Nov. 22, 1932. J. R. GEORGE 1,888,720

RECUPERATIVE FURNACE CONSTRUCTION

Filed May 27, 1930 2 Sheets-Sheet 1

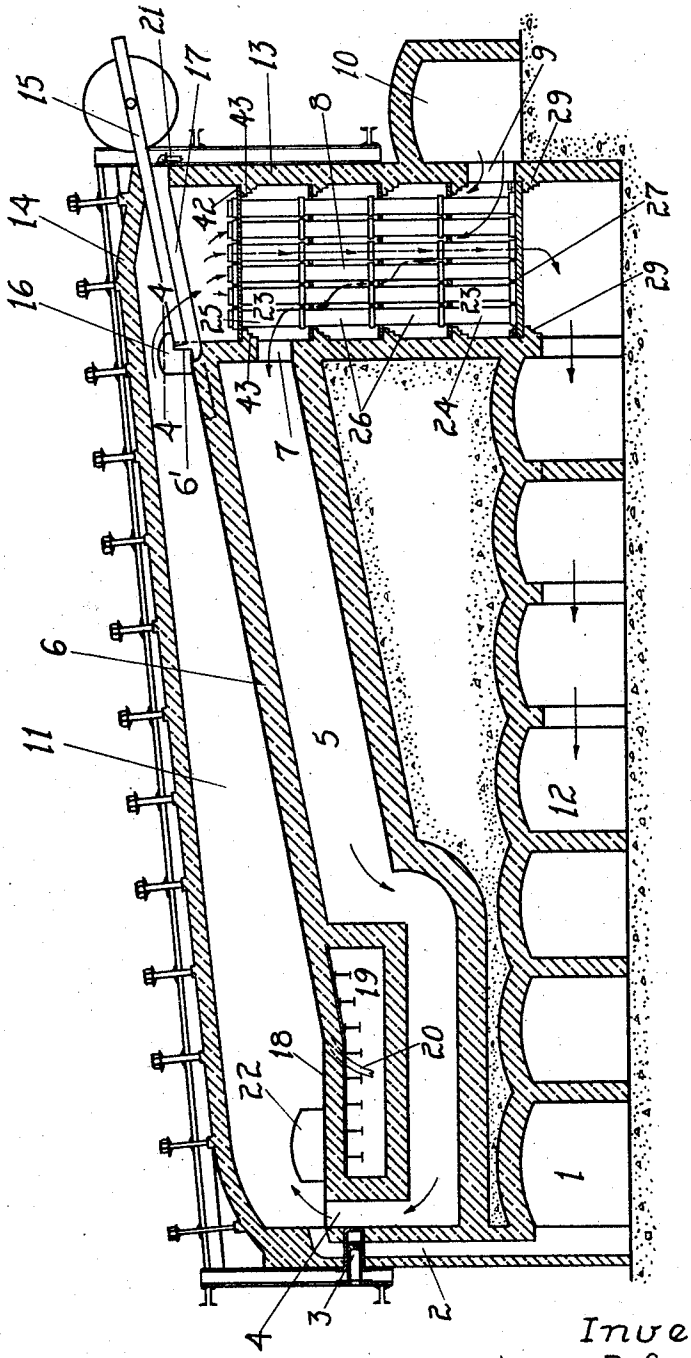


Fig. 1.

