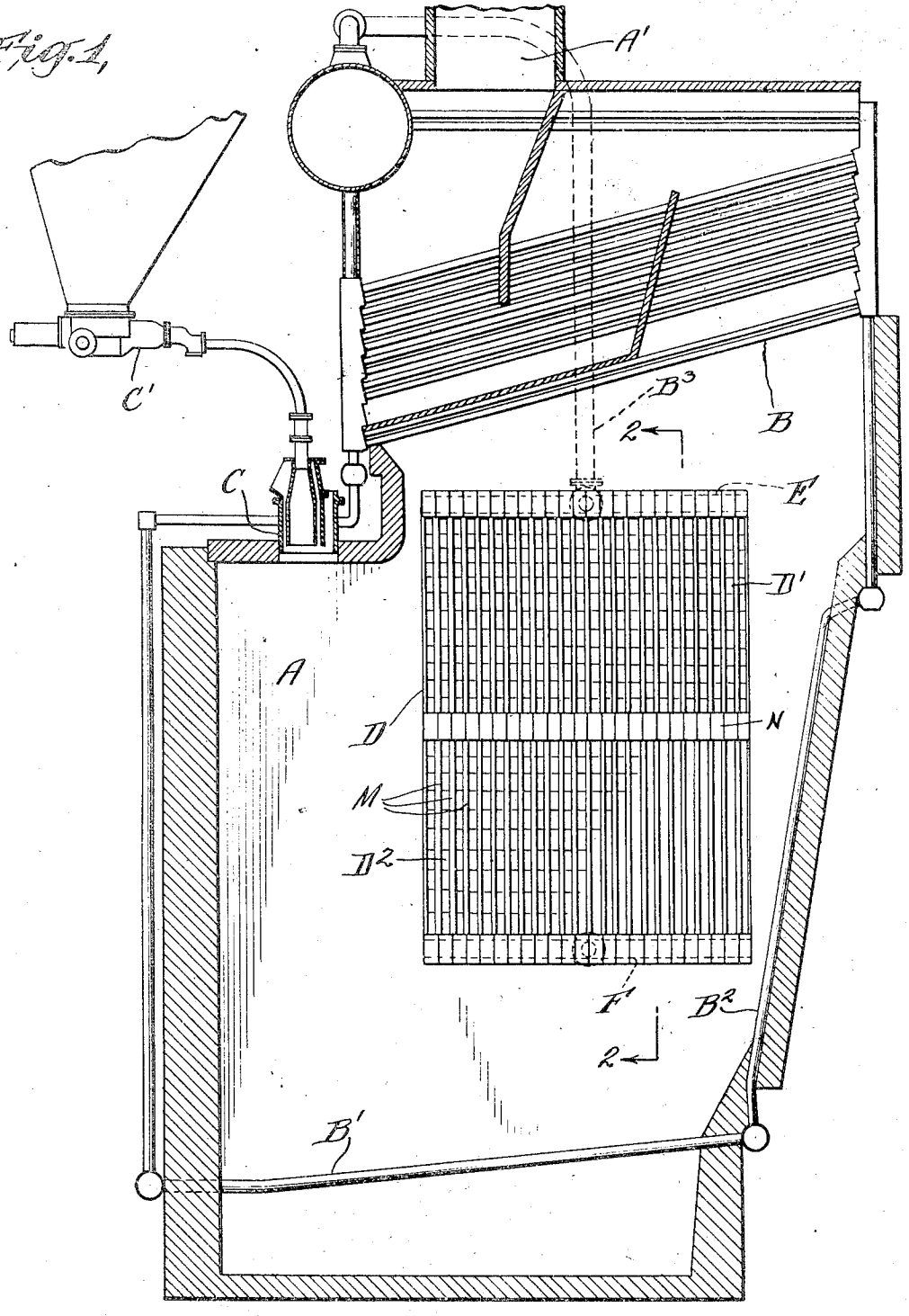
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HEATING APPARATUS

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Fig. 1.



