R. A. WAGSTAFF.

APPARATUS AND METHOD OF DISTRIBUTING PULVERIZED COAL IN BLAST FURNACE WORK.

APPLICATION FILED DEC. 4, 1919.

1,411,072.

Patented Mar. 28, 1922.

2 SHEETS—SHEET 1.

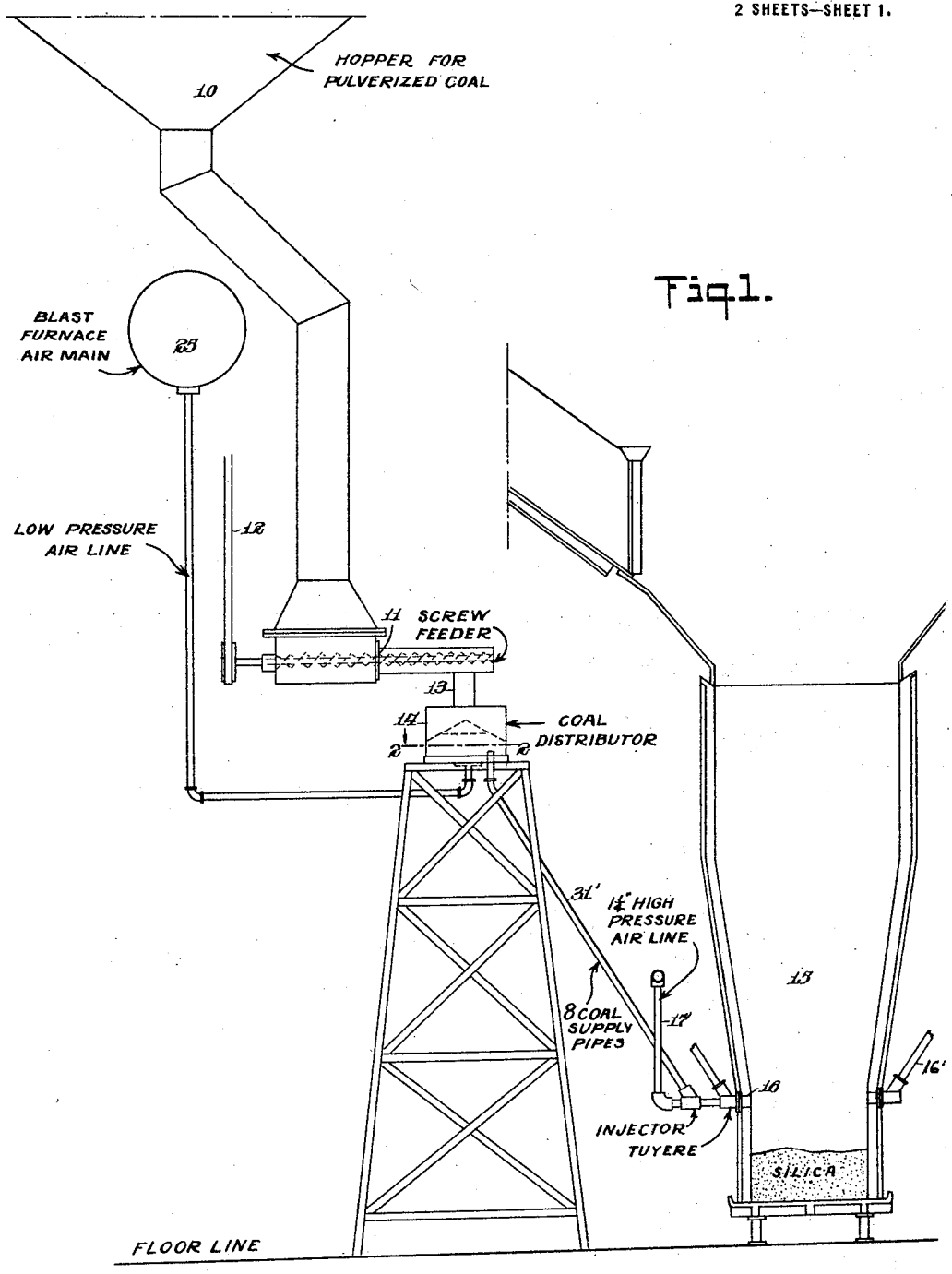

Fig1.

