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OPEN HEARTH FURNACE

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4 Sheets-Sheet 1

Fig. 7.

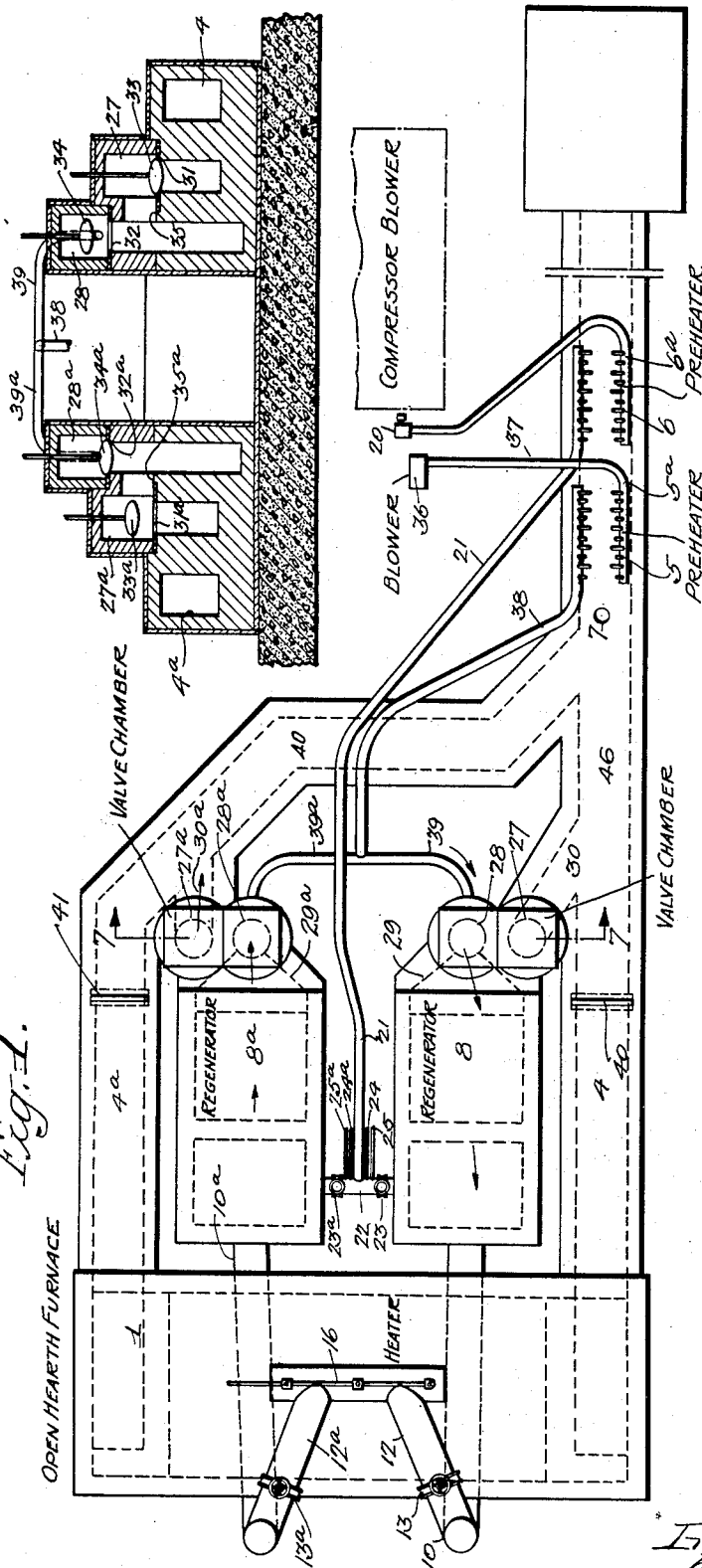


Fig. 1.

