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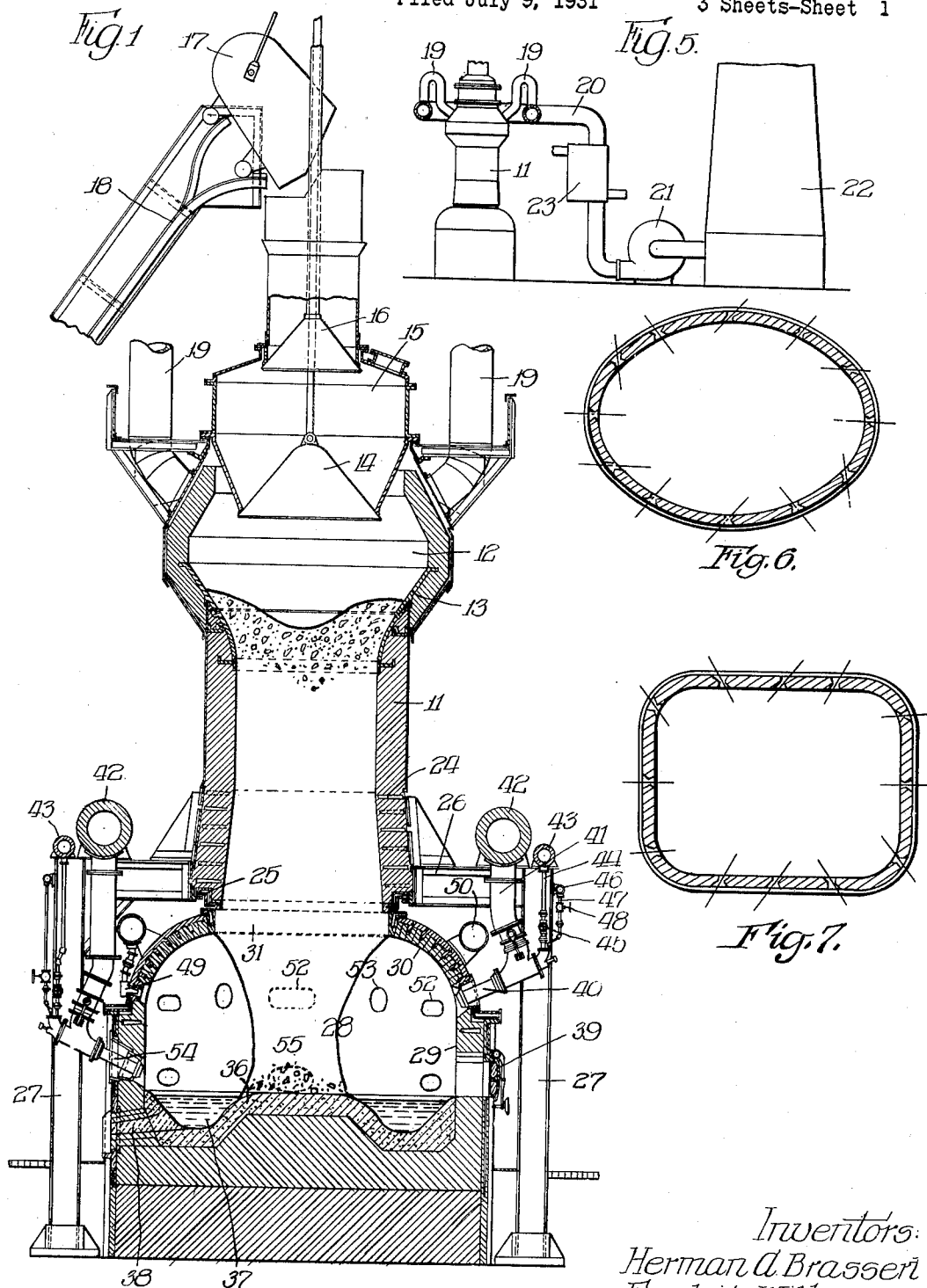
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1,948,696

