May 31, 1927. 1,630,509

H. ADAMS

METHOD AND APPARATUS FOR FUEL BURNING

Filed March 2, 1923 2 Sheets-Sheet 1

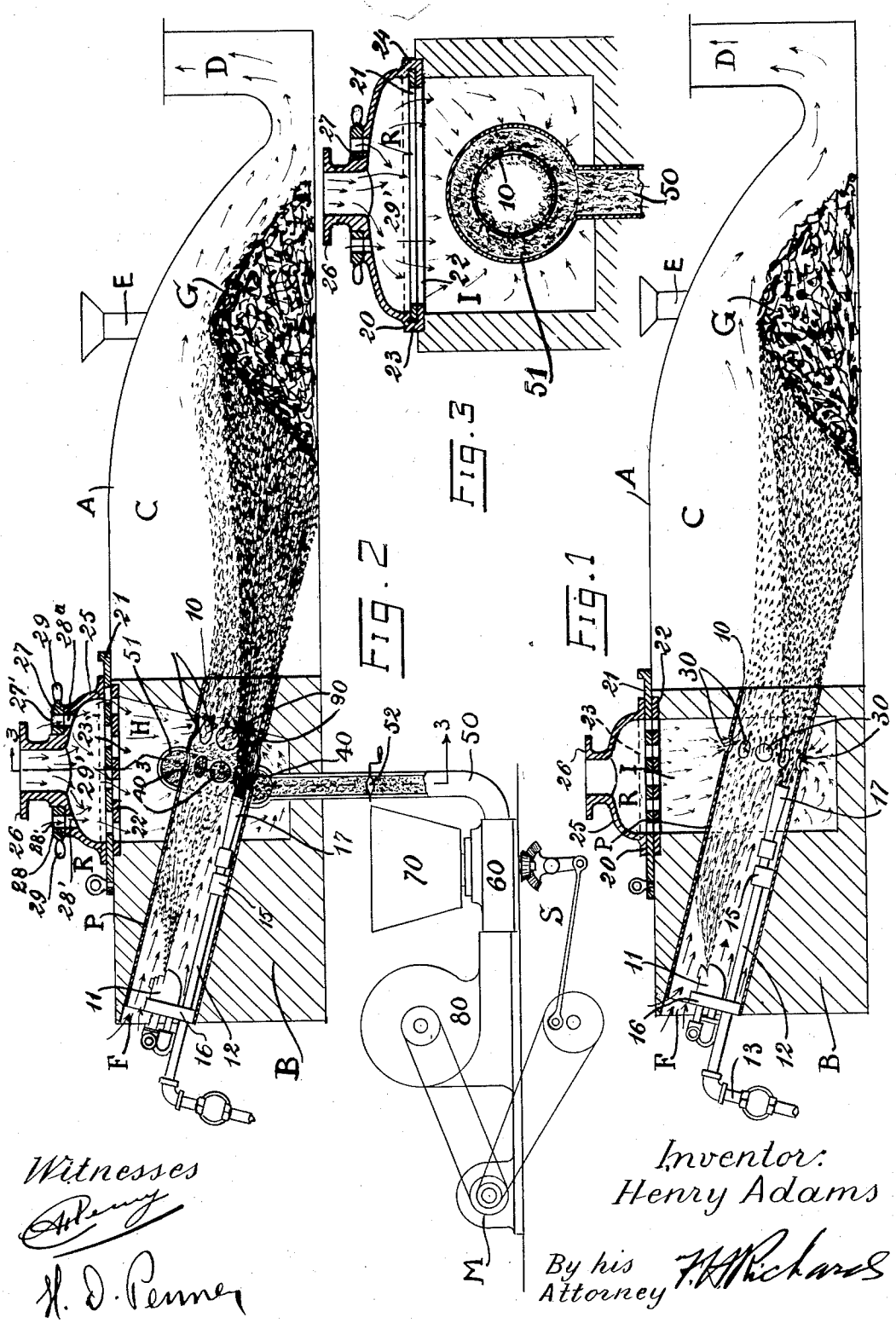


Fig. 3

Fig. 2

Fig. 1

Witnesses

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METHOD AND APPARATUS FOR FUEL BURNING

