Dec. 29, 1964 R. CUZZONE ETAL 3,163,208

BRACE FOR FINNED TUBES

Filed Sept. 29, 1961 2 Sheets-Sheet 1

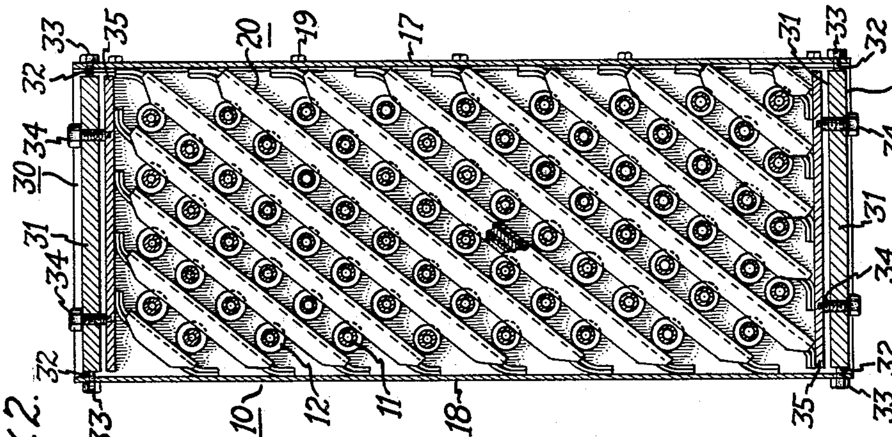

Fig. 2.

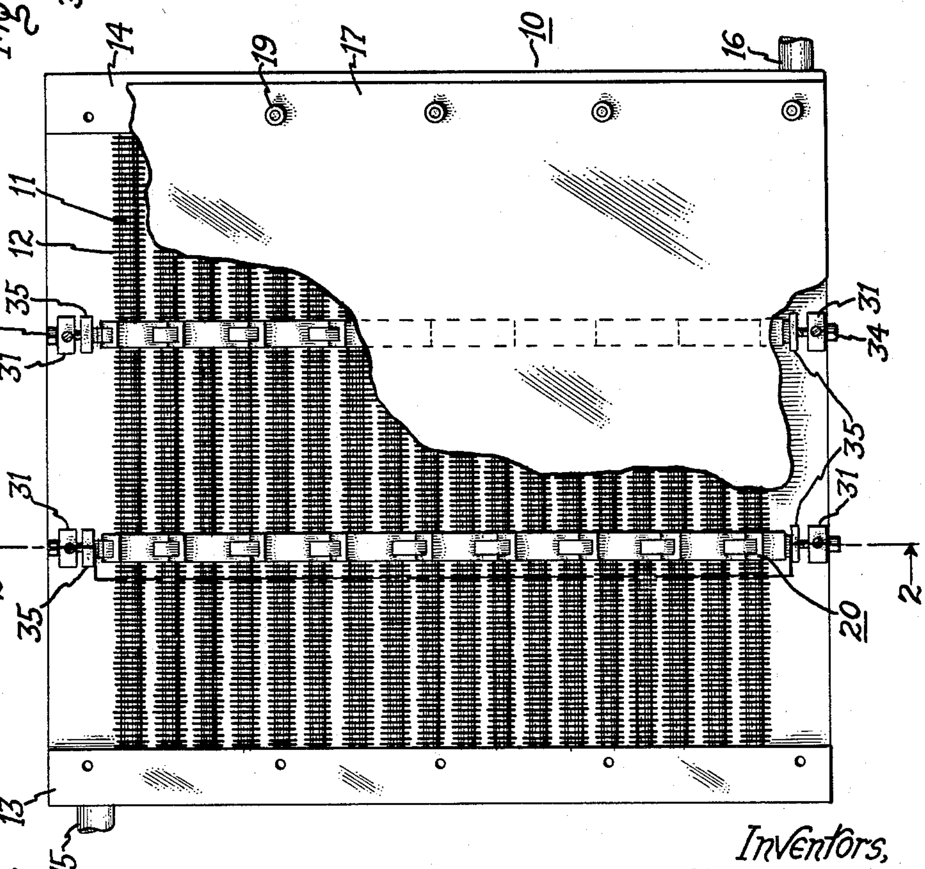

Fig. 1.

