Oct. 12, 1937. C. E. LEHR 2,095,643

RECUPERATOR

Filed Feb. 6, 1937 3 Sheets-Sheet 1

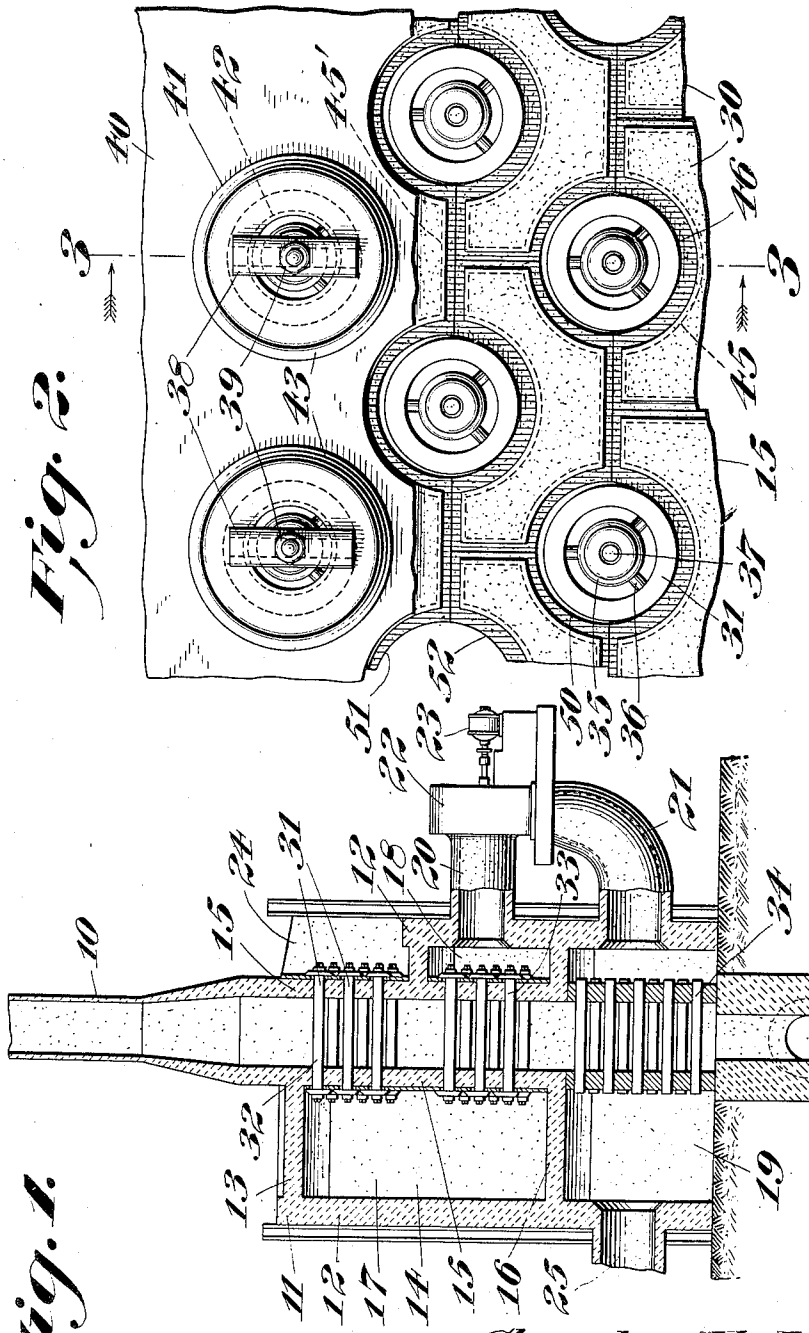

Fig. 2.

Fig. 1.

