Dec. 19, 1933. M. G. STEELE 1,940,152

RADIATOR

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Fig. 1,

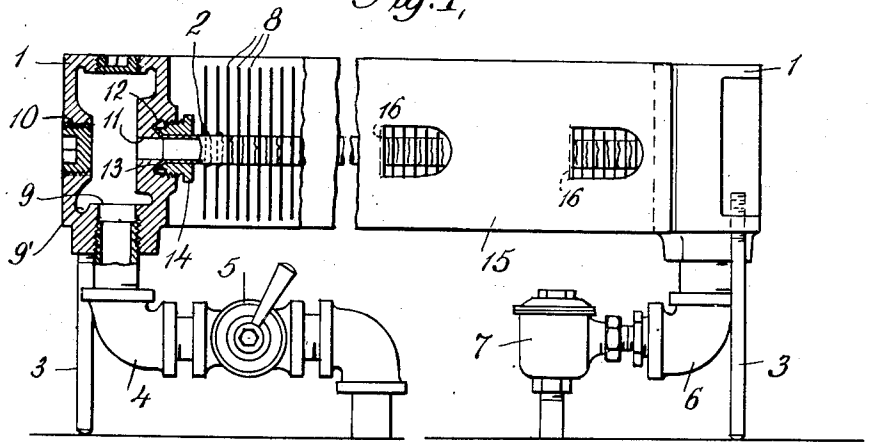


Fig. 2

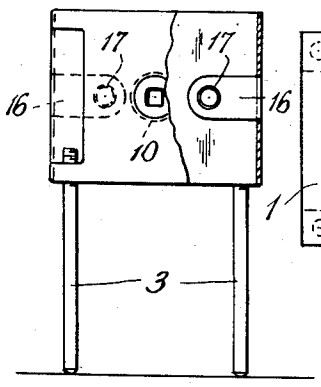


Fig. 3,

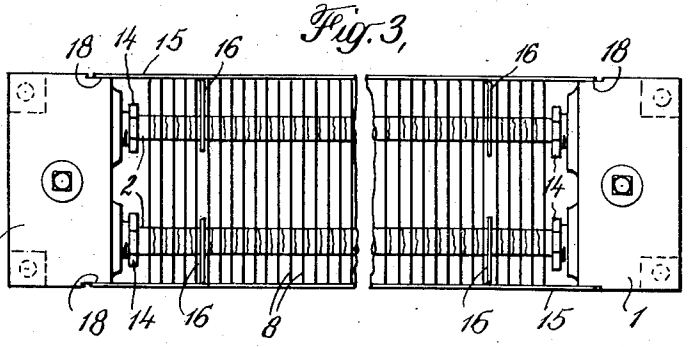


Fig. 4,

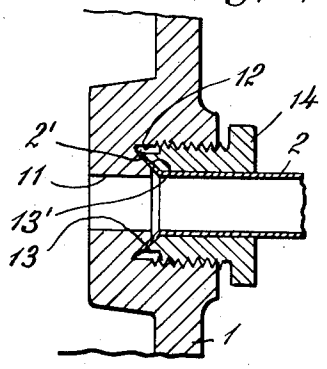