Inventors,
Raymond Cuzzone,
John R. Harvey,
by Gilbert P. Tarleton
Their Attorney.

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Filed Sept. 29, 1961 2 Sheets-Sheet 2

Fig. 3.

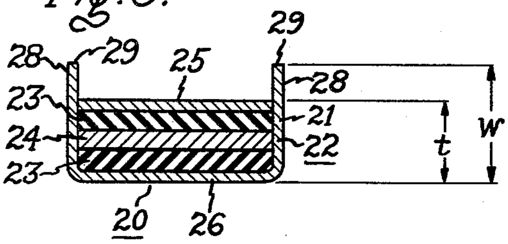


Fig. 4.

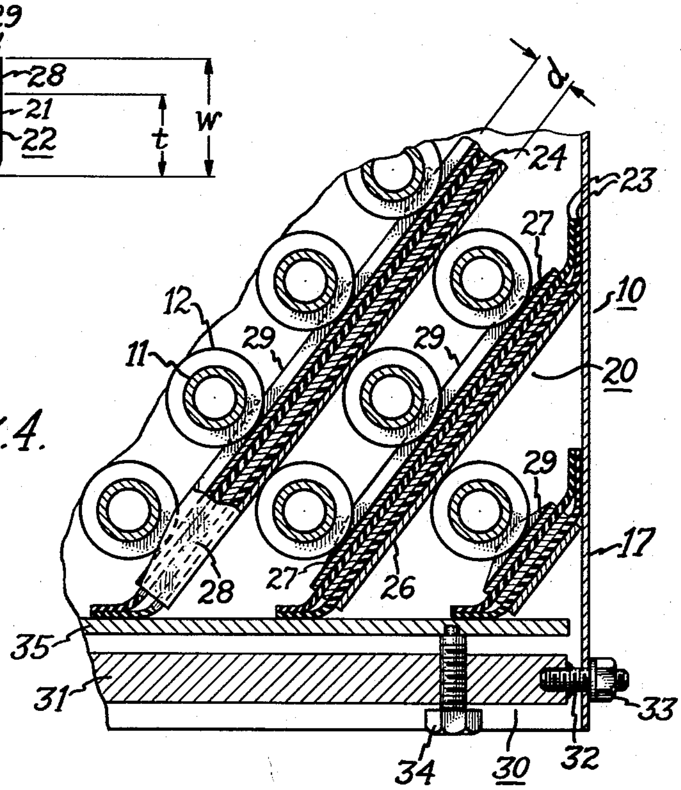


Fig. 5.

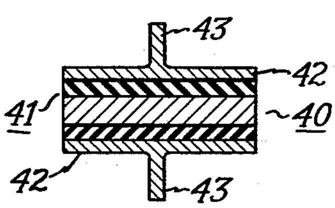
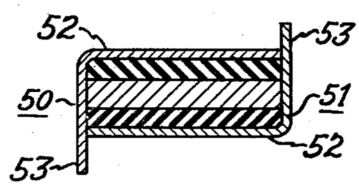


Fig. 6.



Inventors,
Raymond Cuzzone,
John R. Harvey,
by Gilbert P. Tarleton
Their Attorney.

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BRACE FOR FINNED TUBES

Raymond Cuzzone and John R. Harvey, both of Pittsfield, Mass., assignors to General Electric Company, a corporation of New York

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This invention relates to arrangements for inhibiting vibration of finned tubes of the type employed in heat exchangers.