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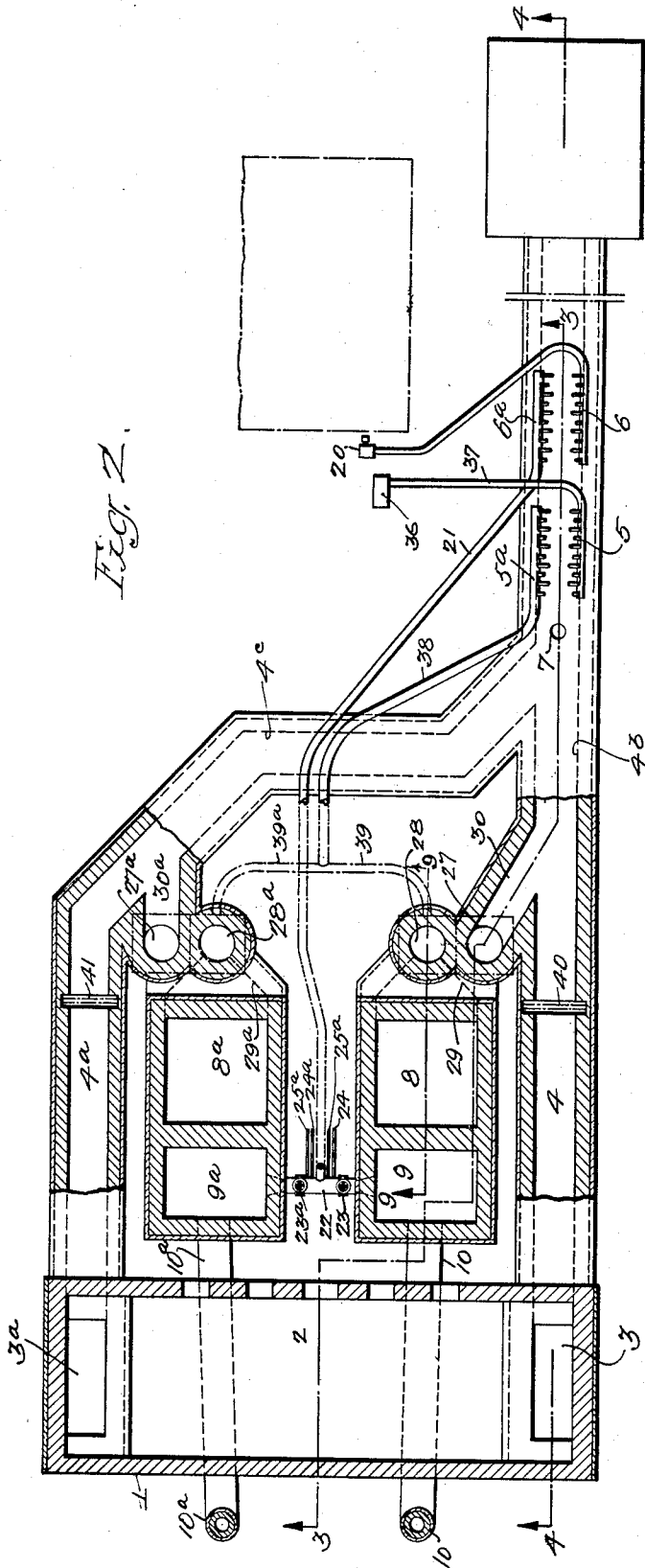
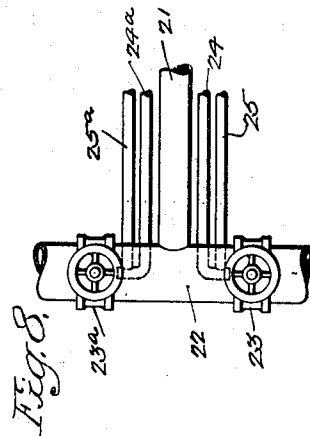
