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

(11) Publication number : **0 682 224 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **95302746.3**

(51) Int. Cl.^{6} : **F28F 21/08**

(22) Date of filing : **24.04.95**

(30) Priority : **12.05.94 JP 123123/94**

(43) Date of publication of application :
15.11.95 Bulletin 95/46

(84) Designated Contracting States :
DE FR GB

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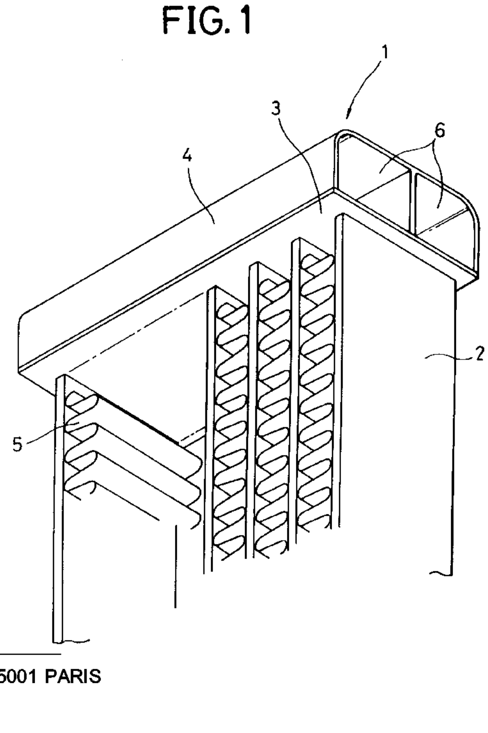
(54) Heat exchanger.

(57) In order to form various parts with brazing sheets covered with filler material in such a manner that the brazing sheets are optimal for individual parts with differing heat capacities, an aluminum brazing sheet for forming a part with a large plate thickness and a relatively large heat capacity, has a larger ratio of Si content in the filler material so that the flow of the filler material that becomes melted during brazing is improved, while an aluminum brazing sheet for forming a part with a small plate thickness and a relatively small heat capacity has a reduced ratio of Si content in the filler material so that the liquidus curve temperature of the filler material is raised and, at the same time, the flow of the filler material is inhibited.

FIG. 1



EP 0 682 224 A1

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The present invention relates to a heat exchanger formed by assembling and then brazing various parts formed with aluminum brazing sheets covered with a filler material.

Aluminum brazing sheets for forming various parts constituting a heat exchanger in the prior art, such as tank plates, end plates, tubes and fins, are formed by covering one surface or both surfaces of the core material constituted of an aluminum alloy with a filler material which contains Si (silicone) Mg (magnesium) and when necessary, Bi (bismuth) and the remaining portion constituted of Al (aluminum). In particular, with the aluminum brazing sheet disclosed in Japanese Unexamined Patent Publication No. H5-26589, in order to achieve satisfactory fillet formations at bonding portions both on the external surface side and internal surface side, the Si content in the filler material on one surface is greater than that on the other surface by at least 0.8%.

However, aluminum brazing type heat exchangers are becoming lighter, and the weight is reduced by making the walls out of thinner material. At bonding portions where parts with greatly different heat capacities are bonded, for instance, the area where a tube and an end plate are bonded, the heat load on a thin-walled part with a small heat capacity becomes locally great during brazing. As a result, the Si of the filler material covering the brazing sheet tends to become dispersed over the core material to allow corrosion, which leaves a hole in the parts material.

Moreover, if the brazing temperature is set low in order to prevent the problem described above from occurring, the filler material covering the brazing sheet does not become fully melted at the bonding portions where parts with largely differing heat capacities are bonded. This tends to cause defective brazing.

Accordingly, an object of the present invention is to provide a heat exchanger whose various parts are formed with brazing sheets covered with filler materials suited for parts with varying heat capacities.

In order to achieve the object described above, the present invention is a heat exchanger formed by assembling and then brazing a plurality of parts that are formed with aluminum brazing sheets, each of which, in turn, is formed by covering a core material constituted of an aluminum alloy with a filler material, in which the ratio of Si (silicone) contained in the filler material to cover the aluminum brazing sheet for forming different parts varies, being increased if the part has a relatively large heat capacity and decreased if the part has a relatively small heat capacity.

As a result, on an aluminum brazing sheet which forms a part with a relatively large heat capacity, the flow of the filler material is improved by increasing the ratio of Si contained in the filler material, while on an aluminum brazing sheet which forms a part with a relatively small heat capacity, the liquidus curve temperature of the filler material is increased and, at the same time, the flow of the filler material is inhibited, by reducing the ratio of Si contained in the filler material.

