June 3, 1930. G. BLUEMEL 1,761,173

SHEET METAL AIR HEATER

Filed Nov. 7, 1928 2 Sheets-Sheet 1

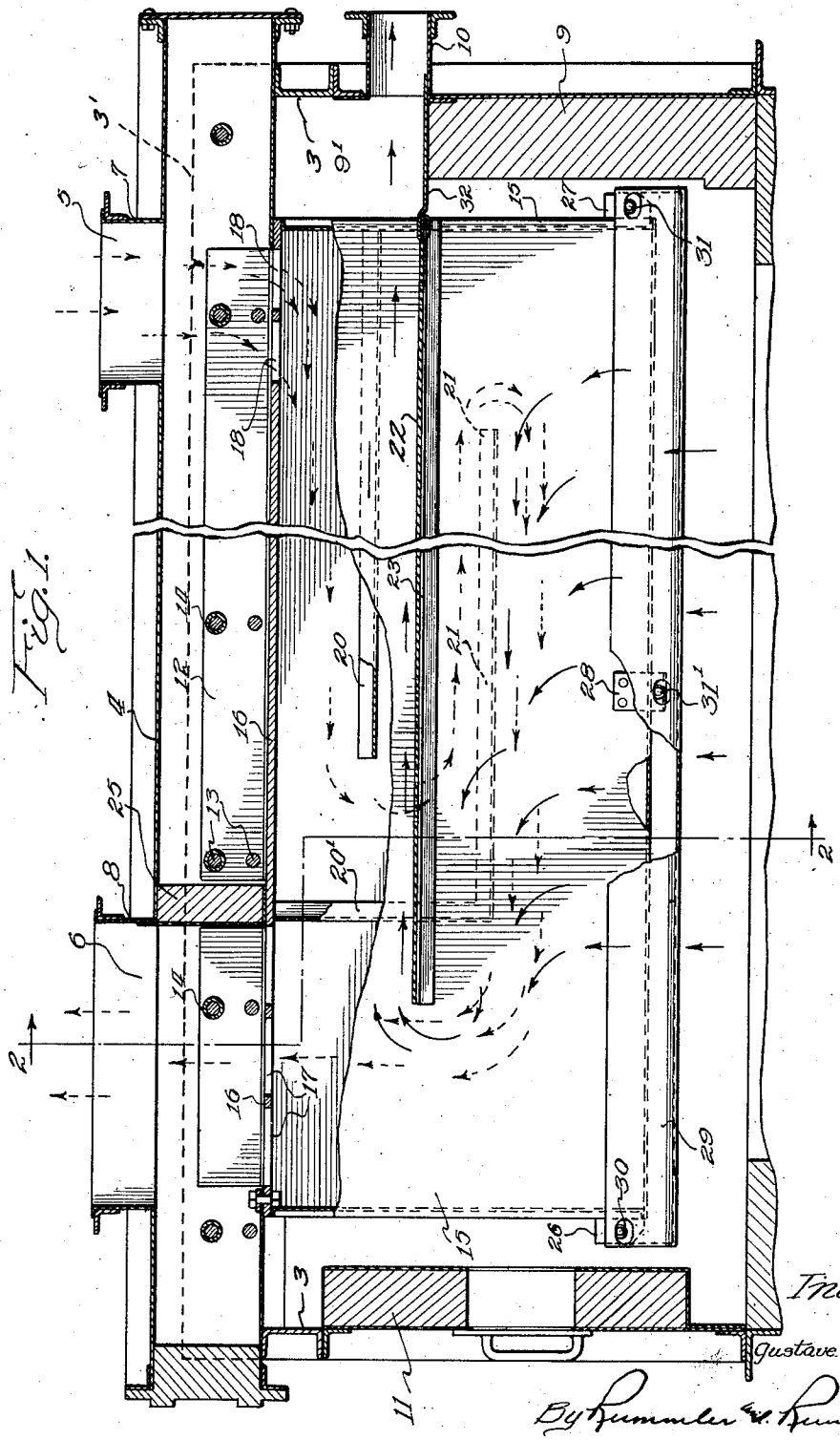


Fig. 1.

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Fig. 2.