Witnesses:

Richard A. Wagstaff Inventor

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2 SHEETS—SHEET 2.

Fig. 2.

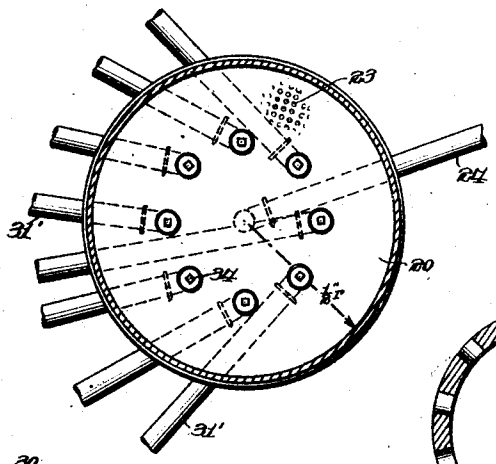


Fig. 5.

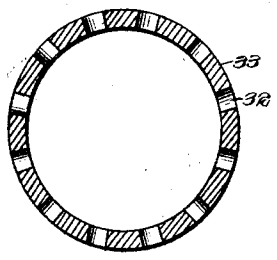
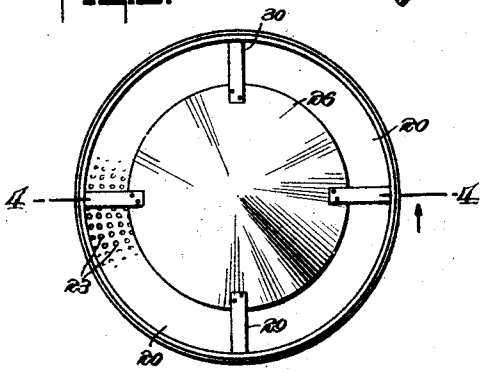


Fig. 3.



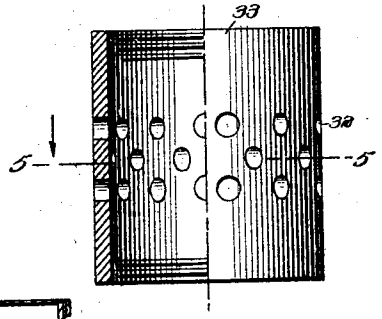


Fig. 4.

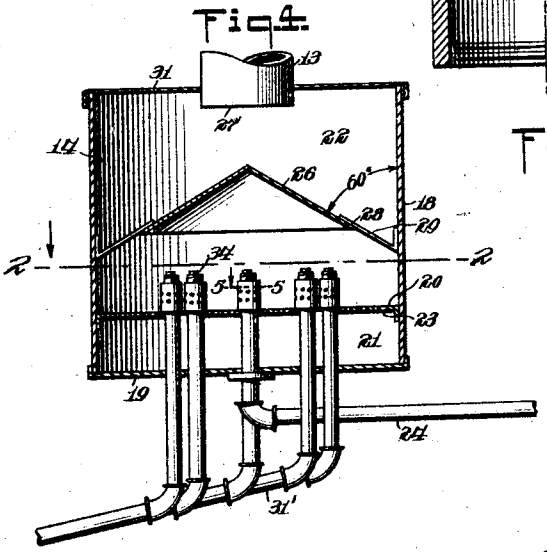


Fig. 6.

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UNITED STATES PATENT OFFICE.

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APPARATUS AND METHOD OF DISTRIBUTING PULVERIZED COAL IN BLAST-FURNACE WORK.

