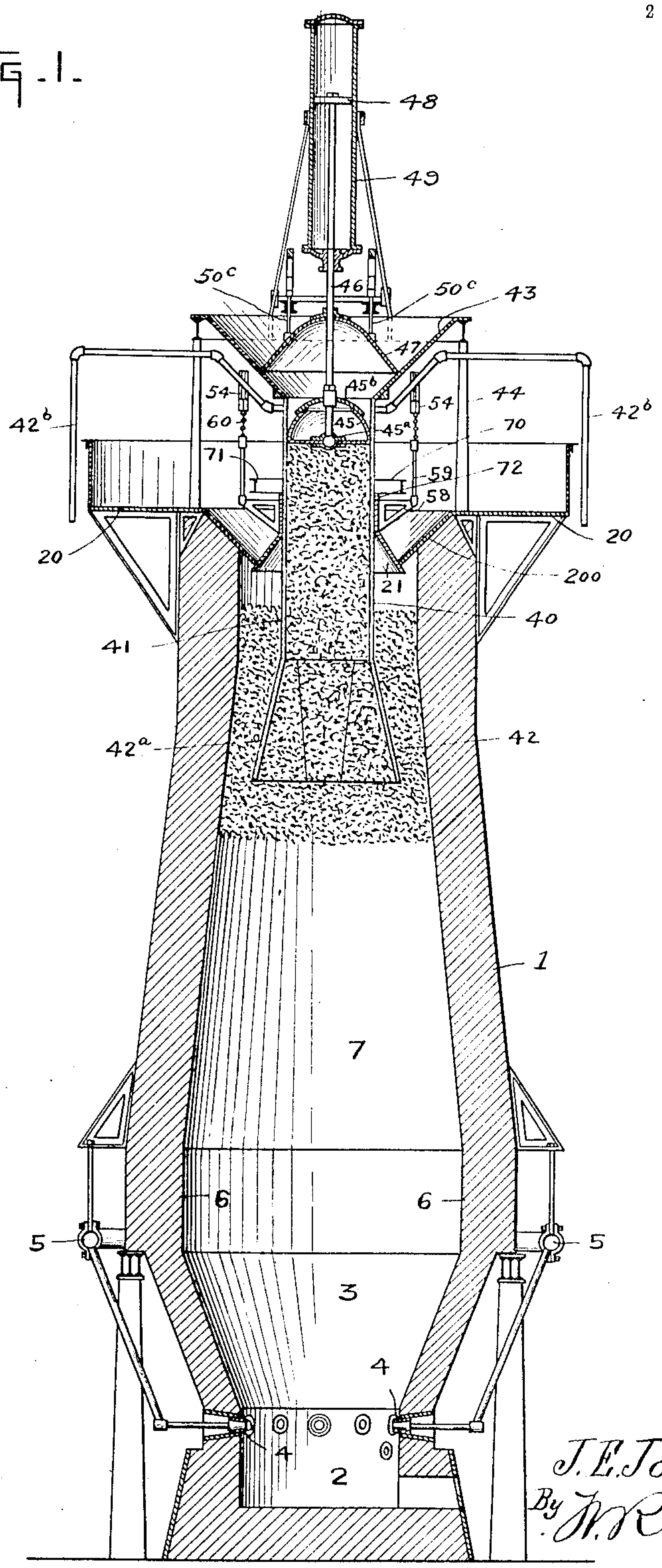
J. E. JOHNSON, Jr.
BLAST FURNACE.
APPLICATION FILED FEB. 7, 1905.

906,717. Patented Dec. 15, 1908.

2 SHEETS—SHEET 1.

FIG. 1.



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2 SHEETS—SHEET 2.

FIG. 2.

