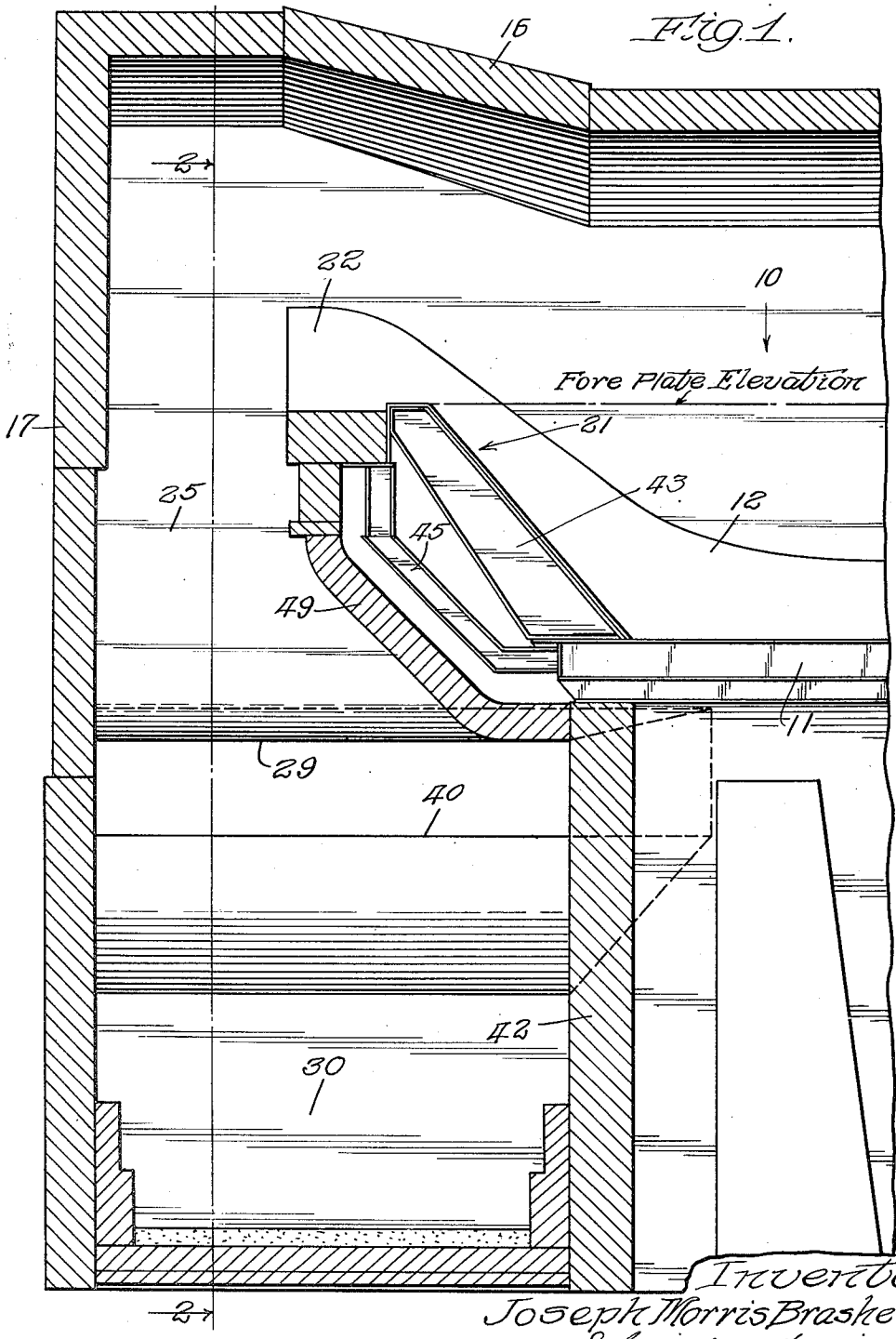
Dec. 1, 1953 J. M. BRASHEAR 2,661,198

FURNACE END STRUCTURE

Filed July 6, 1951 4 Sheets-Sheet 1

Fig. 1.



