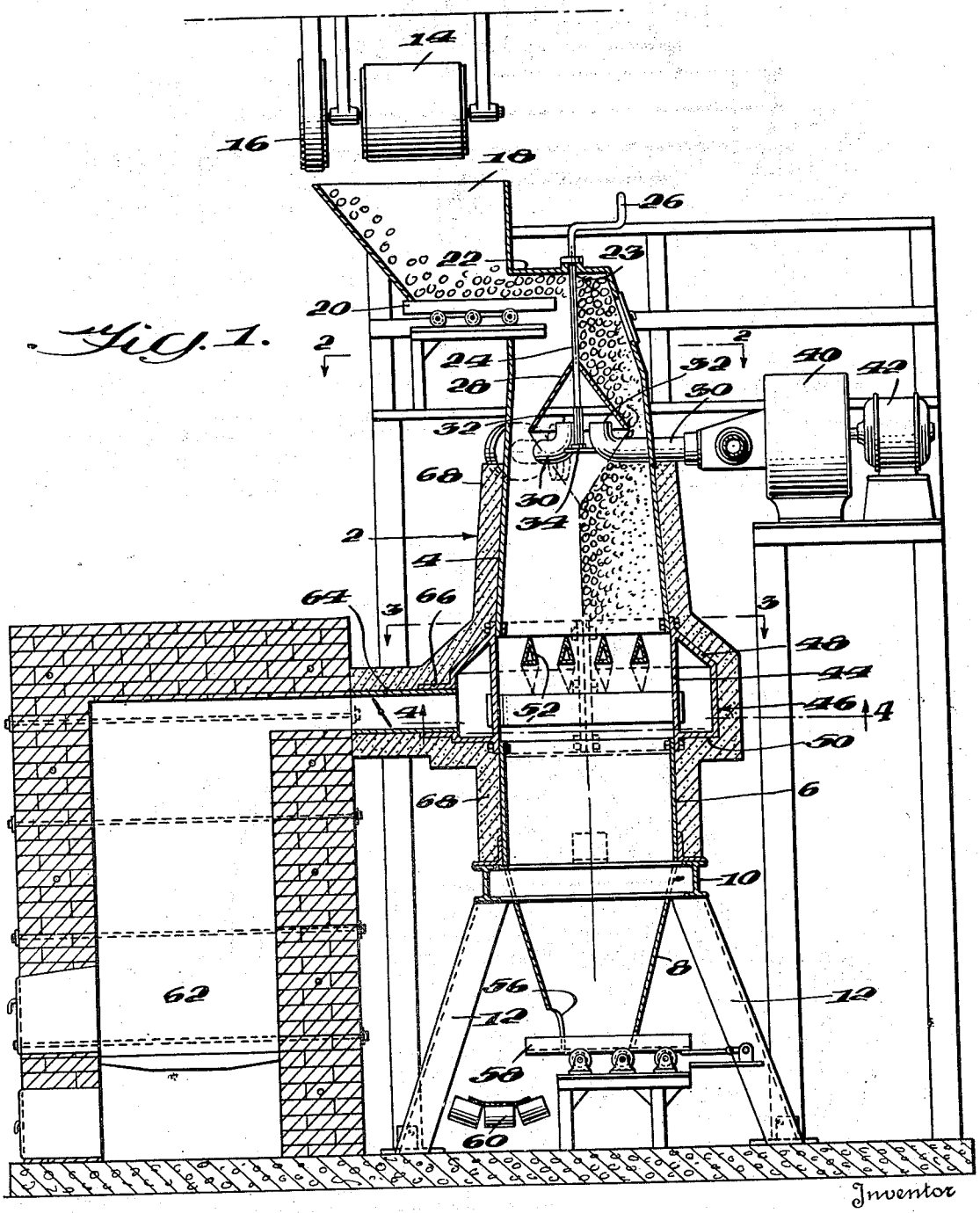
Jan. 22, 1946. E. ANDERSON 2,393,227

APPARATUS FOR TREATING ORES OR OTHER MATERIALS

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Fig. 1.



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APPARATUS FOR TREATING ORES OR OTHER MATERIALS

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Fig. 2.