Fig. 5,

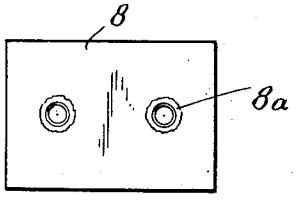


Fig. 6,



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Fig. 7,

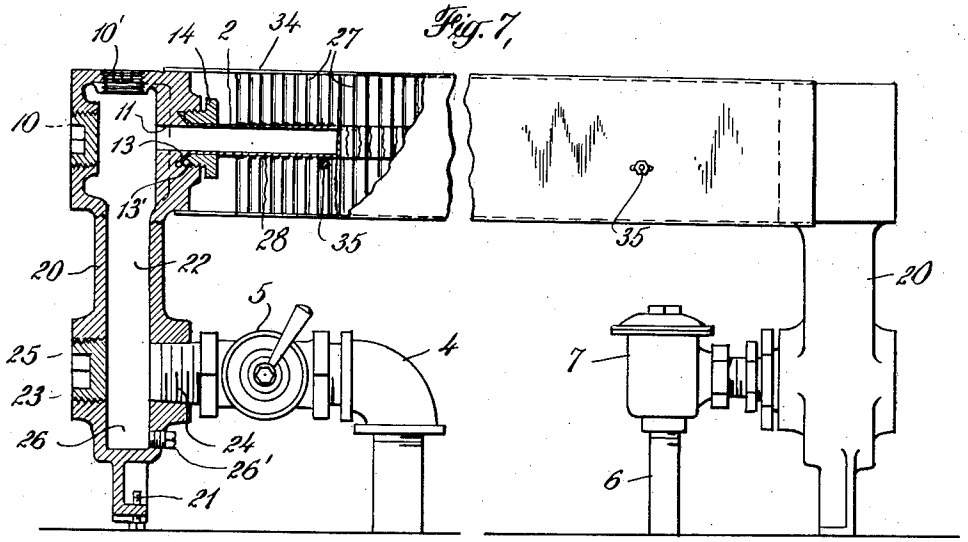


Fig. 8,

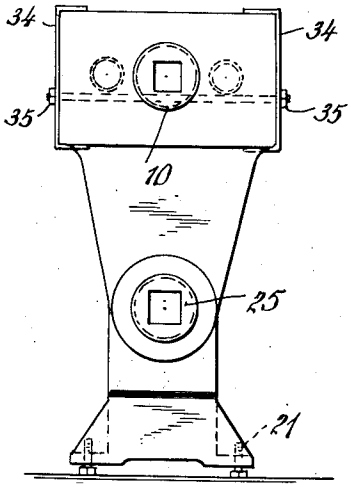


Fig. 10

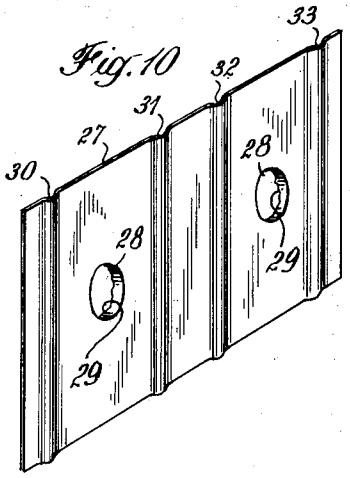
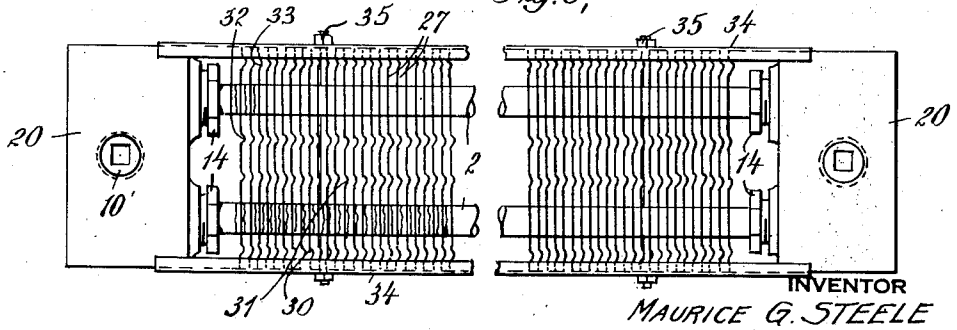