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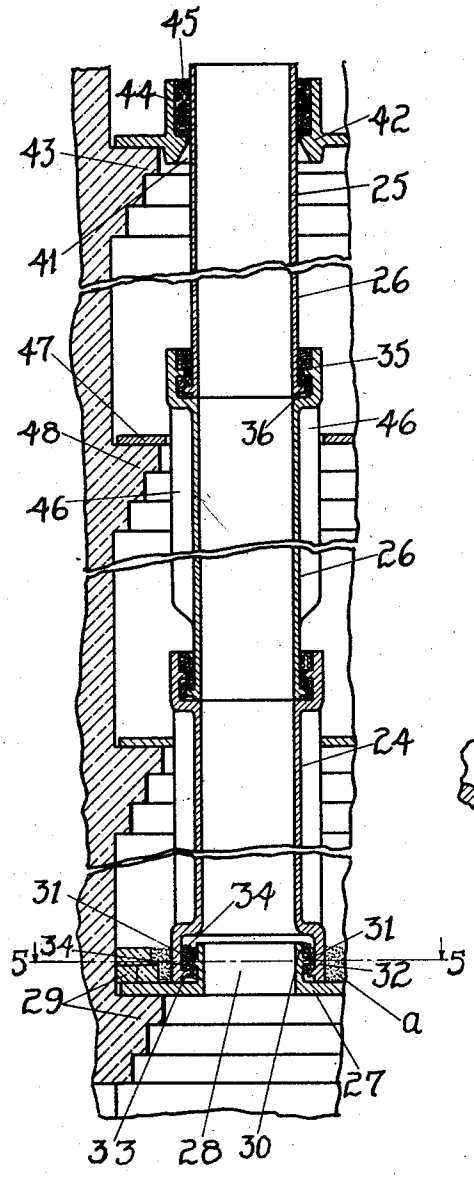


Fig. 2.

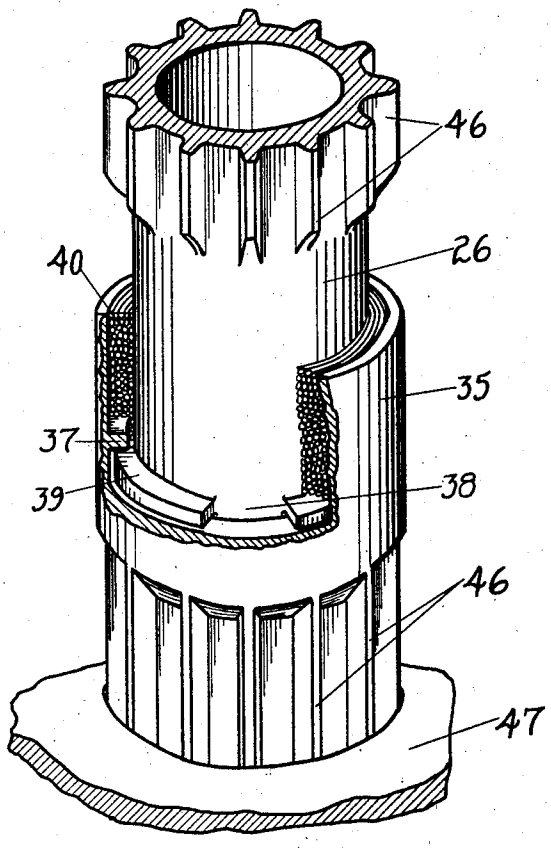


Fig. 3.

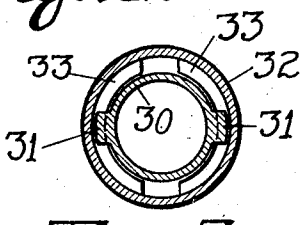


Fig. 5.

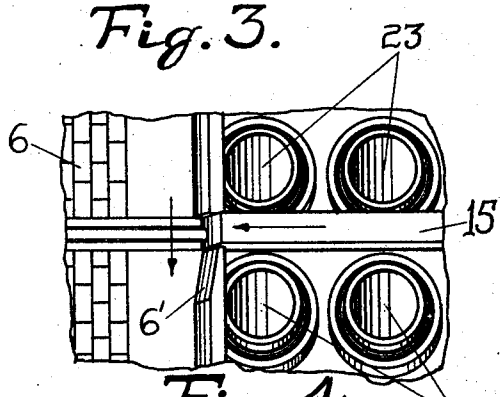


Fig. 4.

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UNITED STATES PATENT OFFICE

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RECUPERATIVE FURNACE CONSTRUCTION

Application filed May 27, 1930. Serial No. 456,206.

This invention relates to recuperative furnaces, in which the air used to support combustion is preheated, on its way to the combustion chamber, by circulating it in contact exteriorly with a plurality of substantially vertical metal pipes or tubes that receive the hot combustion gases from the furnace chamber and convey them to the stack.

