Oct. 18, 1949. H. B. ELLIS 2,485,088

HEAT EXCHANGER REINFORCING MEANS

Filed Feb. 5, 1945 2 Sheets-Sheet 1

Fig. 2

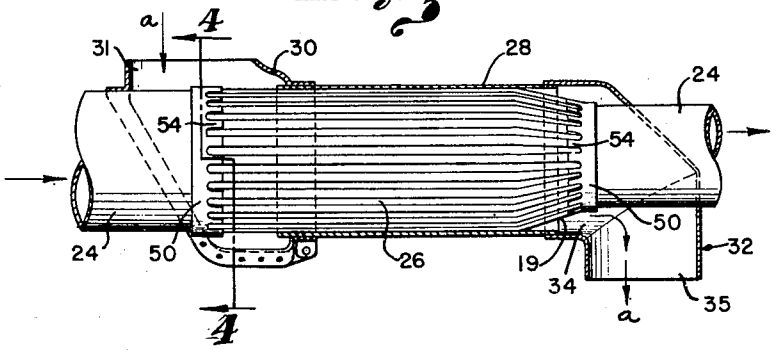


Fig. 3

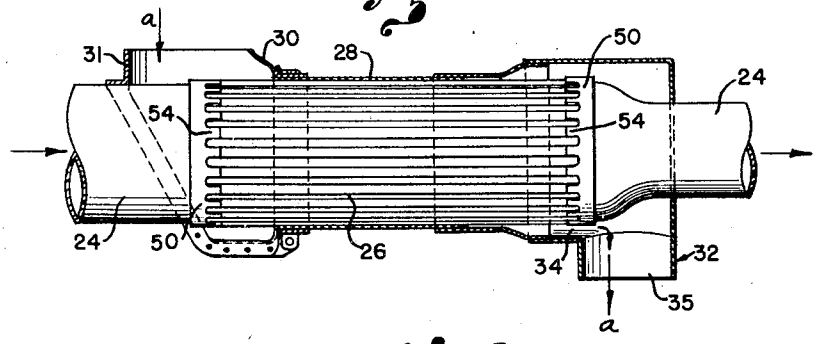
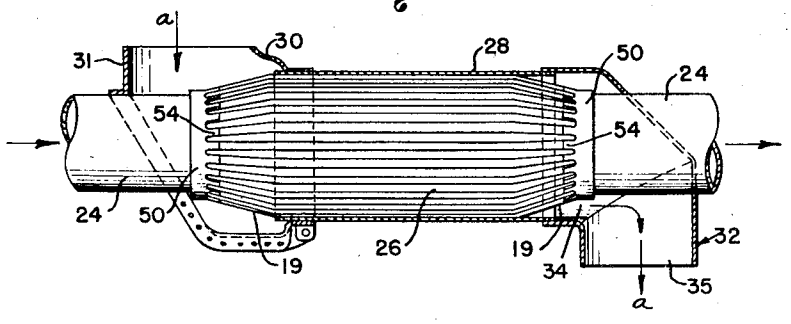


Fig. 1



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Filed Feb. 5, 1945 2 Sheets-Sheet 2