Tubular members having fins extending laterally therefrom are commonly employed in heat exchangers in which a fluid to be cooled passes through the tubular members and dissipates heat to another fluid, such as air passing over the outside of the tubular members. The ends of the tubular members are commonly secured to headers. One problem that frequently occurs with this arrangement is that unexpected vibrations are encountered when the apparatus incorporating the heat exchanger is placed in operation. For example, it has been found that failures occurred in finned tube heat exchangers employed on locomotive transformers when the vibration of the transformer and locomotive were more severe than was anticipated at the time the apparatus was designed. To dampen vibrations, an arrangement was required for bracing the heat exchanger tubes after the apparatus was assembled, without the necessity for removing the tubes from the headers. Although arrangements for bracing finned tubes intermediate their ends were known to the prior art, these arrangements required that the bracing structure be placed between the tubes before they were secured to the headers, or that bulky or expensive clamping arrangements be employed.

Accordingly, it is an object of our invention to provide improved arrangements for bracing finned tubes.

Another object is to provide header-attached finned tubes with braces that can be placed between the tubes without requiring disassembly from the headers.

Another object is to provide a brace arrangement for finned tubes in which the braces are interlocked with the fins to prevent movement of the braces.

Another object is to provide a bracing arrangement for finned tubes in which clamps that act on the tubes are not required.

A further object is to provide bracing assemblies that are economical to manufacture yet rugged enough to withstand continual vibrations during operation of the apparatus.

Other objects and advantages of the invention will become apparent from the drawing, specification, and claims, and the scope of the invention will be pointed out in the claims.

In carrying out our invention in one preferred embodiment, we provide in combination with a plurality of finned tubes arranged in parallel spaced-apart rows, a vibration damping or inhibiting means formed as a straight and substantially inflexible bar having a strip of resilient material sandwiched between hard surfaced protective facing members and interposed in wedging relation between adjacent rows of tubes. The straight and stiff vibration damping bar is wedged tightly between the rows of tubes to compress the resilient strip with the facing members engaging the edges of the tube fins to protect the resilient strip. To prevent lateral displacement of the damping bar, or brace, longitudinally of the tubes at least one facing member is provided with one or more positioning projections disposed to interlock with the tube fins. This resilient bracing assembly, being in the form of a straight bar with the resilient material internally built in, is adapted to be inserted between the rows of tubes after full assembly of the tubes. It requires no holding means

other than the tubes themselves and the side panels of the heat exchanger, i.e. no external clamping means is necessary.

In the drawing:

FIGURE 1 is a schematic, partially cross-sectional, side elevational view of a finned tube heat exchanger in accord with the teachings of our invention.

FIGURE 2 is a cross sectional view taken along the line 2—2 in FIG. 1.

FIGURE 3 is an enlarged cross sectional end view of a brace assembly employed in the embodiment of FIGS. 1 and 2.

FIGURE 4 is an enlarged side view of the lower right hand corner of FIG. 2, with brace assemblies shown in cross section.

FIGURE 5 is an enlarged cross sectional end view of another embodiment of a brace assembly in accord with our teachings.

FIGURE 6 is an enlarged cross sectional end view of still another embodiment of a brace assembly in accord with our teachings.

In FIGS. 1 and 2, a conventional heat exchanger **10** is shown to comprise a plurality of elongated tubes **11** arranged in staggered, parallel rows. The tubes **11** are provided with fins **12** which extend outwardly therefrom generally perpendicularly to the longitudinal axis of the tubes. The tubes **11** may be secured at one end to an inlet header **13** and at the other end to an outlet header **14**. Thus, fluid which is to be cooled by passage through the heat exchanger **10** would flow into the inlet header **13** through suitable conduit means **15**, thence, through the tubes **11** into the outlet header **14**, and then through an outlet conduit **16**. The remaining members of the fluid system are not illustrated or described because they form no part of the present invention. The heat exchanger **10** may be bounded on opposite sides by side panels **17** and **18** for the purpose of protecting the finned tubes, or for baffling the flow of air over the tubes. The panels **17** and **18** may be detachably secured to the headers by bolts **19**.