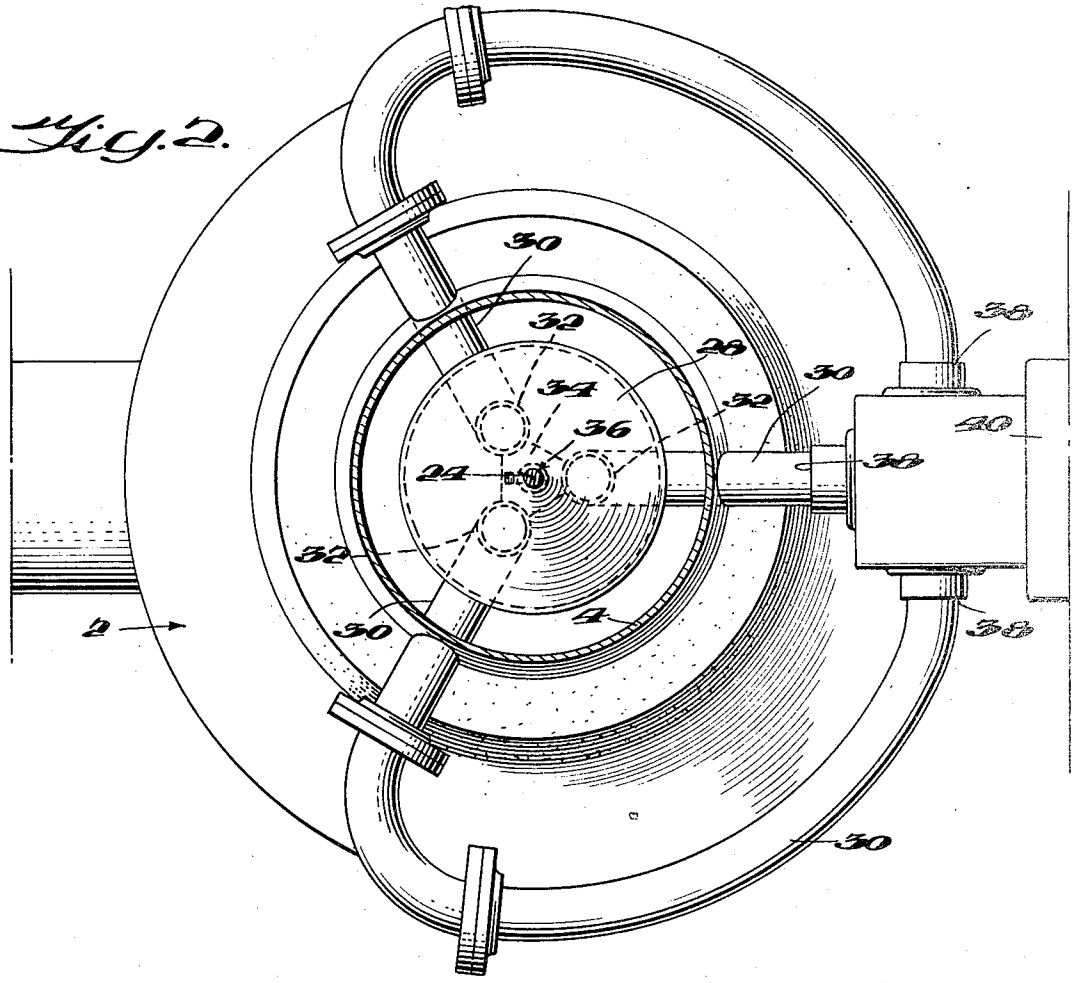


Fig. 5.

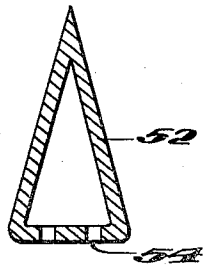


Fig. 6.

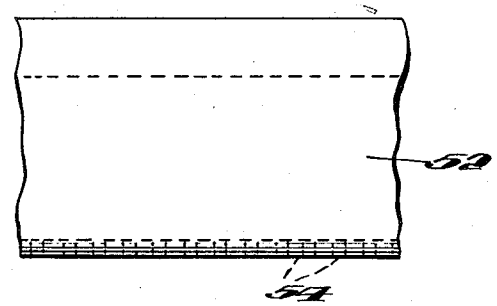
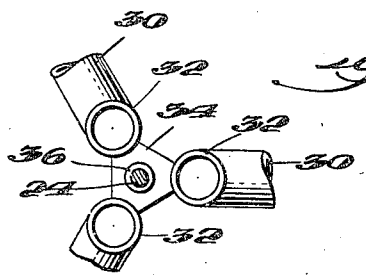


Fig. 7.