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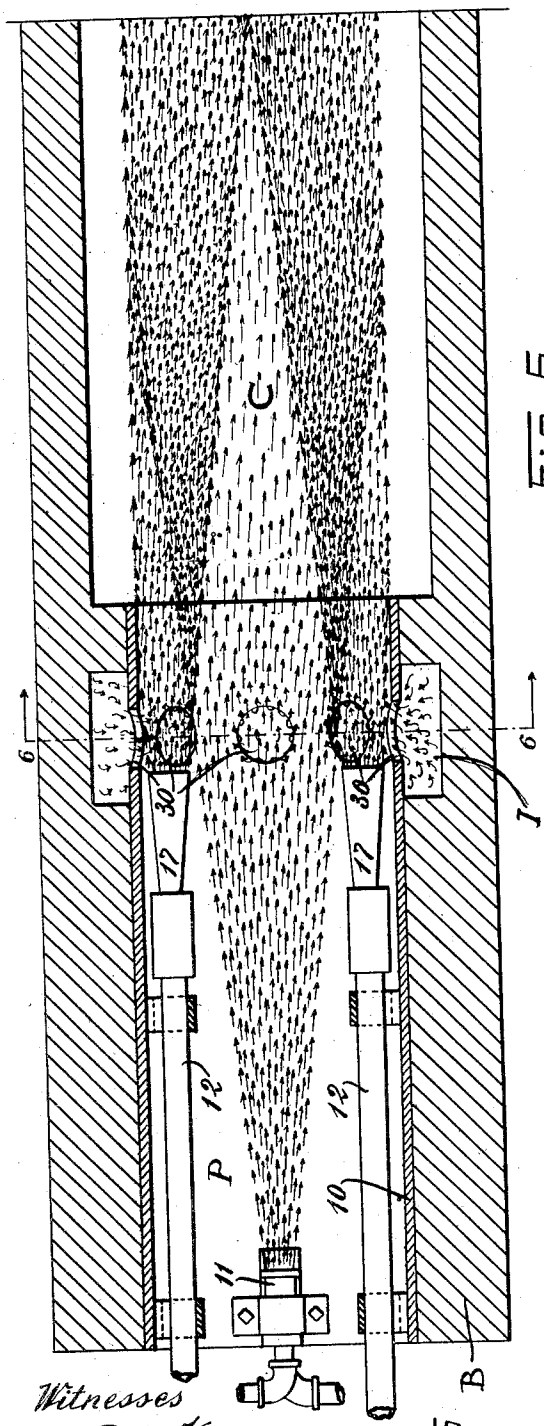


FIG. 5

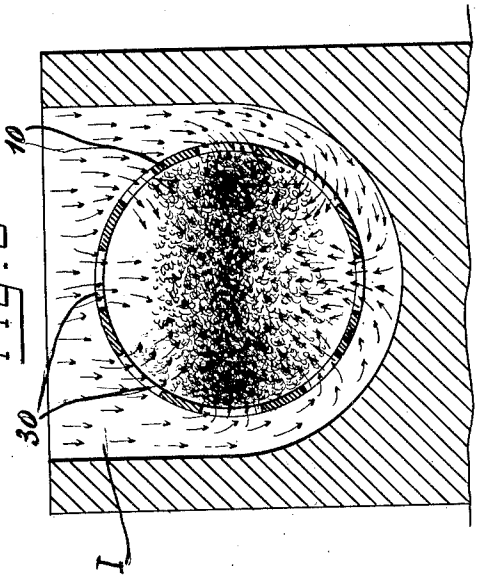


FIG. 6

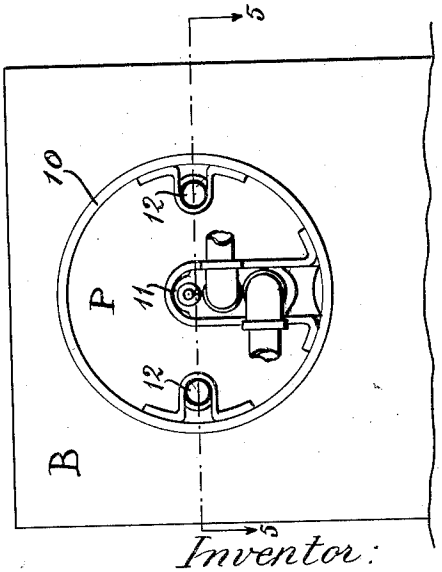


FIG. 4

Witnesses
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UNITED STATES PATENT OFFICE.

