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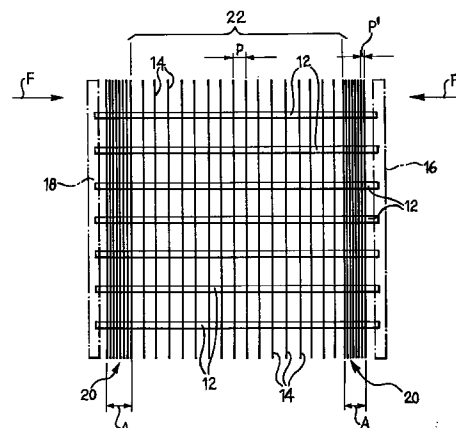
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(54) A condenser for vehicle air-conditioning systems

(57) A condenser for vehicle air-conditioning systems, including at least one row of tubes (12) fixed to a stack of substantially flat fins (14) by mechanical expansion of the tubes (12) once they have been inserted through aligned holes (26) in the fins (14). The spacing (P) between the fins (14) at either end of the stack is smaller than the spacing between the fins (14) in the central portion (22) of the stack.

FIG. 2



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Description

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

More specifically, the invention relates to a condenser of the so-called mechanical assembly type, including at least one row of tubes fixed to a stack of substantially flat fins by mechanically expanding them after inserting them into aligned holes in the fins, in which the ends of the tubes projecting from the stack of fins are fixed by brazing to a pair of tubular manifolds.

Condensers for vehicle air-conditioning systems constitute a very specific class of heat exchangers, because of the difficult operating conditions to which they are subject. Pressures in the tubes can reach values of the order of 30 bar, before a safety system cuts off the system. The operating temperatures of the condenser reach peak values of 120-140°C. These operating conditions make the structural characteristics of a condenser substantially different from those of other types of heat exchangers fitted into a vehicle.

Condensers manufactured using braze welding assembly technology use tubes with a plurality of microducts separated from each other by partitions or ribs which enable the tube to resist arduous operating conditions without suffering permanent deformations or damages involving leakage of refrigerant. Although the performance of condensers of this type is excellent from the point of view of heat exchange capacity and they have a good structural strength, they have the disadvantage of being very expensive.

Condensers of the mechanical assembly type are less expensive than braze welded ones but their heat exchange is generally less effective. This is mainly due to the fact that in mechanical assembly technology tubes with a circular cross section are used, since this stable shape enables them to withstand the high levels of pressure in the system. However the shape of the tubes severely impairs the heat exchange performance of the condenser.

The document EP-A-O 633 435 of the same Applicant describes a mechanical assembly type condenser having tubes with an oblong cross section. Tubes of this type considerably increase the performance of the condenser in terms of heat exchange efficiency. However, the oblong tubes have some problems with regard to structural strength. The aforesaid document EP-A-O 633 435 solves the problem of the lower structural strength of the tubes with an oblong cross section compared to tubes having a circular cross section by adopting special dimensions for the whole tubes-fins assembly.

The structure of the heat exchanger illustrated in this document has given excellent test results and is able to withstand the normal thermal and mechanical stresses to which it is subjected during use in a vehicle.

However, experience has shown that there are still critical points from the structural strength point of view, especially when the condenser is put through laboratory

tests which subject it to far greater stress conditions than those which would normally arise during use in a vehicle.

In particular, laboratory experience has revealed the presence of fragile points which could give rise to fractures, especially as a result of stress tests involving pulsing pressure. A typical test of this type involves bringing the condenser to a temperature of around 100°C and stressing the tubes from within by a variable pressure alternating between 5 and 30 bar with a frequency of around 0.5-3Hz.

The object of the present invention is to provide improvements in mechanical assembly type condensers having tubes with an oblong cross section, which eliminate or reduce the risk of fractures even during pulsing pressure test conditions.

This object is achieved according to the present invention by providing a heat exchanger having the characteristics forming the subject of the main claim.

More precisely, it was noticed that the portions of the tubes situated inside the stack of fins and immediately adjacent the ends of the stack were weaker than those portions of tubes situated in the central portion of the stack of fins.