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Fig. 3.

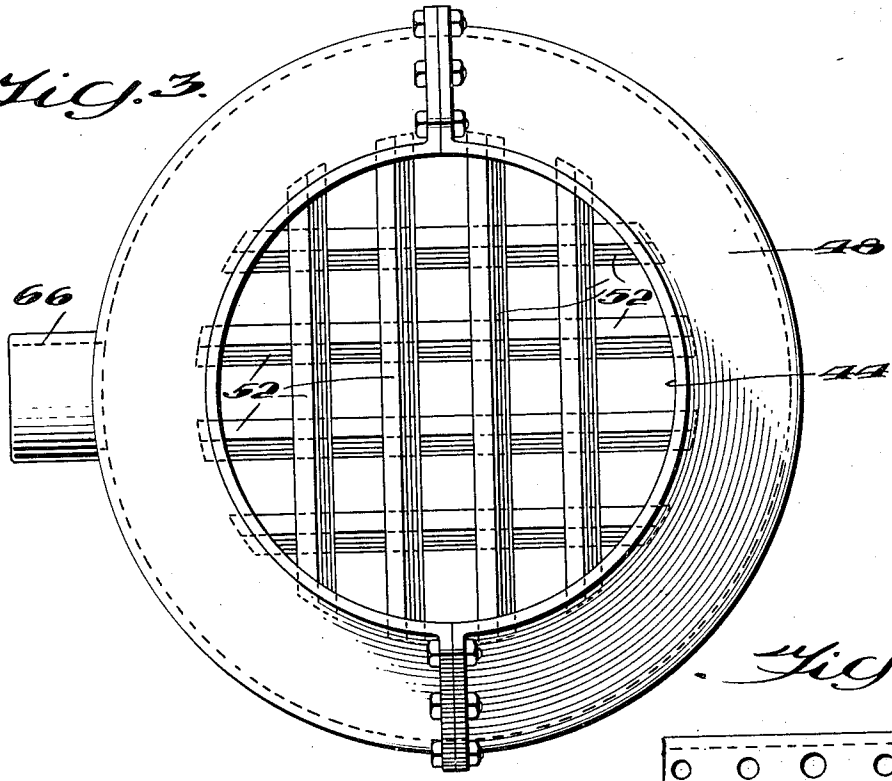


Fig. 8.

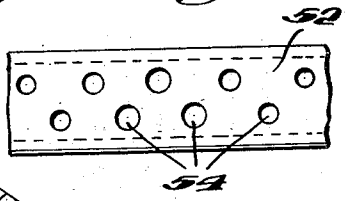
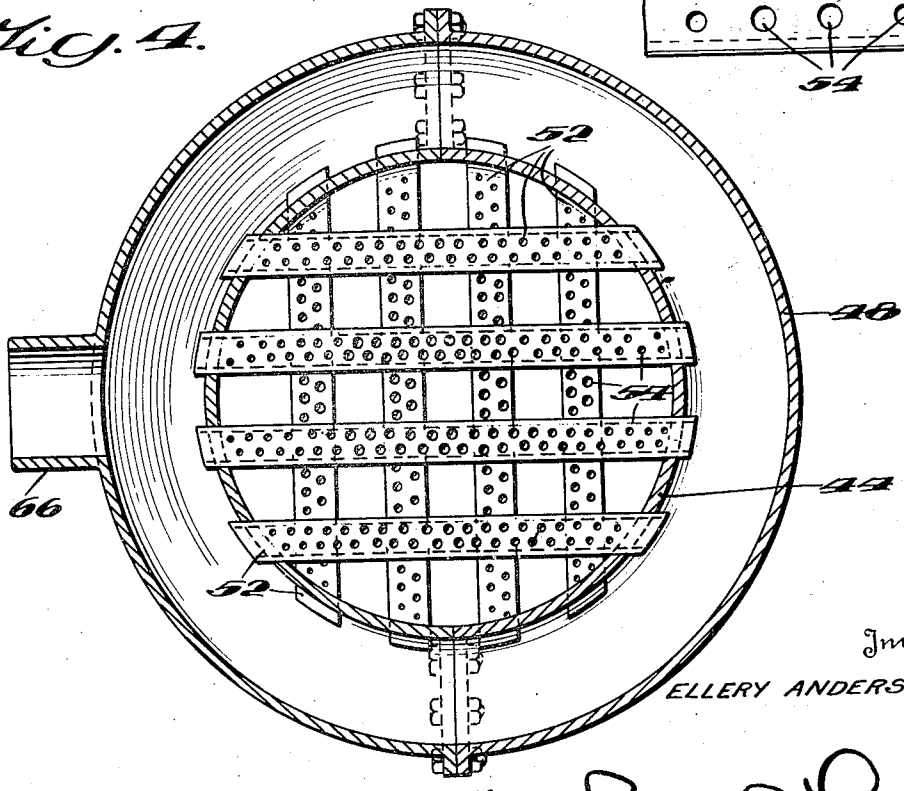