VERTICAL SHAFT FURNACE

Filed July 9, 1931

3 Sheets-Sheet 1



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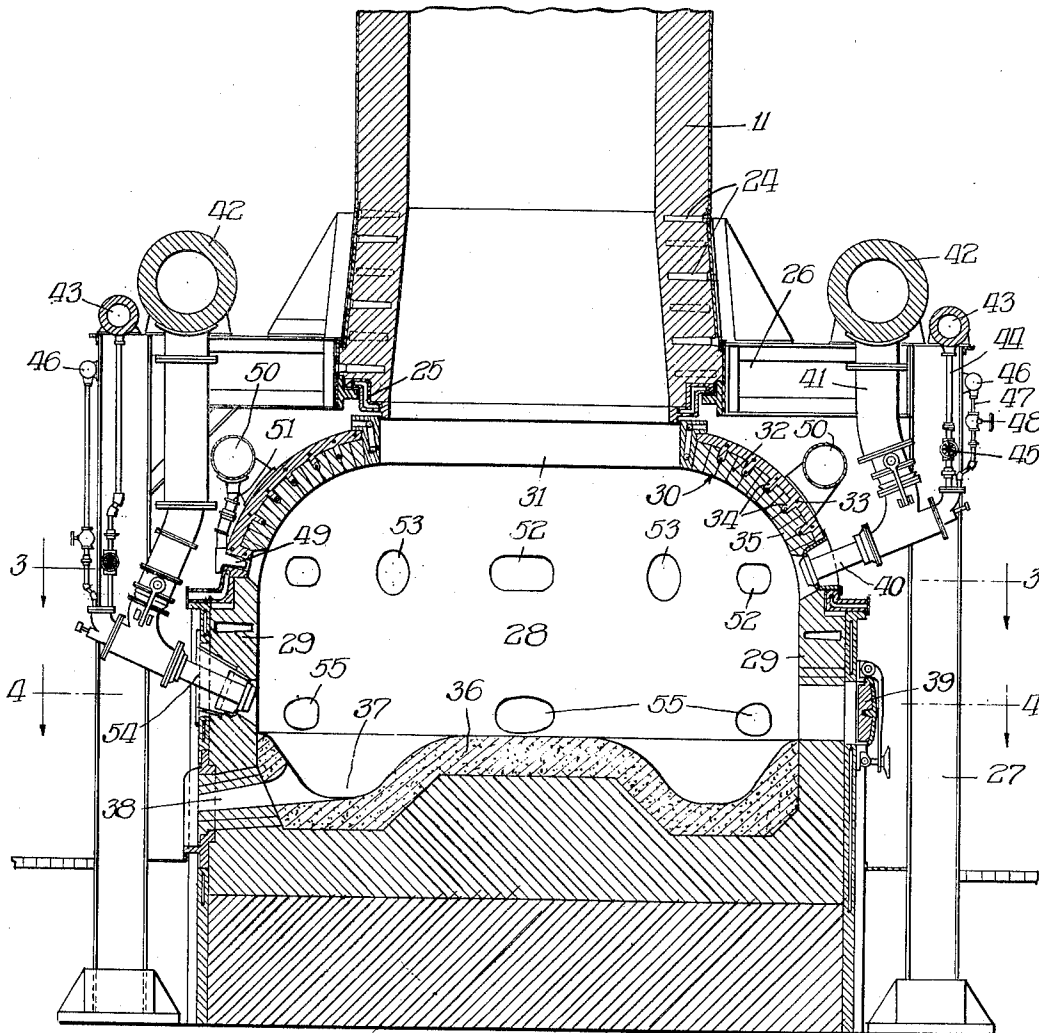
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Fig. 2.