Fig. 5

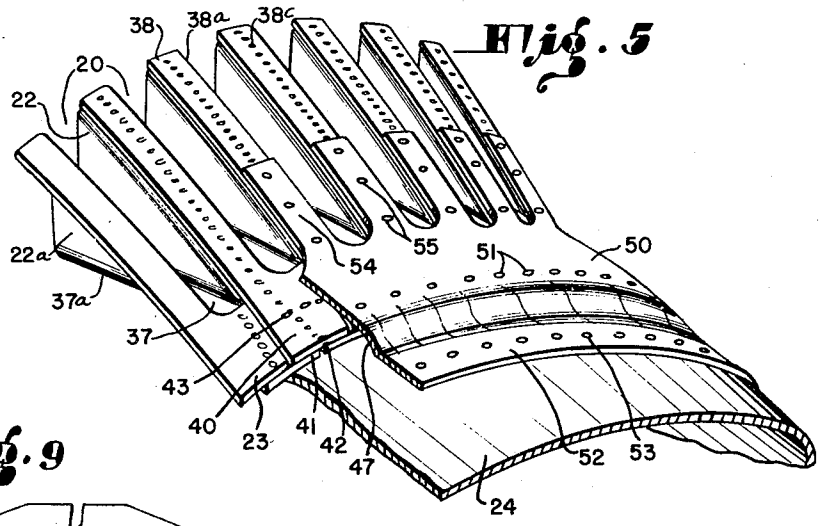


Fig. 9

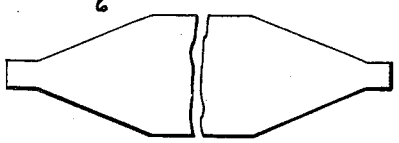


Fig. 6

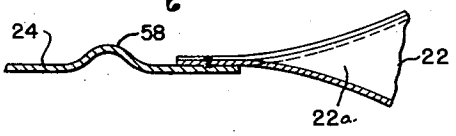


Fig. 4

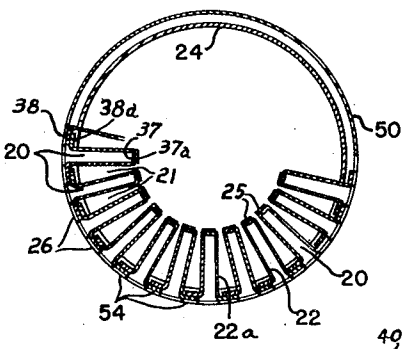


Fig. 7



Fig. 10

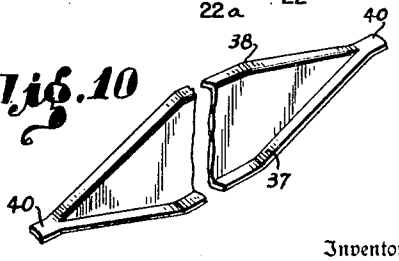


Fig. 8



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HEAT EXCHANGER REINFORCING MEANS

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3 Claims. (Cl. 257—246)

1

This invention relates in general to improvements in heat exchangers or, generally, to apparatus for transferring heat from one fluid to another, and finds its most specific utility in connection with internal combustion engines of the type and character employed in aircraft.

The invention particularly relates to a type of heat exchanger which has an inner sleeve providing a circularly arranged series of longitudinally extending flutes forming longitudinal passageways interiorly for the hot gases of combustion, and passageways exteriorly for atmospheric air, or other fluid to be heated.

Critical stresses are set up, when such a heat exchanger is operating, by reason of the great differences in temperatures of the hot gas and the atmospheric air to be heated on opposite sides of the core or sleeve, and structural failures are quite likely to occur if the stresses developed in the metal rise in excess of the safe values for the metal in question or in excess of the holding ability of the welds which are used to secure the different parts together. Vibration stresses also occur in considerable magnitude and are apt to produce independent structural failures.

Again, inasmuch as the heat exchangers of the character referred to have widespread use in aircraft, the size and weight thereof are critical and must be kept to a minimum. Therefore, the problem of producing an efficient, yet small and light, heat exchanger which will also withstand the abnormal stresses referred to without unreasonable bulkiness or weight is a matter difficult to satisfactorily conclude.

To augment the resistance to abnormal pressures in the heat exchanger structure without materially increasing its size or weight, it is an object of the present invention to provide novel means for suitably reinforcing the annular ends of the flute plates where they encircle the stack, these means including spaced flexible fingers welded to the adjacent hills or ridges of the flutes to add material to the structure to thereby withstand these abnormal stresses created in the exchanger structure.

Another object of the present invention is to provide novel means for reinforcing the flutes of a fluted heat exchanger core or sleeve in a manner to prevent, or greatly minimize, damage resulting from abnormal stresses set up by temperature differences on opposite sides of the flute plates, and by vibrations, for the purpose of lengthening the life of the exchanger.