Fig. 9,



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Fig. 11,

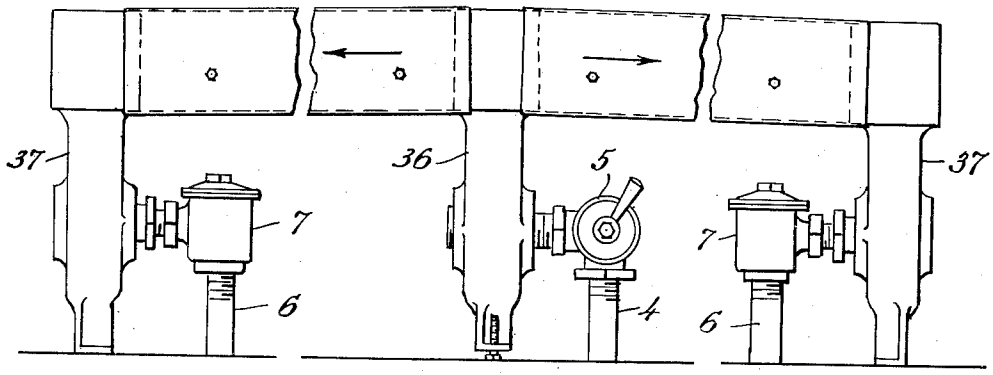


Fig. 12,

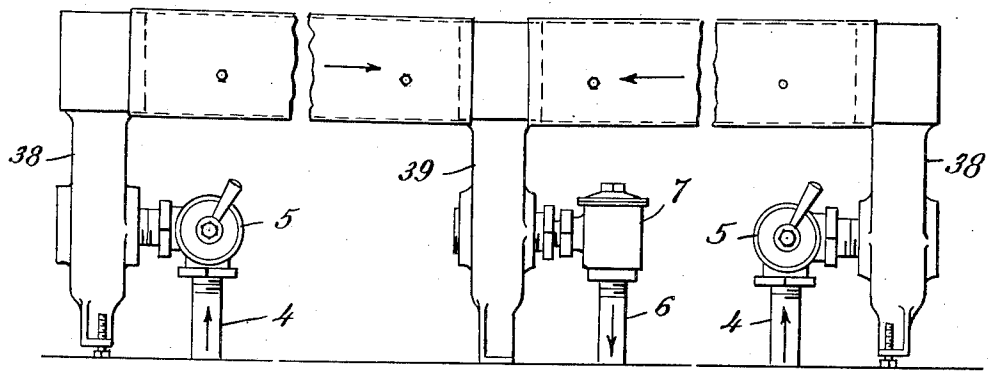
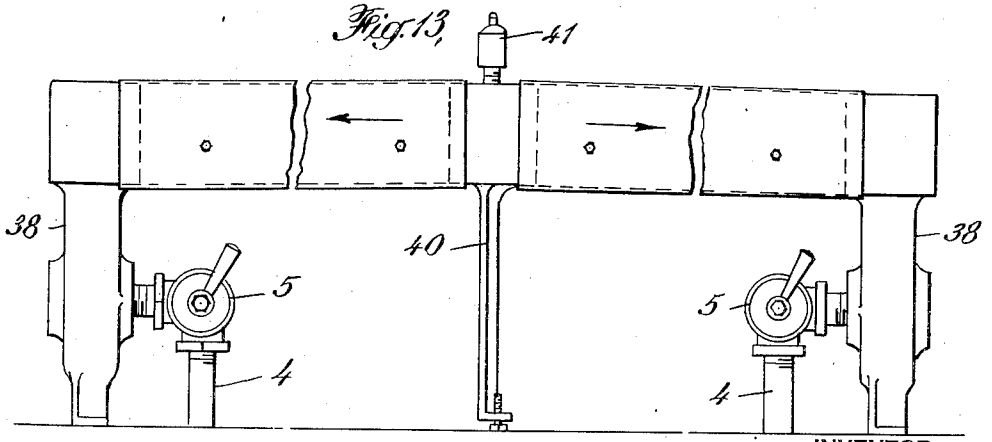


Fig. 13,



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UNITED STATES PATENT OFFICE

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RADIATOR

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Application July 18, 1931. Serial No. 551,651

17 Claims. (Cl. 257—136)

This invention relates to heat-exchange apparatus and has for its object certain improvements in the construction of heat-exchange devices. The invention relates more particularly to radiators, in which a heating fluid, such as steam or hot water, is passed through a conduit made of metal of high heat-conductivity and on which are mounted a plurality of spaced heat-dissipating fins, which transfer the heat from the fluid to the air surrounding the radiator.

Various proposals have been heretofore advanced in the construction of so-called fin-type radiators. At the same time, it is recognized that radiators of this type now available are often deficient in their capacity to extract heat from the heating fluid employed, in lightness, in compactness, and freedom from mechanical difficulties, and in flexibility in use.

