March 18, 1930. G. D. MANTLE ET AL 1,750,850

RECUPERATOR

Filed May 23, 1927 3 Sheets-Sheet 1

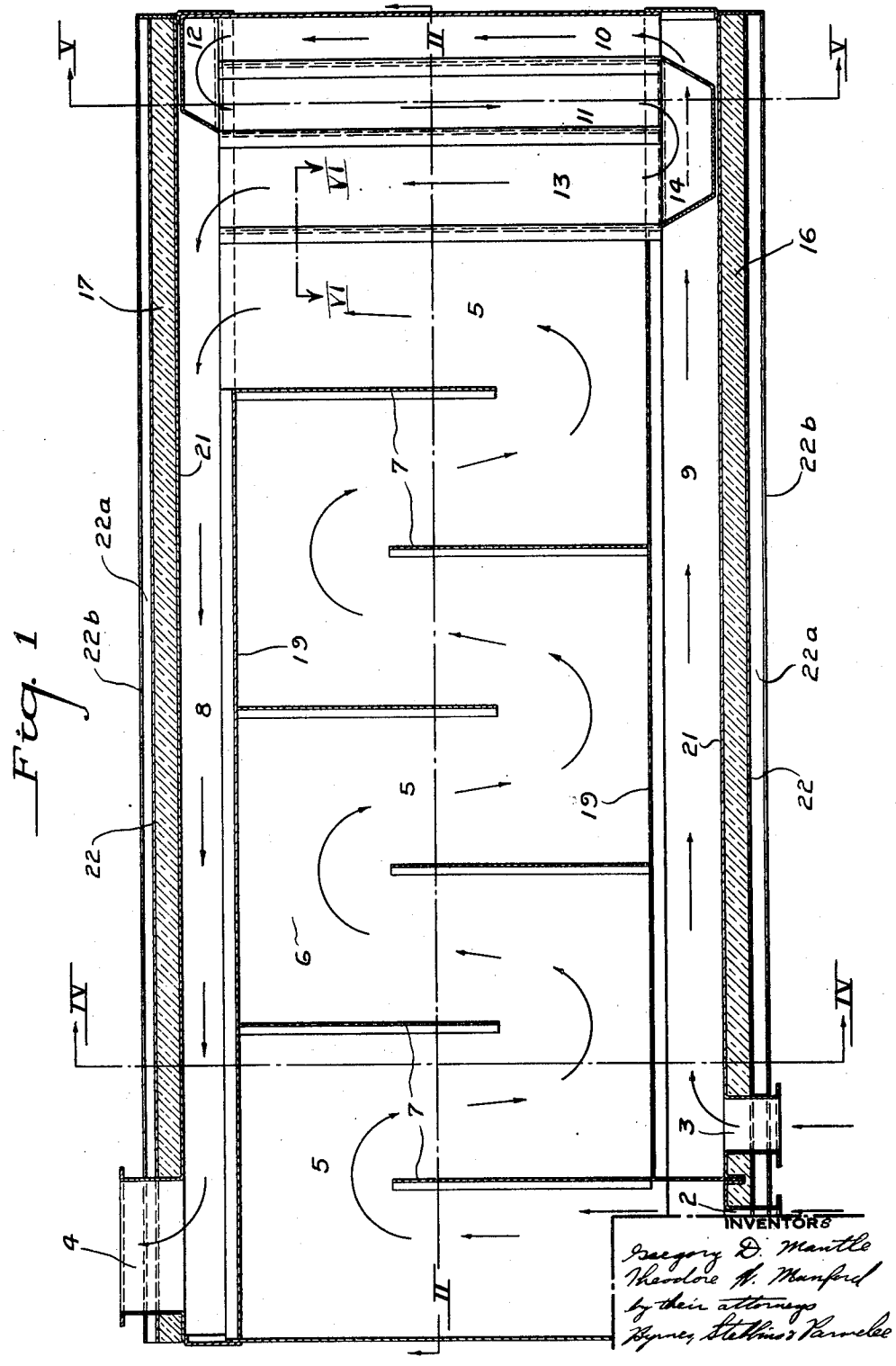


Fig. 1

March 18, 1930. G. D. MANTLE ET AL 1,750,850

RECUPERATOR