Fig. 4.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR TREATING ORES OR OTHER MATERIALS

Ellery Anderson, Buhl, Minn.

Application October 13, 1942, Serial No. 461,882

10 Claims. (Cl. 34—66)

This invention relates to drying stacks or furnaces for removing moisture from the ores and other materials but specifically for the removal of moisture from iron ores.

In apparatus heretofore designed and constructed, the drying of the ore has resulted in a change of the physical or chemical composition of the ore. The primary object of this invention is to provide apparatus for the drying of ores wherein the treated ore is delivered in a physical form identical to its physical state prior to the processing.

Another object of this invention is to provide a drying furnace which is adapted to utilize a novel type of drying duct.

A further object of the invention resides in the provision of means to consume latent heat released by the treated ore in such a manner as to increase the efficiency of the furnace.

A still further object of this invention is to provide an apparatus for removing moisture from ores which is simple in its operation and inexpensive to carry out.

Other and further objects and advantages of this invention will become apparent from the following detailed description when read in the light of the accompanying drawings, in which:

Figure 1 is a view of the ore treating furnace, partly in cross-section and partly in elevation;

Figure 2 is a cross-sectional view of the drying stack without the insulating material taken on the line 2—2 of Figure 1;

Figure 3 is a cross-sectional view of the drying stack without the insulating material taken on the line 3—3 of Figure 1;

Figure 4 is a non-continuous cross-sectional view of the drying stack without the insulating material taken on the line 4—4 of Figure 1;

Figure 5 is a cross section through one of the tuyères;

Figure 6 is a side elevation of one of the tuyères;

Figure 7 is a detail view showing the assembly of several of the elements positioned beneath the bell; and

Figure 8 is an enlarged fragmentary view of a portion of Figure 4 showing the relative sizes and disposition of the openings in the base wall of the tuyères or ducts.

Referring now more specifically to Figure 1 of the drawings, the reference numeral 2 indicates an ore drying stack. The stack 2 is substantially circular throughout its length and is constructed of material suitable to the material to be dried. As shown in Figure 1, the stack may consist of three main sections, the upper portion 4 which tapers upwardly from a central portion 6, and a lower portion 8 which tapers downwardly from the central portion 6.

The ore drying stack is provided with a supporting base which comprises the annular member 10 upon which the central portion 6 rests, and the inclined supporting arms 12 which are adapted to maintain the annular member in an elevated position.

A loading conveyor 14 driven by a pulley 16 is secured in position over a hopper 18. The hopper 18 is provided with a mechanical feeder 20 at the base thereof and communicates with the interior of the upper portion 4 of the stack 2 through an opening formed in the wall of the upper portion 4 adjacent the top edge thereof. As illustrated in Figure 1, the upper portion 4 is provided with a horizontally extending closure member 22 which has a transversely extending circular opening 23 formed therein, the circular opening 23 having its center substantially on the longitudinal axis of the stack 2. A shaft 24 having an external crank arm 26 is rotatably mounted in the opening 23. A substantially hollow cone-shaped bell 28 is fixedly secured on the shaft 24 intermediate its ends.

A plurality of spaced exhaust pipes 30 extend radially inwardly from the wall portion 4, the inner ends of which are curved upwardly and terminate at the points 32 within the hollow space enclosed by the bell 28 (see Figures 1 and 2). As is clearly shown in Figure 2, the exhaust pipes 30 are held in spaced relation within the bell 28 by a spacing member 34 which is also provided with a bearing 36 adapted to receive the lower end of the shaft 24, as shown in Figures 1 and 7.