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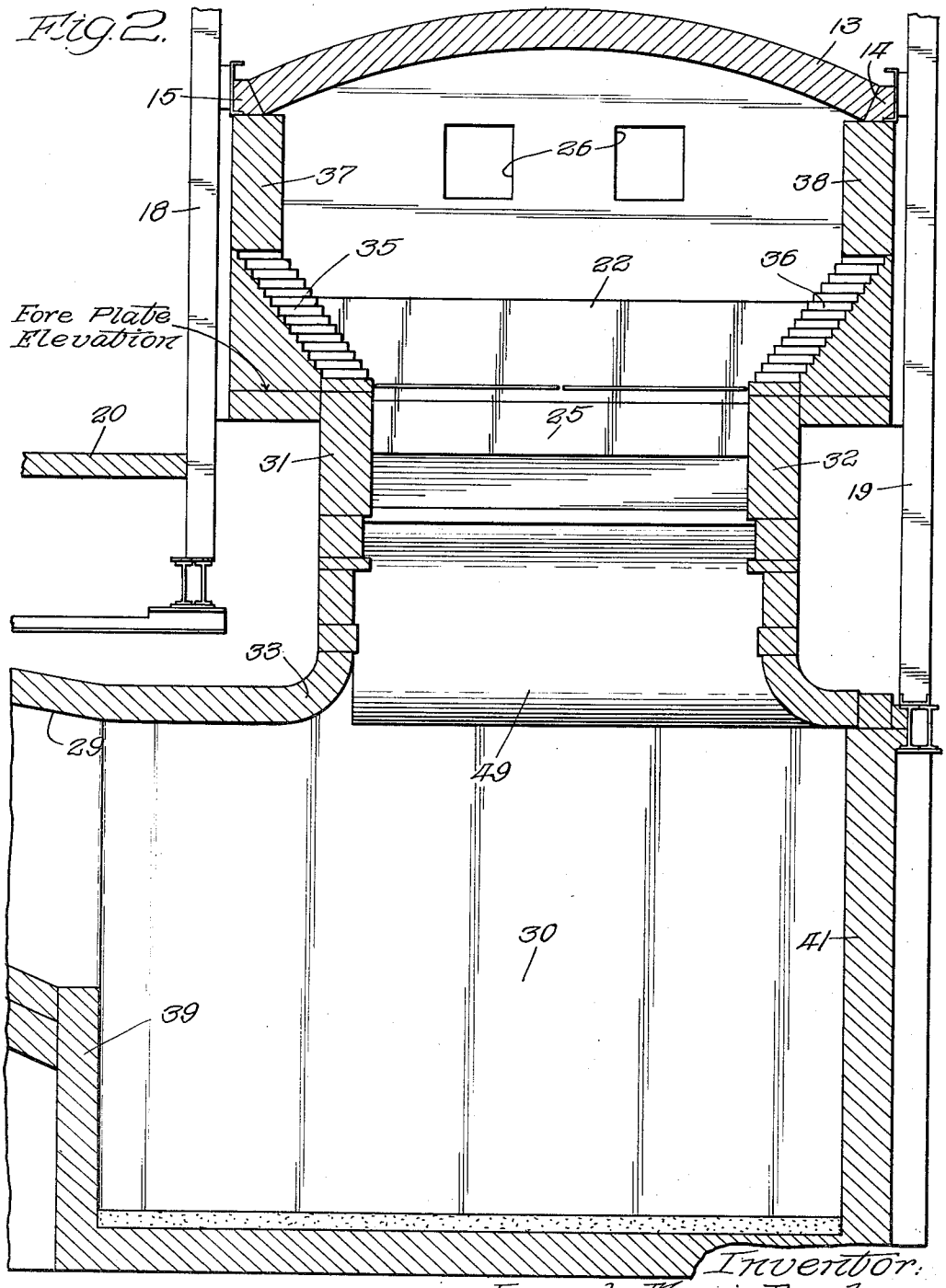
Filed July 6, 1951 4 Sheets-Sheet 2

Fig. 2.



