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R. WAGNER

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HEAT EXCHANGE APPARATUS

Filed Feb. 7, 1930

Fig. 1.

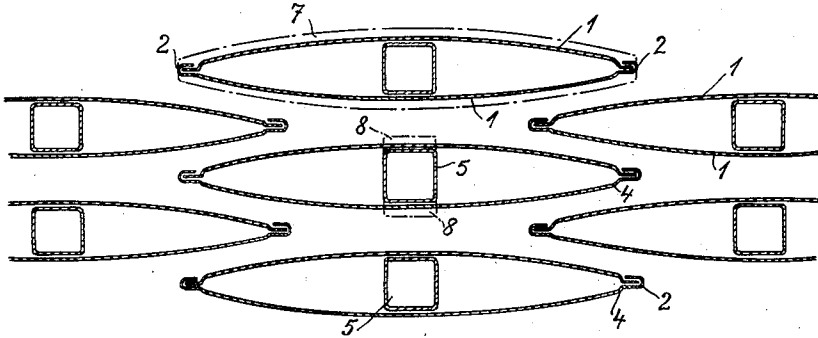


Fig. 2.

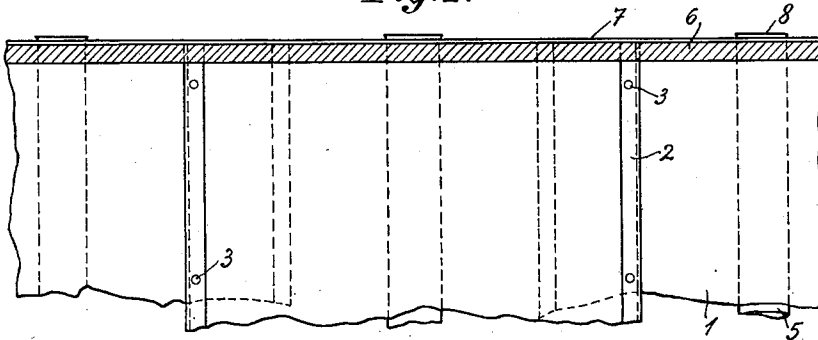


Fig. 3.

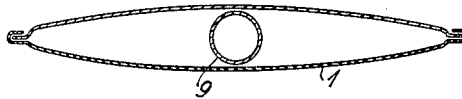


Fig. 4.

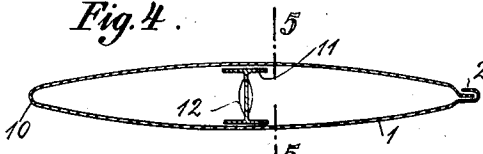


Fig. 6.

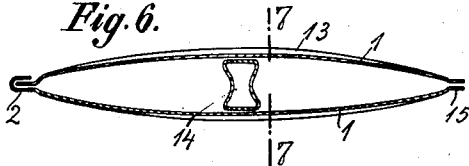


Fig. 5.



Fig. 7.



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HEAT EXCHANGE APPARATUS

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There are already known air heaters for boiler furnaces in which tubes of elongated cross section, as for example, oval, elliptical, or lenticular section, serve as heating elements which are drawn in one piece from wrought iron or are cast in cast iron, and in which the air to be preheated passes through the tubes while the hot gases flow transversely across the tubes in the direction of least resistance, that is, in the direction of the major axis of the cross section.

In consequence of the method of production and also having regard to the requirement of durability the walls of such tubes must be of not inconsiderable thickness, i. e., several millimetres, so that air heaters constituted therefrom are very heavy. Particularly for non-stationary power installations, as, for example, in locomotives or ships and the like, such air heaters represent an undesired deadweight such as is not acceptable for light steam installations as, for example, for aircraft.

On the other hand, for a high boiler efficiency it is necessary to have a maximum heating surface of the air heater in order to cool the waste gases as far as possible below the dew point of the water vapour present in these gases. With the use of the present iron air heaters there is the risk of rapid rusting of the colder parts of the heating surface by the water vapour and the sulphurous acid contained in the waste gases of every furnace.

For this reason, in present furnace installations the cooling of the gases is as a rule not brought below about 150° C. on the average, so that a considerable quantity of heat is lost.