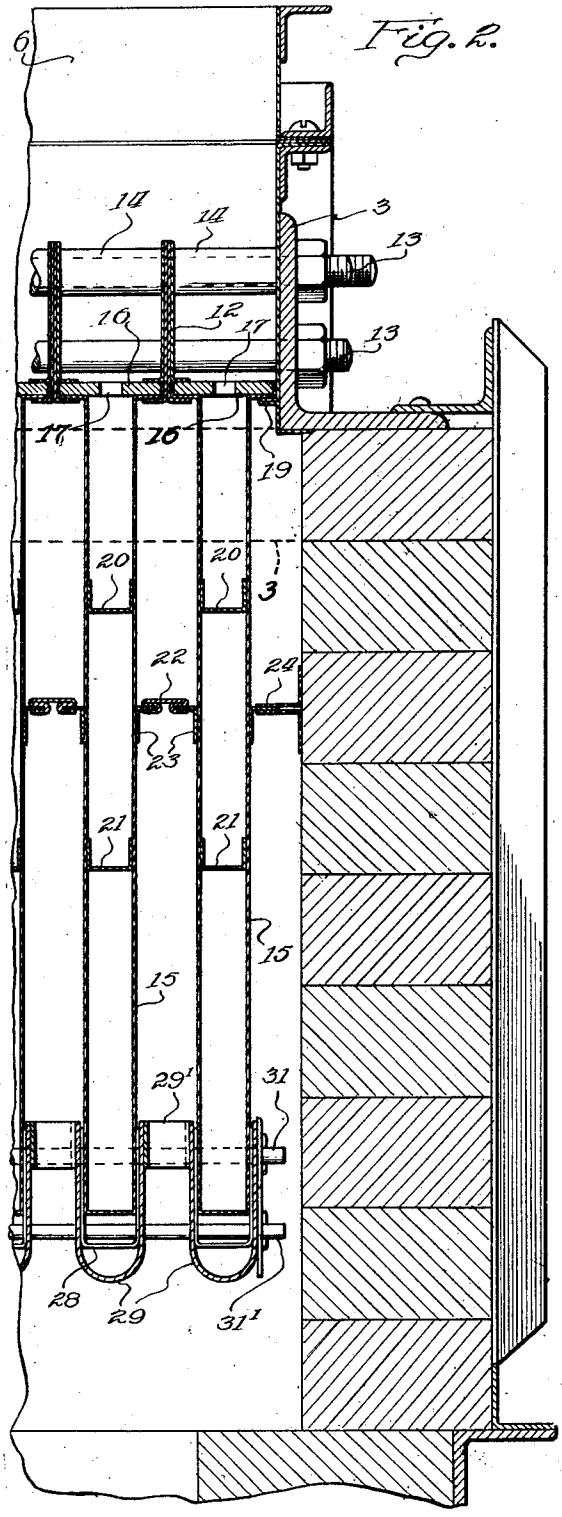


Fig. 3.

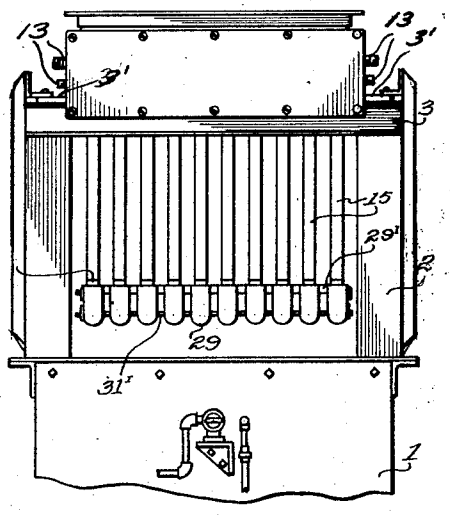
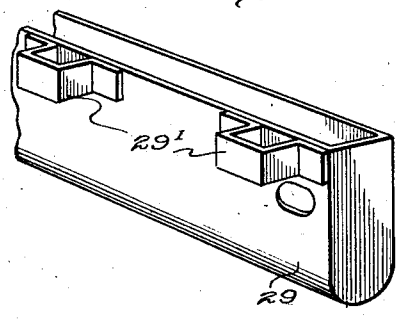


Fig. 4.