It sometimes occurs that finned tube heat exchangers are subjected to vibrations more severe than those expected when the heat exchanger was designed and constructed. In such a case, means must be provided for inhibiting the unexpected vibrations of the finned tubes to prevent damage thereto. To accomplish this function, we provide vibration inhibiting brace assemblies **20** that are wedged between the rows of tubes in directions transverse to the longitudinal axis of the tubes. The restraining action of the brace assemblies substantially prevents movement of the tubes at the points of contact and thereby inhibits vibration of the tubes.

As shown more clearly in FIGS. 3 and 4, each brace assembly **20** may comprise a substantially inflexible U-shaped channel member **21**, made of a metal such as aluminum, in which are placed resilient means **22**. The resilient means **22** may be made from a single strip of resilient material, or from strips **23** of resilient material, such as rubber, bonded to a metal carrier strip **24**. Bonding the resilient strips **23** to the strip **24** facilitates handling by stiffening the resulting laminate and by preventing buckling of the resilient strips **23** caused by the friction generated as they rub against the channel member **21**. To protect the face of the upper strip **23** from the cutting action of the fins **12**, a hard surfaced protector member **25**, such as a strip of aluminum, may be provided over one face of the upper strip **23**, it being obvious that the bight portion **26** of the U-shaped channel **21** acts as a metal protector member for the opposite face of the lower resilient strip **23**. As shown in FIG. 4, the ends **27** of the channel **21** may be bevelled in order to facilitate insertion of the brace assemblies **20** between the heat exchanger tubes.

For proper operation of our vibration inhibiting arrangement, the thickness *t* of the resilient means **22** and its protectors should be greater than the distance *d* (see FIG. 4) between the fins on the heat exchanger tubes between which the brace assemblies are wedged; this ensures that the resilient strips **23** will be compressed by the wedging action of the protector members against the fins to thereby inhibit vibrations. The width *w* of the channel sides **28** should be greater than the thickness *t*. This ensures that the ends of the channels will provide projections at **29** that extend out of the plane thereof to overlap the fins on the rows between which the brace assemblies are inserted, thus interlocking the brace assemblies and fins. This prevents the brace assemblies from moving longitudinally of the tubes **11** and prevents them from falling over or being shaken out of position as the apparatus vibrates.

Braces can be inserted between parallel rows of finned tubes in horizontal, vertical, or diagonal directions. Those skilled in the art are aware that the direction chosen in any specific case should provide an optimum distance *d* between the tube fins that is neither too small nor too large for practical applications. Thus the illustration of the brace assemblies **20** extending in diagonal directions is intended to be exemplary, and not limiting on the scope of the invention.

Although the interlocking action between the fins **12** and projections **29** prevents movement of the brace assemblies longitudinally of the tubes **11**, continual vibration of the apparatus could cause the brace assemblies to be jostled out of position transversely of the tubes. To prevent this, abutment means should be provided for engaging the opposite ends of the brace assemblies **20**. As shown in FIG. 2, each brace assembly contacts one of the side panels **17** or **18** at one of its ends, and some of the brace assemblies contact the side panels at both ends. Some of the brace assemblies do not contact both side panels, so adjustable screw-actuated abutment means **30** are provided adjacent the top and bottom of the heat exchanger. Each adjustable abutment means **30** may comprise, for example, a bar **31** attached at either end to the side panels by bolts **32** and nuts **33**. The bars **31** may have a pair of tapped holes therein, and bolts **34** may be threaded through the tapped holes. The ends of the bolts **34** may be journaled rotatably in abutment members **35** that engages the ends of the brace assemblies that do not contact the side panels. Thus, to raise or lower the position of an abutment member **35**, the appropriate bolts **34** are rotated and thus advanced or retracted through a bar **31**. Those skilled in the art will be aware that the adjustable abutment means **30** could be eliminated if both ends of each brace assembly contacted the side panels, as for example if the brace assemblies **20** extended vertically through the heat exchanger illustrated at FIG. 2.