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Fig. 3

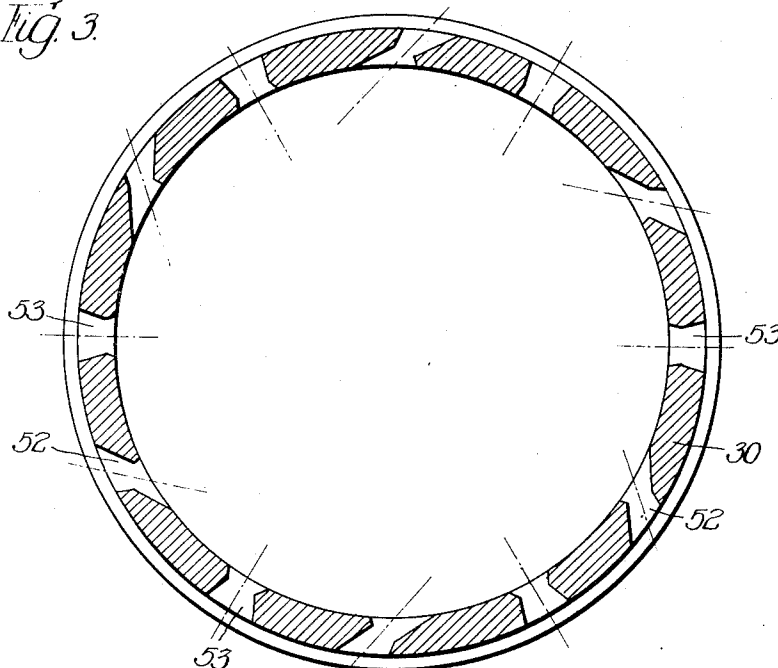
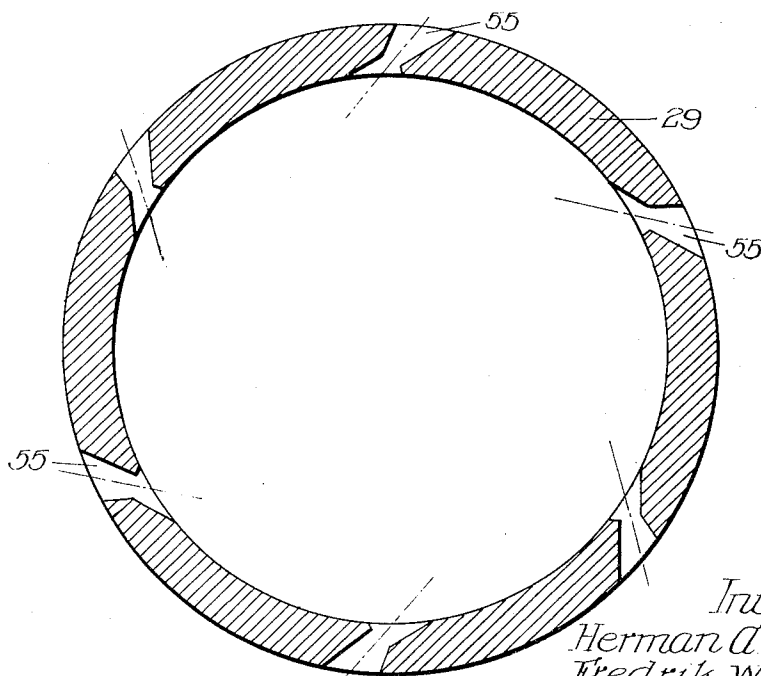


Fig. 4



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UNITED STATES PATENT OFFICE

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VERTICAL SHAFT FURNACE

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Application July 9, 1931. Serial No. 549,722

13 Claims. (Cl. 266—11)

This invention relates to a new and improved melting furnace, and more particularly to a furnace of the shaft type having an enlarged hearth located below the shaft portion of the furnace,

and in which the fuel for melting is injected into the hearth and also to a construction whereby the walls of the furnace may be adequately cooled and protected against high temperatures.