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Filed July 6, 1951 4 Sheets-Sheet 3

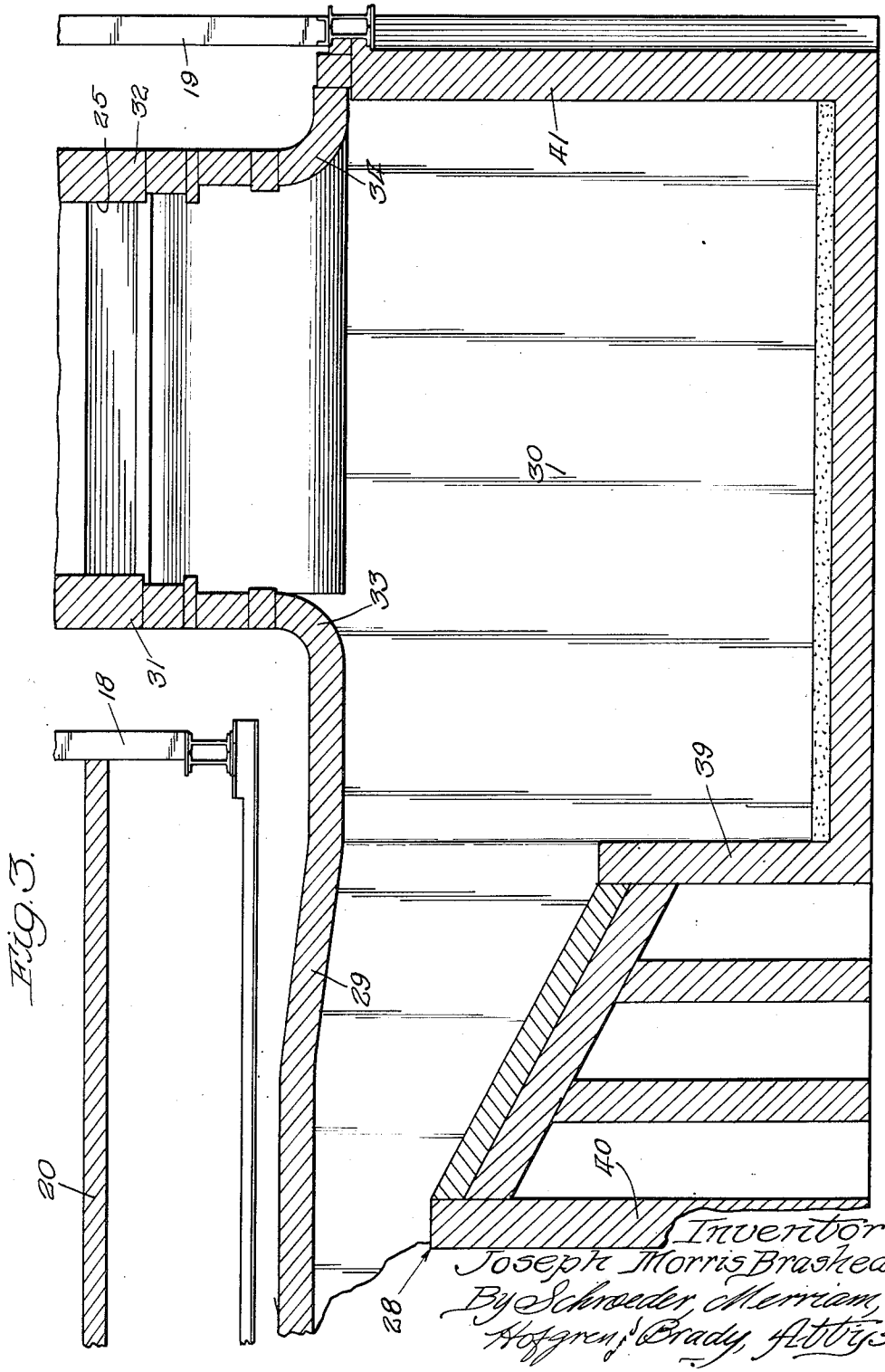

Fig. 3.