The exhaust pipes 30 are coupled at 38 to an exhaust pump or fan 40 driven by the electric motor 42.

Figure 1 discloses that the upper section of the central portion 6 may be considered as a trapezoidal bustle pipe having an inner wall 44, an outer wall 46, and end walls 48 and 50, respectively. The inner wall 44 is provided with a plurality of oppositely disposed triangular shaped, transversely extending apertures adapted to receive and support therein the substantially hollow triangular-shaped parallel heating ducts 52 (Figures 1, 5 and 6) which extend transversely across the interior of the upper portion 6 and are open at each of their respective ends. The heating ducts 52 are positioned in such a manner as to be spaced from each other and have their

respective apices and bases lying in parallel planes. This invention contemplates employing a series of such heating ducts, one above the other, each of the adjacent series being at substantially right angles to each other, as shown in Figures 1, 3 and 4. Each of the heating ducts is provided with a plurality of transverse openings 54 which extend through the base, as shown in Figures 5 and 6 and which increase in area from each end of the heating duct or tuyère toward a maximum at the middle thereof. The openings 54 are greater in diameter at the center of the base of the ducts than the openings at each end, and the total area of the openings is substantially equal to the area of the intake openings in the ends of the triangular ducts.

The lower or discharge portion 8 is open at its end and is provided with an opening 56 formed in the wall thereof. In Figure 1 it will be seen that the discharge end is positioned above a mechanical feeder 58 which feeds the treated ore to the discharge conveyor 60.

A heat generating source such as a furnace 62 furnishes heat which is carried through the pipe 64 which communicates with the interior of the bustle pipe through the flanged opening 66.

The central portion 6 and the upper portion 4 are provided with heat insulation 68.

Having described the apparatus employed in carrying out this invention in detail, its operation is as follows:

The loading conveyor 14 is driven by the pulley 16 which is motivated in any suitable manner. The conveyor 14 deposits the material to be dried in the hopper 18 which in turn discharges the ore into the interior of the stack. The ore falls over the bell 28 under the force of gravity and is passed downwardly into the stack. The ore in the hopper and above the bell 28 comprises a mixture of lump and fine ore. The rotation of the bell 28 by operating the crank arm 26 distributes the ore below the bell in roughly defined zones of fine and lump ore; the fine ore being distributed adjacent the inner surfaces of the walls 4, 6 and 8, the lump ore occupying the center area of the stack. In handling mixed fine and coarse material over a bell, the action tends to create a cone in the column of material below the bell which approximates the size and shape of the bell, but in inverted position as is shown by the broken lines in Figure 1. The material as it moves off the bell thus lands on the constantly maintained slope. The finer material tends to lay flat and proceed downward perpendicularly. A good portion of the lump, however, tends to roll down the slope and thus always dominates the center of the column. As the column settles over the heating ducts, the size of the particles will be, on the average, progressively greater from the outer shell toward the center. The interstices will thus be much larger in the center section than in that area adjacent the wall which, in turn permits a much freer flow of hot gas up the center of the column than is possible in the more closely packed fine material in the area proximate the wall section. As the stack is filled, inverse triangular hollow spaces are formed immediately below the triangular heating ducts 52 and there is also formed the inverted conical space immediately below the cone 28 mentioned above. The cone 28, in addition to its above-noted functions, prevents the ore from entering the ends 32 of the exhaust pipes 30.

Assuming that the ore column has been established it is maintained by feeding the natural ore into the hopper 18 at such a rate as to obtain a full head of ore over the bell 28. Heat is admitted to the bustle pipe from the furnace 62 and enters the heating ducts 52 through the ends thereof and passes into the stack through the openings 54. The lump ore which is forced to the center of the stack creates relatively large interstices wherein the fine ore has only relatively small interstices. The heated drying media pass through the apertures 54 and are forced upwardly under the action of the suction pump or fan 40. The hot blast of drying media passes easily up through the lump ore through the large interstices to the exhaust pipes 30. The hot blasts originating away from the center meet progressively smaller lumps and interstices. This, of course, presents a higher resistance to the passage of the media. As a result thereof, the hot blasts passing through the zone of high resistance is forced to join the main center flow before the heat is vitiated, thus concentrating drying media in the zone of greatest need.