This invention relates in general to a modified and improved form of the furnace shown in the copending application Serial No. 544,492, filed June 15, 1931, in the name of Herman A. Brassert. In furnaces of this type the shaft is preferably supported independently of the enlarged hearth, which is located below the open lower end of the shaft and which receives the reduced and melting charge from the shaft. This enlargement of the lower portion of the furnace makes it possible to have a space around the edge of the furnace in the lower hearth portion which space serves as an annular combustion chamber and permits the use of burners through which fuel and air are injected for carrying on combustion. The copending application above referred to shows a single row of tuyères inclined toward the bottom of the hearth.

It is an object of the present invention to provide a furnace in which both melting and refining can be carried on, with separate control of melting and refining.

It is an additional object to provide a construction including a plurality of rows of tuyères which may be used independently for melting and refining.

It is an object to provide a new and improved construction for water cooling the hearth walls and roof construction of furnaces of this character against the highest temperatures.

It is an additional object to provide means whereby the walls may be protected on their inner surface by the injection of inert or non-combustible gases.

It is a further object to provide a construction in which a suction draft may be applied to the furnace.

It is an additional object to provide a construction in which the melting and refining operations may be carried on with maximum ease and flexibility of operation and economy of fuel, and permitting the accumulation of a large bath of metal.

Other and further objects will appear as the description proceeds.

We have shown a preferred embodiment of our

invention in the accompanying drawings, in which—

Figure 1 is a vertical section through the furnace;

Figure 2 is a vertical section through the lower portion of the shaft furnace section and through the hearth section;

Figure 3 is a diagrammatic horizontal section taken on line 3—3 of Figure 2;

Figure 4 is a diagrammatic horizontal section taken on line 4—4 of Figure 2;

Figure 5 is a diagrammatic showing of the furnace and stack connections.

Figures 6 and 7 are sections on a reduced scale, similar to Figures 3 and 4 but showing furnaces of different cross sectional contour.

In the drawings, the furnace is provided with a shaft portion 11 and upper charging portion 12 having outwardly flaring walls 13 adapted to receive the material discharged from the lower bell 14. The usual type of charging hopper 15 is provided closed at its upper end by the upper bell 16. A charging car 17 is shown operating on the track 18. The products of combustion are led from the upper portion of the furnace through the passages 19, which, as shown in Figure 5, connect to a header 20 leading through fan 21 to the stack 22. A recuperator or other heat recovering means 23 may be provided for heat recovery and to reduce the temperatures so that they will not be injurious to the fan 21.

The lower portion of the stack section 11 is shown as provided with a plurality of water cooled bosh plates 24, and at its lower end has a water cooled ring member 25 mounted thereon in close contact with a water cooled dome ring forming a part of the hearth portion, as hereinafter described. This stack section is supported on a metal framework 26 carried by columns 27 independently of the lower hearth section 28 of the furnace.

This enlarged hearth section 28 is provided with vertical walls 29 and inwardly inclined dome walls 30 which meet a water cooled metallic ring 31 which serves as a key for the upper edge of these walls 30. The dome walls 30 are made up of a metallic cover 32 containing integral cooling elements 33, and with ribs 34 for holding the refractory lining 35. The metallic cover 32 may be air cooled externally if desired, all of which forms a special system of cooling which must be employed to prevent destruction of the furnace walls owing to the very high temperatures resulting from the complete combustion of the rich fuel with preheated air, preferably employed with

this furnace, although all of the furnace walls are formed of refractory material of a high heat resistant character.

The dome walls 30 rest upon the vertical side walls 29 of the hearth portion 28 with the bottom 36 of the hearth portion having an annular depressed portion 37 therein in which the molten metal will accumulate, and is capable of holding a large bath of molten metal. A suitable tapping hole 38 is provided which is in communication with the depression 37 in the hearth bottom. Inspection and charging doors 39 are shown provided adjacent the metal line of the furnace, and through these doors materials may be charged or additions made if desired, for facilitating the refining of the metal or bringing it to the proper analysis, or the bottom can be repaired or remade.