1,411,072. Specification of Letters Patent. Patented Mar. 28, 1922.

Application filed December 4, 1919. Serial No. 342,393.

To all whom it may concern:

Be it known that I, RICHARD A. WAGSTAFF, a citizen of the United States, and resident of Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Apparatus and Methods of Distributing Pulverized Coal in Blast-Furnace Work, of which the following is a specification.

The invention relates to an improved method for preparing a carbonaceous fuel and for feeding the same to a blast or other metallurgical furnace; and the invention further relates to an improved instrumentality for practicing the method.

It has been appreciated, heretofore that in certain metallurgical operations it is desirable to introduce fuel in a semi-gaseous dry condition into a blast furnace, for instance, by pulverizing solid fuel and feeding the pulverized fuel to the injector twyers by means of which the more or less diffused fuel was scattered into the interior of the furnace. The air pressure on the twyers, however, is usually quite high, due to the necessity of supplying sufficient oxygen to support the combustion present. This high pressure air, acting for the necessarily short limits of time on the solid fuel stream fed to the twyers, could not effectively scatter or diffuse the pulverized fuel. As the result of the more or less concentrated condition of the fuel introduced into the furnace intrior, the resulting act of combustion was a relatively slow burning rather than the ideal explosive act which is preferable in certain metallurgical operations.

Accordingly, one of the primary objects of the invention is to provide a preformed carbonized fuel characterized by the fact that each fine particle of carbonaceous particle is surrounded by an envelope of air and in which the body of prepared fuel can be fed to the twyers in the manner in which the solid stream of pulverized fuel has heretofore been fed to the twyers. The present invention contemplates the economic formation of the carbonized fuel which is further characterized by extreme minuteness of the particles of the solid fuel and in which the particles are uniformly scattered in the air present. In other words, the invention features the formation of a nebulous cloud of carbonaceous material which can be ejected in this form into the furnace by high pressure air.

Referring to the mechanical features of the disclosure, one of the objects of this phase of the invention is to provide a simple and economically actuated device for forming the peculiar character of fuel hereinbefore outlined, and for maintaining the fuel in its diffused condition until it is discharged into the combustion zone of the furnace.

Another object of the invention featuring simplicity of construction and economy in operation is to provide such a device as can be used as an attachment to conventional blast furnace plants and which can utilize the sources of air pressures present in conventional plants of this character.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying my invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

Referring to the accompanying drawings:

Figure 1 is a diagrammatic representation in elevation of a plant organized to practice the method herein disclosed, but it is to be understood that the elements illustrated are merely suggestive of one perfected means for practicing the method;

Figures 2 to 4, inclusive, are enlarged detailed views of the coal distributor shown in Figure 1; Figure 2 being a horizontal sectional view taken on the lines 2—2 of Figures 1 and 4; Figure 3 being a plan view looking down upon the coal distributor with its cover removed; and Figure 4 being a vertical sectional view taken axially through the distributor and on the line 4—4 of Figure 3;

Figures 5 and 6 are detailed views of one of the fuel discharge outlets shown in Figures 2 and 4; Figure 5 being a horizontal sectional view taken on the lines 5—5 of Figs. 4 and 6 and Figure 6 being an enlarged view in side elevation of the outlet shown partly in section.

In the following description and in the

claims, parts will be identified by specific names for convenience of expression but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to Figure 1 for a general view of the plant organization, there is shown a hopper 10 constituting a source of supply for the pulverized carbonaceous material which, in one physical embodiment of the invention, is powdered coal. The fuel is discharged in regulated amounts to a screw feeder 11 driven from a variable speed motor indicated symbolically by the driven belt 12 and so timed as to give a regulated feed of the more or less solid fuel stream per unit of time to the feed pipe 13 from which it is discharged into the combined fuel distributor and agitator 14.