Studies carried out by the Applicant have shown that, during braze welding, the fins situated at the ends of the stack were subjected to a reheating treatment during which they were heated by a flame then air cooled. The mechanical characteristics of the fins subjected to this heat treatment were impaired and they became weaker than the other fins. Thus the fins situated at the ends of the stack resist the pressure inside the tubes less effectively and the associated portions of tubes run a greater risk of fractures.

The present invention solves the aforesaid problem by reducing the spacing between the fins near the ends of the stack. This reduced spacing does not prevent the deterioration in the mechanical properties of the fins but compensates for it. In fact the greater quantity of material around the end portions of the tubes makes up for the loss of strength of the fins.

Further characteristics and advantages of the present invention will become clear from the detailed description which follows, given purely by way of non-limitative example, with reference to the appended drawings, in which:

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

Figure 2 is a schematic front elevation view of the condenser of Figure 1.

With reference to Figures 1 and 2, a condenser for vehicle air-conditioning systems is indicated 10. The condenser 10 includes a row of tubes 12 having an oblong cross section, oval in this specific case. Each tube 12 is inserted into a series of aligned holes through substantially flat fins 14, superimposed over one another to form a stack. The tubes 12 and the fins 14

are joined together by mechanical expansion of the tubes, once these have been inserted through the aligned holes in the fins with a slight clearance. The ends of the tubes projecting from the stack of fins 14 are braze welded to respective manifolds 16 and 18.

Structural resistance tests have shown that the portions of tube at either end of the stack of fins 14 are more exposed to the risk of fracture, especially when subjected to an internal pulsing pressure which puts fatigue stress on the system.

According to the invention, in order to improve the structural strength of the ends portions of the tubes, the spacing of the fins 14 is reduced in the end regions of the stack, indicated 20 in the drawings.

As is schematically illustrated in Figure 2, the spacing P between the fins 14 in the central portion 22 of the stack is of the order, for example, of 1.2mm. The distance between the fins 14 is maintained, in a known manner, by a series of spacer elements (not shown) integrally formed with the fins 14.

In the end portions 20 of the stack of fins, the spacing of the fins is reduced to a value P' of the order of 30%-70% of the spacing P. The spacing P' will preferably be between 40% and 60% of the spacing P and will typically be around 50% of P (around 0.6mm). The length A of the reduced-spacing portions 20 is dependent on various factors and in one embodiment is about 10mm.

The preferred procedure for reducing the spacing between the fins 14 at the ends of the stack consists in first forming a stack of fins 14 with a constant spacing P. The tubes 12 are then inserted through the aligned holes in the fins 14 and fixed to the stack of fins 14 by an expansion process, in itself known, which mechanically expands the tubes 12. Once the tubes 12 are connected to the fins 14, a compacting force F is applied to the fins 14 parallel to the axes of the tubes 12.

The forces F may be applied simultaneously to both ends of the stack or one end may be compacted at a time. The compacting force makes the fins slide relative to the tubes and causes a plastic deformation of the spacer elements. The travel of the member applying the compacting force F will be substantially equal to the desired length A of the reduced-spacing portions 20.

After compacting the spacing between the end fins 14, the ends portions of the tubes 14 projecting from the stack of fins 14 are braze welded to the manifolds 16, 18.

Claims

1. A condenser for vehicle air-conditioning systems, including at least one row of tubes (12) fixed to a stack of substantially flat fins (14) by mechanical expansion of the tubes once they have been inserted into aligned holes (26) through the fins (14), in which the ends of the tubes (12) projecting from the stack of fins (14) are braze welded to a pair of tubular manifolds (16, 18), characterised in that

the spacing (P') between the fins (14) at the ends of the stack is smaller than the spacing (P) between the fins (14) in the central portion (22) of the stack.

2. A condenser according to Claim 1, characterised in that the spacing (P') between the fins (14) at the ends of the stack is between 30% and 70%, and preferably between 40% and 60%, of the spacing (P) between the fins (14) in the central portion (22) of the stack.
3. A process for the manufacture of a condenser according to Claim 1 or Claim 2, characterised in that it includes, in order, the steps of:
 - arranging a stack of fins (14) with a substantially constant spacing (P) between the fins (14),
 - inserting a plurality of tubes (12) through aligned holes in the fins (14),
 - fixing the tubes (12) to the stack of fins (14) by mechanical expansion of the tubes (12),
 - reducing the spacing (P') of the fins (14) at either end (20) of the stack, by applying a force (F) parallel to the axes of the tubes (12), and
 - welding the ends of the tubes (12) projecting from the stack of fins (14) to a pair of tubular manifolds (16, 18).