Into the lower part of the dome portion 30 of the furnace an upper series of burners or tuyères 40 is provided, which are supplied with air through passages 41 leading from the bustle pipe 42. This air is preferably preheated to a high degree. The fuel is supplied to these burners 40 through the header 43 and pipes 44 controlled by valves 45. Steam for forcing the fuel into the burner may be supplied through header 46 and pipes 47 controlled by valve 48. The tuyères 40 are shown extending radially inward of the hearth portion 28 and are downwardly inclined. Intermediate the tuyères or burners 40 are shown small nozzles 49 which are supplied through the header 50 and pipes 51 with waste gases, air, steam or other cooling medium for protecting the hearth walls, dome roof, and lower stack walls against excessive heating, and also keeps these parts of the furnace sufficiently cool to prevent formation and adhesions of molten masses on the walls, thereby avoiding scaffolding. These nozzles 49 are preferably inclined tangentially of the hearth through the openings 52, shown in Figures 2 and 3. The burners or tuyères 40 extend through the radial openings 53 of Figures 2 and 3.

A lower set of tuyères or burners 54 are provided, which are supplied with air through the bustle pipe 42, and with fuel and steam through the headers 43 and 44 and are located on a lower level extending through the vertical side walls 29 of the hearth portion. These burners 54 are preferably located tangentially and extend through the openings 55 shown in Figures 2 and 4.

By the use of the fan 21 shown in Figure 5, it is possible to adequately control the pressure and draft conditions in the furnace and if desired, to operate it under slight subatmospheric pressure. This assists materially in the control of the operation.

In operation of the furnace, the upper series of tuyères or burners 40 serve the purpose of melting down the column of materials descending through the shaft. These materials may comprise iron ore, flux and some carbon to aid in the reduction of the ore. Steel or iron scrap may be added to the charge if desired. The furnace may also be used for the melting of scrap metal alone. The reduction of the ore and preheating of the scrap and flux take place in the shaft portion of the furnace, melting taking place normally only in the hearth portion 28. The second or lower set of tuyères or burners 54 is used to accelerate the melting process and also to refine the molten metal. The tangential location of the lower burners 54 causes an annular flame to form, which will travel around the

circumference of the hearth and close to the surface of the liquid metal collected in the annular hearth depression. This action may also cause the liquid metal and slag to revolve and will bring about an intimate contact between the flame and the surface of the bath.

The bath of liquid metal is preferably maintained at a level such that it is below the raised hearth portion 36. The charge in the shaft portion of the furnace remains supported on unmelted material resting on hearth portion 36 and out of contact with the bath of molten metal.

It is obvious that with this arrangement we may carry an oxidizing or neutral flame from the top row of tuyères or burners and we may simultaneously carry a neutral or reducing flame through the bottom row of tuyères, the upper flame being the most advantageous for quick melting and the lower flame being particularly adapted for dead melting the metal and freeing it from gases.

It will be evident to steel makers that the operation of our furnace can be carried on with many variations, for instance, we may melt by injecting a burning fuel through both the top and bottom rows of tuyères simultaneously if rapid melting is desired, or only through the upper row, or in case it is desired to lower the temperature in the lower part of the stack, the melting may be carried on by using the lower tuyères only, during such periods as this procedure may be advisable. Or melting may be carried on through the upper tuyères until sufficient molten metal has been accumulated to fill the annular hearth below with molten metal; then the combustion for the upper tuyères may be shut off and the lower tuyères may be used for refining this metal which is tapped off after refining is completed. The degree to which melting and refining can proceed simultaneously depends on the character of the charge, in the case of steel making, whether cast iron is mixed with the steel scrap, and also on the desirability of making fast or slow heats. The furnace may be operated under pressure, under suction, or with balanced draft.