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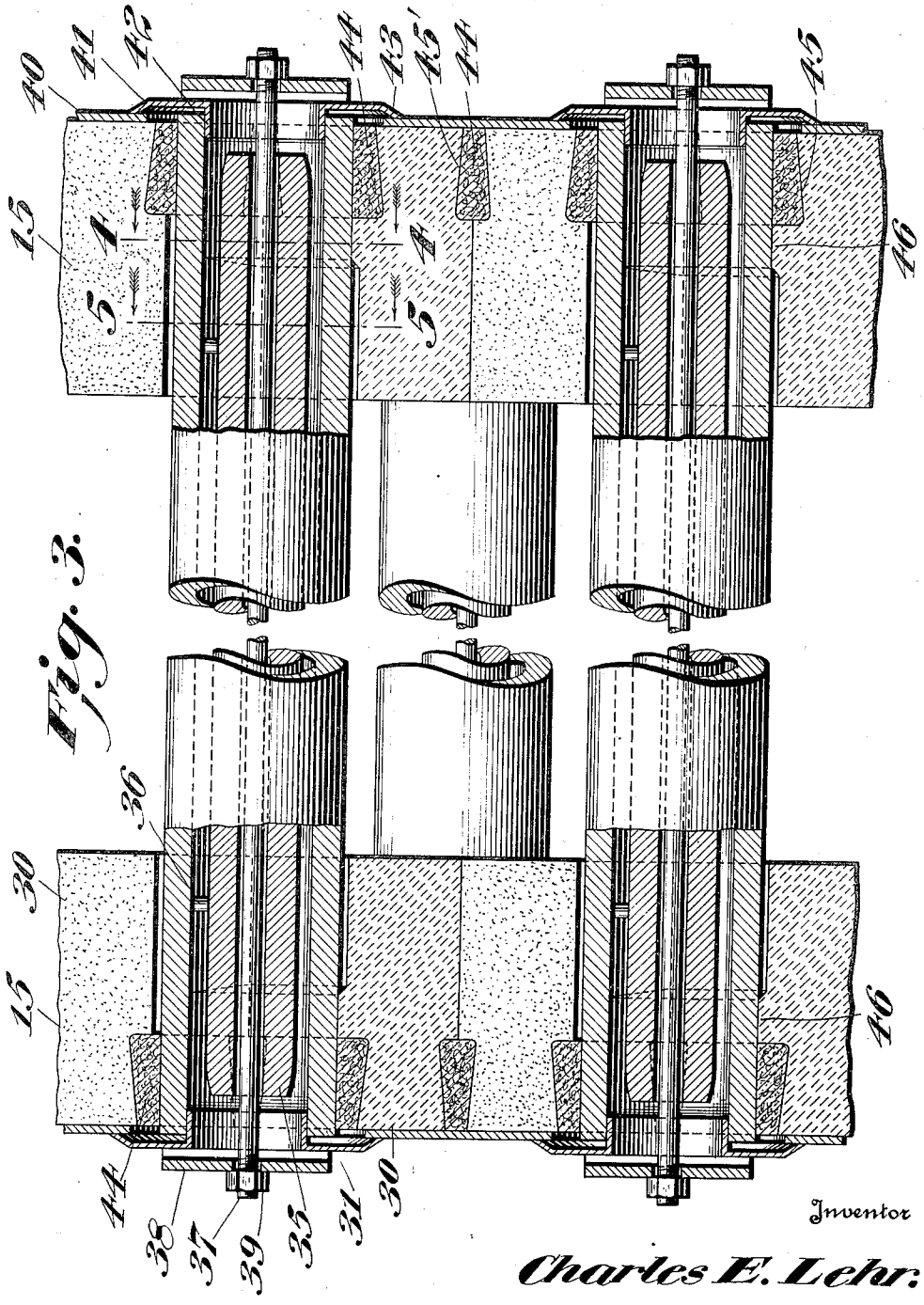

Fig. 3.

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Fig. 5.

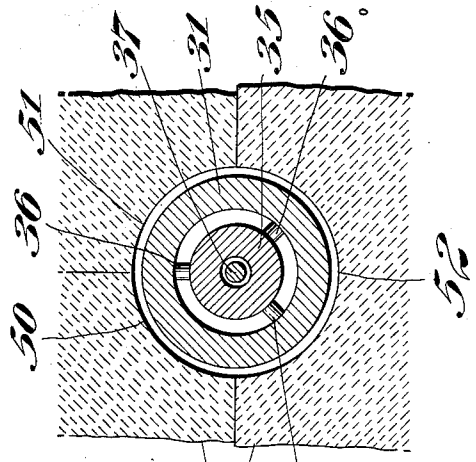
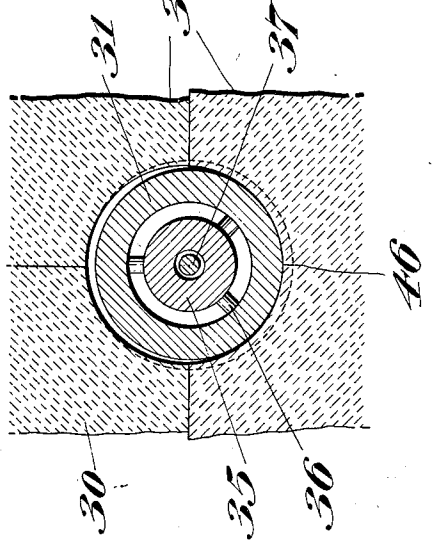


Fig. 4.