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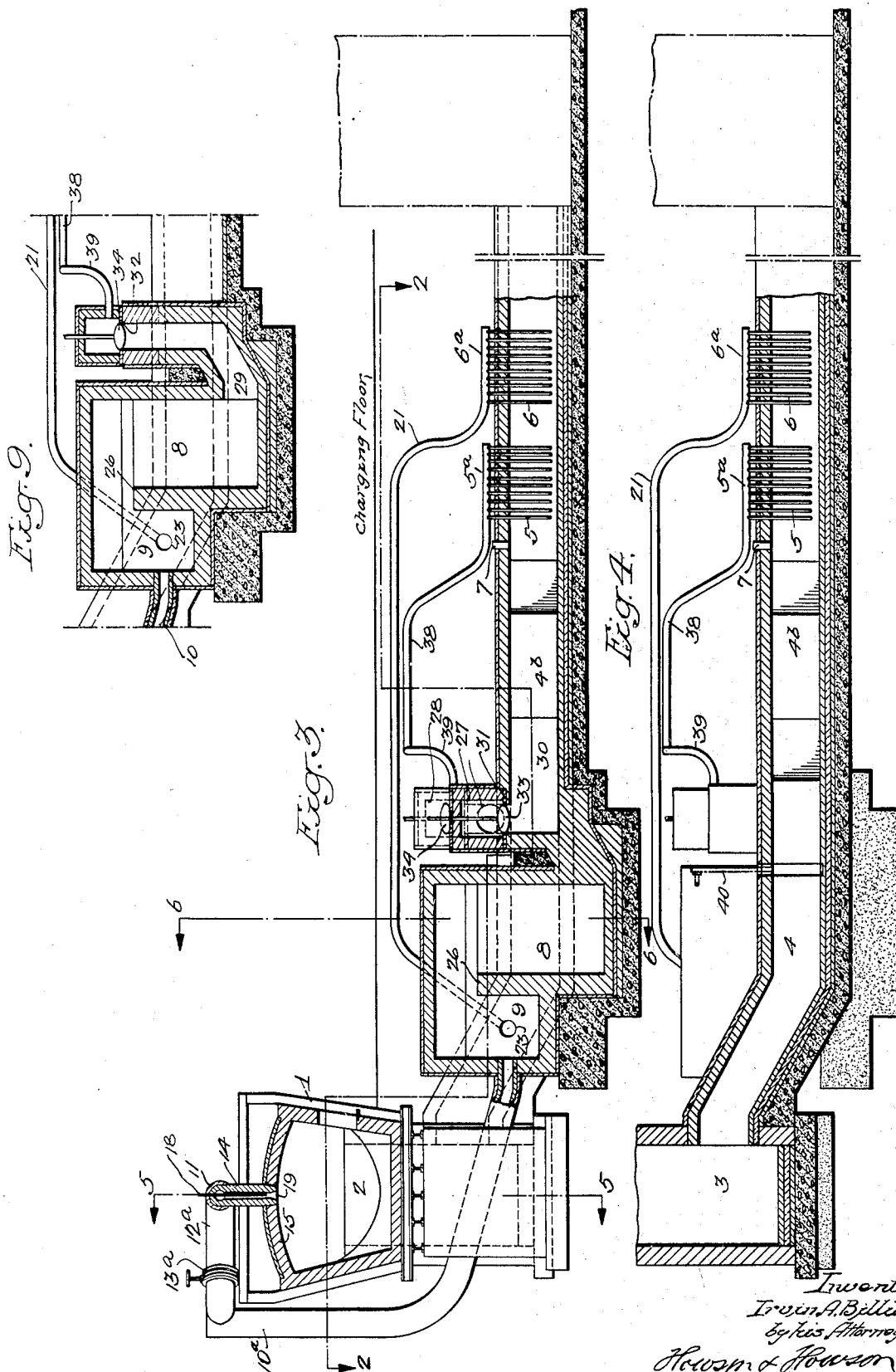
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