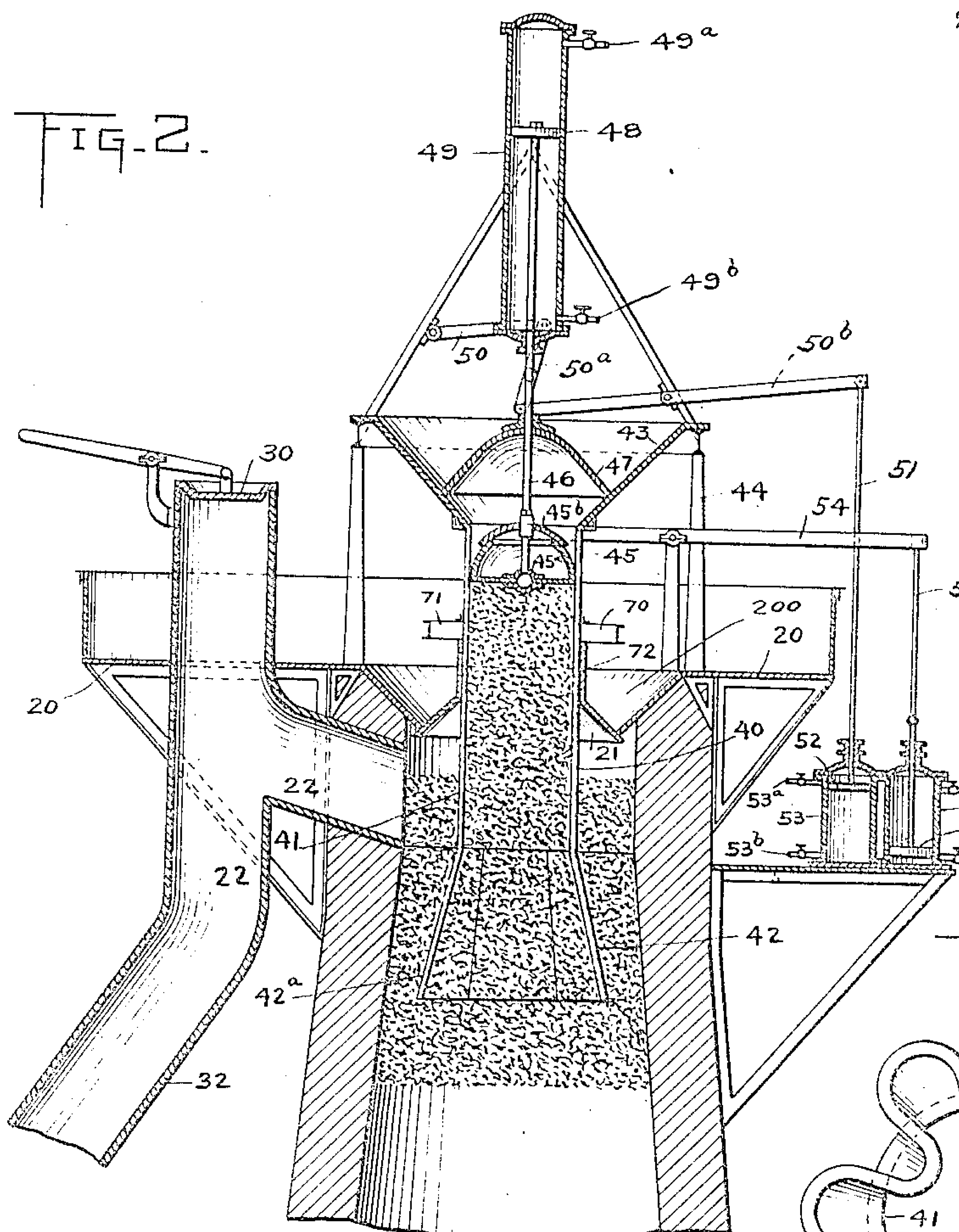


FIG. 4.