The present invention contemplates important improvements in the construction of heat-exchange apparatus, such as radiators of the fin type. A highly efficient extraction of heat from the fluid employed may be obtained; the radiator is light, compact, and substantially free from mechanical difficulties. The radiator is, moreover, so designed as to give considerable flexibility in its use.

An important feature of the present invention is the arrangement of novel side plates extending between the headers in conjunction with the fins mounted on the tubes extending between the headers. These plates are adapted materially to diminish the amount of heat dissipated in the form of radiant heat energy, and, hence, appreciably to increase the amount of heat dissipated by convection. The side plates are also adapted to give rigidity to the assembly, and thus prevent the tubes from sagging; while at the same time offering important protection to the fins against bending and permanent deformation.

Important improvements are also contemplated in the headers employed. They are provided with strategically placed reservoirs or pockets for the accumulation of grit, scale, and foreign metal particles. Suitable provision may be made in conjunction with these pockets for periodically removing accumulated dirt. The headers, moreover, may be adjusted in height to give the radiator proper pitch for the ready flow of condensate. A particular improvement contemplated is the provision in the header of a multiple of suitably placed openings or tappings with which to make connections for the introduction of steam or for the withdrawal of condensate; thereby giving considerable flexibility in the installation of radiators.

Important improvements are also contemplated in the construction of the fins. They are designed to give considerable rigidity and resiliency, while at the same time offering greater surface area for the dissipation of heat than is normally the case. Their spaced relationship to one another is better preserved according to the practice of the invention.

The present invention is also directed to novel improvements in the manner in which the tubes are non-leakably attached to the headers by means of compression screws. The construction of the header and of the compression screw are so inter-related that a flared end of the tube may be rigidly, uniformly and completely locked to provide a joint that may be subjected to considerable rough treatment without leaking.

According to another aspect of the invention, improvements are contemplated in radiator unit assemblies involving the use of more than two (for example three) headers. Thus, in the use of three headers, the radiator units may be assembled so that heating fluid (such as steam) is introduced into the central header and condensate is removed from the end headers; or, so that steam is introduced into the end headers and condensate is removed from the central header. In a modified construction, the central header may act only as a support, in which case the condensate flows back to the end headers.

These and other features of the invention will undoubtedly be better understood from the description which follows of certain embodiments, taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation, in part sectional, of a radiator;

Fig. 2 is an end elevation with parts broken away of the radiator of Fig. 1;

Fig. 3 is a broken top plan view of the radiator of Fig. 1;

Fig. 4 is a detail section showing the manner of securing the ends of the tubes to the headers;

Fig. 5 is a plan view of one of the heat-radiating fins;

Fig. 6 is an end view of the fin of Fig. 5;

Fig. 7 is a side elevation, in part sectional, of another form of radiator;

Fig. 8 is an end elevation of the radiator of Fig. 7;

Fig. 9 is a top plan view of the radiator of Fig. 7;

Fig. 10 is an enlarged perspective view of the

improved heat-radiating fin shown in Figs. 7 and 9;

Fig. 11 is a side elevation of a multiple radiator in which steam is fed into a central header and condensate is withdrawn from end headers;

Fig. 12 is a side elevation of a multiple radiator in which steam is fed into end headers and condensate is withdrawn from a central header; and

Fig. 13 is a side elevation of a multiple radiator in which steam is fed into end headers and condensate is withdrawn through the same end headers.

Referring to the construction shown in Fig. 1 of the drawings, the radiator according to an embodiment of the invention is composed of a pair of headers 1 united by a pair of horizontal tubes 2; although it will be understood that any convenient number of tubes may be thus employed. The headers consist of flat, hollow castings, usually of cast iron; although other metals such as brass, copper or aluminum may be used. These headers are generally rectangular in outline, and are supported above the floor level upon vertical legs 3 screwed into opposite sides of the headers so that by varying the distance to which the pairs of legs are screwed within their respective headers the tubes 2 may be disposed at a slant so as to drain off any condensate forming in the tubes. A heating fluid such as steam is introduced into one of the headers, which may be termed the inlet header, through a conduit 4 provided with a supply valve 5 for regulating the amount of the steam entering the radiator. Condensate is formed in the tubes 2, which are tilted at a slight angle downwardly toward the other header, which may be termed the outlet header, and passes through an outlet conduit 6 provided with a trap 7 for regulating the withdrawal of condensate from the radiator. In order to increase the heat-conducting surface of the radiator the tubes 2 are provided with a multiplicity of fins 8 tightly affixed to the tubes, these fins, as in the case of the tubes, being made of copper or brass (although other metals may be employed, such as aluminum, steel, etc.) by reason of the improved heat-conducting property of these metals.