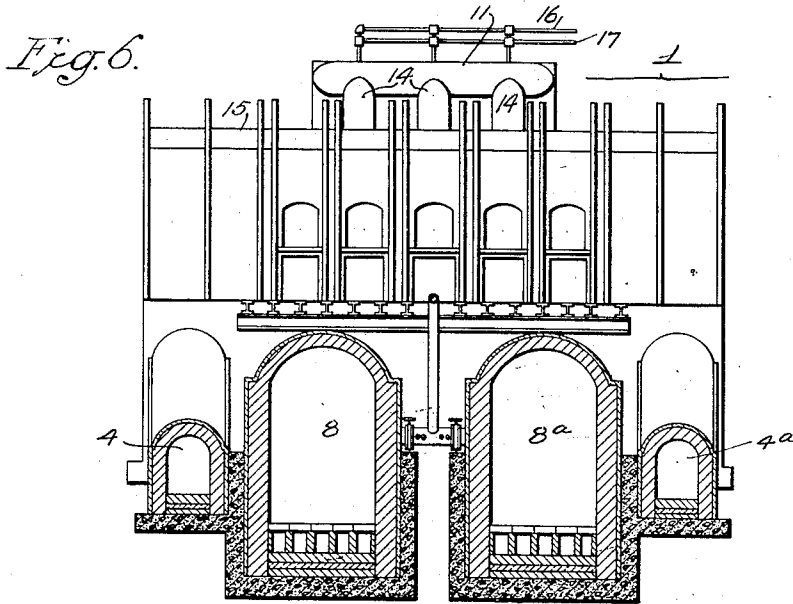
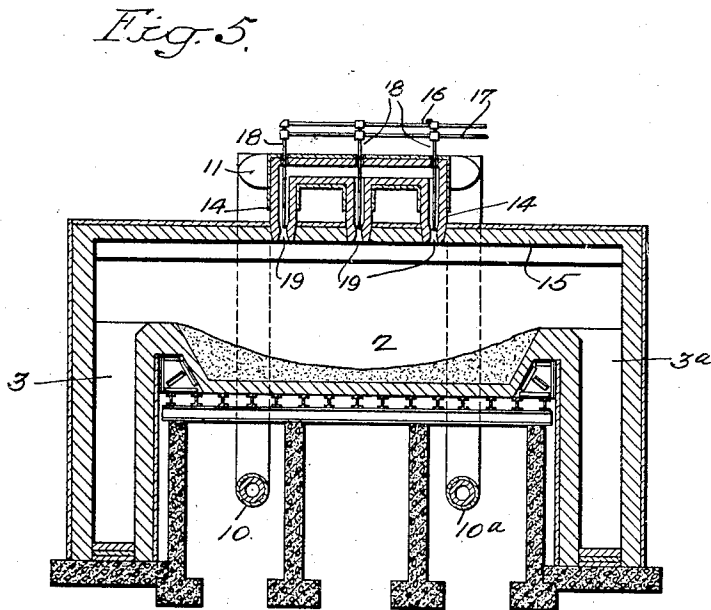
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UNITED STATES PATENT OFFICE