Filed May 23, 1927 3 Sheets-Sheet 2

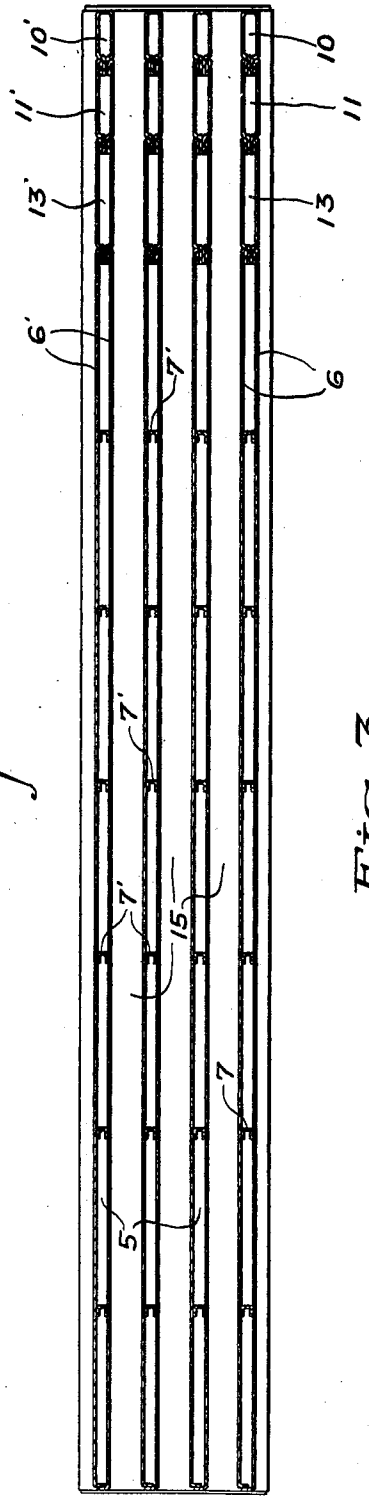


Fig. 2

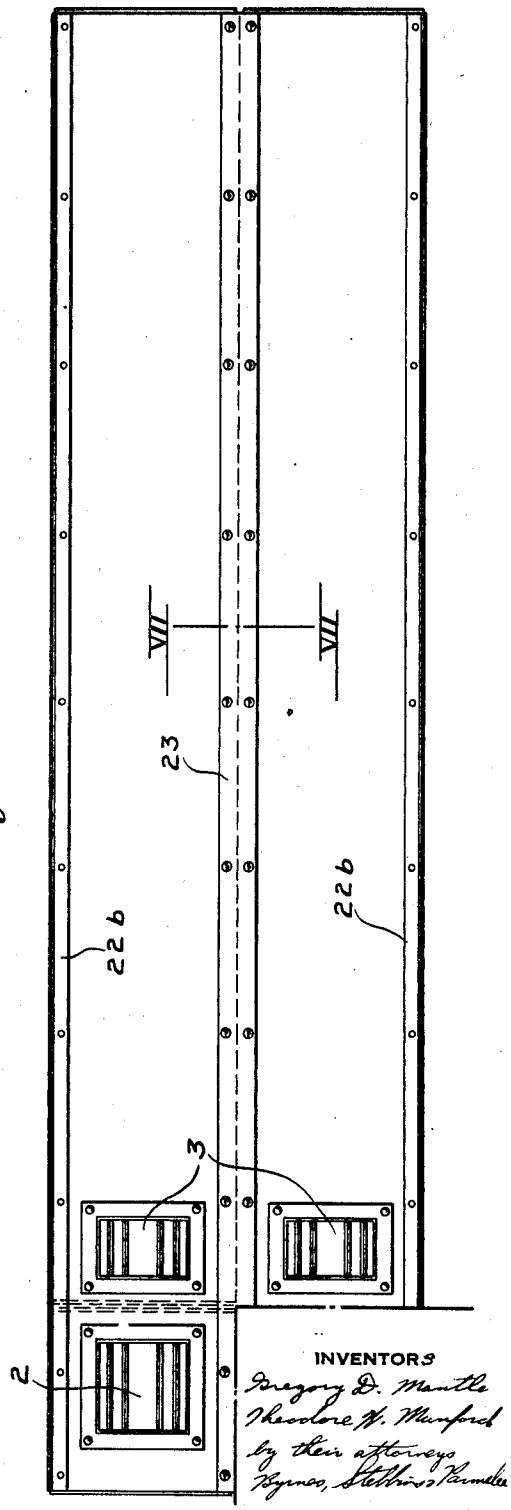


Fig. 3

INVENTORS
Gregory D. Mantle
Theodore W. Mumford
by their attorneys
Byrnes, Stebbins & Parmelee