HENRY ADAMS, OF PLAINFIELD, NEW JERSEY.

METHOD AND APPARATUS FOR FUEL BURNING.

Application filed March 2, 1923. Serial No. 622,335.

The present invention relates to a method of and apparatus for controlling burning fuel, and to a modification of the structure and method thereon as set forth in my Patent No. 1,571,171, issue date February 2, 1926, in furnaces, for smelting or reducing ores, etc., and one object of the invention is to provide a method of and apparatus for controlling the burning gases as soon as they are delivered to the furnace.

Another object is to provide a method of and apparatus for controlling burning fuel after it leaves the respective burners, and supplying sufficient air to afford perfect combustion.

Another object is to provide a method of and apparatus for controlling fuel after it leaves the respective burners, and to supplement its primary air supply for its combustion with additional air inlet passages for superinducing its combustion and thus increasing the heat from said combustion.

Another object is to provide separate means and apparatus to produce and convey pulverized coal as an additional fuel supply to the stream of burning fuel from the primary producers, providing at the same time additional air inlets for the combustion of the additional fuel supply.

Another object is to provide a method of and apparatus for controlling the burning fuels after they leave their respective burners or producers, and directing the heat thereof and causing it to travel to the desired location where the work is to be done.

Another object is to provide a method of and apparatus for controlling burning fuel in smelting or reducing furnaces and the like, whereby to obtain the best efficiency from the burning fuel and obviating the specially constructed roofs, high stacks or chimneys, etc., of such furnaces, except where my device is applied to furnaces already constructed, and whereby the direct heat can be applied and kept at a point desired, perfect control as to the flame produced can be had, and either a reducing or oxidizing flame can be produced at will.

Another object is to provide a method of and apparatus for controlling the heat of burning fuel in furnaces whereby the heat is carried to the bath or charge the entire length thereof, and directly applied to the bath or charge, thereby doing away with the inevitable major portion of heat losses due to deflected or radiated heat from the roof of the furnace.

Another object is to provide separate means and apparatus to produce a mixture of burning gas and air for admixture to the primary supply of burning fuel.

Another object is to provide means whereby the various individual separate means for adding more burning fuel to the primary supply, may be combined to be all worked together, or any one means alone or conjointly with any other fuel supply means or additional air supply means.

Another object is to provide a means for controlling and directing the burning fuel which will carry along the burning fuel and at the same time induce auxiliary air required for complete combustion of the fuel. This is accomplished by means of a steam projector having a nozzle so designed that the steam passing through has complete expansion.

Another object is to have an oil burning furnace without the usual built-in combustion chamber made of refractory material, as my burning fuel leaving the mixing chamber and projector is under complete combustion, it can be directed directly into the furnace, thereby doing away with expensive construction as well as saving in oil burnt.

I attain these and such other objects, features and advantages as may appear during the subjoined description by way of example of several of the possible embodiments of the invention, shown in the accompanying drawings forming part of this specification, in which

Figure 1 is a sectional side view of a reverberatory furnace and of the controller and flame director provided with the additional air supply inlets.

Fig. 2 is a sectional side view of a similar reverberatory furnace with a similar controller and flame director or projector provided with an aspirating chamber for supplying additional fuel and with additional air supply means, and with a diagrammatic view of a coal pulverizer and means to convey the said pulverized coal into the aspirating chamber and from there into the flame controller and projector.

Fig. 3 is a cross sectional view on line 3—3 of Fig. 2, and through the aspirating chamber.

Fig. 4 is a rear end view of a furnace looking towards the front along the axial line of the flame controller and director, showing the said flame controller provided with two high pressure projectors located in a same horizontal diametrical plane with the fuel burner.

Fig. 5 is a horizontal, diametrical sectional view of the furnace on line 5—5 of Fig. 4, and

Fig. 6 is a transverse vertical sectional view of same on line 6—6 of Fig. 5.