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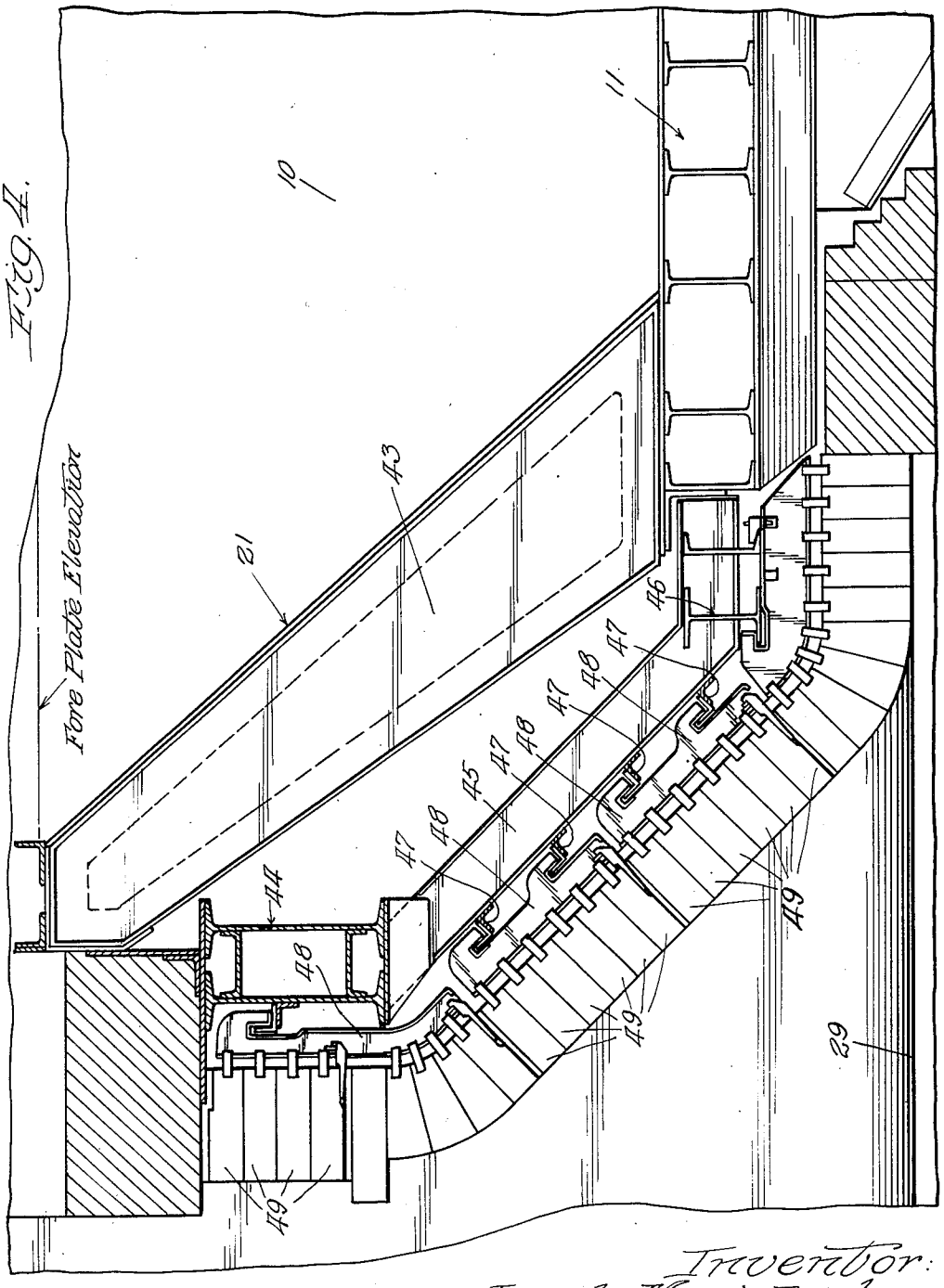
Filed July 6, 1951 4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,661,198

FURNACE END STRUCTURE

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Application July 6, 1951, Serial No. 235,531

4 Claims. (Cl. 263—15)

1

This invention relates to the structure of furnaces intended to operate at high temperatures and more particularly to the end structures of an open-hearth furnace.

Open-hearth furnaces are generally provided with a hearth bed which is like a shallow elongated dish lined with refractory brick and fused material for holding the molten steel. The bed is bounded by refractory brick front and rear walls which are reinforced and held in position by outer steel bindings or buckstays. The front wall is provided with door openings through which the scrap, ore and other materials may be charged into the hearth bed. The rear wall of the furnace is on the pit side of the open-hearth from which the metal in the bed is tapped into ladles for pouring into ingot molds. The furnace structure extends beyond the longitudinal ends of the hearth bed to enclose passages extending generally vertically downwardly from the ends of the bed for alternatingly conducting air and combustion products to and from the hearth. These passages are bounded by extensions of the front and rear walls, ordinarily called wing walls, and an end wall of the furnace also constructed of refractory brick reinforced by metal buckstays. The main portion of the hearth is covered by an arched roof and the end sections have an extension of the roof designated hood members.