This becomes quite clear if one considers that a particle of iron ore ¼" square on two sides and ⅛" in depth when subjected to a certain amount of heat will become completely dried. On the other hand, a lump of ore 2" square when subjected to the same amount of heat will only be dried to a depth of ⅛", the center retaining all of its moisture. Hence, the diversion of the heat media from the outer periphery of the fine zone to the center of the stack permits a heat transfer to take effect whereby the lump ore is more thoroughly dried.

After the dried ore falls below the heating ducts, it is retained for a certain time (depending on the type of material treated) in the lower portions of the central section 6 and in section 8. Air enters the aperture 56 and is forced upwardly through the dried ore and carries with it the latent heat given off by the treated ore. This, of course, increases the efficiency of the stack and lowers the cost of operation.

Thereafter, the treated or dried ore passes into the lower portion 8 onto the feeder 58 and is discharged through the opening 56 onto the conveyor 60.

The rate of charging and discharging is such that the stack is always maintained with a head of ore which extends over the bell and effectively seals the stack in a substantially airtight manner.

Of particular importance is the construction and design of the heating ducts employed in this apparatus with respect to the drying process. While furnaces or stacks have been constructed to carry out similar processes, the construction and operation thereof results in an end product radically dissimilar from the resulting product obtained in practicing this invention. In all drying stacks heretofore, a change of the physical state of the ore takes place. Nodules of the fine ore are produced which when loaded in ore cars and exposed to air, crumble and become reduced to dust and frequently chemical changes are effected. The instant apparatus and process produces an end product which is in every respect identical to the physical form the ore had prior to its introduction into the stack.

In all other constructions the heating ducts are so formed as to function under a comparatively gentle flow of hot air. If an exhaust pressure of the degree employed in the instant invention were used the heated air would escape almost wholly at the point of entrance to the ore column thus channeling the heated air upward

through only a part of the descending ore column, resulting in a burning of a part of the ore and a non-drying of the non-contacted ore. Because of the particular type of heating duct employed herein, these processing faults are obviated and the efficiency of the process is greatly increased.

Having set forth a detailed description of the apparatus employed in carrying out this invention, it is to be understood that this was given merely by way of example, the invention being limited only by the scope of the following claims.

I claim:

1. A treating stack comprising a central portion, an upper portion tapering upwardly from said central portion, a lower portion tapering downwardly from said central portion, a hopper adjacent the top edge of said upper portion, said hopper communicating with the interior of said stack, said central portion having an upper section comprising a bustle pipe, the inner wall of said bustle pipe having a plurality of spaced, oppositely disposed openings therein, a plurality of spaced parallel heating ducts, said openings being adapted to support said ducts within the stack, said heating ducts being substantially triangular in cross-section, said heating ducts being substantially hollow and having drying media inlet openings formed in the ends thereof to permit drying media to pass from said bustle pipe to the interior of said ducts, discharge ports in the base of said ducts, means for supplying said ducts with a gaseous medium, an enlarged opening adjacent the lower end of said lower portion, a bell disposed within said upper portion, means for supporting said bell, exhaust pipes, means for charging said stack with ore, and means for discharging said stack.

2. A treating stack as defined in claim 1, a plurality of series of said ducts, the apices and bases of said ducts of each of said series being disposed in spaced horizontal planes, and the open ends of said exhaust pipes extending within said bell.

3. A drying apparatus for iron ores and the like, said apparatus comprising, an upright stack, an ore inlet opening in the upper portion of said stack, a discharge opening in the lower portion of said stack, distributing means in the upper portion of said stack in the downward gravity path of the ore for depositing the larger ore particles centrally of the stack with the particles of smaller size outwardly toward the walls of the stack, a plurality of heating ducts provided with escape openings, said heating ducts being positioned in said stack in the path of the ore and intermediate said distributing means and said discharge opening, means for supplying said heating ducts with a heated gaseous drying medium, and suction exhaust means, the inlet of which is disposed in said stack in the vicinity of said distributing means.