While my device is herein shown as applied to reverberatory furnaces it is not restricted for use in conjunction with this form of furnace alone, but in fact, is applicable to all kinds of smelting and reducing furnaces.

Similar reference characters denote similar parts throughout the several views.

Referring to Fig. 1 there is shown the furnace A having an end wall B, a combustion and ore smelting chamber C, a stack D for the waste gases and an ore inlet E, the furnace having also the necessary outlets for the smelted metal as well as for the slag or residues but which are not shown, not being considered necessary for the purposes of this description.

The end wall B has therethrough longitudinally and in the axial line of the furnace, a circular opening F, downwardly inclined in a line towards the bottom of the furnace's combustion chamber C and towards the mass of ore G, or other material that is to be treated and which lies directly below the inlet E.

Opening F is circular and of a size to closely receive the flame controller and director P, which generally comprises the casing 10, the fuel burner or producer 11, and one or more high pressure projectors 12.

In Figs. 1 and 2, I show director P provided with only one high pressure projector 12. In Figs. 4 and 5 I have shown the director P with two projectors.

In Figs. 1 and 5, casing 10 is provided at a distance from the projecting nozzles 17 of the projectors 12, with a series of holes 30 around its periphery, that part of casing 10 in which the holes 30 are located being exposed to the open air in a pit form aperture I, provided for air inlet purposes in wall B. With either single or multiple projectors, casing 10 which is preferably cylindrical in form and is snugly held in opening F of wall B, has its inner or rearward end flush with the rear wall of chamber C, but may extend for a short distance into it, its rear or inner end connecting with that of the opening F, both ends of the casing being open.

Casing 10 constitutes a chamber for confining the burning fuel on its discharge from the burner or producer 11 in a cylindrical stream, which is subsequently subjected to the drawing-away and carrying-along effect of the high velocity stream or streams of compressed air, but preferably of the high velocity stream or streams of dry and superheated steam which is projected in the direction of the ore mass G from the nozzle 17 of the projector or projectors 12 connected to a high pressure steam supply (not shown) by a pipe 13.

The fuel for the operation of the furnace is projected into casing 10 by means of a burner 11 having a fuel outlet and a compressed air or a steam outlet cooperating therewith, the air or steam discharge being, preferably, in line with the axis of casing 10, and the casing 10 constituting a chamber or zone of temporary confinement for the burning fuel.

In Figs. 1 and 2, burner 11 and projector 12 are shown held in casing 10 by means of straps 15 and 16, strap 15 having for its particular object the correct location of the high velocity, superheated dry steam projector 12 for the projection of the burning fuel on the ore mass G for the best utilization of the produced heat on said mass G. Nozzle 17 is positioned in the casing 10 at such a distance inwardly from the discharge end or mouth of the casing 10 so that the stream from the mouth of the nozzle 17, in its expansion from the nozzle to the ore mass G, will just about cover said mass, its upper line reaching to the top thereof and its lower line striking the floor of the furnace slightly ahead of the mass, nozzle 17 being the director and controlling agent, the burning fuel is held by it.

In Figs. 4 and 5 where I show the utilization of two high pressure projectors instead of only one, they are located diametrically across from one another in casing 10, the axes of their projected streams of high pressure steam being on the same plane and parallel to that of the projected stream of burning fuel from burner 11.

As will be seen in Figs. 5 and 6, even when both high pressure streams are projected in parallel lines, they will unite into one single stream in chamber C after emerging from flame director P, carrying with them the stream of projected burning fuel from burner 11 which will be thoroughly mixed into and absorbed by the two steam streams, and form with them a single stream of burning fuel, and travelling at a greater velocity than the burning fuel and gases did when leaving burner 11.

The force of the projection of the fuel from the burner 11, combined with the greater force of projection of the dry steam from even a single projector 12 into the furnace creates a strong draft of air from the rear into casing 10 which will provide the oxygen necessary for the combustion of the

fuel. However, as this air comes from behind the fuel conveying jet, its penetrating speed into the casing 10 being, at its maximum, not more than that of the burning stream into the furnace, its mixture with the fuel may not be as perfect as desired and therefore the combustion of the fuel not complete.