Fuel is introduced into the furnace through openings in the end wall so that the fuel may be directed toward the hearth in the space above the end of the bed and the hood member, such space being designated the port end of the furnace. Ordinarily the furnace is fired alternately from one end and then the other, with the direction of firing being reversed periodically.

The necessary high heats required to melt the steel-making constituents are provided by a system of regenerators in which the air for combustion is preheated in a checker chamber previously brought to a high temperature by the passage of combustion gases therethrough. Thus, each uptake is connected at its lower end with a slag pocket generally below the level of the bed. The checker chambers are generally also below and off to one side of the hearth bed and are connected with the slag pocket by a substantially horizontal passage extending through what is known as the fantail section. Air for combustion and to provide oxygen to support the chemical reactions which take place in the hearth passes from the checker chambers into the slag pocket from which it is directed upwardly through the uptake and then again substantially horizontally through the port end into the hearth bed. The right angle turns from the fantail passage to the uptake and from the uptake through the port end are also at substantially 90° to each other, therefore, tending to direct the stream of air against the back wall of the furnace both in the uptake passage and through the port end. The present invention is concerned primarily with delivering air uniformly distributed to the port end where it may be most economically used to support combustion at the fuel introducing agencies. In accomplishing this result, the uptake passage is provided with a restriction tending to direct the air toward the center of the furnace and the fantail passage is so constructed that the incoming air may turn quickly into the uptake passage.

2

The invention will be described with reference to a particular embodiment thereof illustrated in the accompanying drawings, in which:

Fig. 1 is a vertical sectional view through a furnace end section taken substantially through the center line of the furnace; Fig. 2 is a vertical sectional view through the furnace end taken as shown by line 2—2 in Fig. 1; Fig. 3 is a view similar to Fig. 2 showing the fantail section and the adjacent checker chamber fragmentarily. Figs. 1, 2 and 3 are somewhat diagrammatical in that the brick and steel parts included in the walls are not shown in detail; Fig. 4 is an enlarged fragmentary view of the chill box section at the end of the hearth as shown diagrammatically in Fig. 1.

The structure chosen to illustrate the invention is that to be incorporated in an existing open-hearth furnace. The furnace is provided with a hearth bed 10 provided with a base member 11 suitably supported and covered with refractory material 12. The working surface of the bed may be a refractory such as magnesite. The hearth bed contains the molten metal from which is tapped the steel product to be poured into ingot molds. The furnace is provided with an arched roof 13 resting against skewbacks 14 and 15 along the front and back of the furnace. A hood section 16 is provided over the furnace end sections and slopes downwardly from the end wall 17 to the roof 13. The walls of the furnace are made of refractory brick mounted up and reinforced by buckstays 18 on the front of the furnace and similar buckstays 19 along the rear wall of the furnace. The end walls are similarly reinforced aand braced by a network of steel upon which the brickwork may have foundation and support.

In operation of the open-hearth furnace, the ore, scrap and other ingredients are charged into the hearth bed through charging doors in the front wall from the charging floor 20. The ends of the hearth bed are formed by chill box sections 21 over which a bridgewall 22 joins with the refractory 12 of the bed. The bridgewall forms a throat with the hood section 16 leading from the uptake passage 25 through the port and to the

hearth bed. Fuel is introduced through openings 26 in the end wall, usually by one or more burners.

Air is conducted to the burners from the checker chamber 28, through a fantail passage of conduit 29 communicating with the slag pocket 30 below the uptake passage 25. In its travel, the air stream thus comes laterally into the slag pocket, then up the uptake and again laterally in a different direction from the uptake into the port end to the hearth bed. While the uptake at one end of the furnace is conducting air from the adjacent checker chamber to the hearth, the uptake at the other end is conducting the combustion products in the opposite direction to heat the checker chamber associated therewith. The firing is reversed periodically so that high temperatures may be built up in the hearth bed to melt the steel-making constituents.

In most existing open-hearth furnaces the uptake passage has been divided into two or more parts separated by a center brick arch and wall. This in part serves to strengthen the end structure of the furnace and to support arches under the chill box section having their skewbacks against the center wall and the front and rear walls of the furnace. The center wall was also used to support refractory boxes at their upper ends serving to protect the fuel introducing agencies. With the development of more efficient fuel discharging guns, such protective brickwork about them has been rendered unnecessary. In the present structure, the center arch and wall has been removed from the furnace and the chill box section has been protected by refractory elements supported in an entirely different manner, the details of which shall be hereinafter explained.