March 18, 1930. G. D. MANTLE ET AL 1,750,850

RECUPERATOR

Filed May 23, 1927 3 Sheets-Sheet 3

Fig. 4

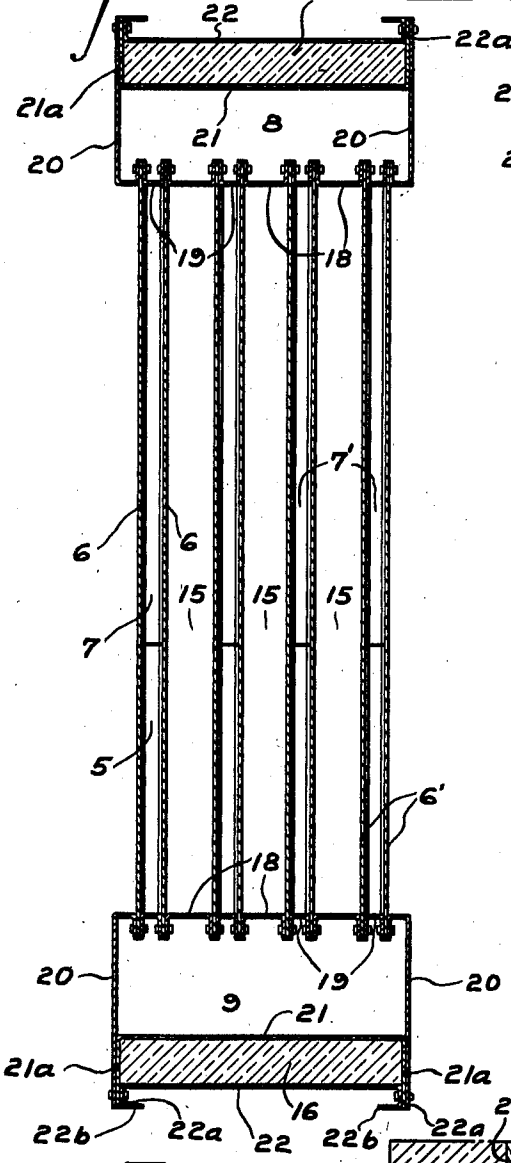


Fig. 5

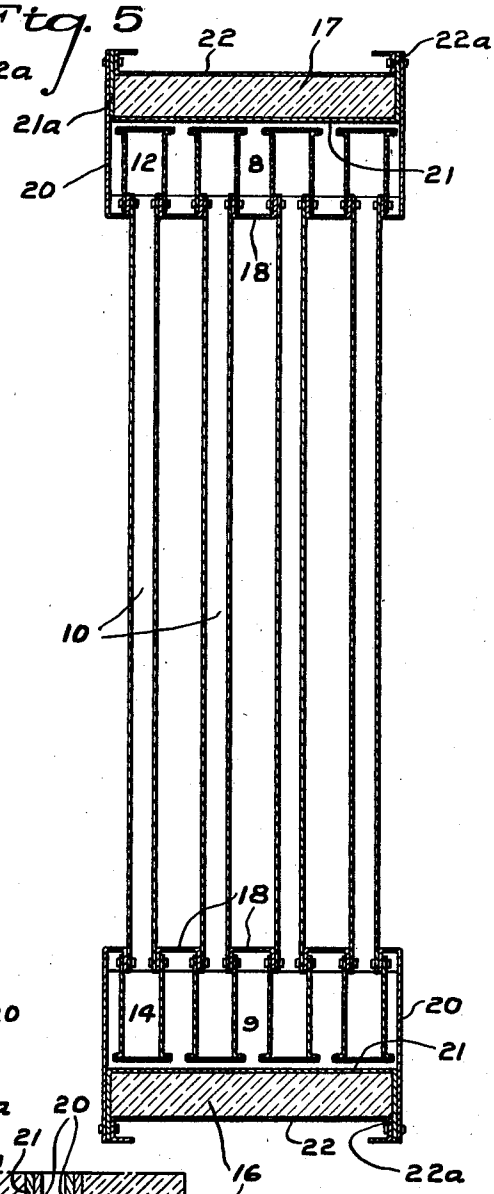


Fig. 6

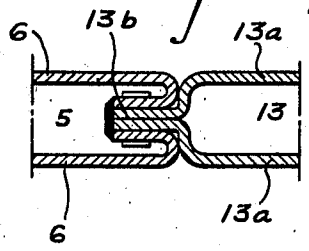
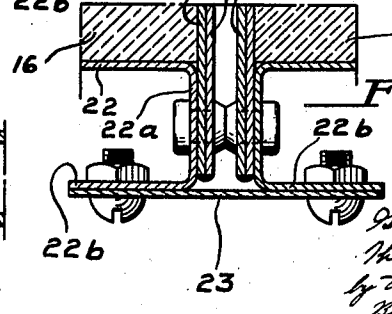


Fig. 7



INVENTORS

Gregory D. Mantle
Theodore W. Mumford
by their attorneys
Byrne, Stetkis & Parmelee

Patented Mar. 18, 1930 1,750,850

UNITED STATES PATENT OFFICE

GREGORY D. MANTLE AND THEODORE W. MUNFORD, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS, BY MESNE ASSIGNMENTS, TO SURFACE COMBUSTION COMPANY, OF TOLEDO, OHIO, A CORPORATION OF NEW YORK

RECUPERATOR

Application filed May 23, 1927. Serial No. 193,446.

This invention relates to recuperators and more particularly to a recuperator comprising a unit adapted to be united with other units to form a heat exchanger of any desired capacity.

Heretofore difficulty has been experienced in recuperators operating to transfer heat from one gas to another in that corrosion has occurred at the joints of the recuperator. We provide an improved recuperator wherein all of the joints are disposed within the ducts adapted to convey one of the gases, either the heating gas or the heated gas. The present invention will be described particularly with respect to a recuperator adapted to transfer heat from a heating gas to air, in which case all of the joints will be disposed within the air passages.

In the accompanying drawings illustrating the present preferred embodiment of our invention:

Figure 1 is a sectional elevation of a recuperator embodying our invention;

Figure 2 is a sectional view on the line II—II of Figure 1;

Figure 3 illustrates two sections of our recuperator joined together to form a single heat exchanger;

Figure 4 is a cross-sectional view on the line IV—IV of Figure 1;

Figure 5 is a cross sectional view on the line V—V of Figure 1;

Figure 6 is an enlarged detail view on the line VI—VI of Fig. 1 of the joint employed between the passages; and

Figure 7 is an enlarged cross-sectional view on the line VII—VII of Figure 3.