This possible defect I prevent by providing a series of air holes or passages 30 in the casing 10. These air holes, as shown, in Figs. 1 and 5, but now referring more particularly to Fig. 1, are located at a certain distance from the mouth of nozzle 17 between the nozzle and the discharge end of the casing 10 in a circular line around casing 10 where the burning stream is fully formed and begins to fall more directly under the drawing along influence of the higher speed projected steam of projector 12. The air holes or inlets being all around the stream and the air being sucked in with great force, mixes thoroughly with the burning fuel of whatever kind that may be, and the oxygenation or combustion of the burning matter is more completely accomplished, the heat of the stream is intensified and reaches its highest degree when the stream reaches the mass G, although by regulation of air through holes 30, the stream of burning fuel can be in a state of complete combustion on leaving casing 10.

Pit I may be left open as per Fig. 6, or it may be provided with an air register R consisting of any well known commercial form. The register shown in Fig. 1 is composed of a metal casing 20 and a metal sheet 21.

Casing 20 which is fixedly set in wall B over the aperture of the pit I comprises a perforated base 22 having a pair of longitudinal and parallel channel guides 23 and 24 as in Fig. 3 for guiding and holding the sliding metal sheet 21. Sheet 21 and base 22 have perforations of similar form and area. By the sliding of sheet 21 backwards or forwards its perforations or apertures may be made to register with those in base 22, or it may be made to decrease the openings in said base or to close them totally, in other words it may be made to graduate and register the amount of air or gas that is to pass into the pit and into casing 10.

In furnaces where the material to be treated or reduced requires only the amount of heat that may be obtained from the fuel delivered by the burner 11, and only a certain amount of additional air for their full combustion and heat intensification thereof, base 22 and sliding member 21 will be sufficient. But in furnaces where varied materials may be treated, some of which may require a much greater heat, or amount of heat, for reduction or treatment than that which may be obtained from the fuel delivered by burner 11, and to which fuel must be added a further amount of fuel gases, the register R is then supplemented by a cupola 25 with a pipe flange attachment 26 for connection to a separate fuel gas supply or to the same fuel gas supply that feeds burner 11.

Cupola 25 may be either made integral with base 22, or separate from it, in which latter case, both parts are provided with adequate flange attachment for assembling together.

As already stated, casing 10 and projector 12 are so focalized that the burning stream's expansion in the furnace attains an area not greater than that presented by mass G on reaching said mass. The whole heat is therefore concentrated on it, very little of it is deflected over the mass and lost or escapes by the stack D and thus, the construction of the furnace may be more cheaply accomplished and the operating expenses will be greatly reduced.

Referring to Figs. 2 and 3, there I show in general lines a furnace with the same fuel and fuel gas conveying apparatus as in Fig. 1, but supplemented with two further means, apparatus and methods to increase the primary stream of burning fuel originating from burner 11.

One of these consists of a coal pulverizer 60 having a hopper 70 for reception of the coal and an air fan 80 for conveying the pulverized coal or coal dust into the zone of an aspirating chamber or casing 51, from which, through the suction or aspiration action of the high pressure superheated dry steam projector 12, the pulverized coal or coal dust is added to the stream of burning fuel originating from burner 11. The pulverizer 60 may be of any commercial type adequate for the purpose, but it should preferably be provided with a stirring device S, to prevent the agglomeration of the coal dust into chunks, or provided with some other means, such as air separation, in order to insure that nothing but coal of the fineness desired enters the burning zone, and in order that it may be carried easily by aspiration from the chamber or casing 51, supplemented by the blowing force of the air current created by the fan 80 into casing 10. The pulverizer 60, the stirring device S and fan 80 may be driven by a motor M or any other suitable method.

The pulverized coal or coal dust is carried into the aspiration chamber 51 by means of a pipe 50 leading from pulverizer 60 into the aspirating chamber. This chamber encircles the casing 10 around and over a series of holes 40 cut circumferentially in said casing 10 preferably at a slight distance below the mouth of nozzle 17 of the high pressure, superheated steam projector 12.