The present invention is also a heat exchanger formed by assembling and then brazing a plurality of parts that are formed with aluminum brazing sheets, each of which, in turn, is formed by covering a core material constituted of an aluminum alloy with a filler material, in which the ratio of Si (silicone) contained in the filler material to cover the aluminum brazing sheet for forming each part varies, being made greater for a part has a relatively large plate thickness and lesser for a part that has a relatively small plate thickness.

As a result, since the heat capacity of a part with a thick wall is relatively large, and since the heat capacity of a part with a thin wall is relatively small, on an aluminum brazing sheet which forms a part with a thick wall, the flow of the filler material is improved by increasing the ratio of Si contained in the filler material, while on an aluminum brazing sheet which forms a part with a thin wall, the liquidus curve temperature of the filler material is increased and, at the same time, the flow of the filler material is inhibited by reducing the ratio of Si contained in the filler material.

Furthermore, the present invention is also a heat exchanger in which, at least, parts constituting tank portions and tube portions are separately formed with aluminum brazing sheets, each of which, in turn, is formed by a core material constituted of an aluminum alloy covered with a filler material in which the Si (silicone) content in the filler material of the aluminum brazing sheets forming the tank portions is greater than the Si (silicone) content in the filler material of the aluminum brazing sheets forming the tube portions.

As explained above, each tank portion is formed with an aluminum brazing sheet with a large plate thickness and each tube portion is formed with an aluminum brazing sheet with a small plate thickness. Moreover, the tube is in direct contact with a fillet with a large heat transfer area for promoting heat exchange and since this has the effect of promoting heat transfer between the furnace atmosphere and the tube during furnace brazing, the difference in the heat load between the tank and the tube becomes even more pronounced. Consequently, on an aluminum brazing sheet which forms a tank portion, the flow of the filler material is improved by increasing the ratio of Si contained in the filler material, while on an aluminum brazing sheet which forms a tube, the liquidus curve temperature of the filler material is increased and, at the same time, the flow is inhibited, by reducing the ratio of Si contained in the filler material.

Figure 1 is an enlarged partial perspective of an example of the heat exchanger according to the present invention.

The following is an explanation of an embodiment of the present invention. A so-called aluminum brazing type heat exchanger 1 as shown in Figure 1 is constituted of a plurality of tubes 2, end plates 3 to which the tubes 2 are bonded, tank plates 4 which are bonded to the end plates 3 to form separate tanks 6, and fins 5 that are provided between the tubes 2. Note that while the end plates 3 and the tank plates 4 are formed separately in this embodiment, the end plates 3 and the tank plates 4 may be formed as a unit to constitute the tank portions.

In this heat exchanger 1, a tube 2 is formed with a thin aluminum brazing sheet (with, for instance, a plate thickness of 0.3 ~ 0.5mm). In comparison the thickness of the end plates 3, in order to provide greater strength, is greater than that of the tubes 2. The end plates 3 are structured to support the tubes 2 and the fins 5, and the end plates 3 have a plate thickness of, for instance, 0.8~1.2mm. Also, the aluminum brazing sheet mentioned earlier comprises a core material constituted of an aluminum alloy and a clad layer formed of a filler material constituted by mixing, at least, Si (silicone), Mg (magnesium) or the like with aluminum at a specific ratio, covering one or both surfaces of the core material.

This heat exchanger 1 is formed by placing a temporary assembly of the tank plates 4, the end plates 3, the tubes 2 and the fins 5 in a furnace, increasing the temperature to a specific level to melt the filler material (clad layer) covering the surfaces of the core material of the aluminum brazing sheets and thereby fixing the bonding portions of the various parts.

At this point, at the bonding portions of the end plate 3 and tubes 2, since the plate thickness of the end plates (0.8 ~ 1.2mm) and the plate thickness of the tubes (0.3 ~ 0.5mm) are different and, consequently, the heat capacities of those parts are also different (a part with a small plate thickness has less heat capacity than a part with a great thickness), the temperature of the tubes 2 with their small plate thickness tends to become higher than the temperature of the end plates 3 during the process in which the temperature rises for brazing, Because of this, if the temperature is set to meet the requirements of the tubes, the increase in the temperature of the end plates is insufficient, and the filler material on the end plates is not fully melted. This presents a problem of defective bonding. Conversely, if the temperature is set to meet the requirements of the end plates, the temperature of the tubes rises too high, which may cause problems such as the tubes themselves melting and the Si of the filler material becoming dispersed over the core material, allowing corrosion to occur, resulting in holes in the tubes.