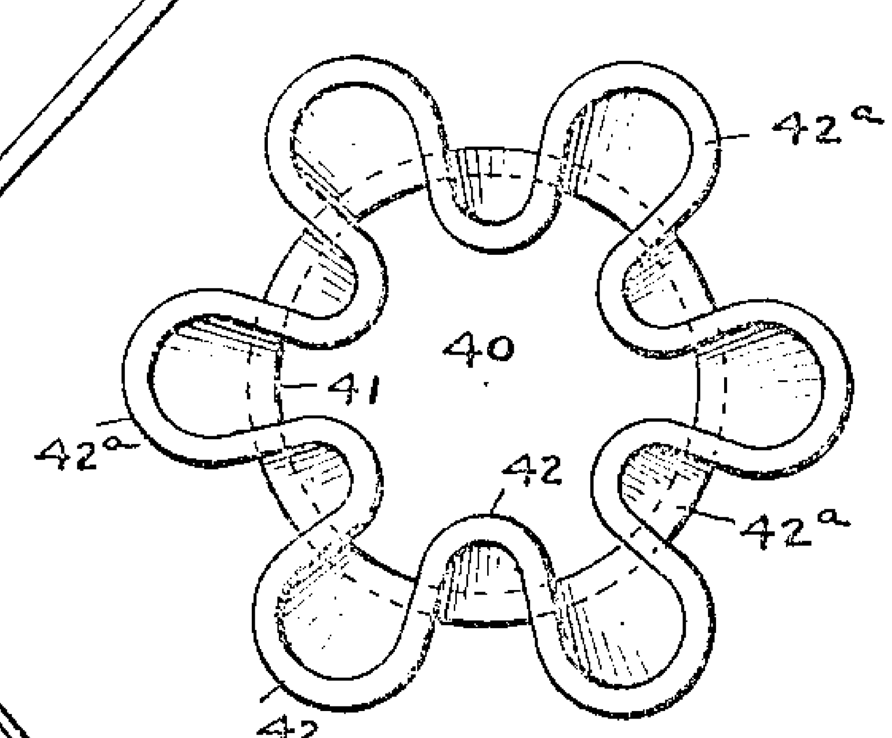
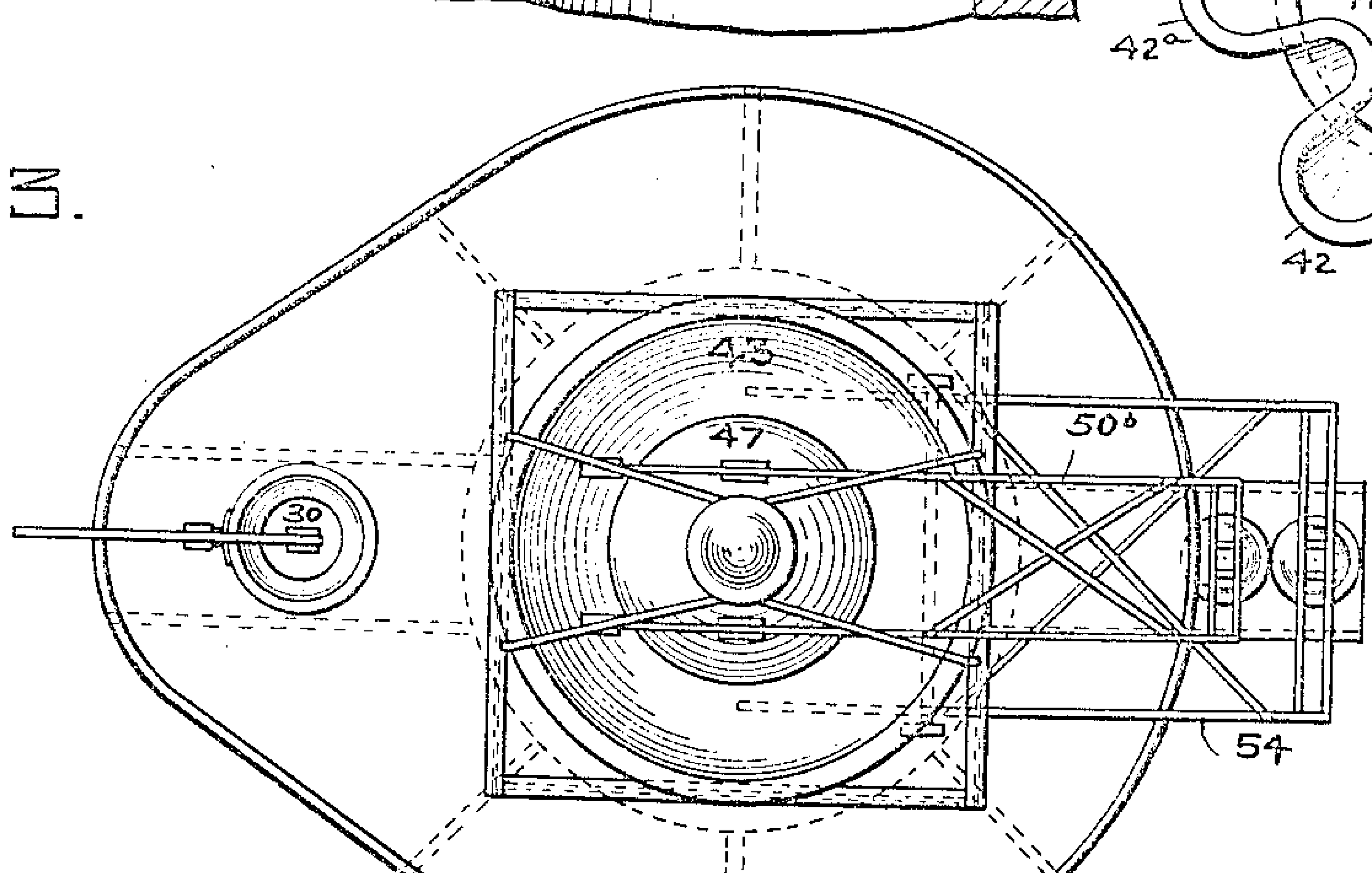