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UNITED STATES PATENT OFFICE

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SHEET-METAL AIR HEATER

Application filed November 7, 1928. Serial No. 317,835.

This invention relates to an improved heat interchanger and particularly air heaters.

The main objects of this invention are to provide individual heat transfer elements or tubes which may be removed and replaced independently without requiring discarding of unworn tubes or other parts of the device; to provide an improved construction for removably supporting individual heat transfer tubes by rigid attachment to a single edge thereof for permitting substantially unlimited thermal expansion and contraction of the material of which they consist; to provide a heat interchanger in which the heat transfer surfaces are conveniently accessible for facilitating cleaning thereof; and to provide heat resisting protective coverings for those portions of the tubes that would otherwise be directly exposed to destructively high temperatures for allowing uniform heat distribution and retarding the rate of heat transfer to the bottom of the tubes. Consequently it is possible, if desired, to employ less expensive material in constructing the tubes than is required for high combustion temperatures.

Heretofore heat interchanging units were made either from inexpensive material which necessitated operation at a low combustion temperature and consequently limited the rate of heat transfer, or from expensive heat-resisting metal which allowed higher combustion temperatures to be used. These interchanging units have usually been rigidly secured at their sides, bottom, top and edges in such a manner as to set up internal stresses in the material of the interchanger elements from thermal expansion which became excessive at high combustion temperatures and consequently resulted in untimely failure through the stresses set up in the material employed. These disadvantages, which were always present in the old constructions, are avoided in my improved heat interchanger, by rigidly attaching the individual tubes to the structure of the furnace along a single edge and allowing them to be suspended into the heating chamber of the furnace so as to permit free and easy thermal expansion and contraction of the materials. Those portions of the interchanger element which generally lie in the path of the heating medium of maximum temperature are protected by replaceable shoes comprising heat resisting metal. This arrangement permits heat to enter the interchanger with combustion temperatures equal to the heat resisting limit of present day heat alloys and allows a maximum rate of heat transfer without causing destructive stresses.

In the accompanying drawings I have illustrated a specific embodiment of my invention, in which—

Figure 1 is a fragmentary longitudinal section showing parts removed to disclose the underlying construction.

Fig. 2 is a transverse section taken on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary front end elevation showing part of the wall removed.

Fig. 4 is a fragmentary perspective detail of a protective shoe.

In the form shown, a rectangular base supports the corner posts 2 which in turn support transverse channel bars 3, one at each end of the machine. Resting upon and secured to the ends of the channel bars 3 and extending longitudinally along each side of the machine are angle bars 3′. The channel bars 3 and the angle bars 3′ constitute an upper rectangular frame structure. The upper side of the top frame is substantially closed by a sheet metal member 4 which is provided with a cold air inlet opening 5 and a hot air discharge opening 6. The openings 5 and 6 are rectangular in shape, extend substantially across the width of the top frame, and are provided with tubular members 7 and 8 respectively to which inlet and outlet air conduits, not shown in the drawing may be attached. The space between the rear corner posts 2 is filled in with fire resisting material such as brick or other suitable means providing a rear wall 9 having a fuel gas discharge passage 9′ therein, which is provided with a tube 10 that may be communicatively connected to a chimney or stack. The space between the

two front corner posts is closed by a removable panel 11.

A plurality of multiple ply hanger plates 12 are arranged longitudinally of the top frame, comprising the angle bars 3, and are rigidly secured thereto by transverse bolts 13. The bolts 13 extend through spaced apertures in the angle bars 3 and through apertures in the multiple ply hanger plates 12. Sleeves 14 on the bolts 13 are located between adjacent hanger plates 12 for permanently holding the same in a fixed spaced relation. The multiple ply hanger plates shown in Fig. 2 comprise 4 layers. The two intermediate layers extend downwardly beyond the extremities of the outermost layers and are flanged outwardly substantially in a horizontal plane. The bottom portions of the outermost layers of the multiple ply hanger plates are flanged outwardly in a spaced horizontal plane. This arrangement provides opposite grooves at the bottom portion of the hanger plates.