FIG. 1

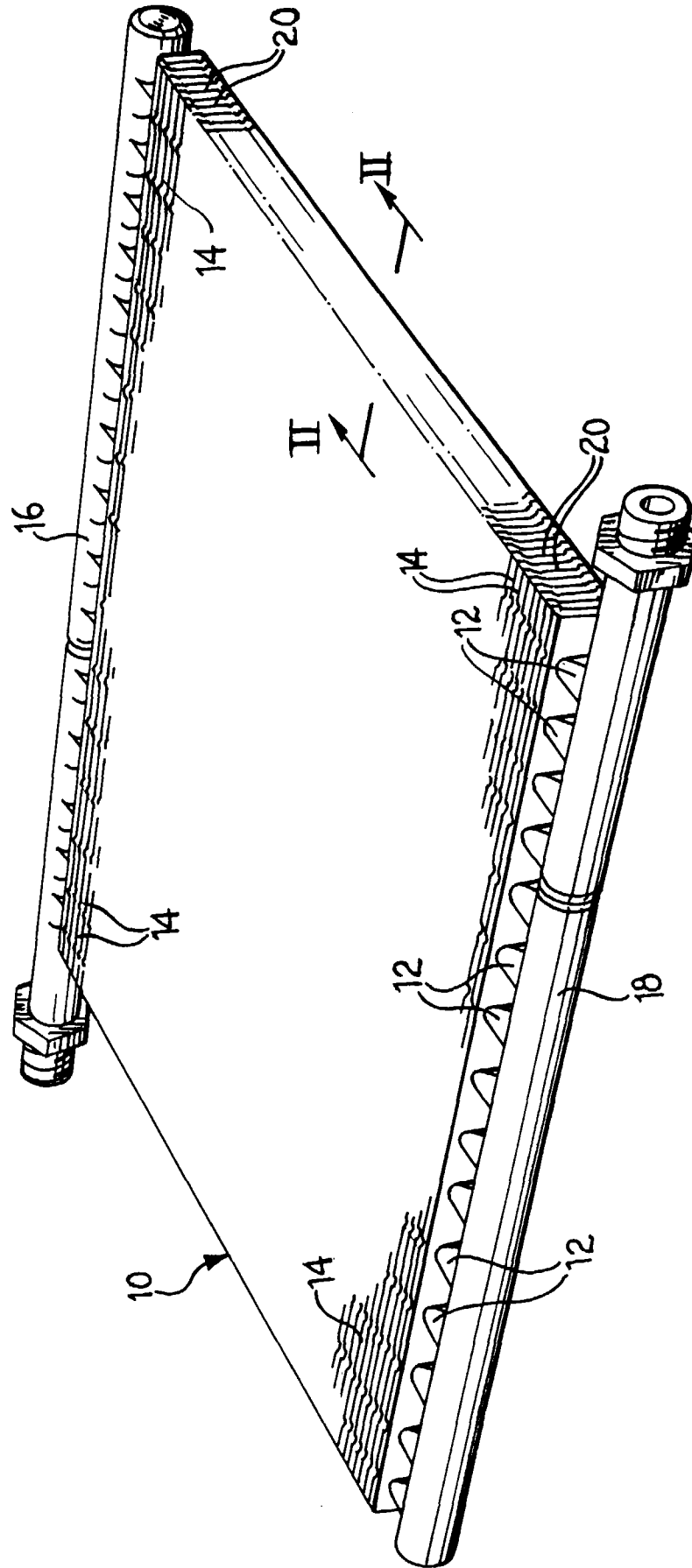
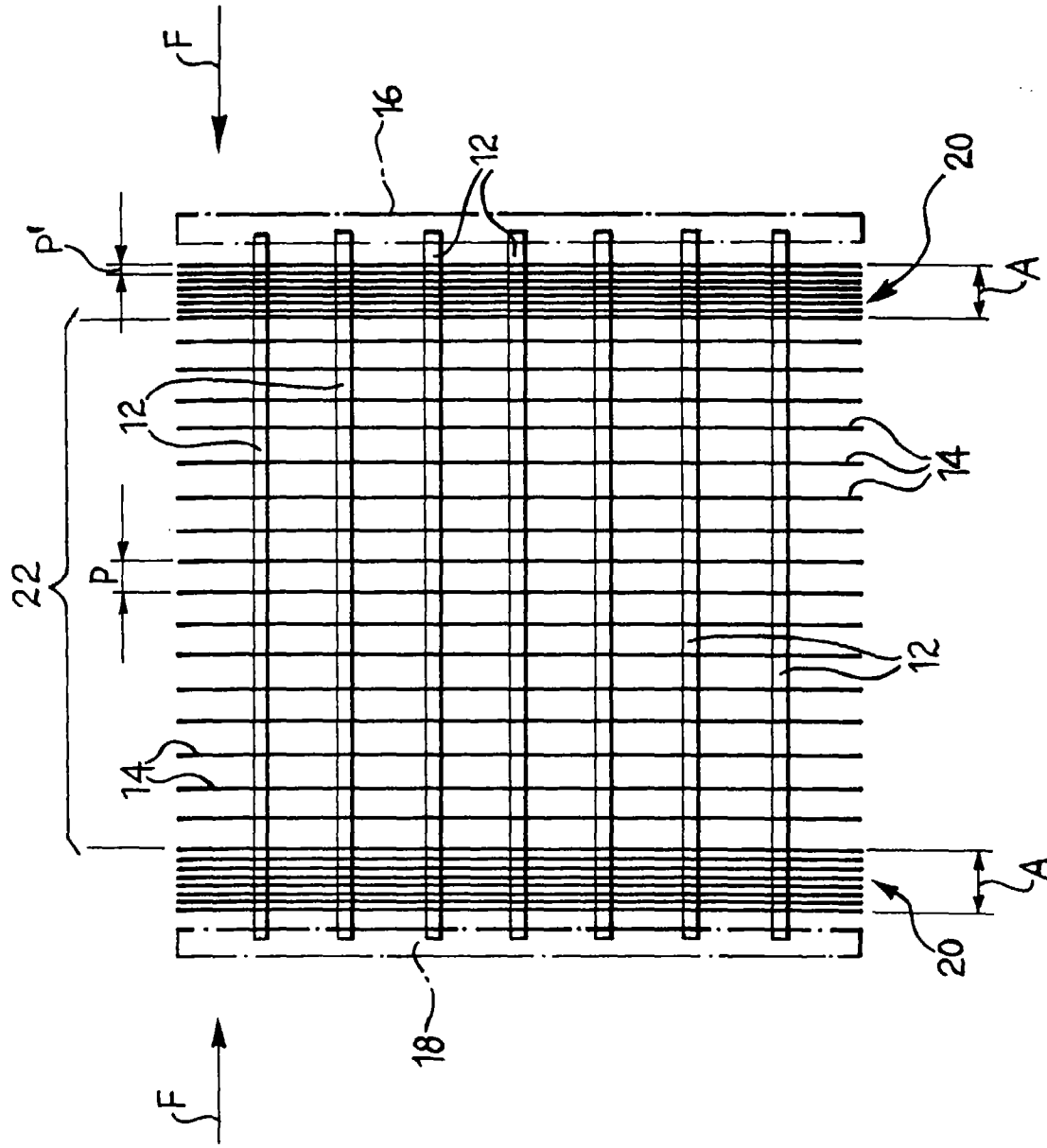


FIG. 2



EUROPEAN SEARCH REPORT

Application Number
EP 97 10 2564

DOCUMENTS CONSIDERED TO BE RELEVANT					
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)		
X	PATENT ABSTRACTS OF JAPAN vol. 011, no. 082 (M-571), 12 March 1987 & JP 61 237996 A (TOYO RADIATOR KK), 23 October 1986, * abstract * -----	1	F28F1/32 F28D1/053		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)		
			F28F F28D B60H F25B		
The present search report has been drawn up for all claims					
Place of search THE HAGUE		Date of completion of the search 15 May 1997	Examiner Zaegel, B		
CATEGORY OF CITED DOCUMENTS			T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document		
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document					