The furnace supplied by the distributor is indicated at 15 and is of the conventional form, provided with a plurality of injector twyers 16 equally spaced in a horizontal plane about the furnace as is usual in some types of such structures. The furnace is supplied through the twyers with air from a suitable source of relatively low pressure air indicated symbolically by the air line 16′ and at the air line 17 there is shown symbolically a source of high pressure air.

Referring particularly to Figure 4 for a detailed description of the distributor 14 it is noted that there is disclosed a cylindrical shell member 18 having a flanged bottom 19 which can be readily removed from the shell to permit access to the interior of the distributor. The shell is provided with a horizontally disposed partition 20 which divides the interior into a lower, air-pressure chamber 21 and an upper, mixing chamber 22. This partition is provided across its entire surface with equally spaced and relatively small holes 23 designed to cause the air passing therethrough from the air chamber 21 to be evenly distributed throughout the lower portion of the mixing chamber. Air under relatively low pressure is introduced centrally through the bottom 19 by means of a low pressure pipe 24 which leads from some suitable source of low pressure air supply, such as the blast furnace air main 25. A cone-shaped spreader 26 is disposed in the mixing chamber; is spaced above the partition and is concentrically positioned below the discharge end 27 of the feed pipe 13. The sides of the cone-spreader are inclined beyond the critical angle of the fuel falling thereon and in the case of pulverized coal this angle is made over sixty degrees declination. The cone is provided with a discharging periphery 28 spaced from the inner side of the shell 18 so as to provide an annular passageway 29 for the fuel as it falls off the spreader towards the partition 20 in the form of a thin hollow cylinder. The cone spreader is supported centrally in the shell by means of angle brackets 30.

The top of the mixing chamber is closed by means of a semi-porous cover 31 which forms an air bleeding inlet permitting some leakage of atmospheric air from the outside into the mixing chamber to agitate the falling fuel therein while permitting the formation of a partial vacuum in the upper portion of the mixing chamber as hereinafter described. In the device illustrated the cover is made of a heavy grade of canvas which has been found to be acceptable under the pressure conditions present in the device herein disclosed.

A plurality of discharge conduits 31′ lead from the lower portion of the mixing chamber to the furnace, one conduit for each of the twyers 16. The intake ends of these conduits extend through the bottom 19, project above the partition 20, are equally spaced apart in a circle concentric with the axis of the shell and are disposed within the downwardly projected outline of the discharge periphery 28 of the cone spreader. In the arrangement illustrated the intake ends are eight in number and equally spaced in a circle, the radius of which is half the radius of the shell. The uniform spacing of the intake ends of the conduits insures at all times an equal withdrawal of the diffused fuel from all parts of the inner periphery of the shell of fuel falling through the annular passageway 29.

For the purpose of insuring against the possibility of the fuel flooding into any one conduit and to assist in maintaining the fuel in its diffused condition, the intake end of each of the conduits is provided with a plurality of apertures 32 spaced about the side of a sleeve 33 threaded into the upper end of each of the conduits. The upper end of each of the sleeves is closed by a plug 34 which permits ready access to sleeves in case the apertures 32 should become clogged.

The discharge end of each of the conduits 31′ is connected to the outer end of its corresponding twyer, as shown in Figure 1, so that the air pressure in line 17 acts to create a relatively high suction effect through the conduits 31′. This high pressure tends to draw the carbonized fuel from the distributor to the twyers and acts through the twyers to project the fuel forcefully into the furnace. It will be understood that the air pressures opened to the mixing chamber are such that the suction effect through the conduits 31′ will maintain a partial vacuum in the mixing chamber and that the pressure from the low pressure pipe 24 is sufficient to maintain the falling fuel in the state of suspension but is not sufficient in volume to overcome the vacuum created in the mixing chamber. It will be understood of course that the pressure and volume of the several

pneumatic pressures hereinbefore described, will be regulated by the operator to fit the peculiar condition present and for such purposes suitable control valves are provided.