INVENTOR
John E. Bell
BY John E. Bubbell
ATTORNEY

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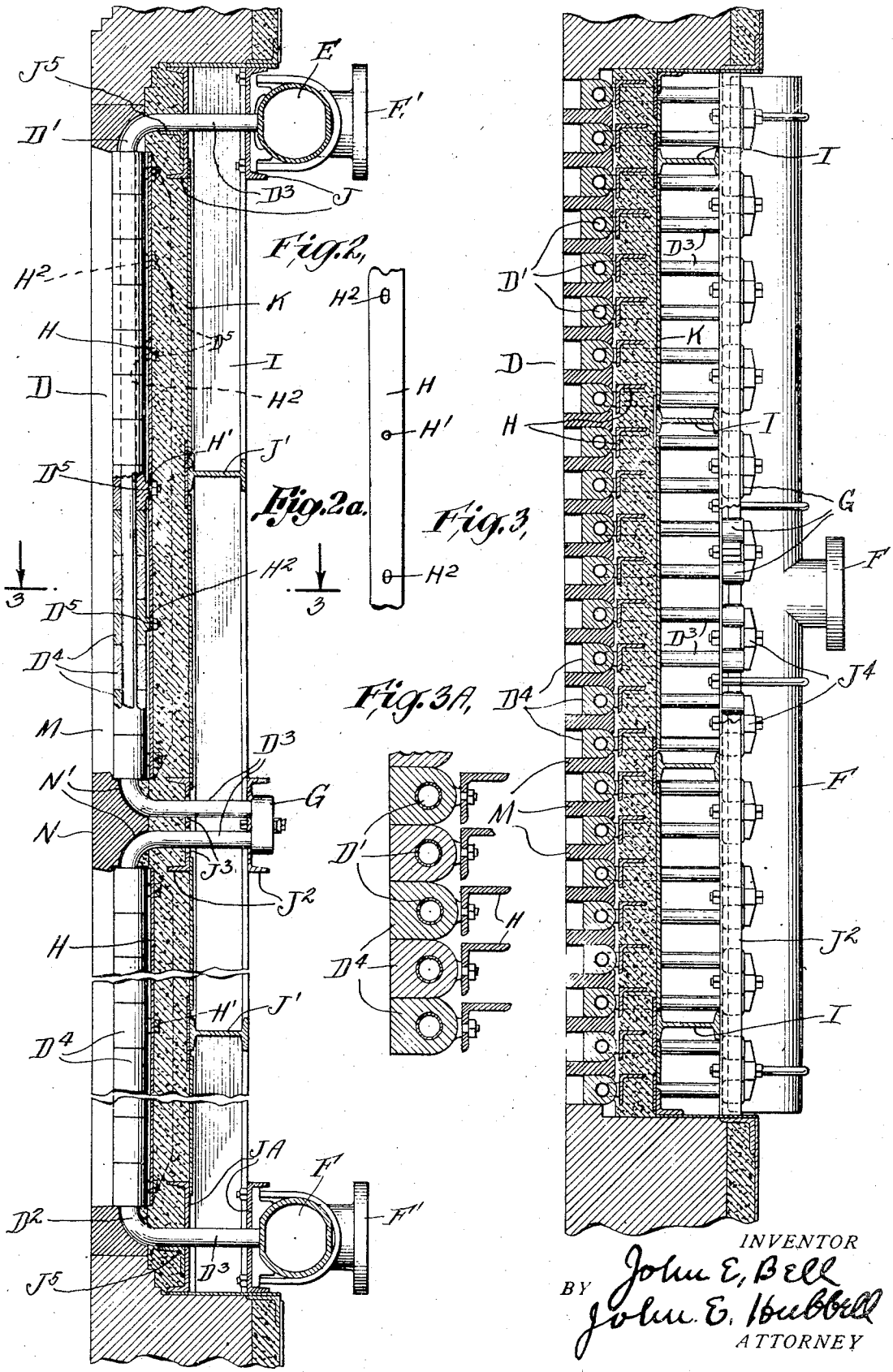


Fig. 2.

