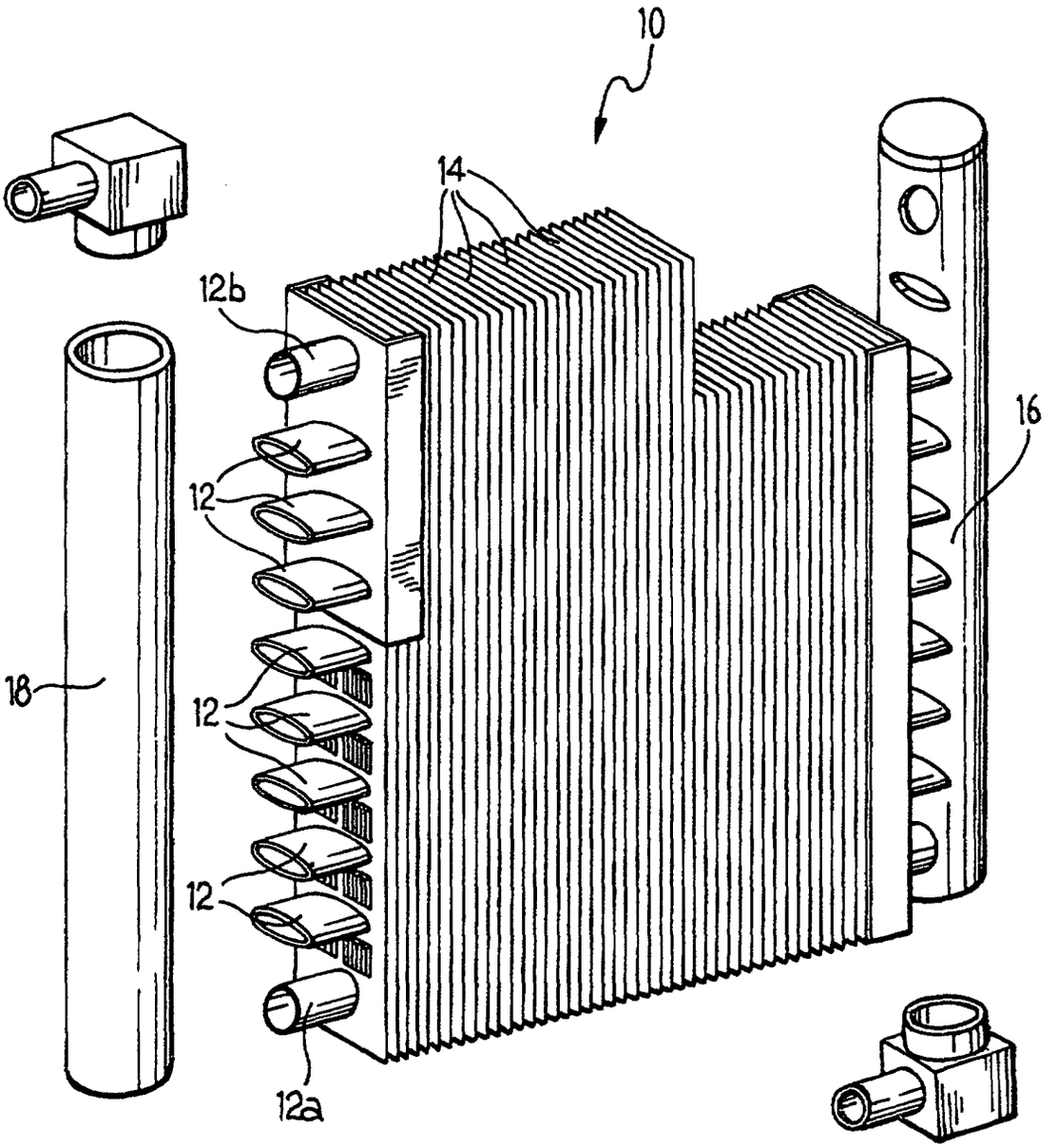


FIG. 3