In operation and assuming that a regulated amount of the powdered coal, for instance, is fed by the screw feeder 11 through the feed pipe 13 and that the several air supplies are in active operation, the desired form of carbonized fuel is fed uniformly into the furnace from all sides thereof.

As the fuel falls on the cone spreader it slides down the same, moving in a substantially uniform stream off the discharge edge of the spreader. As the fuel attempts to fall towards the perforated partition or diaphragm 20, it is met by the up-coming air which causes the particles of the falling stream to separate in the form of a cloud with the particles held suspended in the mixing chamber. The carbonaceous material remains in the mixing chamber a sufficient length of time to insure the maximum possible separation of the particles and the thorough mixing of the air into and between the separated particles. These particles floating in the air medium will tend to obey the laws of gas diffusion and will flow in under the spreader from which position they are picked up by the circle of fuel discharging intake ports and conveyed by a multiplicity of conduits to the different portions of the furnace.

By means of a device of the character outlined it is possible to form a character of carbonized fuel in which a regulated amount of the solid particles are evenly distributed through a body of air and is which the density of the formed fuel is under the accurate control of the operator. This carbonized fuel with its desired density, is fed to the furnace twyers and as there is an accurate control of the air supplied through the twyers there necessarily results that there will be introduced into the furnace a regulated amount of fuel the thermal value of which is accurately controlled.

Having thus described my invention, I claim:

1. In the art of preparing a fuel charge to be fed to a blast furnace, the method which consists in introducing a substantially solid stream of the pulverized fuel into a space having a pressure condition therein less than atmospheric pressure, causing said stream to spread out into a thin layer and while so spread out to fall freely in said space, subjecting the thin falling stream to the action of air under relatively low pressure directed upwardly to hold the scattered fuel in suspension and withdrawing the suspended mixture of air and fuel thus formed from a plurality of points by suction under relatively high pressure.

2. In the art of preparing a fuel charge to be fed to a blast furnace, the method which consists in introducing a stream of the pulverized fuel into a space, causing said stream to spread out while falling freely in said space, subjecting the falling stream while in suspension to the action of upwardly directed air under a pressure sufficient to keep the fuel in suspension but not enough in volume to overcome the reduced pressure condition, said air being directed upwardly to hold the scattered fuel in suspension and withdrawing the suspended mixture of air and fuel thus formed by suction under relatively high pressure and ejecting the withdrawn mixture under pressure into the blast furnace.

3. In the art of preparing a fuel charge to be fed to a blast furnace, the method which consists in introducing a stream of the pulverized fuel into a space having a pressure condition therein less than atmospheric pressure, causing said stream to spread out while falling freely in said space, subjecting the falling stream to the action of air under relatively low pressure directed upwardly to hold the scattered fuel in suspension and withdrawing the suspended mixture of air and fuel thus formed by suction applied to the space at a plurality of equally spaced apart points thereby to effect an even withdrawal of the mixture from the space and to minimize any tendency of the mixture to become condensed.

4. In the art of mixing a pulverized substance with air, the method which consists in causing the substance to fall freely in the form of a thin hollow cylinder into a mixing space having a relatively low pressure condition therein, subjecting the falling substance to the upwardly directed action of air on opposite sides of the cylinder under a pressure sufficient to break up the cylinder into fine particles and to keep the fine particles in suspension and withdrawing the diffused mixture of air and substance thus formed by a suction effort under a pressure greater than the pressure of the air admitted to the space.

5. In the art of mixing a pulverized substance with air, the method which consists in causing the substance to fall freely in a thin stream into a mixing space having a relatively low pressure condition therein, subjecting the falling stream to the upwardly directed action of air under a pressure sufficient to break up the stream into fine particles and to keep the particles in suspension and withdrawing the diffused mixture of air and substance thus formed by a suction effort under a pressure greater than the pressure of the air admitted to the space, the suction action being divided and distributed in the space to minimize the

flooding of the mixture into any one outlet and to prevent the condensing of the mixture.