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OPEN HEARTH FURNACE

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One object of my invention is to improve the construction of stationary open hearth furnaces so that the checker-work will not be clogged by the refuse from outgoing gases.

5 A further object of the invention is to so locate the burners in the roof of the open hearth furnace that the flame will be projected directly onto the charge within the furnace.

10 A still further object of the invention is to so construct the furnace that short hot flames will be projected onto the charge on the furnace hearth and to allow the products of combustion to simultaneously escape from
15 each end of the furnace.

The invention also relates to certain details which will be fully described hereafter.

In the accompanying drawings:

Fig. 1 is a plan view of my improved
20 stationary open hearth furnace;

Fig. 2 is a plan view partly in section, on the line 2—2, Fig. 3;

Fig. 3 is a longitudinal sectional view on the line 3—3, Fig. 2;

25 Fig. 4 is a longitudinal sectional view on the line 4—4, Fig. 2;

Fig. 5 is a transverse sectional view on the line 5—5, Fig. 3;

Fig. 6 is a sectional view on the line 6—6,
30 Fig. 3;

Fig. 7 is a sectional view on the line 7—7, Fig. 1;

Fig. 8 is an enlarged plan view of a portion of Fig. 2; and

35 Fig. 9 is a longitudinal sectional view on the line 9—9, Fig. 2.

The conventional open hearth furnace is fired alternately from the furnace ends and the hot waste gases are permitted to escape alternately from either end, but opposite to the firing end at all times, through ports to regenerator chambers. The direction of the gases is changed approximately every twenty minutes and the air for combustion is admitted through the previously highly heated regenerator chamber to the furnace ports. There are several objections to this conventional design:

50 In the first place, the outgoing extremely hot gases carry large quantities of slag and

oxides in suspension, which soon clog the spaces between the bricks forming the checkerwork system in the regenerator chambers. This reduction in space area retards the action of the furnace cycle, the retarding action increasing with the life of the furnace. It also materially increases the maintenance cost of the checker chambers. 55

In the second place, due to the fact that the volume of hot waste gases is considerably greater than the volume of incoming air required for combustion, the ports alternately used for waste gas exit and fuel, and air admission must from necessity be too large to obtain proper mixing of incoming air and fuel. This causes an inefficient flame of low velocity and comparatively low temperature. 60 65

In the third place, all open hearth steel melting furnaces in use are fired from or very near the ends of the furnace. Because of this remote position of the burner the charge melts at the ends of the furnace much faster than at the center. This considerably increases the furnace time cycle. Even if a hotter flame could be produced in the furnace of conventional design, the flame would become so large as to cause serious and rapid deterioration of furnace walls and roof. If a short hot flame was produced the concentration of heat would be at the extreme end of the charge, where it would again be inefficient. 70 75 80

By my invention the admission ports for the fuel are entirely independent of the waste heat gas ports and the waste products of combustion are discharged at both ends of the furnace. The heat can be better controlled and the elimination of slag and oxides in the space areas of the checker-work insures uniform operating conditions through the entire life of the furnace. 85 90

By my invention fuel and high pressure pre-heated air passes through very small ports and these ports are used only for this purpose and never for the elimination of waste gases, and are designed to intensify the mixture and to produce a short hot flame. The burners are preferably located in the furnace roof directly over the hearth containing the charge to be melted. By this 95 100

construction the concentration of heat in a relatively small area at numerous places over the entire charge will promote faster and more uniform melting, and furnace deterioration will be materially decreased by the elimination of the long uncontrollable furnace fire and flame now commonly used, and the waste gases will be eliminated through ports and downtakes of sufficient size to reduce the velocity, thereby reducing the cutting action on the furnace lining to a minimum.

Referring to the drawings: 1 is an open hearth furnace, having a hearth 2. At each end of the hearth 2 of the furnace are down-take flues 3—3a. These down-take flues 3—3a connect at their base with waste gas flues 4—4a, in which there are regulating dampers 40 and 41. The flue 4 extends in a straight line in the present instance and communicates with a main flue 4b and the flue 4a communicates with a cross flue 4c, which is connected to the flue 4b as shown in Fig. 2.

In the flue 4b are two pre-heaters 5 and 6. These heaters are shown in the form of tubes which extend into the flue 4b from manifolds 5a and 6a but it will be understood that the pre-heaters may be made in any form desired without departing from the essential features of the invention. In the roof of the flue 4b is a cold air inlet 7. The air admitted at this point reduces the waste gas temperature to a certain degree.

8—8a are two regenerator chambers having checker-work therein of the ordinary type. Communicating with the upper end of the regenerator chambers 8—8a are combustion chambers 9—9a. Communicating with the combustion chambers 9—9a are hot blast mains 10—10a. These hot blast mains extend under the open hearth furnace as shown in Fig. 3, and to the opposite side of the furnace from the combustion chambers in the present instance, and are connected to a longitudinal header 11 above the furnace by connecting pipes 12—12a, in which are valves 13—13a, by which the admission of the air to the header 11 is controlled. Extending downward from the header 11 are three burner tubes, 14 in the present instance, which project through the roof 15 of the open hearth furnace 1, directly above the hearth 2, see Figs. 2, 3 and 5.