In order to address the problems discussed above, in the present invention, the clad ratios and the Si contents of the filler material on the tubes 2 with a small plate thickness and a small heat capacity, and on the tank plates 4 and the end plates 3 with a larger plate thickness and greater heat capacity, are set as shown in the table below. For instance, for the combination of an end plate thickness of 0.8~ 1.2mm and a tube plate thickness of 0.3~ 0.5mm, the filler material used for the end plates should be the equivalent of BA4047 (Si content: 11.0~13.0 wt%) or the equivalent of BA4045 (Si content: 9.0~11.0 wt%), and the filler material for the tubes should be the equivalent of BA 4343 (Si content: 6.8 ~8.2 wt%) to set the difference in Si wt% content between the filler material for the end plates and the filler material for the tubes at approximately 2% or more (proven through experiment). Note that the clad ratios refer to the ratios of the thickness of the filler material (clad layer) covering an aluminum brazing sheet to the entire plate thickness of the aluminum brazing sheet.

(Table 1)

	Si content (wt %)	Clad ratio (%)
Part with small heat capacity	6 ~ 8	4 ~ 8
Part with large heat capacity	8 ~ 13	8 ~ 12

As has been explained so far, since a part with a small heat capacity, for example, a tube 2, is formed with an aluminum brazing sheet covered with a filler material that has a relatively low clad ratio and a small Si content, the quantity of filler material that becomes melted is small. Also, since the Si content is low, the filler material does not flow easily, preventing the dispersion of Si and at the same time, increasing the liquidus curve temperature (melting point).

In contrast, a part with great heat capacity such as the end plate 3 or tank plate 4, is formed with an aluminum brazing sheet covered with a filler material that has a relatively large clad ratio and a high Si content and the quantity of filler material that becomes melted is great. Also, since the Si content is high, the filler material flows easily. This makes it possible to assure a sufficient quantity of filler material on the bonding surface.

With this, at a given furnace temperature (brazing temperature), since the flow of the filler material on a part with a small heat capacity, such as a tube 2, i.e., a part with a small plate thickness, can be inhibited and, at the same time, the melting point can be raised, Si is prevented from becoming dispersed over the core material. In contrast, the flow of the filler material on a part with a large heat capacity such as the end plate 3 or the tank plate 4, i.e., a part with a large plate thickness, can be improved and a sufficient quantity of the filler material can be assured. Consequently, a part with a small heat capacity and a part with a large heat capacity, as described earlier, can be bonded with a high degree of efficiency.

As has been explained so far, according to the present invention, by reducing the ratio of Si contained in the filler material covering the aluminum brazing sheet used for forming a part (tube) with a small heat capacity, i.e., a small plate thickness, and increasing the ratio of Si contained in the filler material covering an aluminum brazing sheet used for forming a part (end plate or tank plate) with a large heat capacity, i.e., a large plate thickness, the melting point of the part with the small heat capacity is raised, the flow of the filler material on the part with the small heat capacity is inhibited and, at the same time, the flow of the filler material on the part with the large heat capacity is promoted.

This achieves such advantages as: prevention of corrosion and defective brazing caused by filler running off parts with a small heat capacity, i.e., parts with a small plate thickness; substances with various heat capacities can be brazed at the same time; temperature control for brazing is facilitated; the time required for brazing is reduced; further reduction of the thickness of parts becomes possible and the degree of freedom of design is improved.