6. A combined agitator and distributor provided with a perforated partition forming an upper mixing chamber and a lower air chamber, means for supplying air under relatively low pressure to air chamber, means for supplying a pulverized substance to said mixing chamber to meet the low pressure air directed upwardly through said perforated partition, a suction outlet from said mixing chamber to withdraw the mixture of air and substance from the mixing chamber, said mixing chamber being closed except for an atmospheric air bleeding inlet of less intaking capacity than said suction effect present whereby a partial vacuum is maintained in said mixing chamber.

7. A combined agitator and distributor provided with a perforated partition forming an upper mixing chamber and a lower air chamber, means for supplying air under relatively low pressure to air chamber, means for supplying a pulverized substance to said mixing chamber to meet the low pressure air directed upwardly through said perforated partition, means within the mixing chamber for spreading the substance introduced thereby to direct it evenly over the entire area of the upwardly moving air, a suction outlet from said mixing chamber to withdraw the mixture of air and substance from the mixing chamber, said mixing chamber being closed except for an atmospheric air bleeding inlet of less intaking capacity than said suction effect present whereby a partial vacuum is maintained in said mixing chamber.

8. A combined agitator and distributor provided with a perforated partition forming an upper mixing chamber and a lower air chamber, means for supplying air under relatively low pressure to air chamber, means for supplying a pulverized substance to said mixing chamber to meet the low pressure air directed upwardly through said perforated partition, a suction outlet from said mixing chamber to withdraw the mixture of air and substance from the mixing chamber, said mixing chamber being closed except for an atmospheric air bleeding inlet of less intaking capacity than said suction effect present whereby a partial vacuum is maintained in said mixing chamber, said suction outlet provided with means tending to obstruct the free discharge of the mixture from said mixing chamber.

9. In a device of the class described, a cylindrical member having a closed bottom and an open top, a perforated partition for separating the interior of the member into an upper mixing chamber and a lower air chamber, a semi-porous cover for closing the open top while permitting a slight air leakage, means for introducing fuel through said cover and into said mixing chamber, means disposed in said mixing chamber below said introducing means for spreading the fuel as it falls towards said perforated partition, means for introducing air under pressure to said air chamber in a volume sufficient to suspend said falling fuel in said mixing chamber.

10. In a device of the class described, a cylindrical member having a closed bottom and an open top, a perforated partition for separating the interior of the member into an upper mixing chamber and a lower air chamber, a semi-porous cover for closing the open top while permitting a slight air leakage, means for introducing fuel through said cover and into said mixing chamber, means disposed in said mixing chamber below said introducing means for spreading the fuel as it falls towards said perforated partition, means for introducing air under pressure to said air chamber in a volume sufficient to suspend said falling fuel in said mixing chamber and an outlet for the mixture of air and suspended fuel disposed beneath said spreading means.

11. In a device of the class described, a cylindrical member having a closed bottom and an open top, a perforated partition for separating the interior of the member into an upper mixing chamber and a lower air chamber, a semi-porous cover for closing the open top while permitting a slight air leakage, means for introducing fuel through said cover and into said mixing chamber, a conical spreader having a fuel discharging periphery and a plurality of outlets for the mixture of air and suspended fuel, said outlets being disposed in a circle below and within the projected outline of the periphery of said spreader and a receptacle for receiving the discharge from all of said outlets.

12. In a device of the class described, a cylindrical member having a closed bottom and an open top, a perforated partition for separating the interior of the member into an upper mixing chamber and a lower air chamber, a semi-porous cover for closing the open top while permitting a slight air leakage, means for introducing fuel through said cover and into said mixing chamber, a conical spreader having a fuel discharging periphery and a plurality of outlets for the mixture of air and suspended fuel, said outlets being disposed in a circle below and within the projected outline of the periphery of said spreader and a receptacle for receiving the discharge from all of said outlets, each of said outlets provided with a plurality of intakes to assist in maintaining the fuel diffused in the mixture.