The furnace end structure in the present invention is formed with a single uptake passage 25 which is bounded by the end wall 17, the chill box section 21, a front wing wall 31, and a rear wing wall 32. The chill box section 21 has been moved from its former position outwardly toward the end wall 17 to lengthen the hearth bed and to increase its volumetric capacity appreciably. The uptake passage 25 is specifically formed in a manner to be described to secure the proper distribution of air in the passages and gain proper fuel and air mixture, thus a more efficient use of the fuel introduced into the furnace coupled with greater production for a given furnace. A great difficulty in open-hearths is in directing air uniformly in the uptake and at the burners where it is needed. The particular uptake shape is important in obtaining uniform distribution of the air.

In this connection the front and rear wing walls are converged inwardly by portions 33 and 34, respectively, adjacent the lower portion of the chill box section. These portions of the walls narrow the uptake passage 25 to form a restricted portion which is projected upwardly to about the fore plate elevation indicated on Figs. 1 and 2. As best seen in Fig. 2, the wing walls are provided with diverging portions 35 and 36, respectively, which widen the uptake passage near the upper end to the original width of the wing walls as indicated at 37 and 38. This restricted portion of the uptake passage forms a Venturi-like action on the gases passing through the uptake. The particular position of the restricted portion is important to direct the air to the center of the furnace prior to its mixture with the fuel.

Referring particularly to Fig. 3, air enters the

uptake passage from the fantail passage 29 above the checker wall 39 from the checker chamber under the charging floor 20. The air enters over the top of the near wall 40 of the checker chamber at a relatively high lineal velocity, the smallest section of the passage 29 being at the wall 40. Since the air must turn 90° or more to pass upwardly, it must lose a major portion of its kinetic velocity after leaving the fantail passage. In the furnace illustrated, the checker wall 39 has been moved toward the checker chamber about three feet to enlarge the slag pocket 30 through which the air passes to the uptake. The increased volume permits the incoming air to lose its kinetic velocity much quicker and to make the turn upwardly closer to the center of the uptake. Thus, air entering the slag pocket may turn upwardly before impinging upon the pit wall 41 under the rear wing wall, contributing to uniform distribution of air to the burners. The air that does pass over to the pit wall 41 is directed back toward the center of the furnace by the portion 32 of the back wing wall in the uptake restriction. The ratio of the length of the fantail passage 29 to the dimension of the slag pocket before the checker wall was moved toward the checker chamber was about 1 to 1.23, and after moving the checker wall back three feet, this ratio was 1 to 2.34. The drawings are made to a scale of about one inch representing three and one-half feet so that dimensions may be measured on the drawings.

With the reconstruction of the furnace ends and the provision of the single uptake passage constructed as illustrated and described, the uptake passage was constructed with approximately 60 square feet of area at its narrowest portion as compared with 86 square feet in the double uptake passage of the furnace before reconstruction. With this difference and the provision of the restricted throat therein, it was found that the furnace could be fired at a much greater rate than the top of 450 gallons per hour before reconstruction. The same fuel to air ratio was used, that being approximately 1720 cubic feet of air per gallon of fuel. The narrowest portion of the throat in the port end above the bridgewall is about 105 square feet and the portion of the passage between the uptake restriction and the throat is considerably larger than either.

Air velocities in the furnace ends change throughout a given heat because of the changes in temperature with each reversal of the firing direction. The input at the blower, which is some distance from the checker chambers, can be accurately measured and has been found to be about 1650 cubic feet of air for each gallon of fuel fired. However, at the burners, air is supplied at about 1720 cubic feet per gallon of fuel, with the difference presumably being made up by leakage into the furnace below the bridgewall level. With a double uptake, it has been possible to fire at a rate of only 450 gallons per hour because of an inability to get the air properly directed into the burner fuel stream where it could aid combustion. The present invention conducts and distributes the air in the uptake and to the burners so that much higher firing rates may be sustained. When firing at about 450 gallons per hour and providing 1720 cubic feet of air for each gallon of fuel, air velocities measured at room temperature (about 70° F.) for the narrowest sections are: 143 feet per minute in the fantail passage 29; 215 feet per minute in the uptake passage; and 123 feet per min-

ute in the throat. When increasing the firing rate to 600 gallons per hour, these air velocities become 198 feet per minute in the fantail passage; 286 feet per minute in the uptake passage; and 164 feet per minute in the throat. The single uptake directs the air to the center of the furnace and prevents the air stream from hugging the back wall of the furnace.