Air conduits or tubes 15 of rectangular shape are suspended from the top frame by attachment to the hanger plates 14. These tubes comprise substantially thin, heat resisting material having suitable heat conductive properties and are closed at their bottom and end edges. The top edge of the tube is open and the sides thereof are flanged outwardly and upwardly for providing a recess for a rectangular shaped metal bar 16. The metal bars 16 are provided at their forward end portion with three apertures 17 and at their rearward end portion with two apertures 18 as shown in Fig. 1.

Any desired number of heat interchanger elements or tubes 15 may be rigidly attached to the top frame as above described, the outermost tubes being supported upon flanges 19 mounted on the inner sides of the angle bars 3. In assembling the heat interchanger unit the rectangular bars 16 together with the upper open end portion of the tube 15 are clamped together and the hanger plates 12 are driven in between adjacent tubes by a pneumatic hammer or other suitable driving means.

Each tube is provided with an upper and lower horizontal partition or baffle, 20 and 21 respectively, and with a vertical upwardly extending baffle 20′ connected with the lower baffle 21.

These partitions, as shown in Fig. 2, comprise metal channel members the sides of which may be spot-welded to the sides of the tube.

Removable partitions 22 are located substantially midway between the top and bottom of the spaces between adjacent tubes. These partitions are slidably engaged on angle bars 23 which are spot-welded to the outer sides of the tubes. Those partitions which occur between adjacent tubes are formed with longitudinal grooves for receiving the horizontal edges of the angle bars 22. Partitions 24 are also provided between the outermost tubes and the adjacent wall.

When the heat interchanger is in operation, cold air is forced through the intake aperture 5, and passed downwardly through the upper frame and also through the apertures 18 in the rectangular shaped bars 16. The air enters the tubes at the apertures 18 and progresses forwardly as indicated by the dotted arrows in Fig. 1 until it reaches the end of the upper baffle 20. At this point the air is restrained from further forward movement by the vertical baffle 20′ and is caused to travel in a rearward direction until it passes around the rear end of the lower baffle 21. The air then again travels forwardly and upwardly and is ultimately discharged through the apertures 17 of the rectangular bars 16 and into the discharge conduit. All of the tubes communicate with each other at their forward ends through the apertures 17 and at their rearward ends through the apertures 18 but communication between the forward ends of the tubes and the rearward ends of the tubes is cut off by a partition 25 extending transversely of the upper frame.

End brackets 26 and 27 are welded or otherwise rigidly attached to the ends of the tubes 15 as shown in Fig. 1, and U-shaped straps 28 are rigidly attached to the sides of the tubes at the bottom portion intermediate the ends thereof. The U-shaped straps 28 extend below the bottom of the tubes and are provided at their lower portions with apertures. A trough-shaped protective shoe 29 comprising suitable heat-resisting material is suspended from the bottom of each tube by attachment to the brackets 26 and 27 and to the straps 28. The trough-shaped shoes 29 are long enough to accommodate the end brackets 26 and 27 and they are provided with oblong apertures which register with the apertures in the brackets 26 and 27, and in the strap 28. Rods 30 and 31 respectively extend through the registered apertures in the brackets 26 and 27 and in the shoes 29 and a rod 31′ extends through the registering apertures in the intermediate portion of the shoe and in the straps 28. These rods extend transversely of the heat interchanger unit and simultaneously hold a shoe suspended from each tube. Brackets 29′ on one side of each shoe hold adjacent shoes and the lower end portions of the tubes in spaced relation.

A current of heated gas, preferably the products of combustion from an oil or gas burner, is introduced into the base portion 1 of the heat interchanger at the bottom thereof. These highly heated gases pass upwardly between the spaced tubes and engage

the baffle plates 22 therebetween. The baffle plates 22 terminate short of the forward ends of the tubes and thus allow the incoming heated gases to pass forwardly around the forward ends of the baffle plates 22, and rearwardly to the discharge opening in the rear wall. The path of the hot products of combustion is indicated by full line arrows in Fig. 1. A baffle plate 32 is secured at the rear end of the baffle plates 22 closing the space between the wall 9 and the rear ends of the tubes 15, so as to prevent the discharge of the incoming heated gases directly through the outlet opening in the rear wall, and to cause the same to pass forwardly as above described.