FIG. 3.



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UNITED STATES PATENT OFFICE.

JOSEPH E. JOHNSON, JR., OF LONG DALE, VIRGINIA.

BLAST-FURNACE.

No. 906,717. Specification of Letters Patent. Patented Dec. 15, 1908.

Application filed February 7, 1905. Serial No. 244,581.

To all whom it may concern:

Be it known that I, Joseph E. Johnson, Jr., a citizen of the United States, residing at Long Dale, in the county of Alleghany and State of Virginia, have invented certain new and useful Improvements in Blast-Furnaces, of which the following is a specification.

My invention relates to blast furnaces and its novelty consists in the construction and adaptation of the parts.

In a blast furnace of common form, the fuel, ore and flux are so charged as to form in succession approximately horizontal layers extending substantially across the entire area of the furnace. After the stock has passed into the zone of fusion, the fuel is the only one of the materials charged which remains solid, the others, in the form of iron or slag, melting and running down through the mass of incandescent fuel into the well or crucible at the bottom. The blast enters just above this and unites with the fuel to form carbon mon-oxid which passes up through the materials as they descend and is there oxidized to a greater degree forming mixtures of carbon mon-oxid and di-oxid of proportions differing with the circumstances.

It is a fact that a mixture of carbon di-oxid and carbon mon-oxid behaves during a considerable range of temperature in a precisely opposite manner in the presence of free carbon and in the presence of oxygen-bearing ores. In the presence of free carbon, for instance in the form of fuel, the carbon di-oxid absorbs an amount of carbon equal to that which it already contains and becomes carbon mon-oxid. In the presence of oxygen-bearing ores, for instance, hematite, a portion of the carbon mon-oxid absorbs oxygen therefrom and it becomes a carbon di-oxid. It follows from these re-actions that, as the gases resulting from the combustion of the fuel, pass upward through the furnace, they are subjected to rapidly alternating conditions having precisely opposite tendencies and any oxidation of the fuel which goes beyond the mon-oxid stage is efected under difficulties. The result of such condition is that in ordinary good practice about one-third of the carbon entering the furnace as fuel is oxidized to the di-oxid stage. Another result is that the carbon derived from the flux is liberated therefrom in the form of carbon di-oxid, and, consequently, after undergoing the reactions referred to, passes out of the furnace as two-thirds mon-oxid and one-third di-oxid. These reactions mean a loss of heat and of carbon from the fuel. It is obvious that if some of these disadvantageous reactions could be prevented, an economy in fuel could be secured, and it is furthermore obvious that they can be prevented if the gases resulting from the combustion of the fuel (after the desirable reactions necessitating contact of the fuel and ore have taken place) are prevented from coming subsequently into contact with the incoming fuel and confined to contact with the incoming ore, or ore and flux. In the ordinary blast furnace, also, it is evident that it is necessary to secure a certain temperature (which, for the sake of convenience, I will call the "critical" temperature) below which it is impossible to accomplish the desired reactions between the fuel, the gases derived therefrom, the ore and the flux. The energy expended in bringing the products of combustion up to this critical temperature is, therefore, unavailable for these reactions, which can only take place at or above that temperature, though it is useful in the preparatory or preliminary reactions which occur at lower temperatures. The efficiency of the furnace depends much upon the amount of heat available above this critical temperature.