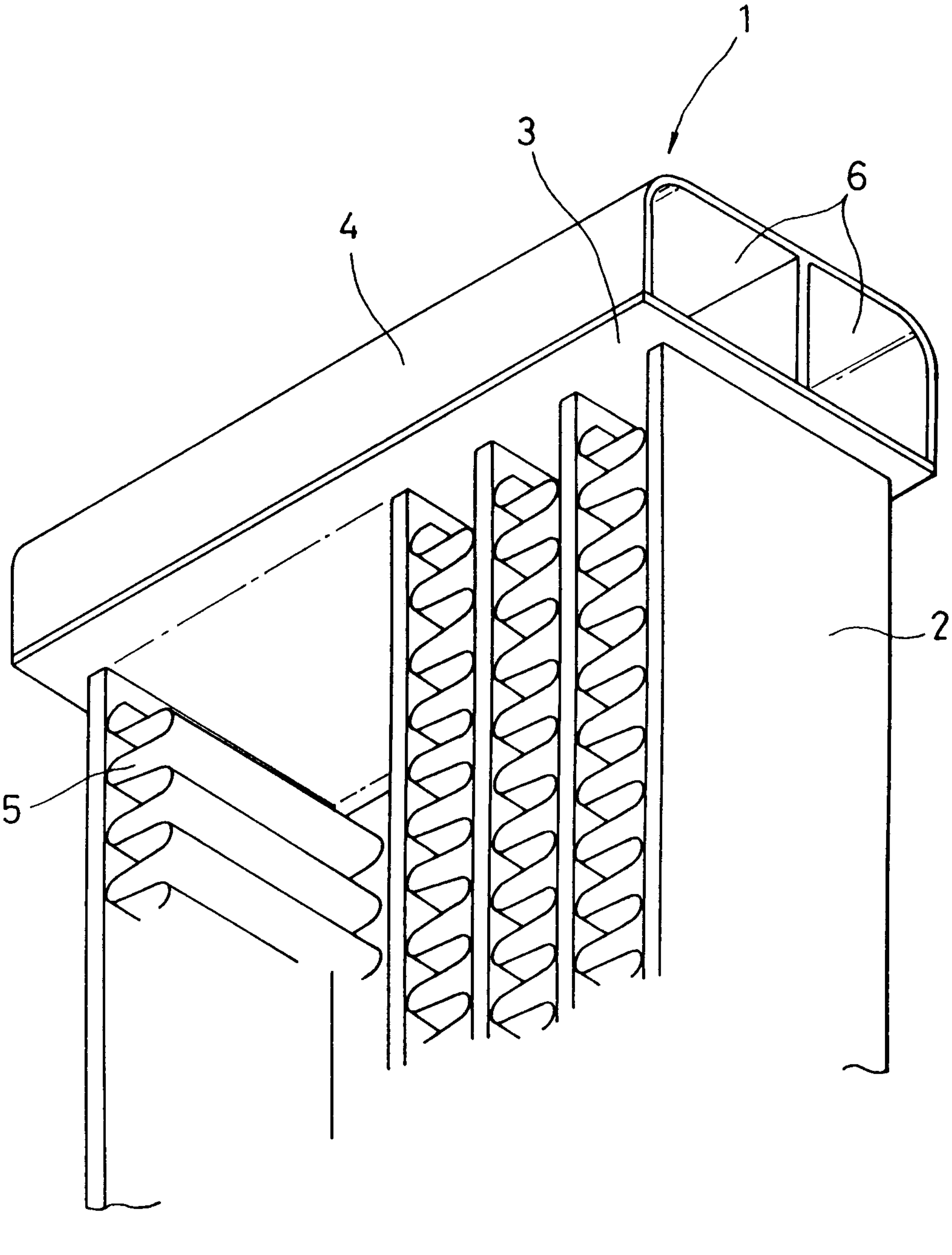
Claims

1. A heat exchanger formed by assembling and then brazing a plurality of parts that are constituted of aluminum brazing sheets, each of which is, in turn, formed by covering a core material constituted of an aluminum alloy with a filler material, wherein;
   the ratio of Si (silicone) contained in said filler material to cover said aluminum brazing sheet for forming each part is increased if said part has a relatively great heat capacity and is decreased if said part has a relatively small heat capacity.

2. A heat exchanger formed by assembling and then brazing a plurality of parts that are constituted of aluminum brazing sheets, each of which is, in turn, formed by covering a core material constituted of an aluminum alloy with a filler material, wherein;
   the ratio of Si (silicone) contained in said filler material to cover said aluminum brazing sheet for forming each part is increased is said part has a relatively thick plate thickness and is decreased if said part has a relatively small thickness.

3. A heat exchanger in which, at least, parts constituting tank portions and tube portions are separately formed of aluminum brazing sheets, each of which, in turn, is formed by covering a core material constituted of an aluminum alloy with a filler material, wherein;
   the Si (silicone) content of said filler material of said aluminum brazing sheets constituting said tanks portion is larger than the Si (silicone) content of said filler material of said aluminum brazing sheets forming said tube portions.

FIG. 1



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 2746

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. 14 no. 361 (M-1006) ,6 August 1990 & JP-A-02 127992 (CALSONIC CORP.) * abstract * -----	1-3	F28F21/08
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 August 1995	De Mas, A

CATEGORY OF CITED DOCUMENTS

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
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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
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