These drawbacks are obviated by the present invention by reason that the lenticular, elliptical or oval tubular elements are not drawn or cast but are produced from sheet metal strips, the edges of which are connected in suitable manner as by interfolding, welding, brazing or the like to form a closed duct, and in which, for the purpose of avoiding caving in of the tubes and of obtaining lateral stiffness, the walls are held apart by means of a distance piece extending longi-

tudinally through the element at about the middle of the cross-section. With this construction there is the possibility of using very thin sheets of less than 1 millimetre in thickness so that with reduced weight larger heating surfaces can be used for the purpose of extracting the maximum quantity of heat from the waste gases. As a much smaller quantity of material is required, the sheet metal strips may be of non-oxidizable and heat-resisting material, which may even be expensive, such, for example, as Monel metal, non-oxidizable steel, nickel or nickel alloy without involving excessive cost. The use of the said materials offers the advantage that the sheet metal strips produced therefrom may be very smooth, and, partly for this reason and partly due to the nickel content as contrasted with iron air heaters heretofore used, have but slight tendency to deposit of soot.

Consequently the gas and air speeds can be increased with the same pressure drop. There are thus obtained increased transfer of heat and preheating of the air without necessity for a frequent use of the soot blower. Due to this increased transfer of heat per unit of surface it is possible either to reduce the heating surface as compared with previous constructions of air heaters so that the cost of forming the tubular elements is less notwithstanding the use of an expensive material, or with the employment of an equally large or larger heating surface than in previous constructions, to obtain a very high boiler efficiency which was not heretofore obtainable. The resultant economy of fuel thus compensates in a short time for any initial difference in price due to employment of expensive material.

The great saving in weight with this system of construction rendered possible by the use of very thin sheets, as for example sheets of Monel metal of about 0.2 millimetres in thickness and less, also renders possible in the lightest power installations, as for example, in aircraft the use of a relatively large heating surface whereby there is obtained a high boiler efficiency.

Figs. 1 to 7 of the accompanying drawing

illustrate several embodiments of the invention.

Fig. 1 is a cross-section and Fig. 2 a side elevation of an arrangement of several tubular elements of lenticular cross-section in approximately natural size, the said elements each being produced from two sheet metal strips and there being employed as a distance piece a tube of square cross-section.

Fig. 3 shows in cross section a two-part tubular element with an inserted round tube serving as a distance piece.

Fig. 4 shows in transverse section a tubular element formed of a single strip of sheet metal bent to elongated cross section, the distance piece being constituted by a bar of I-section.

Fig. 5 is a section on the line 5-5 of Fig. 4 showing the distance piece in side elevation.

Fig. 6 is a cross section and Fig. 7 a section on the line 7-7 of Fig. 6 of a two-part tubular element the walls of which are slightly corrugated for the purpose of obtaining increased stiffness with the use of very thin sheet metal and for increasing the turbulence of the air flowing through the element. In this embodiment the distance piece is constituted by a tube bent to approximately I-section.

Referring to Figs. 1 and 2, 1 denotes the walls of the tubular element which is produced from two thin sheet metal strips connected by interfolding the edges 2. The interfolded edges are secured together by spot-weldings 3. To obtain greater lateral stiffness at the edges and to avoid having the pointed ends of the lenticular cross section being too sharp, the sheet metal strips are cranked slightly at 4 adjacent to the fold. The distance pieces are constituted by tubes 5 of square cross section extending through the elements midway of the cross section of said elements.

These distance pieces serve to shape the tubular elements and to increase their lateral stiffness in that by insertion of the distance pieces the walls of the elements are buckled outwards, for example, to form a figure of lenticular cross section, so that the sheets 1 do not require to be shaped before interfolding. Besides serving to shape the elements, the distance tubes also increase the heating surfaces for exchanging heat to the air.

The tubes 5 may be for example of thin brass as they do not come in contact with furnace gases, while the sheet metal strips 1 may be either of non-oxidizable and heat-resisting material as, for example, Monel metal, nickel or the like, or may be of sheet iron which at least on the side exposed to the hot gases is given a surface coating to protect the same against oxidation, e. g., may be plated with chromium or copper.

The tubular elements 1 are mounted in usual manner in tube plates 6, and may be

flanged at their ends 7 to prevent the tubes from falling out and to obtain a tight fit. In like manner the distance tubes 5 may be flanged or expanded at their ends as at 8.