Referring to the illustrated embodiment, there is shown in Figure 1 a recuperator having air inlet passages 2 and 3 and an outlet 4. The inlet 2 communicates with a tortuous passage 5 formed between side plates 6 (Figure 4) and baffles 7 extending between the side plates. The passage 5 communicates with an outlet duct 8 which terminates in the outlet 4. The inlet 3 communicates with the passage 9 leading to the opposite end of the recuperator. A cross-passage 10 conducts the air transversely across the recuperator from the passage 9, the passage 10 being connected to a similar passage 11 by a duct 12 located at the end of the passages 10 and 11, and lying within the outlet duct 8. The passage 11 communicates with a cross-passage 13 extending parallel thereto, connection between the passages 11 and 13 being effected by a short duct 14 lying within the inlet passage 9. The end of the passage 13, opposite the duct 14, communicates with the outlet duct 8. The passages 10, 11 and 13 are preferably formed as hereinafter described.

The heating gas enters the recuperator from the right, as viewed in Figure 1, and flows longitudinally through a straight unobstructed passage 15 to the opposite end thereof (Figure 4). The recuperator is provided with a number of similar passages to those described. The recuperator being formed of a number of similar passages, may be readily built up to form a convenient unit, such as shown in Figures 4 and 5. These units may be joined together to build up a heat exchanger of any desired size, as shown in Figure 3.

The air entering the recuperator through the inlets 2 and 3 is divided into two streams, one of which flows in a tortuous path countercurrent to the heating gas, flowing substantially to the end of the recuperator at which the heating gas enters, but for convenience being conducted back to the end of the recuperator at which the air enters, before being discharged. The other air stream is conducted directly to the end of the recuperator at which the heating gas enters, and is passed back and forth across the end of the recuperator several times to effect cooling of the incoming heating gases to avoid burning out the recuperator if the incoming heating gases be initially too hot. The two streams of heated air are eventually united. The relative quantities of air in the two streams may be proportioned as desired.

The heat transferred to the heated air is conserved by insulation 16 and 17 lying along the exterior walls of the inlet and outlet passages 8 and 9. It will be evident from Figures 4 and 5 that when two sections of recuperator are joined to form a large heat ex-

changer, the insulating portions will lie adjacent one another (Figure 7).

The plates forming the walls of the passages within the recuperator are spaced apart by the baffles 7 which are preferably channel shaped to serve to stiffen the structure. The passage wall plates are connected to the walls of the ducts 8 and 9, extending into the interior of the ducts where they are fastened to flanged portions of the wall of the ducts. The joint is preferably riveted as well as being welded to give maximum mechanical strength and insure that there be no gas leakage. The joints being gas-tight obviate seepage of the heating gas between the joined portions so that the passages conducting the heating gas are gas-tight and free from projecting portions or joints which are subject to corrosion. The joints which are necessarily formed in the construction of the recuperator are all disposed within the air passages and the heating gases cannot wash the joints. The plates forming the recuperator are preferably made of an alloy or of other material which is heat resistant and corrosion resistant. By our improved construction embodying an advantageous disposition of the joints, the alloy or treated plates present only corrosion resistant surfaces to the heating gases.

As shown in Figure 5, the short connecting ducts 12 and 14 which extend into the passages 8 and 9 are connected to the flanged members which engage the passage wall plates. The joints in these ducts are also protected from contact with the heating gases for the reason that the ducts are disposed wholly within air passages.

The transverse passages 10, 11 and 13, which serve to convey the coolest air across the hottest portion of the recuperator are preferably formed, as shown in Figures 2 and 6, so that the joints lie within an air passage and are protected from the corrosive action of the heating gases. As shown in Figure 6, the passage walls 13^a of the passage 13 are bent together to form a closed joint having projecting flanges 13^b lying adjacent one another. The walls 6 which join the projecting flange portions 13^b are folded so that the flange contacting portions are disposed within the walls 6, placing the entire joint inside of the air passage 5, away from the heating gases. The joint is preferably riveted and welded to insure mechanical strength and gas-tight construction.