Another object of the present invention is to provide novel means for reinforcing the ends of

2

a double tapered fluted heat exchanger core or sleeve by providing at least one tension ring or band having a portion of its width encircling the arcuate, overlapped ends of the flutes and secured by welding to the sub-adjacent arcuate portions of the flute ends for maintaining the flutes in desired spaced relation and spaced apart relatively, at least one such ring being disposed adjacent the portion of the core where the taper joins the exhaust stack or end member. Such a ring may also be utilized in heat exchangers of the present fluted type but having the core tapered at only one end, the other end being straight and untapered. The ring may also be employed in heat exchangers having neither end of the core tapered.

Another object of the present invention is to provide novel means for reinforcing the ends of a fluted heat exchanger core or sleeve by arranging the arcuate ends of adjacent plates in overlapping relation to form an annular wall to receive one end of a stack and securing both together by intermittently spot welding circumferentially and providing a ring which encircles adjacent portions of both, the ring being secured to both by separate rows of intermittent spot welding circumferentially and the ring having circumferentially spaced integral flexible fingers adapted for engagement with the adjacent ends of the fluted plate hills or ridges and intermittently spot welded thereto.

Another object of the present invention is to provide a simple means for use in a heat exchanger by which severe or abnormal stresses within the heat exchanger may be reduced to a minimum and stress in the structure prevented.

Another object of the present invention is to provide a device by which deformation or deflection of the flute or flute plates, due to heat, may take place in the heat exchanger ensemble without causing excessive or undue stresses to occur, and by which rupture of the plates or other elements composing the heat exchanger may be effectively prevented.

Another object of the present invention is to provide a simple means by which the flutes or the plates composing them may be protected against external rupture and by which the internal and external flexure of the plates may be limited and yieldingly resisted to the end that normal radial deformation or deflection of the plates due to high temperature differentials may occur without inducing damaging stresses.

Another object of the present invention is to provide a heat exchanger which is simple in con-

struction, efficient in operation, and inexpensive to manufacture and assemble.

With the objects above indicated and other objects hereinafter explained in view, my invention consists in the construction and combination of elements hereinafter described and claimed.

Referring to the drawings,

Fig. 1 is an elevational view of a heat exchanger incorporating the invention, showing, in elevation, a core tapered at both ends, portions of the exchanger being in section and portions broken away;

Fig. 2 is a similar view of an exchanger having a core tapered at one end and straight or untapered at the other;

Fig. 3 is a similar view of a heat exchanger having a core tapered at neither end;

Fig. 4 is a section on line 4—4 of Fig. 2;

Fig. 5 is a fragmentary sectional view, in perspective, showing the presently-preferred mode of reinforcing the flutes and further showing the manner in which the core and stack are joined;

Figs. 6, 7 and 8 are transverse sectional views showing several differing ways of reinforcing the stack itself against vibration;

Fig. 9 is a view showing a flat blank plate from which the corrugated plates are made; and

Fig. 10 is a perspective view of a corrugated plate formed from said blank.

A heat exchanger in which my invention may be embodied comprises an inner core or sleeve, tapered at both ends in Fig. 1, at one end only in Fig. 2, and at neither end, in Fig. 3 and providing a series of longitudinal exterior and interior channels or passageways 20 and 21, best seen in Fig. 4, which are radially arranged and which may be formed by respective right and left-hand plates 22 and 22*a*. The plates are formed from a flat metal blank, such as shown in Fig. 9, and have cooperating pairs of flanges 38*a* and 38 respectively along the outer edges thereof in superposed relation and cooperating pairs of flanges 37*a* and 37 respectively, along the inner edges thereof in superposed relation, as best shown in Fig. 10, the cooperating pairs of oppositely extending flanges being connected together by spot welding 38*c*, or other suitable method of joining, to alternately connect the inner and outer edges of the radiating flutes 22 and 22*a* in a manner to form between the plates the alternate inner and outer channels 20 and 21, Figs. 4 and 5. The cooperating pairs of flanges follow the tapering of the flute flanges to their ends. The plates 22 and 22*a* may be tapered as indicated by 19, Figs. 1 and 2, at their respective ends and the ends conjoined, in a manner to be later described, to form circumferentially extending, sectionalized, "stepped," or irregular, rings 23 to which the respective portions 24 of an exhaust stack or pipe may be attached. Gases from the exhaust flue pass through the internal passageways 21 and air or other cooling fluid passes through the external passageways 20 and absorbs the heat conducted through the plates 22 and 22*a* which form the passageways.