The pulverized coal, as said, through the

combined action of the air fan or blower 80, and the aspiration from casing 51 is brought into said casing, out of which it is sucked through holes 40 in casing 10 into the primary stream of burning fuel by which it is absorbed and carried away. But as the air supply from the rear opening in casing 10 may not be sufficient for the total combustion of both fuels supplied, and therefore a new supply of oxygen becomes necessary. This additional fresh air supply I provide by the same means as in Fig. 1, that is, by means of additional holes 90 in case 10 cut behind the aspirating chamber or casing 51, the air supply coming from an air inlet pit H, more or less similar to that in the front end wall B, shown in Fig. 1.

The same air registering device shown in Fig. 1, may also be utilized here, either with or without cupola 25. The object of a cupola with a pipe attachment 26 is primarily that for supplying the original burning fuel stream of burner 11, with an additional supply of gas fuel.

The fuel delivered by burner 11 in Fig. 1, may be liquid fuel, for example. This may then be increased by fuel gas coming through cupola 25 which would be connected to the mains of a fuel gas supply. The air supply would come from the rear air draft in casing 10.

In Fig. 2, there is shown an apparatus by which the burning fuel stream from burner 11 may either be increased by fuel gas only as in Fig. 1, or as above described by pulverized coal or coal dust, or, with both fuel gas and coal. The cupola 25 here is provided with an arrangement by means of which the supplemental or additional air supply is furnished through the cupola. This arrangement consists of two half circular rings 27 and 28, adjustably and rotatably mounted around the cupola 25. The ring has a series of holes 27′ and the ring 28 has a series of holes 28′, the holes of the respective rings being registerable with a series of similar holes 28^a in the cupola. By rotating the whole ring in either direction by means of handles 29, the amount of air admitted through the holes 28^a into the chamber 29′ may be regulated to any degree or closed completely, and the air supply for either the pulverized coal supply or the fuel gas supply, or for both conjoined supplies may be regulated at will. When only pulverized coal is supplied, the fuel gas supply should be shut off, and whenever only fuel gas should be wanted the pulverized coal supply would be closed. In either case, of either single fuel gas supply or combined pulverized coal and fuel gas supplies, the cupola chamber 29 becomes a mixing chamber for the fuel gas and air. There is yet a further method to supply additional air to the stream of burning fuel from burner 11, either alone or increased with fuel gas from the cupola, and this is by means of the pipe 50 of the pulverizing coal supply, the coal supply being shut off, and air taking the place of coal.

By adding new fuel to the primary stream of burning fuel originating from burner 11, the heat of the stream becomes greatly intensified, and the reduction of the ore or whatever material is to be treated, and forming the mass G, is therefore greatly accelerated, with a corresponding economy in the general treatment which will more than compensate the additional installational cost of the coal pulverizer and the necessary driving apparatus for same, even if increased by the cost of the air register cupola 25.

The amount of the additional pulverized coal supply may be regulated by means of various well known methods, one of which may consist of a damper 52 in the supply pipe 50. In the present instance the supply regulation may further be obtained by increasing or decreasing the speed of the driving motor M.

I wish to call particular attention to the fact that by the above and variously described means, apparatus and methods of supplying burning fuel or gases to furnaces for the smelting, reducing and general treatment of ores, minerals, metals, etc., I may utilize only one single kind of fuel, or I may utilize various kinds of fuels, at the same time. I may also grade the amount of fuel, of either kind, to be burned, either singly or combined, as well as grade the heat intensity of the burning fuel.

Having thus described my invention it should be understood that there may be further modifications thereof and variations therein without departing from the spirit of the invention or exceeding the scope of the appended claims.

I claim:

1. The combination with a furnace having a wall and a combustion chamber adjacent to said wall, of a casing passing through said wall at a downward inclination to the line of the floor of said chamber and communicating at its inner end with said chamber and having at its outer end means for inlet of air into the casing, a fuel burner arranged in the casing at the outer end thereof and extending into the casing for discharging therein, a projector arranged in the casing at the outer end thereof and having its discharge end in the casing inwardly of the discharge end of the fuel burner for discharging a stream of fluid of greater velocity than the stream of burning fuel so that the burning fuel is drawn along in the casing by induction of the stream of fluid and mingles therewith and is discharged from the inner end of the casing into the combustion chamber at an inclination to the bottom of said

chamber substantially the same as the inclination thereto of said casing, means for inlet of air into the casing transversely of the casing inwardly of the discharge end of the projector, and means for regulating the amount of air admitted by the last mentioned air inlet means.