The construction of the tubular element illustrated in Fig. 3 may be effected similarly to that of the examples shown in Figs. 1 and 2 but in the Fig. 3 construction the distance tube 9 is of round section instead of square section.

In the example according to Figs. 4 and 5 there is employed a continuous sheet metal strip 1 constituting both walls of the tubular element, said strip being bent over at 10 so that one of the interfolds provided in the construction according to Figs. 1 and 2 is avoided. As a distance piece there is provided in this example a bar 11 of I-section the web of which is indented or perforated at 12 so as to give a greater capacity for linear expansion relatively to the hotter flanges of the bar and thus prevent distortion. Otherwise the bar might tend to be twisted.

In the example according to Figs. 6 and 7 the walls 1 of the tubular element are slightly corrugated as at 13 so as to give the section greater stiffness in countering the pressure differences internally and externally of the element than with the use of quite smooth metal strips. In cases where it is extremely important to economize weight, therefore sheets of minimum thickness may be used, In this embodiment the distance piece employed is constituted by a tube 4 of approximately I-section.

Besides the examples above described and illustrated, the invention may be carried out in numerous other ways, employing different forms of tubular elements or distance pieces, or different means of interconnecting the edges without departure from the scope of the invention.

For example, instead of interfolding the edges the latter may be slightly cranked and connected simply by line-welding or brazing or the like as indicated at 15 in Fig. 6. Also the edges of the sheet metal strips may be connected by a row of small rivets.

Furthermore the principles of construction and features described above may be used in connection with heat exchange apparatus other than air heaters e. g. for the cooling elements of air cooled steam condensers or coolers for steam driven vehicles such as aircraft as the weight of the condenser or cooler must be reduced as much as possible particularly in devices of that kind.

I claim:—

1. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements consisting of strips of relatively very thin sheet metal connected along their edges, the side walls of said elements being separated by

distance pieces extending longitudinally of said elements at about the middle of the cross-section of the elements.

2. Heat exchange apparatus particularly for use as air heater for furnaces, comprising heat exchanging elements having elongated cross-section, said elements consisting of strips of sheet metal, distance pieces extending longitudinally within said elements for separating the side walls of them, said distance pieces having tubular cross-section of suitable form.

3. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section said tubular elements consisting of strips of sheet metal, distance pieces extending longitudinally within said elements for separating side walls and consisting of bars of I-section.

4. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements consisting of strips of sheet metal connected along their edges and having side walls separated by distance pieces extending longitudinally of said elements at about the middle of the cross-section, said sheet metal strips being interfolded at their edges, said edges being secured to each other.

5. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements consisting of strips of sheet metal connected along their edges and having side walls separated by distance pieces extending longitudinally of said elements at about the middle of the cross-section, said sheet metal strips being united at their edges.

6. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements consisting of strips of sheet metal connected along their edges and having side walls separated by distance pieces extending longitudinally of said elements at about the middle of the cross-section, said sheet metal strips being slightly corrugated for the purpose of obtaining transverse stiffening.

7. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements each consisting of a single strip folded to form a figure of elongated cross-section, the contacting edges of said strip being united by suitable means, and distance pieces extending longitudinally of said elements at about the middle of the cross-section.

8. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongat-

ed cross-section, said tubular elements comprising strips of sheet metal connected along their edges, distance pieces loosely located within said elements and adapted to bring the side walls of said elements into their final shape and to hold them in that shape apart from each other under pressure.

9. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements comprising strips of sheet metal, distance pieces loosely arranged and extending longitudinally within said elements for holding the side walls apart under pressure and consisting of members of substantially I-section.

10. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements each comprising a single strip folded to form a figure of elongated cross-section, the contacting edges of said strip being united by suitable means, and distance pieces located within said elements.

11. Heat exchange apparatus particularly for use as air heater for furnaces, comprising tubular heat exchanging elements of elongated cross-section, said tubular elements comprising strips of sheet metal, distance pieces extending longitudinally within said elements for separating the side walls and consisting of bars of I-section, and indentations provided in the web of said bars.

In testimony whereof I have signed my name to this specification.

RUDOLF WAGNER.