The character and quantity of the inert gases introduced through the openings 52 may also be varied depending upon the kind of reducing which is being performed and the character of material with which the furnace is being charged and metal desired. These gases being incombustible will ascend along the dome walls and stack walls, thereby protecting them from the destructive effects of the very high temperatures developed in this furnace. The space between the water cooled ring 25 and the dome ring 31 may be packed with asbestos or other heat resisting material if desired.

The furnace need not be circular in cross section as shown in Figures 3 and 4, but may be of other shapes such as oval or rectangular with rounded corners as shown in Figures 6 and 7.

While we have shown certain preferred embodiments of our invention, this is to be understood as illustrative only, as we contemplate such changes and modifications as may come within the spirit and scope of the appended claims.

I claim:

1. A furnace having an enlarged hearth portion, the roof of which consists of a dome shaped metallic covering having ribs thereon for supporting a refractory lining.

2. A furnace having an enlarged hearth portion, the roof of which consists of a dome shaped

- metallic covering having interior cooling means therein.
3. A furnace having an enlarged hearth portion, the roof of which comprises a dome shaped metallic covering having cooling passages therein and a refractory lining secured to the inner face thereof by means of ribs.
4. A melting furnace having a shaft portion and an enlarged hearth portion, the shaft portion being independently supported above the hearth portion, the supporting element of the shaft being water cooled.
5. A furnace having a shaft and an independent hearth structure and a dome shape roof ending in a water cooled dome ring adjacent to the base of the shaft.
6. In a vertical shaft furnace having an enlarged hearth, the enlarged hearth being provided with substantially vertically extending wall portions and upper wall portions extending inwardly to join the lower end of the shaft portion, said inwardly extending walls being formed of heat resistant brick and metallic water cooled members surrounding said brick.
7. In a vertical shaft furnace having an enlarged hearth, the enlarged hearth being provided with substantially vertically extending wall portions and upper wall portions extending inwardly to join the lower end of the shaft portion, said inwardly extending walls being formed of heat resistant brick and metallic water cooled members having portions extending into the brickwork.
8. In a vertical shaft furnace having an enlarged hearth, the enlarged hearth being provided with substantially vertically extending wall portions and upper wall portions extending inwardly to join the lower end of the shaft portion, said inwardly extending walls being formed of heat resistant brick and metallic water cooled members surrounding said brick, and water cooled plates associated with other portions of the furnace walls.
9. In a vertical shaft furnace having an enlarged hearth, the enlarged hearth being provided with substantially vertically extending wall portions and upper wall portions extending inwardly to join the lower end of the shaft portion, and a water cooled metallic ring serving as a key to maintain the upper edge of said inwardly extending walls.
10. In a vertical shaft furnace having an enlarged hearth, the shaft and hearth being provided with an unrestricted opening therebetween, tuyères for injecting fuel and air into said hearth, a stack, passages connecting the upper portion of the shaft furnace and the stack, and a fan associated with said passage to control the pressure in said furnace.
11. In a vertical shaft furnace having an enlarged hearth, the shaft and hearth being provided with an unrestricted opening therebetween, tuyères for injecting fuel and air into said hearth, a stack, passages connecting the upper portion of the shaft furnace and the stack, a fan associated with said passage to control the pressure in said furnace, and means between the furnace and fan to reduce the temperature of the gases reaching the fan.
12. In a vertical shaft furnace having an enlarged hearth, the enlarged hearth being provided with substantially vertically extending wall portions and upper wall portions extending inwardly to join the lower end of the shaft portion, said inwardly extending walls being formed of heat resistant brick, metallic water cooled members partially surrounding said brick, and tuyères extending into the enlarged hearth portion to introduce fuel and air for combustion.
13. A furnace, comprising in combination, a stack portion and a hearth portion, fuel and air supply means, and means whereby non-combustible wall cooling gases are so injected into the hearth portion of said furnace as to travel along the upper portion of the hearth portion and into said stack portion.
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