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Patented Oct. 12, 1937 2,095,643

UNITED STATES PATENT OFFICE

2,095,643

RECUPERATOR

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Application February 6, 1937, Serial No. 124,422

8 Claims. (Cl. 263—20)

This invention relates to improvements in recuperator structures for pre-heating air or gas for combustion in a furnace chamber. It relates particularly to the type of recuperator in which refractory tubes are employed to convey the gas to be pre-heated through the recuperator chamber.

In recuperators of this type, considerable difficulty has heretofore been experienced, due to the method of mounting the tubes in the terminal walls. The tubes were mounted rigidly in the wall blocks, no provision being made for expansion and contraction of the tubes or of the wall. As a result, a great deal of breakage of the tubes took place, causing increased expense in operation as well as delays and inconvenience.

It is an object of this invention to provide a recuperator having walls so constructed as to permit the tubes to be firmly and securely mounted therein, and at the same time to allow the tubes to expand and contract as necessitated without damage to the tubes.

It is a further object to provide means for sealing the openings in said terminal walls to prevent leakage of gases.

The novel features of my invention will be more fully understood from the following description and claims taken with the drawings, in which

Fig. 1 is a vertical section of a three pass recuperator of the vertical type with my improved wall structure incorporated therein;

Fig. 2 is an enlarged end view of a portion of the terminal wall, with a part of the metal wall plate broken away;

Fig. 3 is a section along the line 3—3 of Fig. 2;

Fig. 4 is a section along the line 4—4 of Fig. 3, and

Fig. 5 is a section along the line 5—5 of Fig. 3.

Referring now to the drawings, Fig. 1 shows the furnace stack 10 with the recuperator structure 11 integral therewith. The recuperator has walls 12 and roof 13 which form the recuperator chamber 14. Walls 15 and horizontal wall 16 divide the chamber 14 into compartments 17, 18 and 19. Communicating with chambers 18 and 19 through pipes 20 and 21 is fan 22 driven by motor 23. Air or gas to be preheated is admitted to the recuperator through duct 24 and is conveyed to the furnace through conduit 25. Waste gases from the furnace are conveyed to the recuperator through conduit 26.

Terminal walls 15 are constructed of bricks or blocks 30, the details of whose shape will be hereinafter described. Mounted in walls 15 are a plurality of refractory tubes 31. In the structure shown in Fig. 1, these tubes 31 are divided into three groups 32, 33 and 34 to form a three pass recuperator. Tubes 31 are provided with refractory cores 35 mounted within tubes 31 and spaced therefrom by pins 36. Metallic bolts or rods 37 pass through cores 35 and are held in place by U-shaped yokes or plates 38 and nuts 39. Walls 15 are covered by heat-resisting metal plates 40 having openings therein for tubes 31. Cupped metallic washers 41 have annular flanges 42 adapted to fit into the ends of tubes 31 and beveled flanges 43 adapted to fit tightly against metal wall plates 40. Washers 41 are held in tight engagement with plates 40 by yokes 38.

Tubes 31 are surrounded at their ends by packing or sealing material 44.

Blocks 30 are generally Y-shaped in cross-section. They are provided in their external faces with recesses 45 adapted to receive and retain sealing material 44. The top surfaces of the blocks are provided with bearing surfaces or shoulders 46, positioned almost intermediate the front and back faces of the block. The under surfaces of the blocks are also provided with recesses 45′ for the reception of sealing material. The cut out portions 50, 51 and 52 of blocks 30 are so proportioned that when in position they provide an opening of slightly larger diameter than that of tubes 31. This provides a clearance above the tubes 31, as clearly shown in Figs. 3, 4 and 5. The shoulders or bearing surfaces 46 support the bottom of the tubes and hold them out of contact with the surface of blocks 30, except that portion of the blocks forming shoulders 46. This provides a clearance for the bottom half of the tubes 31, also as shown in Figs. 3, 4 and 5. As a result, the tubes are free to expand and contract with practically no danger of breaking on account of rigid installation.

Blocks 30 may be of firebrick or similar inexpensive material, because, due to my improved construction, it is not necessary that the recuperator tubes and the terminal walls be made of materials having the same coefficient of expansion.