Fig. 2a.

Fig. 3.

Fig. 3A.

INVENTOR

BY John E. Bell

John E. Hubbell

ATTORNEY

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Fig. 4.

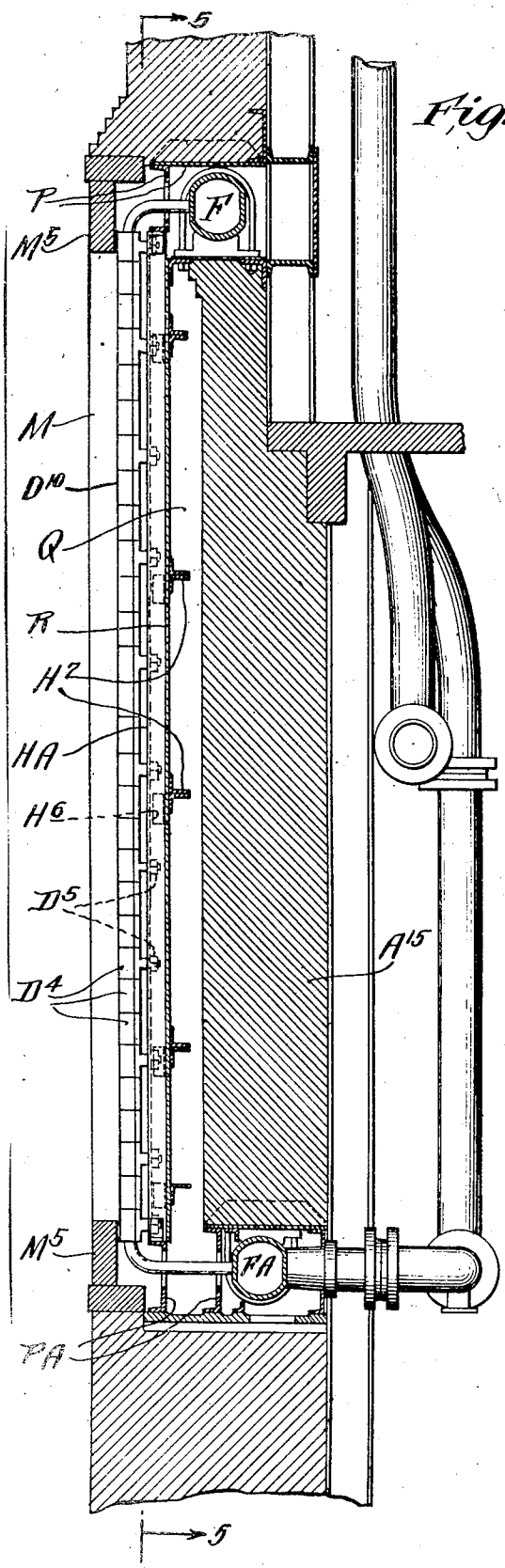
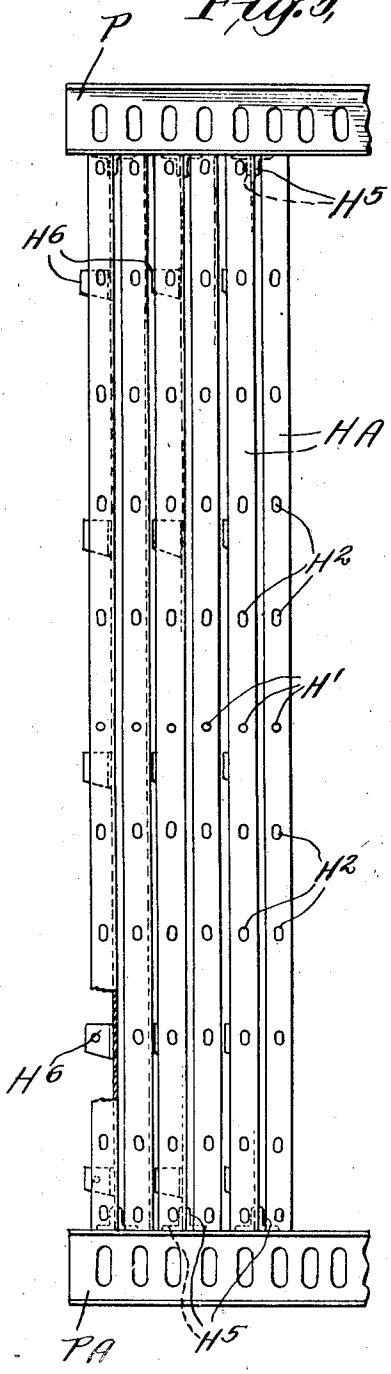