16 is the fuel oil supply line and 17 is the steam line, the steam being used to atomize the fuel. Connected with these pipes are pipes 18, which pass through the header 11 and into the burner tubes 14, the steam atomizing the oil as it escapes from the ends of the tubes 14, and the lower ends of the burner tubes are slightly contracted and then flared as at 19, so as to insure the proper mixture of the atomized oil with the

hot blast gases which pass through the burner tubes 14.

The three burners shown in Fig. 5 are located one at the center of hearth and one at each side of the center, so that the flame projected from the burners will impinge directly upon the surface of the charge on the hearth, each burner producing a comparatively short intense flame. While I have shown three burners projecting through the roof of the furnace, it will be understood that a greater or less number may be provided according to the dimensions of the furnace, and while I have shown the burners directly over the center of the hearth, they may be located at one side or the other of the center of the roof, or in the side walls at or near the center of the furnace, but the flame should impinge upon the charge in the furnace.

20 is a low pressure blower which is connected to the pre-heater 6. A pipe 21 leads from this pre-heater to a burner pipe 22, in which are two valves 23—23a. This pipe 22 communicates with the lower portion of the combustion chambers 9 and 9a, and the valves 23—23a control the flow of pre-heated air to the combustion chambers 9—9a.

24—24a are steam pipes and 25—25a are oil fuel pipes which extend into the burner pipe 22, and the steam and oil mix with the pre-heated air in the burner pipe, producing a hot flame in the combustion chamber. This flame passes over the partitions 26—26a into the regenerator chambers, thus heating the brickwork to the desired degree.

At the rear of the regenerator chamber 8 are two valve chambers 27 and 28. The valve chamber 28 is connected to the lower portion of the regenerator 8 by a passage 29, and the lower portion of the valve chamber 27 is connected by a flue 30 to the flue 4b.

In the upper portion of the valve chamber 27 is a seat 31 for a valve 33, and in the upper portion of the valve chamber 28 is a seat 32 for a valve 34. The valve seat 32 is located considerably above the valve seat 31 and a passage 35 forms a communication between the two valve chambers between the two valve seats, as shown clearly in Fig. 7.

Back of the regenerator chamber 8a are two valve chambers 27a and 28a, similar in construction to the valve chambers 27 and 28 of the regenerator 8.

The lower portion of the valve chamber 28a communicates with the lower portion of the regenerator 8a by a passage 29a and the lower portion of the valve chamber 27a communicates with a flue 30a, which in turn communicates with the flue 4c. In these valve chambers are the seats 31a and 32a, for the valves 33a and 34a, and the two valve chambers are connected between the valve seats by a passage 35a.

36 is a blower for about 10 to 20 pounds air

pressure. This blower communicates with the pre-heater 5, and a pipe 38 leads from this pre-heater to two branch pipes 39—39a. The branch pipe 39 communicates with the valve chamber 28 above the valve seat 32, and the branch pipe 39a communicates with the valve chamber 28a above the seat 32a, so that the passage of gas to and from the regenerators is controlled by these four valves.

It will be seen by the above construction that the waste gases from the open hearth furnace do not pass through the regenerators, but pass through flues which communicate with a long flue in which are the two pre-heaters 5 and 6. As these pre-heaters are closed pipes there is no tendency whatever to clog the pipes of the pre-heaters.

One pre-heater 6 is connected to a low pressure blower and the heated air passes through a pipe 21 to the burner pipe 22, at which point oil and steam is added, which mixes with the pre-heated air and is projected into one or other of the combustion chambers 9—9a, and the heat generated in these chambers passes over the bridge wall into the regenerator connected to the particular combustion chamber.

The waste gases pass through the valve chambers through flues 30 or 30a and to the main flue 4b, where the gases unite with the gases from the open hearth furnace.