Without going into any detailed discussion of the matter or presenting in detail facts which are well known to blast furnace engineers, I may state that it is a fact that much of the heat which would otherwise be available for use in this connection is carried off by the nitrogen derived from the air of the blast and that a smaller though important quantity of the heat is used in decomposing the moisture accompanying the air current. It is obvious, therefore, that if the amount of nitrogen and moisture commonly present in the blast could be reduced, the amount of heat available for the efficient working of the furnace would be increased.

I have invented a process of treating ores in a blast furnace which consists in brief in supplying a blast containing an excess of oxygen, utilizing the heat in the fuel by passing the gases escaping from the furnace through the incoming body of ore and maintaining them out of contact with the incoming fuel. This process forms the subject matter of an application for Letters Patent of the United States, filed by me April 9, 1903, Serial No. 151,763, and forms no part of this invention, which relates to the form of furnace in which the process is carried out.

In the drawings, Figure 1 is a central vertical section of a blast furnace embodying my improved apparatus; Fig. 2 is an enlarged section and partial elevation of the ore hopper and upper part of the furnace; Fig. 3 is a top plan view of the same, and Fig. 4 is a bottom plan view of the mantle.

In the drawings, 1 is the stack of usual construction, provided with a hearth 2, crucible 3, twyers 4, 4, blast pipes 5, and boshes 6, 6 and shaft or column 7. All of these parts are constructed in the usual manner common to the art and need no detailed or other description.

Suitably supported at the mouth of the stack is a platform 20 to which the ore is conveyed and from which it is dumped into a conical hopper 200, from which it is fed into the stack as required. At one or more points in the stack there are flues 22, for the removal of the gases which normally occurs through the downcomer 32 of the customary type, but one of the flues is carried up and ends in a bleeder or explosion door 30, or both combined, which differ but slightly from those of the ordinary type.

At the center of the hopper 200 is a vertically placed mantle 40 composed in its upper portion 41 of a cylindrical body and in its lower portion 42 of a fluted conical body. It is preferably made of metal with hollow walls having between them an annular space 42^a adapted for the circulation of a cooling medium such as water, air, steam or the like, supplied from a suitable source and coming in and going out through proper valve-controlled pipes, 42^b. At the top of the mantle 40 is mounted a conical fuel hopper 43 secured firmly to a frame work 44, supported from the stack.

A pusher 45 of hemispherical form and having its plane surface undermost, and resting upon the upper surface of the fuel, is provided for charging the latter. Secured to the pusher 45 by a ball joint 45^a (with its center approximately in the plane surface of the pusher) is a rod 46 extending vertically upward through a bell 47 and itself terminating in a piston 48 fitting a cylinder 49 mounted upon the upper frame of the stack. The pusher 45 has an opening in its top to admit of a movement relative to the rod 46, the opening being covered by a fixed collar 45^b of corresponding shape fast on the rod 46. This construction enables the pusher to accommodate itself to the surface of the fuel within the hopper 43 without danger of leaving a gap at the side past which the fuel can be crowded. The pusher 45 is operated by the piston 48 in the cylinder 49, a pressure being maintained of such an amount upon the upper side of the piston as will cause such a quantity of fuel to be discharged from the mantle that it will be properly proportioned to the quantity of ore passing the lower end thereof at the same time. The cylinder 49 is provided with suitable valve-controlled inlet pipes 49^a and 49^b.