Figures 4 and 5 illustrate the construction of the ducts 8 and 9. The recuperator is preferably formed by joining the plates forming the gas passages together with channel shaped portions 18 and 19. The side walls of the ducts 8 and 9 are formed by flanged plates 20 which are riveted to the plates 6 and 6′ forming the sides of the passage walls. These plates 20 extend longitudinally of the recuperator and form the side walls of the ducts 8 and 9. Disposed within these plates 20 and engaging the same, are channel bars 21 which have flanged portions 21^a extending outwardly from the gas passages. These channel bars form walls of the ducts 8 and 9. The insulation 16 and 17 lies within the channel bars 21 and is retained there by flanged plates 22 which form the outer wall of the recuperator. The flanged plates 22 have outwardly extending flanges 22^a adapted to overlie the flanges 21^a of the channel bars 21 so that the plates 20, channels 21 and plates 22 may all be connected together by rivets through the flanged portions 22^a, 21^a and the plates 20. Thus a single row of rivets along each side serves to maintain the insulation in place, retaining the end wall of the recuperator, and forming the gas-tight joint between the walls of the ducts 8 and 9. This construction greatly simplifies assembly operations and forms an efficient closure from a mechanical standpoint, both with regard to strength and prevention of gas leakage.

The end plates 22 are provided with inturned flanges 22^b which serve as connecting portions when several recuperator units are joined to form a single large heat exchanger, as shown in Figure 7. Connection between the flanges 22^b is effected by means of a plate 23 which is bolted to the flanges, as shown in Figure 3.

It will thus be seen that our recuperator may be constructed in convenient units which may be assembled together to form heat exchangers of any desired capacity. We further provide an improved recuperator wherein the joints are all disposed within passages subjected to but one of the operating gases.

The recuperator shown in Figure 1 is illustrated in a horizontal position, but it will be understood that the recuperator may be operated in a vertical position in which case the right end, as viewed in Figure 1, will constitute the bottom. No insulation is provided at the ends of the recuperator for the reason that the ends of the recuperator form the inlet and outlet openings for the heating gas and no appreciable area is exposed to losses by conduction and radiation but the major portion of the end areas constitutes passage openings. The units are provided with insulation along the tops and bottoms thereof, as viewed in Figures 1, 4 and 5. The insulated portions lie adjacent when the units are assembled to form a large heat exchanger. Insulating material may then be applied to the side portions, as desired.

It will be understood that the term "recuperator" is used herein as a word of general definition and not of limitation, and that the term is meant to include air heaters and similar structures, as well as heat exchangers.

While we have illustrated and described

the present preferred embodiment of our invention, it will be understood that the invention is not limited thereto, but may be otherwise embodied within the scope of the following claims.

We claim:

1. A recuperator having passages adapted to conduct air and having spaces through which hot gases are circulated, said recuperator comprising plates joined together, said joints being all disposed within the air passages out of contact with the hot gases.

2. A recuperator comprising a plurality of joined members forming passages for heating and heated gases, all of the joints being disposed within the passages for the heated gases.

3. A recuperator having a gas passage and an insulating medium adjacent said passage, at least two of the walls of said passage comprising substantially parallel plates, a channel bar intermediate the plates and forming a third wall of the passage, insulating material adjacent the channel bar, and a flanged plate intermediate the flanges of the channel bar and adapted to retain the insulating medium within the channel bar.

4. In a recuperator, a pair of adjacent passages, the walls of one of said passages being inwardly bent and outwardly flanged to form a closure, the flanges lying in contact with one another, the walls of the adjacent passage being folded inwardly, the inner ends of said folds lying in contact with the flanged portions of the adjacent passage walls, and means securing the folds and flanges together to form a gas-tight joint.