FIG. 5 shows another embodiment of the invention in which a brace assembly **40** has resilient means **41** identical to the means **22** of FIG. 3 sandwiched between inflexible T-shaped aluminum protector members **42**. The legs of the members **42** define projections **43** which extend out of the plane of the protector members to engage the fins **12** on the tubular members **11** in the same way as the projections **29** on the U-shaped channel of the embodiment shown in FIGS. 1–4. This locks the brace assemblies **40** in place in the manner previously described.

FIG. 6 shows still another embodiment of the invention in which a brace assembly **50** has resilient means **51** identical to the means **22** of FIG. 3 sandwiched between inflexible L-shaped aluminum protector members **52**. One leg of each member **52** defines a projection **53** that extends out of the plane of the member for locking with the fins **12** in the same manner as described above for the preceding embodiments.

It is often convenient to glue together the elements forming the brace assemblies **40** or **50** to facilitate handling as a single unit. It also may be desirable to glue together one or more of the elements forming the assembly **20**; however, this is not always necessary because the sides **28** of the channel **21** confine the resilient means **22** and protector member **25**, thus facilitating handling as a single unit. For this reason, the embodiment of FIGS. 1–4 is preferred over the embodiments of FIGS. 5 and 6.

It has thus been shown that by the practice of our invention, novel braces of straight elongate configuration may be inserted intermediate the ends of the finned tubes of a heat exchanger and between adjacent rows of tubes without requiring disassembly of the tubes from their headers. Consequently, when unexpectedly severe vibrations are encountered during operation of apparatus employing a finned tube heat exchanger, our brace assemblies may be employed without unreasonable expense. The braces have as inherent structure thereof, projections which lock the assemblies in place, thus preventing them from displacement lengthwise of the tubes. This is accomplished without external clamping structure to exert positive clamping forces on the tubes. The elimination of the need for clamping structures enables our bracing arrangement to be employed without increasing the space occupied by a heat exchanger. Our arrangement is also economical, since it is made from standard, relatively inexpensive components, and is sufficiently rugged in construction to withstand the forces encountered during continual vibration of the apparatus.

It will be understood, of course, that while the forms of the invention herein shown and described constitute preferred embodiments of the invention, it is not intended herein to illustrate all of the equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limitation, and that various changes may be made without departing from the spirit or scope of the invention herein disclosed, and it is aimed in the appended claims to cover all such changes as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. The combination comprising a plurality of tubes arranged in a plurality of rows, said tubes having fins extending outwardly therefrom, means secured to the ends of said tubes closing off the space therebetween, and a straight and stiff elongate assembly for inhibiting vibration of said tubes comprising a strip of resilient material, hard surfaced members protecting opposite faces of said resilient material from being cut by the fins, and a projection on a hard surfaced member extending out of the plane thereof, said vibration inhibiting assembly being firmly wedged between said rows of said tubes intermediate their ends and extending transversely of the tubes and in engagement with edges of said fins, said resilient material being compressed between said hard surfaced members by their wedging action against the tube fins, and said projection interlocking with a plurality of said fins to prevent movement of said assembly longitudinally of the tubes.

2. A heat exchanger comprising a plurality of parallel tubes arranged in at least two spaced-apart parallel rows, said tubes having fins extending outwardly therefrom and being secured to headers at opposite ends thereof, and a straight substantially inflexible bracing bar interposed in wedging relation between said rows of tubes in edge engagement with said fins, said bar comprising a strip of resilient material sandwiched between straight elongate metal facing members, and a projection on at least one said facing member extending out of the plane thereof, said bar being wedged between said rows of tubes intermediate the ends of said tubes and extending transversely of the

tubes so that said resilient material is compressed between said facing members thereby to inhibit vibration of said tubes, said projection engaging said fins in interlocking relation to prevent displacement of said bracing bar longitudinally of said tubes.