In order to charge the fuel it is put into the hopper 43 above the bell 47. The bell 47 is then raised, admitting steam or other suitable fluid under pressure through the pipe 53^a into the cylinder 53, which operates the bell 47 through a lever 50^b and piston rod 51 and the parallel motion comprising the levers 50 and 50^a. The downward movement of the piston in the cylinder 53 raises the bell 47 upward, allowing the fuel to come in on top of the pusher 45, which is raised to its highest position under the bell 47, which allows the fuel to go into the mantle 41. The pusher is then forced down to the top of the fuel and establishes on it a desired pressure. The motions of the pusher are controlled by the piston 48 in the cylinder 49 by admitting steam above or below it by opening and closing the valves 49^a and 49^b, as desired. The pressure in the cylinder 49 is variable at will. The bell 47 is provided with two rods 50^c, the upper ends of which are attached to the central joint of the parallel motion 50, 50^a and 50^b, and through the lever 50 and the piston rod 51 are connected to the piston 52 in the cylinder 53. It will be observed that this construction provides substantially a means for feeding the fuel, which constitutes a lock or gas seal intermediate between the mantle and the source of fuel supply.

The mantle 40 is fluted at its lower portion, the change being gradual and the outer extremities of the flutes being divergent rather than the inner ones being convergent from the line of the initial cylinder. This might be otherwise expressed by saying that the inner lobes of the flutes do not fall much, if any, within the initial cylinder, while the outer lobes are tangent to a divergent cone outside of it. The result of this form of mantle is that the fuel is discharged therefrom in a fluted or star-shaped column surrounded on all sides by the descending ore which comes down between the external surface of the mantle and the inner wall of the stack. An intimate contact between the ore and fuel is thus effected.

The ore charger consists of the conical hopper 200 secured to the stack and the bell 21 terminating in the sleeve 72, which fits loosely around the cylindrical portion 41 of the mantle 40. Brackets 58 are secured to the bell at suitable points and in turn are secured to links 59 and chains 60, which are connected to the end of a lever 54 fulcrumed in suitable bearings at the side of the stack, and which lever is actuated by a piston rod 55, terminating in a piston 56, which moves in a cylinder 57, and is controlled by fluids, such as steam, which may be admitted and discharged through the valve-controlled pipes 57^a and 57^b. The movement of the bell 21 with relation to the conical hopper 200, through the lever 54, is practically the same as the arrangement now ordinarily used. The upper edge of the sleeve 72 abuts against the lower side of a double diaphragm or elastic point, 70, 71, and makes a tight joint with it, even though the relative positions of the hopper 71 and mantle 40 should be slightly altered through expansion or otherwise.

In the improved form of furnace, if the mantle and furnace outside of it were both kept full to an approximately constant height, the proportion between the fuel and the ore charged would be determined by the areas inside and outside of the mantle at its lower end, and the weights of the respective columns of materials above these areas, and would be approximately constant whether right or wrong if no provision were made to vary this ratio. The ore being heavier than the fuel, will tend to cut off the descent of the fuel and the column of the fuel is, therefore, made higher to compensate for this. The purpose of the piston 48 and pusher 45, which works with a free fit within the cylindrical portion of the mantle 40 and presses upon the fuel, is introduced as an adjustable factor to enable the ratio of the amount of ore and fuel charged into the furnace to be controlled.

I have invented a form of apparatus and sundry processes carried out therein whereby there can be economically and readily extracted from the atmosphere a large proportion of its oxygen. This invention forms no part of the present invention and forms the subject matter of another application for Letters Patent of the United States, Serial No. 154,945, filed April 30, 1903. The supply of oxygen which I thus secure is introduced into the twyers and blast pipes of the furnace illustrated and is forced into the bottom of the furnace by means of a blowing engine of any suitable type and which needs no specific description. The quantity of oxygen giving the most successful results in practice varies greatly with different conditions even with the same furnace and in comparatively brief intervals and the purity of the oxygen obtainable being regulable by the adjustment of my apparatus for producing it, such regulation takes the place of the regulation of the temperature of the blast now commonly practiced. Under all normal conditions, however, the oxygen in the blast will be associated with much less nitrogen than occurs with atmospheric air. By using this oxygen-laden gas as the material for the blast, I can do away with the heating stoves now required for the blast and with many of the accessories thereto with a resulting economy.