It is found that the inner surfaces and particularly the inner edges 25 of the flutes are subject to a much greater temperature than the outer edges 26 thereof which are constantly wiped by a multiplicity of air currents and that this heat differential produces a corresponding differential in the expansion of the inner and outer surfaces. The greater expansion of the inner surfaces or edges tends or causes the flutes to bend or deform

inwardly longitudinally which places the entire structure of the heat exchanger under stress.

To counteract or prevent the development of injurious excessive stresses in the heat exchanger, I provide rings or bands 50, as generally shown in Figs. 1, 2 and 3 which are arranged to have a portion of their width extend around the fluted heater core and are disposed in spaced relation relatively. The bands are arranged to be pressed over the ends of the stacks or reducers and with portions overlying the adjacent end-edges of the flutes. One such band is on or adjacent, the junction of the core portion of the heat exchanger with the reducer or stack portions, at each end of the heat exchanger. Another band may be placed at the central portion if desired, this band being a plain band. The band 50, later particularized, resists pressure produced within the heat exchanger by backfire explosion or other cause, and the tension of the band prevents any rupture or displacement of or other damage to the flutes.

The heat exchanger core is located within a shell or casing 28 through which air to be heated is moved in a selected direction as indicated by the arrows *a*—*a*. This member 28 may consist of any suitable housing or enclosure, but as shown in Figs. 1 and 2 comprises a tubular shroud positioned in encircling spaced relation about the flutes of the core and provides the outer confining wall of the air flow. At one end of the shroud 29, an inlet manifold 30 is provided which has its end formed to tightly fit about the adjacent stack portion 24 and about the core, to which it is removably secured, as by bolts. The manifold 30 has an inlet opening 31 formed in its free end to afford entrance of atmospheric air or other cooling fluid for the purpose described. The opposite end of the shroud is provided with a tubular outlet manifold 32 which has an opening 34 to tightly receive the adjacent end of the core and an outlet opening 35 through which the heated air is discharged. This outlet manifold, likewise, has its intermediate portion formed to tightly fit about the adjacent stack portion 24. It should be understood that while the core enclosure as described is the preferred, other enclosures may be employed where desirable.

Due to the liability of heat exchangers of this type to fail structurally under the abnormal stresses set up by reason of the great temperature differences existing on opposite sides of the fluted core, it is one of the important features of the present invention to provide novel means for strengthening the ends of the flute plate structure without materially adding to the weight of the unit and additionally provide for flexure in a manner which will compensate for abnormal stresses without the injury or damage heretofore encountered.

At the end of the plates, as shown in Fig. 5, the ends of the outer flanges 38*a* are formed with lateral projections 40 disposed in arcs concentric with the axial center line of the core, the projections being of arcuate shape and arranged to form a circular opening. The projections 40 are slightly spaced apart relatively to afford tolerances for ease in manufacturing. At the end of the plates, in a like manner, the stack ends of the inner flanges 37 are formed with lateral projections 41 disposed in arcs concentric with the axial center line of the core, the projections being of arcuate shape and arranged to form a circular opening within the projections 41. The projections 41 are also slightly spaced apart relatively to afford toler-

ances for ease in manufacture and are preferably arranged to be covered by the overlapping projections **40**.