Fig. 5.



INVENTOR

BY John E. Bell
John E. Hubbell

ATTORNEY

Patented Apr. 8, 1930 1,753,192

UNITED STATES PATENT OFFICE

JOHN E. BELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

HEATING APPARATUS

Application filed December 19, 1922. Serial No. 607,781.

My present invention comprises improvements in fluid heating apparatus of the type in which the fluid to be heated is passed through metallic pipes located in the wall of a furnace chamber, so that the heat imparted to the pipes is wholly or to a substantial degree radiant heat. The invention was primarily devised, and is especially adapted for use in superheating steam, but may be used for other purposes, as in heating water, or in heating oil and oil vapors in refining petroleum and petroleum products.

The general object of my invention is to provide improved apparatus of the character specified. A specific object of my invention is to provide a construction in which the heating tubes are incorporated in the refractory housing wall of a furnace in such manner as to provide a satisfactory wall construction, and to minimize difficulties rising from the relative thermal expansion and contraction of the parts.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of my invention.

Of the drawings:

Fig. 1 is a somewhat diagrammatic elevation of a boiler furnace with one form of my improved superheater incorporated in the furnace wall.

Fig. 2 is a partial sectional elevation taken on the line 2—2 of Fig. 1.

Fig. 2A is an elevation of a portion of the superheater supporting means.

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

Fig. 3A is a partial sectional plan illustrating a modified superheater construction.

Fig. 4 is a view taken similarly to Fig. 2 illustrating another modified construction; and

Fig. 5 is a partial sectional elevation taken on the line 5—5 of Fig. 4.

In the drawings, and referring first to the construction shown in Figs. 1, 2, and 3, A represents the combustion chamber of a boiler furnace, at the upper portion of which is mounted a water tube boiler B of conventional type, A′ representing the outlet for heating gases from the boiler and furnace housing. As shown, the boiler furnace is heated by the combustion of powdered coal passing to the furnace through a suitable nozzle C, from a powdered coal feeding device C′. In one or more of the vertical housing walls of the furnace, I incorporate a steam superheater D. In the particular superheater construction illustrated in Figs. 1, 2 and 3, the superheater D comprises an upper set of superheating tubes D′, and a lower set of superheating tubes D^2. The various tubes D′ and D^2 may be, and are shown as similar in shape and dimensions, each comprising an elongated straight body portion, and transverse end portions D^3 at each end of the body portion. The body portions of the tubes D′ and D^2 are located in the furnace housing wall, and the end portions D^3 project out from the outer surface of the housing wall. As shown, the upper end portions D^3 of the upper set of tubes D′ are connected to the superheater inlet header E which, as shown in Fig. 2, is provided with a flanged inlet E′ adapted to be connected to the boiler steam pipe B^3. The lower end portion D^3 of each tube in the set D′ is connected by a coupling or return header G to the upper end portion D^3 of a corresponding one of the tubes D^2. The lower end portions D^3 of the tubes D^2 are connected to the superheater outlet header F which, as shown in Fig. 2, is provided with a flanged outlet F′ for connection to the steam pipe, (not shown) leading to the turbine or other devices provided with superheated steam.