The pre-heater 5 is connected to a blower for about 10 to 20 pounds air pressure and communicates through the pipe 38 to the branch pipes 39—39a to the upper portions of the valve chambers 28—28a. The valves 34—34a control the flow of this pre-heated air to the valve chamber 28 or 28a, and as the valves 33 or 33a are closed when either of the valves 34 or 34a are open, the heated air under pressure passes through the valve chambers 28 or 28a, past the highly heated checker-work in the particular regenerator, and this air passes through the particular air blast main to the header 11, one or other of the valves 13—13a being open to allow the highly heated air to enter the header and combine with the steam and gas, so as to produce a very hot flame directly upon the charge on the hearth of the furnace, the waste gases passing through the downtakes 3—3a at each end of the furnace, and to the flues 4—4a and the main flue 4b.

It will be seen that valves are so arranged that they control the passage of gases through the checker-work in one regenerator while air under 10 to 20 pounds pressure is passing through and taking up the heat of the checker-work in the other regenerator, so that at no time do the products of combustion from the furnace enter the regenerator chambers. This will make possible a chamber designed along scientific lines, and this entirely eliminates slag and oxides from

entering the regenerating chambers, insuring uniform operating conditions throughout the entire life of the furnace.

The burner tubes which are in the upper portion of the furnace are only used for the introduction of fuel and high pressure pre-heated air and never for the elimination of waste gases.

The theoretical flame temperature of the highly heated air and fuel is considerably above that used in the ordinary open hearth furnace.

The use of several short hot flames concentrating the heat in a relatively small area at numerous places over the entire charge promotes faster and more uniform melting, and furnace deterioration will be materially decreased by the elimination of the long uncontrollable furnace firing flame now commonly used, because the waste gases will always be eliminated through ports and downtakes designed for this purpose, of sufficient size to reduce the velocity, thereby reducing the cutting action on furnace linings to a minimum.

I claim:

1. The combination of an open hearth furnace having downtakes at each end; a series of burners in the upper portion of the furnace and near the center thereof, said burners projecting short intense flames onto the metal within the furnace; two regenerator chambers; means for alternately heating the regenerators with air and gas, independent of the downtake flues of the furnace; a waste gas flue with which the downtake flues communicate, and flues for the waste gases of the regenerators communicating with the waste flue; means for admitting heated air alternately to the regenerator chambers; hot air pipes connecting the regenerators with the burners; and valves for controlling the flow of gas from the said regenerators.

2. The combination in an open hearth furnace having downtake flues at each end; waste gas flues with which said downtake flues communicate; a header; burners projecting from said header into the upper portion of the furnace and arranged to project short intense flames onto the charge in the furnace; two regenerators heated independently of the furnace; hot air pipes leading from the two regenerators to the said header; valves for controlling the flow through the pipes; means for alternately heating the regenerators, independent of the waste gases from the furnace, the waste gases from the regenerators passing to the waste gas flues; a pre-heater in the main flue; a blower connected to the pre-heater; a pipe leading from the pre-heater and connected to the two regenerators; and valves for controlling the flow of heated air to the regenerators, the valves being arranged so that one set of valves can be closed while the other set are open, to allow

the pre-heated air which enters one regenerator to pass to the burners, while the other regenerator is being heated.

3. The combination in an open hearth furnace, of a furnace having downtake flues at each end; a waste gas flue with which said downtake flues communicate; a series of burners in the roof of the furnace, arranged to direct the flames upon the charge within the furnace; two regenerator chambers; a pre-heater in the waste gas flue; a burner pipe connected to each regenerator chamber; a pipe leading from the said pre-heater to said burner pipe; valves in said burner pipe for controlling the flow of highly heated air to either regenerator furnace; a hot blast pipe leading from each regenerator chamber to the burner at the roof of the open hearth furnace; and a valve in each of said hot blast pipes for controlling the flow of heated air therethrough.