In the present form of furnace using the existing methods of filling, as the fuel forms continuous layers across the furnace it is necessary that the blast be able to traverse these, in fact, the openness of the fuel is a principal factor in permitting the air and gases to pass upward through the furnace. For this reason, coke has come to be the principal blast furnace fuel, and few kinds of coal can be used. On account of their bituminous nature, it is impossible to use most soft coals, because, when they become hot, they stick together and practically seal the furnace up, making the passage of the gases impossible. By my method of filling, however, the fuel is charged in a continuous column of fluted cylindrical section through which there is no necessity that the gases should pass, it being, in fact, undesirable that they should do so to any great extent, and, accordingly, bituminous fuels are workable and even desirable, the fact that they cohere into one solid mass when hot protecting them largely from the dissolving action of carbon di-oxid. The fuel column being in the center of the furnace is also out of contact with the walls of the same and, therefore, any possibility of "hanging" by the adherence of the fuel to the wall is thereby prevented. The gaseous products resulting from the distillation of the coal as it is heated, which are very combustible and have a powerful de-oxidizing effect, pass up through the column of ore and assist in the de-oxidation of the ore.

It is to be noted that I do not employ a blast containing an excess of oxygen to raise the temperature in the furnace, but to increase the amount of heat which is at the critical high temperature requisite for performing that part of the smelting operation which can only take place at the highest temperature produced in blast furnaces employing an air blast.

The use of a mantle or fuel chute which is provided with cooling means makes it possible to use bituminous coal, which would otherwise adhere to the chute as soon as it began to distil and impede or prevent the fuel from being fed into the furnace.

What I claim as new is:

1. In a blast furnace comprising a stack and an ore charger, the combination therewith of means for guiding the incoming fuel in the form of a central column and guiding the incoming ore away from the incoming fuel, and means for regulating the rate of feeding the fuel, the latter consisting of a pusher adapted normally to press on the upper surface of the fuel.

2. In a blast furnace comprising a stack and a stock charger, means adapted to guide the incoming fuel and to keep it out of contact with the incoming ore, in combination with means for regulating the rate of feeding the fuel, the latter consisting of a pusher adapted normally to press on the upper surface of the fuel and provided with means for regulating said pressure.

3. In a blast furnace comprising a stack and a stock charger, means adapted to guide the incoming fuel and to keep it out of contact with the incoming ore, in combination with means for regulating the rate of feeding the fuel, the latter consisting of a pusher adapted normally to press on the upper surface of the fuel and provided with means for regulating said pressure, and means for raising and lowering the pusher to admit of the introduction of more fuel.

4. A blast furnace comprising a stack and a stock charger, means for charging the fuel and forming it into a central "fluted" column, and independent means for charging the ore and causing it to descend in a hollow column around said fuel column.

5. In a blast furnace comprising a stack and a stock charger, a mantle adapted to receive the fuel and keep it separated from the ore, comprising a frustum of a fluted cone.

6. In a blast furnace comprising a stack and a stock charger, a mantle adapted to receive the fuel and keep it separated from the ore, comprising an upper cylinder and a lower frustum of a cone flaring downwardly, the latter being fluted whereby the fuel is discharged in a star-shaped column.

7. In a blast furnace comprising a stack and a stock charger, a mantle adapted to receive the fuel and keep it separated from the ore, comprising an upper cylinder and a lower frustum of a cone flaring downwardly, the latter being fluted whereby the fuel is discharged in a column having flutes within the body of the ore.

8. In a blast furnace comprising a stack and a stock charger, a mantle adapted to receive the fuel and keep it separated from the ore, comprising an upper cylinder and a lower frustum of a cone flaring downwardly, the latter being fluted so that its inner lobes are substantially tangent to the cylinder and its outer lobes with the external divergent cone.

In testimony whereof I affix my signature in presence of two witnesses.

JOSEPH E. JOHNSON, Jr.

Witnesses:

Stephen S. Newton,
Herman Meyer.