The body portions of each of the tubes D′ and D^2 is encased by cast metal casing sections D^4 advantageously shrunk or expanded on the tube proper. The casing sections D^4 are shaped to close the outer edges of the slot-like spaces provided between slender pillars M of fire-brick. In the construction shown in Figs. 1, 2 and 3, there is a set of pillars

M for each set of tubes D′ and D². The two sets of pillars M and the intervening brickwork beam N, extend from the top of the superheater and support a part of the weight of the portion of the refractory housing wall of the furnace above the superheater. Some of the casing elements D⁴ are connected, as by means of stud bolts D⁵, to superheater aligning elements H shown as angle bars, each having one flange at the back of the casing elements D⁴ of a corresponding one of each of the tubes D′ and D². In the preferred construction illustrated, each of the tubes D′ and D² is anchored or clamped to the corresponding angle bar H at a point about midway between the ends of the tube and bar as by passing the corresponding bolt D⁵ through a close fitting bolt hole H′, while the holes H² in the bar H through which the other stud bolts D⁵ carried by the corresponding casings D⁴ pass, are elongated parallel to the length of the bar to permit the relative elongation of the superheater tube relative to the bar H.

In the construction shown in Figs. 1, 2 and 3, the portion of the weight of the furnace housing wall above the superheater not carried by the pillars M is supported by a metallic framework comprising vertical pillars or I beams I, and transverse upper and lower composite beams or sills J and JA, to which the ends of the columns I are secured, and intermediate transverse beams or stiffening members J′ and J².

The superheater headers E and F are secured to this metallic framework. As shown the header E is directly secured by clamping yokes to the outer channel bar forming a part of the composite beam or sill J, while the header F is similarly secured to the outer channel bar of the beam JA. The weight of the upper set of tubes D′ and the bars H secured thereto, is mainly carried by a flange shown as formed by an angle bar J⁵ secured to the inner channel bar member of the beam J, the upper end portions D³ of the tubes D′ resting on this flange. The weight of the lower set of tubes D² and bars H, is mainly carried by a similar angle bar J⁵ secured to the inner channel bar member of the beam JA. The lower end portions D³ of the upper tubes D′, and the upper end portions of the tubes D² are anchored adjacent the return bends or connecting members G by being passed through close fitting openings in the outer channel bar or transverse beam J² against which the inner sides of the members G seat. The members G are locked against their seats by suitable yokes or clamping devices J⁴. The orifices J³ in the inner beam J² are vertically elongated however to permit flexure of the transverse end portions D³ passing through them to accommodate the elongation and contraction of the tubes D′ and D² resulting from changes in temperature, and clearance space is provided at N′ between the brickwork N and the curved portions of the tubes D′ and D² to permit the body portions of the tubes to contract and elongate freely under changing temperature conditions. Advantageously the superheater portion of the furnace wall is made air tight by means of metal plates K secured to the inner sides of the columns I and a filling of Silo-cel or other refractory material of suitable character, between these plates and the inner edges of the brick pillars M.

With the construction shown in Figs. 1, 2 and 3, the superheater, as a whole, forms a durable and substantial section of the furnace housing wall effectively supporting the weight of the housing wall above the superheater; and the expansion and contraction of the superheater tubes can occur without putting strains on any portion of the superheater liable to create undesirable steam leakage, or air leakage through the furnace housing wall, or to distort, crack or otherwise weaken the furnace housing wall as a whole. The bars H each hold the corresponding superheater tube body portion against transverse bending or warping movements, and prevent the insulating material from working into the spaces between the brick pillars M. The tube sections D⁴ increase the superheater surface exposed to radiant heat, protect the encased tubes against overheating and corrosion, and substantially increase the strength of the tubes. Advantageously, in many cases, the inner faces of the casing sections D⁴ are not flush with the inner faces of the pillars M but are set out therefrom as shown in Fig. 3, to thereby reduce and regulate the amount of radiant heat absorbed by the superheater.