2. The combination with a furnace having a wall and a combustion chamber adjacent to said wall, of a casing passing through said wall at a downward inclination to the line of the floor of said chamber and communicating at its inner end with said chamber and having at its outer end means for inlet of air into the casing, a fuel burner arranged in the casing at the outer end thereof and extending into the casing for discharging therein, a projector arranged in the casing at the outer end thereof below the fuel burner and having its discharge end in the casing inwardly of the discharge end of the fuel burner for discharging a stream of fluid of greater velocity than the stream of burning fuel so that the burning fuel is drawn along in the casing by induction of the stream of fluid and mingles therewith and is discharged from the inner end of the casing into the combustion chamber at an inclination to the bottom of said chamber substantially the same as the inclination thereto of said casing, and a pit in said wall having inlet means at its top, said casing passing through said pit and having apertures therein located inwardly of the discharge end of the projector and communicating with the interior of said pit.

3. The combination with a furnace having a wall and a combustion chamber adjacent to said wall, of a casing passing through said wall at a downward inclination to the line of the floor of said chamber and communicating at its inner end with said chamber and having at its outer end means for inlet of air into the casing, a fuel burner arranged in the casing at the outer end thereof and extending into the casing for discharging therein, a projector arranged in the casing at the outer end thereof and having its discharge end in the casing inwardly of the discharge end of the fuel burner for discharging a stream of fluid of greater velocity than the stream of burning fuel so that the burning fuel is drawn along in the casing by induction of the stream of fluid and mingles therewith and is discharged from the inner end of the casing into the combustion chamber at an inclination to the bottom of said chamber substantially the same as the inclination thereto of said casing, a pit in said wall, a dome at one end of the pit having inlet means at the top of the dome, and regulatable inlet means cooperating between the interior of said dome and the interior of said pit, said casing passing through said pit and having apertures therein located inwardly of the discharge end of the projector and communicating with the interior of said pit.

4. The combination with a furnace having a wall and a combustion chamber adjacent to said wall, of a casing passing through said wall at a downward inclination to the line of the floor of said chamber and communicating at its inner end with said chamber and having at its outer end means for inlet of air into the casing, a fuel burner arranged in the casing at the outer end of the casing and extending into the casing for discharging therein, a projector arranged in the casing at the outer end thereof and having its discharge end in the casing inwardly of the discharge end of the fuel burner for discharging a stream of fluid of greater velocity than the stream of burning fuel so that the burning fuel is drawn along in the casing by induction of the stream of fluid and mingles therewith and is discharged from the inner end of the casing at an inclination to the bottom of said chamber substantially the same as the inclination thereto of said casing, a pit in said wall having inlet means at its top, said casing passing through said pit and having apertures therein located inwardly of the discharge end of the projector, means in said pit disposed around said apertures and forming an aspirating chamber, and means for supplying flowable fuel to said apertures, said casing having apertures therein located inwardly of the first mentioned apertures and communicating with the interior of said pit.

5. In apparatus of the character described, the combination of a casing having means for inlet of air at its outer end and having a discharge inner end, a fuel burner arranged in the casing at the outer end thereof and extending into the casing for discharging therein, a projector arranged in the casing at the outer end thereof and having its discharge end inwardly of the discharge end of said burner for discharging a stream of fluid of greater velocity than the stream of burning fuel so that the burning fuel is drawn along in the casing by induction of the stream of fluid and mingles therewith and is discharged from the inner end of the casing, means for providing an aspirating chamber, said casing having apertures therein located inwardly of the discharge end of the projector and communicating with the aspirating chamber, and means for supplying flowable fuel to said apertures.