The oblong openings in the protective shoes 29 are larger in size than the diameter of the rods which pass therethrough and thus the shoes are freely suspended from the bottom portions of the tubes in such a manner as to permit free and unobstructed thermal expansion and contraction of the materials comprising the shoes and tubes. These shoes partly envelop the bottom portions of the tubes and protect the same from direct exposure to the incoming heated gases.

The entire heat interchanger unit comprising all of the tubes is supported from the upper ends of the corner posts 2 and allows all of the tubes to depend into the combustion chamber. The tubes are rigidly attached to the top frame only along the top edge and the bottoms, sides and ends of the tubes are not rigidly attached to the structure of the combustion chamber in any manner.

This arrangement affords unlimited freedom of thermal expansion and contraction in the materials of the tubes, and avoids their untimely failure.

Although but one specific embodiment of this invention has been herein shown and described, it will be understood that details of the construction shown may be altered or omitted without departing from the spirit of this invention as defined by the following claims.

I claim:

1. In a heat interchanger comprising a substantially enclosed casing, a plurality of air tubes suspended in said casing, brackets on the bottom portions of the end of said tubes, a shoe enclosing the bottom portions of said tubes, and a rod at each end of said tubes extending through registered apertures in said brackets and shoes.

2. In a heat interchanger comprising a base and a spaced top frame a plurality of tubes clamped together at their upper extremities between the sides of said frame and suspended downwardly therein, means enveloping a portion of said tubes and freely suspended therefrom for permitting unrestrained thermal expansion and contraction of the materials of said enveloping means and said tubes.

3. In a heat interchanger comprising a base and a spaced top frame, a source of heat in said base, a plurality of air conduits clamped together at their top extremities by the sides of said frame comprising heat transmitting material and suspended into the space above said source of heat, and a shoe comprising a heat resisting material suspended from the bottom portion of each of said conduits, and partially enclosing the same for protecting selected portions thereof from direct exposure to heat.

4. In a heat interchanger comprising a base and a spaced frame mounted thereon, a plurality of spaced hanger plates rigidly mounted in said frame, and a heat interchanger unit comprising a plurality of individual tubes each rigidly secured to one of said hanger plates along a single edge and depending freely throughout their remaining portions between said base and spaced frame.

5. In a heat interchanger, a walled structure, a plurality of spaced, suspended, U-shaped, vertical tubes, closed at their ends, and having a plurality of horizontally disposed partitions therein, not extending from end to end of the tube, whereby air may be guided in a tortuous path through the tubes; said tubes being outwardly flanged at their upper ends; and means for supporting said tubes by said flanges.

6. In a heat interchanger; a walled structure; a plurality of spaced, suspended, U-shaped, vertical tubes, closed at their ends, and having a plurality of horizontally disposed partitions therein, not extending from end to end of the tube, whereby air may be guided in a tortuous path through the tubes; said tubes being outwardly flanged at their upper ends; and means for supporting said tubes by said flanges; said means for supporting tubes comprising engaging elements above and below the flanges of the tubes; and provided with air inlets and outlets.

7. In a heat interchanger, a walled structure; a plurality of spaced, suspended, U-shaped, vertical tubes, closed at their ends, and having a plurality of horizontally disposed partitions therein, not extending from end to end of the tube, whereby air may be guided in a tortuous path through the tubes; said tubes being outwardly flanged at their upper ends; and means for supporting said tubes by said flanges; said means for supporting tubes comprising engaging elements above and below the flanges of the tubes, and provided with air inlets and outlets; said supporting means also including hanger plates and bolts, passing transversely through said hanger plates, and supported

by said walled structure, and adapted to draw the tube flanges and hanger plates together for the purpose of forming a seal between the tubes and spaces therebetween.

8. In a heat interchanger, a walled structure; a plurality of spaced, suspended, U-shaped, vertical tubes; closed at their ends, and having a plurality of horizontally disposed partitions therein, not extending from end to end of the tube, whereby air may be guided in a tortuous path through the tubes; said tubes being outwardly flanged at their upper ends; and means for supporting said tubes by said flanges; protecting shoes made of heat resisting material enveloping the lower ends of the tubes, and attached to the tubes by means permitting free expansion and contraction of the shoes independently of the tubes.

Signed at Chicago this 2nd day of November, 1928.

GUSTAVE BLUEMEL.