With an effective furnace wall superheater, such as is obtained with the construction shown in Figs. 1, 2 and 3, a number of important practical results are obtained. The superheater itself is efficient and compact. On account of the high temperature at which it may operate, the bulk of the metallic portion of the superheater for a given duty may be considerably less than where heated by furnace gases previously cooled somewhat by their passage over boiler heating surface. Furthermore, a superheater heated mainly by radiant heat from the furnace chamber does not have the tendency to increase the degree of superheat obtained when the load on the boiler increases, which is characteristic of a superheater heated by furnace gases which have already given up a portion of their heat to the boiler heating surface proper.

The furnace wall superheater also exercises a beneficial influence on furnace conditions. The heat absorbed by the superheater and transmitted to the steam passing through it, not only keeps down the temperature of the section of the furnace wall formed by the

superheater, but also lowers the temperature of other portions of the furnace wall which are cooled by radiating heat to the superheater. The combustion chamber absorption of radiant heat by the superheater directly from th combustion chamber has a generally beneficial effect on the boiler proper, in that it diminishes the excess of work done by the water tubes or other boiler heating surface adjacent the combustion chamber, as compared with that done by the boiler heating surface more remote from the combustion chamber.

The reduction in furnace wall temperature obtained with the superheater construction and arrangement illustrated is desirable from the standpoint of boiler wall maintenance in all cases, and is especially desirable in the case of furnaces heated by the combustion of powdered coal wherein great difficulty is experienced from slag formation on the walls of the combustion chamber, if those walls are at too high a temperature. For this reason it is common to provide combustion chamber walls of such furnaces with screens formed of water tubes to keep the walls cool enough to avoid objectionable slag formation.

In the furnace arrangement shown in Fig. 1, the back wall of the furnace is protected by a screen of tubes B^2 forming a part of the boiler circulating system, and a second screen B′ extends transversely across the furnace chamber some distance above its bottom to prevent the bottom wall of the furnace chamber from being so hot that the ashes settling at the bottom of the chamber will slag together. While in the furnace construction shown in Fig. 1, screen tubes B′ and B^2 may advantageously be provided in some cases, the provision of the furnace wall superheater minimizes the importance of those tubes, and makes the conditions to which they are subjected much less severe than would otherwise be the case; and in many cases the use of a suitable furnace wall superheater or superheaters may make the use of screen tubes unnecessary in furnaces where they would otherwise be required.

The division of the superheater tubes into sets or sections such as are formed by the tubes D′ and the tubes D^2, in the construction shown in Figs. 1, 2 and 3, obviously minimizes the maximum elongation and contraction of the straight body portion of each tube, which is desirable in some cases, but is unnecessary in other cases, and most of the features of invention embodied in the construction of Figs. 1, 2 and 3 may be employed in a superheater such as that shown in Figs. 4 and 5, which comprises but a single set of superheater tubes D^{10}. The tubes D^{10} which are encased in sections D^4 arranged between firebrick pillars M as in the construction first described, are shown are generally similar in shape to the tubes D′ and D^2 of the construction first described. Each tube D^{10} is connected by bolts D^5, to a vertical stiffening member HA in the form of an angle bar provided with holes H′ and H^2 to receive the bolts as in the construction first described. The bars HA, as shown, are secured at their ends, as by brackets H^5, to angle bars forming parts of composite or structural beams or sills P and PA, respectively, and carry a part of the weight of the furnace heating wall above the superheater. The upper and lower superheater headers EA and FA are mounted in the sills P and PA, respectively.

In the particular construction shown in Figs. 4 and 5, an air space Q is provided in the furnace wall between the superheater proper and an outer furnace wall portion A^{15} of fire brick, which rests upon the sill PA and assists in supporting the weight of the beam or sill P and the superimposed portion of the furnace housing wall. The inner wall of the air space Q is formed by metal plates R secured by brackets H^6 to the stiffening bars HA. The latter are braced by transverse angle bars H^7. In the particular furnace illustrated in Figs. 4 and 5, the secondary air for combustion in the furnace is intended to be drawn through the air space Q, and to be thereby preheated. Brick work portions M^5 are provided at the tops and bottoms of the pillars M, to screen the bare bent end portions of the superheater tubes and the metallic beams P and PA against the furnace heat. With the construction illustrated in Figs. 4 and 5, the two transverse end portions D^3 of each superheater tube flex or bend to accommodate the elongation and contraction of the straight body portion of the tube.