In removing the center arch and wall which previously divided the uptake into two parts, it has been found that the chill box section could be moved outwardly toward the end wall to increase bed capacity. Arch construction of the brickwork under the chill box section has been eliminated and the refractory elements protecting the chill box section have been made of suspended construction as will more clearly appear in Fig. 4. The lower portion of the uptake passage is provided with a section wall 42 which is a bearing wall under the end of the hearth bed. A metal hearth end section 43 is supported upon the lower portion 11 of the hearth bed which rests upon the bearing wall 42 and by girders 44 which have their support in the front and rear walls of the furnace. The girders support framing members 45 secured to beams 46 at their lower end which also find their support in the front and rear walls of the furnace. A number of transverse stringers 47 are provided to run horizontally between the framing members 45. These stringers support a plurality of cast hanger members 48 to which the refractory elements 49 are attached. The refractory elements form the exposed wall under the chill box section and serve to protect the metal parts thereof from the high heats existing in the furnace. In previously used structure about the chill box sections, the refractory elements were formed of arches which supported the chill box section and in the present structure the chill box structure supports the refractories. The refractory wall about the chill box section further narrows the passage through which air enters the furnace and cooperates with the wing walls in providing the directing influences on the air entering the furnace.

It will be understood that the present invention may be utilized in constructing new furnaces as well as in the reconstruction of existing open-hearths. Its advantages are however immediately apparent in the reconstruction of existing furnaces in that it provides a means for gaining greater capacity and production without changing or removing the hearth section or the existing outer walls of the furnace. Substantially the entire change necessary in the furnace to accomplish the new results may be made in the wing walls, at the furnace ends and in the chill box section at each end of the hearth bed.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. In an open-hearth furnace having a hearth bed and a fuel supply at each end of the furnace, furnace end sections each comprising a wing wall on the front and back of the furnace, an end wall joining said wing walls, a chill box at each end of the hearth bed spaced inwardly from said end wall, a protective wall under and around said chill box, said walls enclosing a single uptake passage for conducting air from an air supply to the hearth bed, each wing wall having an intermediate portion placed inwardly toward the opposite wing wall and sloping wall surfaces joining said portions with the remainder of the wing walls, said wing wall portions providing a restricted passage in the uptake intermediate its ends to direct air passing upwardly through the uptake away from the front and rear wing walls and toward the longitudinal center line of the furnace.

2. In an open-hearth furnace having a hearth bed, furnace end sections each comprising a chill box at the end of the hearth bed having a protective wall around and under the chill box, a wing wall on the front and back of the furnace each joined to said protective wall, an end wall joining said wing walls and having an opening in its upper portion for admitting fuel to the hearth bed, said walls forming and enclosing a single uptake passage for conducting air from an air supply to the hearth bed, said protective wall sloping downwardly away from the end wall, said wing walls forming said uptake each having converging portions near the lower end of the uptake passage joined to parallel portions extending upwardly opposite the chill box with diverging portions near the upper end of the uptake joining said parallel portions with the remainder of the wing walls, said converging, parallel and diverging portions of the wing walls extending between the chill box protective wall and the end wall and forming an uptake restricted portion centered on the longitudinal center line of the furnace and said fuel admitting openings in the end walls positioned above said restricted portion of the uptake.

3. In an open-hearth furnace having a hearth bed and a fuel burner at each end of the furnace, furnace end sections comprising walls forming a substantially horizontal air conduit, upright front, rear, end and chill walls forming a single substantially vertical uptake passage communicating directly with said conduit and with the hearth bed, means for supplying air to the conduit whereby air in the conduit tends to continue its flow horizontally to flow predominantly against one side of the uptake, means for distributing the air in the uptake and from the uptake in a controlled uniform stream to the burner which comprises a restriction in horizontal cross section of the uptake adjacent the conduit and built into the upright front and rear walls transverse to the conduit and an enlargement immediately thereabove in the same walls.

4. Furnace end sections as set forth in claim 1 in which the lower end of the uptake passage forms a slag pocket and a fantail passage for air extends laterally from the slag pocket, the ratio of the length of the fantail passage to the slag pocket measured in the same direction being at least 1 to 2.34.

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