These pipes or tubes in the ordinary recuperator or stove construction are a source of constant trouble. Owing to the high temperatures of the waste gases passing through them, they frequently burn out, especially at their upper ends where the gases are hottest; the task of replacing a burned out tube or tubes is ordinarily extremely arduous, requiring usually, among other things, the removal of the furnace roof or arch, in order to take out the burned tube and to set the new tube in position. Another source of constant trouble is the tendency for the expansion and contraction of a tube to destroy the seal made by the lower end of the tube with the supporting plate of the recuperator structure; when the tube expands, its movement is upward through the top plate of the recuperator structure, and the friction at this point is oftentimes sufficient to support the weight of the tube so that when contraction takes place, the lower end of the tube is pulled away from the bottom plate, allowing the sand or other sealing material to get in under the lower edge of the tube; when expansion again occurs, the tube pushes up still further through the upper plate and finally, through repetition of the above described action, the seal at the bottom is entirely destroyed, so that the necessary segregation of the outgoing gases and the ingoing air can no longer be maintained.

By the present invention, the seal at the bottom of each tube embodies an interlock between the tube and the bottom plate so that, regardless of expansion and contraction, the seal is always maintained. Also, according to the invention, each tube is made in a plurality of sections, so that in case of burning out, the necessary replacement can be made without any great difficulty, and with no need to remove the furnace roof for passage of a full-length tube. This sectional construction makes possible another important feature of the invention, namely, the use, as a material for the upper part of each tube, of special heat-resisting alloys, which, because of their expense, could not be economically employed in the lower tube sections where the temperatures prevailing are much less destructive. A further feature of the invention is the employment of exterior heat-radiating ribs on the tube sections, to promote the transfer of heat to the air which circulates through the recuperator. Other and further objects and advantages of the invention will be apparent from the following detailed description thereof taken in connection with the accompanying drawings, in which—

Fig. 1 is a longitudinal sectional view of a metal heating furnace having a recuperator or stove of the improved construction and arrangement.

Fig. 2 is a large scale fragmentary vertical sectional view showing the tube construction.

Fig. 3 is a large scale isometric view partly in section, illustrating the tube construction and assemblage.

Fig. 4 is a fragmentary large scale plan view of the charging end of the furnace, as viewed from the line 4—4 of Fig. 1.

Fig. 5 is a section on the line 5—5 of Fig. 2.

Like reference characters refer to like parts in the different figures.

Referring first to Fig. 1, the invention is shown by way of example in connection with a metal-heating furnace of the gas-fired type, providing near one end thereof a suitable flue 1 for conducting producer gas or other gaseous fuel to an upwardly-extending passage 2, which is controlled by the usual valve 3. The air for admixture with said gaseous fuel, to support combustion within the furnace, is delivered adjacent the outlet of passage 2 from a suitable port or ports 4, being conveyed thereto through a passage 5 running nearly the full length of the furnace, beneath the furnace floor 6. Said air enters passage 5 through a suitable opening or openings 7 from the upper end of the recuperator or stove structure, designated generally by the numeral 8, being blown into the latter at the

bottom through an opening or openings 9 from a flue 10, to which is connected a suitable blowing device, not shown. In said recuperator or stove structure 8, as hereinafter described, the upwardly moving entering air is heated by its contact with tubes or pipes that carry off the hot waste gases from the heating chamber 11 of the furnace,—said gases being drawn longitudinally of said chamber 11 from left to right in Fig. 1 for passage downwardly through the recuperator tubes and thence exhausting through a suitable flue or flues 12 to the stack, not shown.