The brick pillars M between the superheater elements, while advantageously employed in some cases, are unnecessary in others. When the pillars M are omitted, the superheater tubes are spaced closely enough so that their casing elements D^4 form a continuous wall as shown in Fig. 3A, and the furnace housing wall above the superheater may then be entirely supported, in accordance with the present invention, by the metallic framework of the superheater.

While in accordance with the provisions of the statutes, I have illustrated and described the best forms of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed, without departing from the spirit of my invention as set forth in the appended claims, and that certain features of my invention may sometimes be used to advantage without a corresponding use of other features.

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

1. In a furnace housing wall comprising a row of side by side brickwork pillars spaced

apart to form vertical slots in a lower portion of said wall open at their inner edge to the interior of the furnace chamber, said pillars carrying a part of the weight of the housing wall above said pillars, superheater elements comprising vertically disposed straight elongated tube portions arranged one in each of said slots, each of said tube portions being encased in metallic sections which unite to substantially fill the width of the slots, a metal bar at the rear of each slot comprising a portion closing the outer edge of the slot, connections between the casing elements and the bars, an external casing providing an enclosed space between said bar portions and the casing, and a packing of refractory material in said space.

2. A radiant heat superheater comprising supporting means, a row of superheater tubes at one side of said supporting means, and adapted to absorb radiant heat from a source of radiant heat at the opposite side of said row, each tube being anchored at one point to said supporting means and connections between said tube and supporting means at other points along the length of the tube, said connections being constructed to permit longitudinal and to prevent transverse movements of the tube in response to changes in the temperature to which it is subjected.

3. A radiant heat superheater comprising supporting means, a row of superheater tubes at one side of said supporting means, and adapted to absorb radiant heat from a source of radiant heat at the opposite side of said row, said supporting means comprising a metal support alongside each tube and anchored to the latter at a point intermediate the ends of the tube, and connections between said support and tube at other points along the length of the tube, said connections being constructed to permit longitudinal, and to prevent transverse relative movements of the tube and support.

4. A radiant heat superheater comprising supporting means, a row of superheater tubes at one side of said supporting means, and adapted to absorb radiant heat from a source of radiant heat at the opposite side of said row, metal casing sections surrounding said tubes, said supporting means comprising a supporting bar alongside each tube and formed with a series of holes, and bolts passing through said holes and connecting said bar to casing sections distributed along the length of the corresponding tube, said holes being elongated longitudinally of the length of the tube.

5. In a furnace housing wall, a metallic framework incorporated in said wall and carrying a part of the weight of the housing wall portion above the framework and superheater elements extending parallel to said wall at the inner side of said framework and supported by the latter.

6. In a furnace housing wall, a metallic framework incorporated in said wall and carrying a part of the weight of the housing wall portion above the framework, superheater elements at the inner side of said framework and supported by the latter, and parts co-operating with said elements to shield said framework from the heat of the furnace.

Signed at city of New York in the county of New York and State of New York this 13th day of December, A. D. 1922.

JOHN E. BELL.

CERTIFICATE OF CORRECTION.

Patent No. 1,753,192. Granted April 8, 1930, to

JOHN E. BELL.

It is hereby certified that the above numbered patent was erroneously issued to "Power Specialty Company, of New York, N. Y., a corporation of New York", whereas said patent should have been issued to "Foster Wheeler Corporation, of New York, N. Y., a corporation of New York", said corporation being assignee of the entire interest in said invention, as shown by the records of assignments in this office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of April, A. D. 1930.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

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