5. A heat exchanger comprising a plurality of recuperating units joined together, said recuperator units comprising a plurality of plates joined together to form gas passages and insulating portions lying outside of the gas passages, said insulating portions being adapted to lie adjacent one another when the units are joined together to form a substantially continuous insulating covering on the outside of the heat exchanger.

6. In a recuperator, a pair of plates forming the side walls of a duct, a channel bar interposed between the plates and forming a third wall of the duct, insulating material lying within the channel bar, a flanged plate disposed outside the insulating material and adapted to hold the same within the channel bar and means connecting the first mentioned plates, the channel bar and the flanged plate, whereby the insulating material is retained in place and a gas-tight joint is formed between the channel bar and the plates forming the walls of the duct.

7. In a recuperator, a plurality of substantially parallel plates forming passages for heating and heated gases, a plurality of baffle members disposed transversely of the longitudinal axis of the plates forming passages transversely of said axis, and ducts connecting adjacent transverse passages, said ducts lying at the edges of said plates whereby the transverse passages are longer than the width of the plates.

8. In a recuperator, a plurality of substantially parallel plates forming gas passages, a conduit disposed at the edge of said plates, a wall of said conduit comprising a plurality of channel shaped members connecting said plates, the joints between the plates and channel members extending into the conduit.

9. A recuperator having hot gas circulating passages and air heating passages, and constructed of alternated longitudinally extending channel bar members and plate members lying in planes at right angles to each other, the joints between the channel bar members and the plate members being welded and being turned outwardly so that they are outside the hot gas passages.

10. A recuperator unit having hot gas circulating passages and air heating passages, said recuperator being constructed of longitudinally extending plates, channel bars between adjacent plates holding them in spaced relation, the channel bars having their flanges turned outwardly, the joints between the channel bars and the plates being gas-tight, longitudinally extending flanged side plates secured to the edges of the outer two plates to provide parallel confining walls along each side of the unit, an outwardly turned channel between the two confining walls at each side of the unit to form, with the confining walls, longitudinally extending conduits at each side of the unit, heat insulating material in said last mentioned channel bars, and a flanged member set in the last named channel bars to retain the heat insulating material in place.

11. A recuperator unit having hot gas circulating passages and air heating passages, said recuperator being constructed of longitudinally extending plates, channel bars between adjacent plates holding them in spaced relation, the channel bars having their flanges turned outwardly, the joints between the channel bars and the plates being gas-tight, the spaces between alternate pairs of plates being air passages, the plates at one end being turned inwardly into the air circulating passages, other pairs of spaced apart plates having their edges extending between the inwardly turned ends of the air passages and forming a gas tight joint therewith, the said joint lying entirely in the air passage and being protected from contact with the gases in the hot gas passages.

12. A recuperator comprising a plurality of jointed members forming passages for heating and heated gases, all of the joints longitudinally and transversely of the structure being disposed within the passages for the heated gases.

13. A recuperator comprising a plurality of jointed metal members forming passages for heating and heated gases, all of the meeting edges of the metal members projecting into passages for the heated gases and being welded within said passages.

14. In a metal recuperator structure, a plurality of metal members joined together to provide hot gas and air circulating passages, all meeting edges between the metal members both longitudinally and transversely of the structure projecting into the air passages and providing heat dissipating fins or projections within said air passages.

15. In a metal recuperator structure, a plurality of metal members joined together to provide hot gas and air circulating passages, all meeting edges between the metal members both longitudinally and transversely of the structure projecting into the air passages and providing heat dissipating fins or projections within said air passages, said meeting edges being welded together with the welds in the air circulating passages.

16. In a metal recuperator structure, a series of spaced metal plates arranged in pairs and providing alternate air and gas circulating passages, the plates of a pair having some of the edges turned inwardly and jointed within the air passage formed between them whereby the joint is protected from contact with the gases in the gas circulating passages.

In testimony whereof we have hereunto set our hands.

GREGORY D. MANTLE.
THEODORE W. MUNFORD.