The recuperator or stove structure 8 is here shown as within the end wall 13 of the furnace, said wall providing the usual opening, at or near its juncture with the furnace roof or arch 14, for the passage of a suitable pusher or pushers 15, by which the metal billets or bars, as charged longitudinally into the furnace at this end, are moved broadside, step-by-step, along the furnace floor 6 toward the other end of the heating chamber 11. The billets are successively charged onto the hearth 6 through the usual side wall door 16, in substantial alinement with which is a transverse upstanding guide 6′, recessed for the passage of pusher 15, and arranged to prevent deflection of an entering billet onto the pusher skids 17, 17 that overlie the recuperator 8, and thus the scale from said billets is prevented from dropping into said recuperator through the spaces between said skids 17, 17,—which spaces serve for the exit of the combustion products from the furnace chamber 11 to the recuperator or stove. The above-described disposition of the charging zone of the furnace, relative to the recuperator or stove, forms the subject matter, in part, of my copending application Serial No. 613,643, filed May 26, 1932, for a "Metal-heating furnace", and therefore no claim to such subject matter is herein made. The pushers 15 operate in the usual way to advance the row of billets, step-by-step, toward the furnace hearth 18, the latter preferably being cooled by the admission of a suitable cooling medium, such as air or water to its underlying hollow space 19; said cooling medium, if desired, may be discharged from said space through a pipe 20 running lengthwise of the furnace floor 6 and communicating at its other end with the inner ends of the skids 17, 17, the latter being made hollow, as shown in Fig. 4, for the circulation therethrough of said cooling medium. A pipe 21, Fig. 1, connected to the skids 17, 17 at their outer ends, serves for the disposal of the cooling medium in any suitable manner. The discharge of the individual billets as they arrive at the end of the hearth 18, after passage through the entire length of the furnace, is through the usual door 22 provided by one of the side walls of the furnace.

In the recuperator or stove structure 8, the hot waste gases pass downwardly through a plurality of pipes or tubes 23, 23, each comprising a bottom section 24, a top section 25, and a plurality of intermediate sections 26, 26. The several tubes find support on the bottom plate 27 of the recuperator, the latter, as shown in Fig. 2, having an aperture 28 for registration with each tube and being itself supported and held by the brickwork 29 of the furnace walls. Each aperture 28 has an upstanding flange 30 which, as shown in Fig. 5, is provided with diametrically opposite exterior lateral projections 31, 31. The flange 30 is received within the enlarged lower end 32 of bottom tube section 24, when the latter is lowered into position,—this lowering movement being possible only when the diametrically opposite gaps between interior segmental projections 33 on enlargement 32 are registered with the projections 31, 31 of flange 30. Afterwards, the tube section 24 thus lowered is turned through an appropriate angle, say 90°, to offset said gaps from the projections 31, 31, so that the projections 33, 33 underlie said projections 31, 31, as shown in Fig. 5, thus securely interlocking the tube section 24 with the bottom plate 27. The annular space between flange 30 and enlargement 32 is filled with suitable packing material 34, and all the joints thus made between the bottom plate 27 and the lower ends of the tubes 23, 23 are effectively sealed with sand or other suitable material, as indicated at *a*; for this purpose, the sand is simply packed to the desired depth on the upper surface of plate 27 to fill the spaces between the enlargements 32, 32 of the several lower tube sections 24, 24. Such a seal is permanently maintained, notwithstanding repeated expansion and contraction of the tubes, because the interlock above described between each lower tube section 24 and the bottom plate 27 prevents any relative movement between these parts such as would allow the sand or other sealing material to run beneath the lower end 32 of the tube.

At the upper end, each bottom section 24 is bell-mouthed, as shown at 35, to receive telescopically the lower end of the adjoining intermediate tube section 26, the latter seating on an interior flange 36. Each added tube section has a similar connection to the one preceding, and in each case the superposed and telescoped sections have an interlock between them of substantially the same construction as that employed at the base of each tube,—each bell-mouth 35, as shown in Fig. 3, having diametrically opposed inner projections 37, 37 with which are registered the gaps 38 in the segmental flanges 39 of the superposed tube section, as the latter is lowered into position within the bell-mouth, whereupon said superposed tube section is turned on its axis, as shown in Fig. 3, to interlock the flanges 39 with the projections 37.

Suitable packing material 40 is inserted to fill the space between each bell-mouth 35 and the telescopically received lower end of the other tube section.

The final or upper section 25 of each tube, whose lower end is telescopically received as above described in the bell-mouth 35 of the underlying or intermediate tube section 26, is formed, as shown in Fig. 2, with a plain upper end for passage through an aperture 41 of top plate 42, the latter being suitably supported on abutments 43 of the furnace wall. Each aperture 41 of top plate 42 has an upstanding flange 44, encircling the upper end of section 25 and spaced therefrom for the reception of asbestos or other suitable packing material, as indicated at 45. Each upper tube section 25, according to the invention, is made of a special heat-resisting alloy, for example chrome nickel steel, the better to withstand the extremely high temperatures in this part of the recuperator where the furnace gases are the hottest. This feature is made possible by the sectional construction of the tubes 23, 23; if said tubes were of the ordinary one-piece construction, the cost of using such an alloy for the material of said tubes would be prohibitive. The sectional construction of the tubes furthermore permits the relatively easy replacement of any burned-out tube or tube section, because it is not necessary, for this purpose, to dismantle or disturb the furnace roof, in removing the burned-out tube or putting a new tube in place.