4. A drying apparatus for iron ores and the like, said apparatus comprising an upright stack substantially circular in section, an ore inlet opening in the upper portion of said stack, a discharge opening in the lower portion of said stack, distributing means in the upper portion of said stack in the downward gravity path of the ore for depositing the larger ore particles centrally of the stack with the particles of smaller size outwardly toward the walls of the stack, a plurality of heating ducts provided with escape openings, said heating ducts being positioned in said stack in the path of the ore and intermediate said distributing means and said discharge opening, means for supplying said heating ducts with a heated gaseous drying medium, said stack having an air opening in its lower portion, and suction exhaust means, the inlet of which is disposed in said stack in the vicinity of said distributing means.

5. A drying apparatus for iron ore and the like comprising, an upright stack substantially circular in section, an ore inlet opening in the upper portion of the stack, a conical bell member disposed in the upper portion of said stack below said ore inlet opening and centrally of said stack, an ore discharge opening in the lower portion of the stack, a plurality of heating ducts of triangular section and provided with escape openings on their lower surfaces, said heating ducts being positioned in said stack in the downward path of the ore and intermediate said bell member and said discharge opening, means for supplying said heating ducts with a gaseous drying medium, and suction exhaust means, the inlet of which is disposed in said stack beneath said bell member and protected thereby.

6. A drying apparatus for iron ore and the like comprising, an upright stack substantially circular in section, an ore inlet opening in the upper portion of the stack, a conical bell member disposed in the upper portion of said stack below said ore inlet opening and centrally of said stack, an ore discharge opening in the lower portion of the stack, a plurality of heating ducts of triangular section and provided with escape openings on their lower surfaces, said heating ducts being positioned in said stack in the downward path of the ore and intermediate said bell member and said discharge opening, means for supplying said heating ducts with a gaseous drying medium, said stack having an air opening in its lower portion, and suction exhaust means, the inlet of which is disposed in said stack beneath said bell member and protected thereby.

7. A drying apparatus for iron ores and the like, said apparatus comprising, an upright stack substantially circular in section, an ore inlet opening in the upper portion of said stack, a discharge opening in the lower portion of said stack, distributing means in the upper portion of said stack in the downward gravity path of the ore for depositing the larger ore particles centrally of the stack with the particles of smaller size outwardly toward the wall of the stack, a plurality of heating ducts provided with escape openings, said heating ducts being positioned in said stack in the path of the ore and intermediate said distributing means and said discharge opening, means for supplying said heating ducts with a heated gaseous drying medium, said stack having an air opening in its lower portion, and suction exhaust means, the inlet of which is disposed in said stack in the vicinity of said distributing means, the escape openings in said heating ducts being largest in the vicinity of the longitudinal center of the stack and progressively diminishing in size toward the walls of the stack.

8. A drying apparatus for iron ore and the like comprising, an upright stack substantially circular in section, an ore inlet opening in the upper portion of the stack, a conical bell member disposed in the upper portion of said stack below said ore inlet opening and centrally of said stack, an ore discharge opening in the lower portion of the stack, a plurality of heating ducts of triangular section and provided with escape openings on their lower surfaces, said heating ducts being positioned in said stack in the downward path of

the ore and intermediate said bell member and said discharge opening, means for supplying said heating ducts with a gaseous drying medium, and suction exhaust means, the inlet of which is disposed in said stack beneath said bell member and protected thereby, the escape openings in said heating ducts being largest in the vicinity of the longitudinal center of the stack and progressively diminishing in size toward the walls of the stack.

9. A heating device for an ore drying stack or the like, said heating device comprising, a plurality of hollow heating ducts of triangular section, said ducts having a plurality of escape openings on one face only, means for disposing said heating ducts in a drying stack with said face disposed downwardly, said escape openings at the end portions of said face being relatively small and progressively increasing in size at the central intermediate portion, said heating ducts having end inlet openings for the introduction of a gaseous medium or the like.

10. A heating device for an ore drying stack or the like, said heating device comprising a plurality of hollow heating ducts of triangular section, said ducts having a plurality of escape openings on one face only, an annular hollow chamber, said heating ducts being secured to the inner wall of said chamber with the ends of the ducts extending into and communicating with said chamber, an inlet for said chamber for a gaseous medium or the like, said ducts being each disposed with its face having the openings disposed in a plane transversely of said chamber, said escape openings at the end portions of said faces being relatively small and progressively increasing in size at the central intermediate portion thereof.

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