The inlet header 1 is provided on its bottom wall with an opening 9 by which the conduit 4 is threadedly connected with the header. A dirt pocket 9′ is advantageously located at or near the bottom of the interior of the headers for the collection of grit, metal particles and the like; to prevent them from entering and obstructing the delicate operation of the trap 7. A tapped opening at the top of the header permits the attachment of an air valve; or when such a valve is not used, this opening may be closed by a plug as shown in the drawings. The tapped opening may also be adapted for connection with a source of fluid supply. A tapping or screw-threaded port 10 in the end wall of the header permits optional connection with a source of fluid supply; or to connect a plurality of the radiators in series; otherwise this port is closed by a suitable plug as shown. The plug is preferably of the recessed socket, or countersunk type, to give a flush construction.

The side walls of the headers are provided with holes 11, in the present case two in number, which provide passages through which the tubes 2 communicate with the interior of the headers. Exteriorly of the header and concentrically formed with reference to the holes 11 are recesses 12 each provided on its bottom with a tapered seat 13 arranged to fit within and cooperate with one of the flared ends of the tube (Fig. 4). The interior of the recess at its outer end is screw-threaded, and loosely surrounding the tube and engaging the screw threads of the recess is a compression screw 14.

The compression screw has its inner end complementarily beveled as at 13′ to conform to the taper of the inner side of the flared end of the tube, so that when the compression screw is turned home its beveled edge engages the flared end 2′ of the tube and forces it into fluid-tight engagement with the tapered seat 13. The joint is capable of withstanding high internal pressures and is not easily loosened by repeated expansion and contraction of the tube. The outlet header at the opposite end of the radiator is of substantially the same construction and requires no discussion, equivalent elements being designated by the same reference numerals. In flaring the ends of the tubes the flared metal is stretched and expanded. This means that the metal lip is made gradually thinner toward its extreme end. To compensate for this varying thickness of the metal lip, the tapered seats 13 and 13′ are pitched at an appropriate angle so that the entire lip is tightly, uniformly and completely engaged between the tapered seats. Thus, I have determined that when the seat 13′ of the compression screw is given an 82° bevel, the seat 13 of the header should be given a 90° bevel when using a tube having a wall thickness of 0.035 of an inch.

The core section, comprising the tube and fin assembly, is constructed as follows: The tubes 2, as has before been stated, extend between the spaced headers 1 and deliver the heating fluid from the inlet header to the outlet header; and in order to increase the heat-transference capacity of the tubes a series of fins 8 are arranged upon the tubes. These fins, as shown in Fig. 5, comprise thin metal plates of rectangular shape and formed with two holes through which the tubes pass. These holes are punched out in such a manner as to leave a short lip or burr 8a surrounding the apertures, this lip affording a narrow circumferential band of metal which firmly grips the circumferential outer surface of the tubes. The tubes and the fins are preferably bonded together, such as by a solder joint, to obtain optimum heat conduction.

Upon its two opposite sides the radiator is skirted by a pair of vertical walls 15. These walls not only protect the fins, add strength and rigidity to the assembly, and contribute to the neat appearance of the radiator unit, but serve, in conjunction with the fins, the purpose of creating at least a partial flue effect—that is, inducing a circulation of air from below the radiator up between the walls 15 past the radiating fins 8, the heated air passing out above the radiator. The walls 15 are rigidly assembled with the radiator in one embodiment of the invention by means of tongues 16 punched out of their sides and bent inwardly. These tongues are perforated as at 17 to encircle the tubes 2 with which they are rigidly united in the same manner as the fins. These side plates prevent sagging of the tubes, which sagging might otherwise trap condensate and seriously impair the heat-exchange efficiency of the assembly. The corners of the fins are protected against being pushed and bent together, whereby their spacing is better preserved.