The end of the stack **24** is disposed, as in Fig. 5, within the circular opening formed by the plate projections **41** and securely connected thereto by welding, preferably by intermittent spot welds **42** extending circumferentially; and spaced apart axially, if more than one row is desired. The projections **40** are also securely connected to the encircled projections **41** by welding, preferably by intermittent spot welds **43** extending circumferentially and spaced apart axially if more than one row is desired. This arrangement provides a rigid unitary construction, but one which yields sufficiently to compensate for stresses occurring through expansion and contraction without resulting in permanent injury or damage to the material of the core or stack.

The ring-like members **50** for reinforcing the ends of the fluted plates, are shown in detail in Figs. 4 and 5. In these figures, the reinforcing means comprises a ring shaped member **50** of any desired width, which is mounted on the outer peripheral wall of the projections **40**, preferably one at each end of the junction of the core with either the stack or the reducer. The members **50** are securely connected to the sub-adjacent projections **40** by welding, preferably by intermittent spot welds **51** extending circumferentially; and spaced apart axially, if more than one row is desired. The members **50** in this construction project, as at **52**, beyond the ends of the ring **40** and **41** and are bent downwardly at **47** into engagement with the adjacent wall of the stack **24** to the wall of which member **50** is likewise securely connected by intermittent spot welds **53**. On the opposite side of the members **50**, a plurality of flexible fingers **54** are formed which project longitudinally a certain distance into engagement with the top wall of the sub-adjacent hill or ridge, to which they are securely connected by intermittent spot welds **55**. This construction adds the rigidity and strength necessary, but affords sufficient yieldability to compensate for the stresses occurring through expansion and contraction.

In Figs. 6, 7 and 8, additional reinforcing means are shown wherein the structure may be given additional strength to increase the length of life of the heat exchanger. The stack **24**, adjacent the ends of the flutes, is formed with a circumferential bead **58** which adds materially to the rigidity of the stack and lessens its tendency toward vibration, which is one of the causes of failure. The bead may be single and formed on either the top or bottom face of the stack, as shown in Figs. 6 and 7; or it may be double, the bends being formed on opposite sides, as shown in Fig. 8.

While I have described the presently preferred embodiments of the invention, it is to be understood that I am not to be limited thereto, inasmuch as changes and modifications may be resorted to without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. In a heat exchanger: longitudinally extending flutes arranged radially and circumferentially spaced, the ends of the flutes being provided with projections arranged to form a ring in which the end of a stack is adapted to be connected; a band fitted over said projections; and a plurality of flexible members extending from said band and joined to the crests of the ridges of said flutes at points spaced apart longitudinally of said members, said members being adapted to afford limited yieldability to compensate for stresses occurring as the result of temperature changes of the exchanger.

2. In a heat exchanger: a plurality of alternately arranged right and left-hand plates provided with oppositely turned marginal flanges, the flanges of one plate overlapping the flanges of adjacent plates to form a plurality of circumferentially spaced, longitudinally extending radial flutes, said flutes having end projections arranged to form a ring in which the end of a stack is securely connected; a ring-like member arranged around the projections at the ends of the flutes and securely connected to said projections, said members having flexible fingers projecting therefrom towards the longitudinal center of the exchanger and connected to the adjacent top walls of the ridges of the flutes by intermittent spot welds to afford limited yieldability to compensate for stresses occurring through expansion or contraction of the heat exchanger.

3. In a heat exchanger: a plurality of alternately arranged right and left-hand plates provided with oppositely turned marginal flanges, the flanges of adjacent plates overlapping so that said plates form a plurality of circumferentially spaced, longitudinally extending, radial flutes having end projections arranged to form a ring in which the end of a stack is adapted to be connected; a band fitted over said projections; and a plurality of flexible members extending from said band and joined to the crests of the ridges of said flutes by intermittent spot welds, said members being adapted to afford limited yieldability to compensate for stresses occurring as the result of temperature changes of the exchanger.

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