4. The combination in an open hearth furnace; downtakes at each end of the furnace; a series of burners above the hearth of the furnace and arranged to project short hot flames onto the charge on the hearth; a waste gas flue connected to the downtakes of the open hearth furnace; two regenerator chambers; a combustion chamber connected to each regenerator chamber; burners communicating with each combustion chamber valves for regulating the flow of air to said chambers; a pre-heater located in the flue; a low pressure blower communicating with the pre-heater; a pipe connecting the pre-heater with the burners which communicate with the two combustion chambers; fuel pipes and steam pipes entering the last mentioned burners; two hot blast mains, one connecting with the combustion chamber of one regenerator chamber and the other connected to the combustion chamber of the other regenerator chamber; a header with which the two hot blast mains communicate; a valve in each pipe for controlling the flow of air through said pipe, said header communicating with the burners of the open hearth furnace; steam and oil pipes in each burner; two pairs of valve chambers; a valve in each chamber, one chamber of each pair communicating with the lower portion of the regenerator chamber, the other chamber of each pair communicating with the waste gas flue; a second pre-heater in the flues; a blower communicating with the pre-heater; a pipe leading to the two valve chambers, which communicate with their respective regenerator chambers.

5. The combination of an open hearth furnace having downtake flues at each end; a waste gas flue with which the downtake flues communicate; two regenerator chambers; a combustion chamber for each regenerator chamber; two pairs of valve chambers, one valve chamber of each pair communicating with the lower portion of a regenerator chamber, the other valve chamber communicating

with the waste gas flue; a valve in each chamber, the two chambers of each pair being connected between the valves in the said chambers; a pre-heater in the waste gas flue; a blower connected to the said pre-heater; a pipe leading from the pre-heater and communicating with the two valve chambers which connect with their respective regenerator chambers, above the valves therein; a second pre-heater; a low pressure blower connected to the pre-heater; a burner pipe communicating with each combustion chamber; valves in said burner pipe; a pipe leading from the last-mentioned pre-heater to the burner pipe; oil and steam pipes entering said burner pipe; a hot air pipe leading from each combustion chamber to a point above the open hearth furnace; a header to which the hot blast pipes are connected; a valve in each hot blast pipe; and a series of burners connected to the header projecting into the upper part of the open hearth furnace and steam and oil pipes forming part of the burner apparatus.

6. The combination in an open hearth furnace, of downtake flues at each end of the hearth; a waste gas flue communicating with the downtake flues; burners in the upper portion of the open hearth furnace for projecting flames onto the material within the furnace; two regenerators; hot blast pipes connecting the regenerators with the burners; valves controlling the flow of hot air through the hot blast pipes; a preheater in the waste gas flue; a low pressure blower for supplying the preheater with air; a burner pipe leading from the preheater and connected to the two regenerators; valves in said pipe controlling the flow of air to the said regenerators; oil and steam pipes extending into the burner pipe; waste gas flues connecting the regenerators with the waste flue of the furnace; and means for supplying air to one of the regenerators when the waste gas passage is closed, said air passing through the regenerators and through the hot blast pipes to the furnace burner.

7. The combination in an open hearth furnace, of burners in the upper portion of the furnace above the hearth; downtake flues at each end of the furnace; a waste gas flue with which said downtake flues communicate; two regenerator chambers; hot blast pipes connecting the said regenerator chambers with the furnace burners, said regenerators arranged to alternately supply hot air to the above-mentioned burners, the downtake flues passing clear of the said regenerator chambers; valve chambers for the regenerator chambers; waste gas flues connecting the said valve chambers with the waste gas flue; means for independently heating the regenerators; means for supplying air to either one of the regenerators; and valves controlling the flow of hot air and gases through the regenerators.

8. The combination in an open hearth furnace, of burners; downtake flues at each end of the hearth of the furnace; two regenerators, the downtake flues passing clear of the regenerators; a main waste gas flue with
5 the regenerators; which the downtake flues communicate; waste gas flues connecting the regenerators with the said main waste gas flue; burner means for independently heating the regenerators; two preheaters in the waste gas flue,
10 one for supplying air to the burners which heat the regenerators, and the other supplying air to the heated regenerators; and hot blast pipes connecting the regenerators with
15 the furnace burners of the open hearth furnace.

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