The headers 1 are rabbeted as at 18 snugly to receive the ends of the walls 15 which lie flush with the corresponding surfaces of the casting.

Such an arrangement adds to the beauty of the assembly and prevents exposure of sharp edges with which those handling the device might otherwise cut and scratch themselves.

While the escape of condensate through trap 7 is shown in the above described device, it will be clear that a different practice may be followed. Thus, the radiator may be inclined downwardly toward the inlet header, in which case condensate will flow through the tubes into the inlet header. Suitable provision should then be made for the escape of entrapped air, which may be accomplished by placing an air valve preferably in the top of the far header.

The heat-exchange device, or radiator, may take a form such as that illustrated in Figs. 7, 8, 9 and 10. This construction is similar to that of the radiator shown in Figs. 1 to 6, inclusive, except for certain novel differences in the end headers, the heat-dissipating fins and the side walls. Referring to Fig. 7, it will be seen that the construction contemplated comprises integral headers 20 elongated in a vertical direction so that one end rests directly upon the floor; or close thereto by means of pitch adjusting screws 21, which are advantageously arranged with their heads at the bottom for ready access. This header construction permits of a relatively large interior chamber 22, communication to which is permitted by a plurality of tappings or openings strategically placed and spaced in opposite side walls, as well as in the top wall. Thus, holes 23 and 24 are advantageously provided in opposite walls of the header at a convenient distance above the bottom of the chamber 22. In the instant construction the conduit 4 provides an inlet for steam through hole 24 into the chamber 22, by way of the inside side of the radiator. When not in use, the hole 23 is closed by means of a suitable plug 25. This plug is preferably of the countersunk type, so that it may be brought flush with the side walls of the header. Depending on local conditions, it will be clear that in some installations it may be preferable to connect the conduit with the header by means of the hole 23; in which case the hole 24 would be suitably plugged. An extra upper side hole 10 and a top hole 10' are shown for similar connections; these holes being plugged when not in use.

In order to provide a reservoir or space for the collection of grit and foreign particles, openings 23 and 24 are made to communicate with the chamber 22 a convenient distance above its bottom. Thus, the bottom portion 26 of the chamber may be utilized as a dirt pocket or sump for the collection of foreign impurities. The header may well be constructed so that the sump extends close to its bottom. A clean-out plug 26' advantageously fits into a hole located at or near the bottom of the sump so that accumulated dirt may periodically be withdrawn from the system.

The side of the upper end of the header 20 is advantageously constructed in accordance with the form shown for header 1 in the radiator of Fig. 1. The tubes 2 are attached in a similar manner by means of compression screws.

Instead of employing strictly flat heat-dissipating fins, as more particularly shown in the radiator of Figs. 1 and 3, fins 27 of the radiator of Figs. 7 and 9 are formed in accordance with the design of Fig. 10. These fins are provided with suitably spaced holes 28 for the insertion of the tubes 2. The holes are appropriately broached to provide burrs or shoulders 29 for fitting around and against the tubes. In the construction shown, suitably spaced vertical corrugations, grooves or channels 30, 31, 32 and 33 are provided across the width of the fins. Corrugated fins are more rigid and resilient than they would be in the absence of corrugations. Due to the added surface provided by these depressions, the fins offer greater heat-dissipating surface. As will be more clearly shown by referring to Fig. 9, the corrugations tend to maintain the fins in spaced relationship to one another. Should any of the fins be bent toward one another, these corrugations give the fins greater resiliency, or snap, which will tend to bring the fins back to their original position. In order to make the placement of the fins on the tubes easier, the grooves should be suitably spaced away from the holes 29, as shown. The ends of the fins are given greater strength by virtue of the grooves 30 and 33 along or near the end edges.

Since the fins employed in this type of radiator are extremely thin, it is highly important that adequate provision be made to protect them against bending so that their spaced relationship to one another may be maintained. The heat-dissipation efficiency of the radiator is also in large part dependent upon the maintenance of the spaced relationship of the fins. Passageways for the free movement of air are provided between adjacent fins. In the construction shown a light force may be employed to bend the fins toward one another, but when that force is released, the fins promptly spring back to their normal position. This highly desired resiliency or snap is given to the fins by the corrugations.