The heat exchange between the descending furnace gases in the tube and the ascending air on the outside of said tubes is materially promoted by providing each tube section, as shown in Figs. 2 and 3, with heat radiating ribs 46, 46, and by obliging the air in its ascent to travel in the channels between said ribs; for this purpose, suitable transverse plates or baffles 47, 47 are supported within the recuperator on abutments 48, 48 of the furnace walls, and said plates or baffles are apertured to receive the ribbed portions of the several tube sections, as best shown in Fig. 2. In this way, the air in its upward movement is constrained to follow the channels between the ribs, and is thus maintained in intimate heat exchanging relation with the surfaces of said tubes.

My invention, as compared to other tube recuperators whose bottom tube-supporting plates provide a sand-seal around the lower ends of the tubes, affords an outstanding advantage. In said other sand-sealed constructions, repeated expansions and contractions of a tube tend ultimately to render ineffective the sand-seal at its lower end, because the frictional engagement of the expanded tube with its aperture in the upper plate oftentimes prevents said tube on contraction from maintaining the contact of its lower end with the bottom plate; as a result, the sand of said seal flows in under the lower end of the tube, so that when expansion again occurs, the tube pushes up still further through the top plate, and finally, by successive repetitions of this action, reaches such an elevation that the seal at the bottom is entirely destroyed. In my construction, on the other hand, the detachable interlock between tube and bottom plate, provided by the matching projections 31 and 33, prevents any impairment of the sand-seal at the bottom of the tube, while still allowing free expansion and contraction of the tube.

I claim:

1. In a furnace recuperator of the class described, a tube for the passage of hot waste gases from the furnace, said tube providing exterior heat-radiating ribs, and means for directing the air in its passage through said recuperator into the spaces between said ribs.

2. In a furnace recuperator of the class described, an upper plate and a lower plate, a tube with its lower end resting on said lower plate in registry with an aperture therein, and with its upper end telescopically received in an aperture of said upper plate, sand or like material on the surface of said lower plate to provide a seal in surrounding relation to the lower end of said tube, and means for detachably interlocking said tube with said lower plate to prevent axial displacement of the lower end of said tube, whereby upon recurring expansions and contractions of said tube, its frictional engagement with the aperture of said upper plate is rendered ineffective to so space the lower tube end from the lower plate as ultimately to destroy the seal provided by said material.

3. In a furnace recuperator of the class described, a pair of spaced tube-supporting plates having registering apertures, a tube passing telescopically through an aperture of one plate and having its other end in sand-sealed registry with an aperture of the other plate, and means on said last-named tube end to provide a detachable interlock with said last-named plate, thereby rendering ineffective on said sand-seal the recurring expansions and contractions of said tube that tend, by the friction between the tube and the first-named plate, to separate said tube from the last-named plate.

4. In a furnace recuperator of the class described, a pair of spaced tube-supporting plates having registering apertures, a tube passing telescopically through an aperture of one plate, with its other end seated on the other plate in registry with an aperture therein, sand or like material on said last-named plate to provide a seal between said plate and said tube, and a projection on said tube adapted, by angular movement of the latter, to be brought into opposition with a matching projection on said last-named plate, thereby to provide a detachable interlock between tube and plate which prevents impairment of said

seal due to recurring expansions and contractions of said tube.

5. In a furnace recuperator of the class described, an upper plate and a lower plate, said plates having registering apertures, a tube connecting said apertures and passing telescopically through one of them, a sand-seal surrounding said tube at its juncture with the other of said apertures, and a bayonet-joint interlock between said tube and the plate which provides the last-named aperture, whereby to maintain said seal under recurring expansions and contractions of said tube, while permitting the latter's detachment for removal by a relatively slight angular movement.

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