13. In a device of the class described, the combination with a furnace, of means for

feeding a mixture of pulverized fuel and air to said furnace, said means including a source of fuel supply means for feeding a fuel stream in a regulated amount per unit of time from said source, a combined agitator and distributor for receiving and scattering the fuel streams, means for diffusing air uniformly through said scattered fuel and for holding the same in suspension, a plurality of conduits having their intake ends spaced apart in said combined agitator and distributor so as to draw from all parts of the diffused fuel thereon and having their discharge ends spaced apart in said furnace and pneumatically actuated means for causing the mixture of air and diffused fuel to pass through said conduits and into said furnace.

14. In a device of the class described, the combination with a furnace, of means for feeding a mixture of pulverized fuel and air to said furnace, said means including a combined agitator and distributor for receiving and scattering the fuel stream, means for diffusing air under pressure through said scattered fuel and for holding the same in suspension, a plurality of conduits having their intake ends spaced apart in said combined agitator and distributor and having their discharge ends spaced apart and opening into said furnace at a plurality of points whereby the mixture of air and diffused fuel will be introduced thereto in a plurality of directions and pneumatically actuated means for causing the mixture of air and fuel to pass through said conduits and into said furnace.

15. In a device of the class described, the combination of a mixing chamber, means for introducing fuel so as to fall into said chamber, means for spreading the fuel as it falls towards the bottom of the chamber, means for directing air to move in an even distribution upwardly through said bottom to meet the falling fuel and to hold the same in suspension diffused in the air and pneumatically actuated means for discharging the mixture of air and suspended fuel from said chamber.

16. In a device of the class described, the combination of a mixing chamber, means for introducing fuel so as to fall into said chamber, means for spreading the fuel as it falls towards the bottom of the chamber, means for directing air to move in an even distribution upwardly through said bottom to meet the falling fuel and to hold the same in suspension diffused in the air, means permitting a slight air leakage to said mixing chamber to permit a partial vacuum to form therein, suction means open to said chamber to maintain said partial vacuum therein and to discharge the mixture of air and suspended fuel from said chamber.

17. In a device of the class described, a mixing chamber having means defining the bottom thereof for diffusing air passed therethrough, means for causing pulverized fuel to fall freely through said chamber, means for passing air under pressure through said air diffusing bottom to act on the fuel and suspend the same diffused in the air present in the chamber, a semi-porous cover for said chamber permitting an air leakage thereto, said chamber provided with a diffused fuel discharge port and pneumatic means acting through said port to withdraw the fuel from the chamber under a relatively low pressure condition.

18. In a device of the class described, the combination with a furnace having a plurality of fuel intakes, injector twyers at each of said intakes, of means for supplying said twyers equally and a mixture of air with pulverized fuel diffused evenly throughout the air, said means including a fuel distributor, means for feeding fuel to the distributor, means for causing air under relatively low pressure to be projected evenly throughout the entire mass of the fuel and to hold the same in suspension in diffused condition, conduits leading from spaced apart points in said distributor to said twyers thereby to draw from all parts of the same, and a source of relatively high pressure air supplied to said twyers to draw the fuel mixture from the distributor and to project the same through the twyers and into the furnace.

19. In a device of the class described, the combination with a furnace, an injector twyer for introducing fuel under pressure to the furnace, of means for supplying said twyer with a mixture of air having a pulverized fuel diffused therein, said means including a distributor having elements therein for subjecting a falling, thin stream of the pulverized fuel to the action of a current of air under relatively low pressure and a source of air under relatively high pressure directed through said twyers for projecting the fuel into the furnace and for drawing the diffused fuel from the distributor and into the twyer.

Signed at Garfield in the county of Salt Lake and State of Utah this 17th day of Nov. A. D. 1919.

RICHARD A. WAGSTAFF.