In cases where extremely high temperatures are developed in the waste gases, it may be desirable to build the terminal walls of a more highly refractory material in the location where the temperatures are highest. Thus, in Fig. 1, I have shown that portion of the terminal walls which contains group 34 of tubes 31 as built of the same refractory materials as the tubes. I employ in this portion of the terminal walls my

improved shape of block **30**, but the metal wall plates **40** and cupped washers **41** may be dispensed with.

In operation, the hot waste gases from the furnace are conveyed to the recuperator through conduit **26** and pass upwardly, circulating about and heating tubes **31** and passing off through stack **10**. The air or gas to be heated enters through duct **24**. It is drawn by fan **22** through groups **32** and **33** of tubes **31**, and compartments **17** and **18**, and is blown through group **34** of tubes **31** and compartment **19**, and to the furnace through conduit **25**.

In actual operation, my improved form of construction has effected a considerable reduction in tube and wall breakage, with resultant economies in operation. Expensive delays for repair or replacement of cracked tubes and wall blocks are substantially eliminated, and waste of heat through leakage is greatly reduced.

While I have described my invention in considerable detail, I do not wish to be limited to such details, as numerous variations of my invention might be constructed without departing from the scope thereof.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a recuperator structure a tube terminal wall having a tube passing therethrough, said wall providing a sealing recess around the extremity of the tube, and a bearing in offset relation to said recess for supporting the tube directly on the wall and a clearance above the tube, whereby the portion of the tube above the bearing is unconfined with respect to the wall structure.

2. In a recuperator structure a tube terminal wall having a tube passing therethrough, said wall providing a sealing recess around the extremity of the tube, a bearing in offset relation to said recess for supporting the tube directly on the wall, a bottom clearance recess in offset relation to said bearing, and a top clearance recess above the bearing, whereby the portion of the tube above the bearing is unconfined with respect to the wall structure.

3. In a recuperator structure a tube terminal wall having a tube passing therethrough, said wall being provided with a sealing recess around the extremity of the tube, a bearing in offset relation to said sealing recess for supporting the tube, a clearance recess at the bottom of the tube in offset relation to said bearing, and a clearance recess above the tube in offset relation to said sealing recess.

4. In a recuperator structure a tube terminal wall having a tube passing therethrough, said wall being provided with a sealing recess around the extremity of the tube, a bearing in offset relation to said sealing recess for supporting the tube, a clearance recess below the tube extending from said bearing to the inside face of the wall, and a clearance recess above the tube extending from said sealing recess to the inside face of the wall.

5. In a recuperator structure a tube terminal wall having a tube passing therethrough, said wall being provided with a sealing recess around the extremity of the tube, a bearing in offset relation to said sealing recess for supporting the tube, a clearance recess below the tube extending from said bearing to the inside face of the wall, a clearance recess above the tube extending from said sealing recess to the inside face of the wall and sealing compound in said sealing recess only, whereby that portion of the tube inside of said bearing and said seal is unconfined with respect to the wall structure.

6. In a recuperator structure, refractory tube terminal walls, tubes passing through said walls, means for sealing the tubes in the walls, heat-resisting plates covering the outside faces of the walls, cupped washers engaging said plates and openings defined by flanges engaging the ends of said tubes, yokes engaging said washers, and bolts extending through the tubes and the yokes adapted to draw said washers against said plates, whereby to reduce leakage through said walls.

7. In a recuperator structure, refractory block terminal walls, refractory tubes passing through said walls, means for sealing the ends of the tubes in the walls for a distance less than the thickness of the walls, means for sealing the joints between said blocks, heat-resisting plates covering the outside faces of the walls, cupped washers engaging said plates and having central openings defined by the tubes, flanges adapted for entering the ends of yokes engaging said washers, cores positioned in the tubes, bolts extending through the cores and the yokes adapted to draw said washers against said plates, said tubes being normally of less length than the distance between the inside faces of the cupped washers, whereby to allow free expansion of the tubes when heated and to reduce leakage through the joints in the walls.

8. In a recuperator structure, a tube terminal wall consisting of refractory blocks having complementary recesses arranged to form staggered openings for the reception of the ends of the tubes, said openings being formed so as to provide shallow tapered recesses around the ends of the tubes for the reception of packing, narrow bearing portions for the bottoms of the tubes intermediate said recesses and the inside face of the wall, and clearances above the tubes extending from said recesses to the inside face of the wall.

CHARLES E. LEHR.