The corrugation of the fins is also highly desirable in order to take out a slight curvature that is normally present when the fins are first cut from stock material. The stock material usually comes in the form of a roll or spool of thin copper or brass sheeting. The metal sheeting is unrolled and cut into standard fin sizes. In the absence of such corrugations, the fin blanks would normally assume a slightly curved form. On corrugating these slightly curved fin blanks, they assume and maintain a substantially flat shape.

Unlike the side walls of the radiator of Figs. 1, 2 and 3, side walls 34 of the radiator of Figs. 7, 8 and 9 are in the form of a channel, their upper and lower edges being flanged over preferably in amount sufficient to cover and protect the corners of the fins. In the instant construction, the side walls or side plates are pulled against the headers by means of bolts 35 extending from one side plate to the other; the bolts extending through slotted holes in the plates spaced to make them register oppositely to one another. This form of side plate offers a number of important advantages: Due to the flanged edges, the channel-like side walls are made extremely rigid. This construction not only prevents sagging and side-bending of the walls, but it also prevents sagging of the tubes 2. Since the tubes are made of relatively thin metal they tend to sag when suspended between headers placed too far apart, and when too many fins are attached to the tubes. The undermost flanges of the side walls are adapted to extend slightly under the fins. Hence, when any sagging tends to take place, the core assembly of tubes and fins is supported by those flanged portions. Even though every sixth or seventh fin, for example, should alone touch these bottom flanges, sagging of the tubes will not take place. Sagging

of the tubes is inherently disadvantageous in at least several important respects: In the first place, when the tubes sag at their centers, condensate is trapped in the bottommost portion. The collection of condensate at this point may tend to clog the tubes with water, and thus prevent the passage of steam through the tubes. Furthermore, when the tubes sag, the upper ends of the fins tend to close-in toward one another, thus inhibiting the free passage of air upwardly through the spaces normally provided between adjacent fins.

In the construction shown in Fig. 7, the radiator is tilted at a very slight angle so that condensate formed in the tubes 2 may flow by gravity toward the opposite or outlet header, and from the header into the trap 7. It will be clear that the trap may be omitted, in which case the radiator is tilted in the opposite direction so that condensate may freely flow toward the steam inlet header. In this case an air valve should be attached to the top of the far header for the escape of entrapped air.

The present invention also contemplates the type of radiator construction shown in Figs. 11, 12 and 13 in which more than two headers are employed; for example, three headers. When employing three headers, the intermediate header may be employed either as an inlet header for steam (as in Fig. 11); or as an outlet header for the escape of condensate and entrapped air (as in Fig. 12); or as a mere support (as in Fig. 13), in which case fresh steam is not introduced through the header nor is condensate removed therethrough. In the case of the radiator construction shown in Fig. 11, the steam enters a central header 36, and condensate flows to the end headers 37. In the construction shown in Fig. 12, steam is introduced into end headers 38, and condensate and entrapped air are withdrawn through central header 39. In the construction of Fig. 13, the steam is likewise introduced into the end headers 38 and the condensate flows backwardly into the same headers; the intermediate header 40 being employed primarily as a central support. In this construction an air valve 41 is preferably attached to the top of the central header for the escape of entrapped air. The tubes between adjacent headers may be suitably inclined to get the desired flow of condensate, by suitably adjusting the height of the headers relatively to one another. In the radiator of Fig. 11, the central header is elevated slightly higher than the two end headers; of Fig. 12 the end headers are elevated slightly higher than the central header; and of Fig. 13, the central header (like Fig. 11) is slightly higher than the two end headers.

While the invention has been described in connection with a steam radiator, manifestly heating mediums other than steam may be employed, such, for example, as vapor or hot water. Furthermore, variations in the size, shape and number of fins and heater tubes may obviously be made without departing from the present invention. The apparatus herein contemplated may likewise be employed as a cooling device, in which case the tubular members may contain the cooling fluid, such as cold water, brine or various other familiar cooling mediums known to this art.