3. The combination recited in claim 2 in which one of said metal facing members is substantially U-shaped, said resilient means and another metal member being confined within the U-shaped member, and said projection being defined by a side of said U-shaped member extending beyond said confined metal member.

4. The combination recited in claim 2 in which at least one of said metal facing members is substantially T-shaped, and said projection is defined by the leg of said T-shaped member.

5. The combination recited in claim 2 in which at least one of said metal facing members is substantially L-shaped, and said projection is defined by the leg of said L-shaped member.

6. The combination comprising a plurality of elongated finned tubes arranged in a plurality of parallel rows, the fins on tubes in adjacent rows being spaced apart a predetermined distance, and a plurality of substantially inflexible straight bars interposed in wedging relation between said rows of tubes for inhibiting vibration thereof, each said bar comprising a strip of resilient material sandwiched between hard surfaced facing members and including a positioning projection on at least one said facing member extending out of the plane thereof, said bars each having a thickness greater than said predetermined distance and being wedged between said tubes transversely thereof so that said resilient material is compressed between said facing members by their wedging action against the tube fins, said positioning projections each interlocking with said tube fins to prevent displacement of said bars longitudinally of said tubes.

7. A heat exchanger comprising in combination, a plurality of parallel tubes arranged in a plurality of spaced-apart parallel rows with the tubes of adjacent rows in staggered relation to form diagonal rows in angular relation with said parallel rows, said tubes having fins extending outwardly therefrom and being secured to headers at opposite ends thereof, outer side panels on said heat exchanger connected to said headers and disposed in parallel relation with said parallel rows of tubes, a plurality of straight, stiff bracing bars interposed between said diagonal rows of tubes in wedging relation, each said bar comprising a strip of resilient material having metal facing members on opposite sides thereof and a positioning projection on at least one such facing member extending out of plane thereof, said bracing bars being wedged between said diagonal rows of tubes transversely of the tubes so that said facing members engage said fins and said resilient material is compressed between said facing

members, said positioning projections engaging a plurality of fins to prevent displacement of said bars longitudinally of the tubes, the ends of said bars extending transversely beyond said diagonal rows of tubes, and means including said side panels for engaging the extending ends of said bars to prevent displacement of said bars transversely of said tubes, said last-mentioned means including an adjustable abutment movable in a direction parallel to said side panels and engaging the extending ends of at least some of said bars.

8. A heat exchanger comprising a plurality of elongated tubes arranged in a plurality of staggered parallel rows, said tubes having fins extending outwardly therefrom, said tubes being secured to headers at opposite ends thereof, side panels on said heat exchanger removably connected to said headers, and straight elongated bracing assemblies for inhibiting vibration of said tubes, each assembly comprising a resilient laminate comprising resilient strips bonded to opposite faces of a metal carrier strip, said resilient laminate being sandwiched between metal facing members protecing the unbonded faces of said resilient strips from being cut by said fins, one metal facing member in each assembly being a stiff bar of substantially U-shaped cross section, the resilient laminate and another metal member in each assembly being confined within the U-shaped member, projections defined by the sides of the U-shaped members extending beyond the confined members, an end of said U-shaped members being bevelled to facilitate insertion between said tubes, said vibration inhibiting assemblies being wedged between said tubes transversely of the tubes so that said resilient laminate is compressed between said metal members by their wedging action against the tube fins, said projections engaging a plurality of fins to prevent movement of said assemblies longitudinally of the tubes, the ends of said assemblies extending transversely beyond said tubes, means preventing movement of said assemblies transversely of said tubes by abutting their ends, the last mentioned means including said side panels contacting at least one end of some assemblies, and a screw-actuated abutment adjustably movable longitudinally of said tubes contacting an end of some of said assemblies.

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CHARLES SUKALO, *Primary Examiner.*

HERBERT L. MARTIN, PERCY L. PATRICK, *Examiners.*