I claim:

1. In a heat-exchange apparatus, the combination comprising at least one fluid conducting tube connected at each end with a header, a connection in one of the headers for the introduction of a heating fluid, a plurality of spaced heat-dissipating fins mounted on and bonded to the tube, and vertical side plates extending between the headers adjacent to and in part supporting the tube and fin core by means of flanged lower edges of the plates that extend partly under the fins and on which at least one of the fins may rest to prevent sagging of the tube and fin core thereof whereby the fins are maintained in their normal spaced relationship and condensate cannot collect in the tube, said side plates being held in free spaced relationship exteriorly of the tube and fin core and header assembly by means of a securing member extending laterally there between at a suitable point between the headers whereby the tube and fin core and the header assembly may expand and contract independently of the side plates and thereby prevent the apparatus from being twisted out of shape.

2. A heat-exchange apparatus according to claim 1, in which the header is provided with a dirt pocket above the connection for the introduction of a heating fluid for the accumulation of foreign particles.

3. A heat-exchange apparatus according to claim 1, in which the header is provided with an elongated interior chamber, the bottom of the chamber extending well below the connection for the introduction of steam or for the withdrawal of condensate, said bottom of the chamber providing a sump for the accumulation of foreign substances.

4. A heat-exchange apparatus according to claim 1, in which the header is provided with a sump for the deposit of dirt, said sump being located above the connection for the introduction of a heating fluid, an opening being provided through the header wall into the sump for periodic cleansing thereof.

5. A heat-exchange apparatus according to claim 1, in which the vertical side plates support the tube by means of lugs running from the plates to the tube.

6. A heat-exchange apparatus according to claim 1, in which the fins are vertically corrugated along their vertical edges.

7. In a heat-exchange apparatus the combination comprising tube ends flared to fit over beveled seats in headers, and beveled seats of compression screws fitting loosely around the tube which are tightly, uniformly and completely screwed against the flared ends of the tube to make a non-leakable joint, the respective beveled seats of the headers and the compression screw being complementarily pitched to conform to the graduated thickness of the flared end of the tube.

8. A heat-exchange apparatus according to claim 1, in which a connection is provided in the opposite header for the withdrawal of condensate and entrapped air.

9. In a multiple heat-exchange apparatus, the combination comprising a pair of end headers and an intermediate header disposed between the end headers, tubes connecting the intermediate header with the end headers, a series of heat-dissipating fins mounted on the tubes and vertical side plates extending between the headers adjacent to and in part supporting the tube and fin core to prevent sagging thereof whereby the fins are maintained in their normal spaced relationship and condensate cannot collect in the tubes.

10. A multiple heat-exchange apparatus according to claim 9, in which a connection is provided for introducing a heating fluid into the intermediate header.

11. A multiple heat-exchange apparatus according to claim 9, in which connections are provided for introducing a heating fluid into the end headers.

12. A multiple heat-exchange apparatus according to claim 9, in which connections are provided for introducing a heating fluid into the end headers, connections being likewise provided in the end headers for the withdrawal of condensate.

13. A multiple heat-exchange apparatus according to claim 9, in which connections are provided for introducing a heating fluid into the end headers, a connection being likewise provided in the intermediate header for the withdrawal of condensate.

14. A multiple heat-exchange apparatus according to claim 9, in which connections are provided for introducing a heating fluid into the end headers, a connection being provided in the intermediate header for the escape of entrapped air, said intermediate header being slightly elevated with respect to the end headers so that condensate may flow freely through the tubes to the end headers.

15. A multiple heat-exchange apparatus according to claim 9, in which the headers are provided with a sump for the accumulation of foreign substances.

16. In a heat-exchange apparatus, the combination comprising an integral header provided with a plurality of tappings adapted for making connections with a source of fluid supply or with a drain for the withdrawal of condensate, said tappings being located in opposite side walls of the header, and a sump at or near the bottom of the header below the tappings for the accumulation of dirt.

17. In a heat-exchange apparatus, the combination comprising a header, a flared tube, and a compression screw, a tube end being flared to a lip of graduated thickness and fitting over a beveled seat provided in a threaded hole in the header, the compression screw fitting loosely around the tube and having a beveled seat fitting on the flared lip, the respective beveled seats of the header and the compression screw being complementarily pitched to conform to the graduated thickness of the flared tube lip whereby the lip may be tightly, uniformly and completely compressed to make a non-leakable joint.

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