6. In apparatus of the character described, the combination of a casing having means for inlet of air at its outer end and having a discharge inner end, a fuel burner arranged in the casing at the outer end thereof and extending into the casing for discharging therein, a projector arranged in the casing at the outer end thereof and having its dis-

charge end inwardly of the discharge end of said burner for discharging a stream of fluid of greater velocity than the stream of burning fuel so that the burning fuel is drawn along in the casing by induction of the stream of fluid and mingles therewith and is discharged from the inner end of the casing, means for providing an aspirating chamber, said casing having apertures therein located inwardly of the discharge end of the projector and communicating with the aspirating chamber, means for supplying flowable fuel to said apertures, said casing having therein apertures located inwardly of the first mentioned apertures, and means for supplying air to the last mentioned apertures.

7. In apparatus for controlling and directing flowable fuel during combustion, means for providing a zone of temporary confinement for the burning fuel and supplying air to the zone in the longitudinal line of the zone, means for projecting the burning fuel into said zone, means for projecting into said zone substantially in the line of projection of the burning fuel and inwardly in said zone of the point of discharge of the burning fuel gaseous fluid of greater velocity than the velocity of the burning fuel; means for supplying air to said zone transversely of the zone at a point in the zone inwardly of the point of discharge of the fluid projecting means, and means for supplying additional flowable fuel to said zone at a point therein between the point of discharge of said fluid projecting means and the transverse air supplying means.

8. In apparatus for controlling and directing flowable fuel during combustion, means for providing a zone of temporary confinement for the burning fuel, means for projecting the burning fuel into said zone, means for projecting into said zone substantially parallel to the line of projection of the burning fuel and inwardly in said zone of the point of discharge of the burning fuel gaseous fluid of greater velocity than the burning fuel, and means for supplying to said zone additional flowable fuel inwardly in the zone of the point of discharge of the gaseous fluid.

9. In apparatus for controlling and directing flowable fuel during combustion, a casing for providing a zone of temporary confinement for burning fuel and supplying air to the zone in the longitudinal line of the zone, means for projecting burning fuel into said zone, means for projecting into said zone substantially in the line of projection of the burning fuel and inwardly in said zone of the point of discharge of the burning fuel steam of greater velocity than the velocity of the burning fuel, means for supplying air to said zone transversely of the chamber at a point therein inwardly of the point of discharge of the fluid projecting means, and means for supplying fuel to said zone transversely of the zone at a point therein between the point of discharge of the steam projecting means and the transverse air supplying means.

10. In apparatus for controlling and directing flowable fuel during combustion, a casing, for providing a zone of temporary confinement for burning fuel and supplying by induction air to the zone in the longitudinal line of the zone, means for projecting the burning fuel into said zone, means for projecting into said zone substantially in the line of projection of the burning fuel and inwardly in said zone of the point of discharge of the burning fuel steam of greater velocity than the velocity of the burning fuel, means for supplying by induction air to said zone transversely of the zone at a point therein inwardly of the point of discharge of the fuel projecting means, and means for supplying by aspiration additional flowable fuel to said zone transversely of the zone at a point therein between the point of discharge of the steam projecting means and the transverse air supplying means.

11. In apparatus for controlling and directing flowable fuel during combustion, a casing having an opening at one end of the casing for supplying air to the casing longitudinally thereof and having a discharge outlet at its opposite end and having a series of holes through the casing for supplying air to the casing transversely thereof and having a second series of holes through the casing for supplying additional flowable fuel to the burning fuel transversely of the casing, a projector for discharging burning fuel into the casing, and a projector for discharging into the casing fluid of greater velocity than the burning fuel substantially in the line of projection of the burning fuel and having its discharge end located in the casing inwardly of the discharge end of the first projector, the second series of holes being located in the casing between the discharge end of the second projector and the first series of holes.

12. In apparatus for controlling and directing flowable fuel during combustion, a casing having an opening at one end for supplying air to the casing longitudinally thereof and having a discharge outlet at its opposite end and having a series of holes through the casing for supplying air to the casing transversely thereof and having a second series of holes transversely of the casing, a projector for discharging burning fuel into the casing, a projector for discharging into the casing fluid of greater velocity than the burning fuel substantially in the line of projection of the burning fuel

and having its discharge end located in the casing inwardly of the discharge end of the first projector, the second series of holes being located in the casing between the discharge end of the second projector and the first series of holes, a pipe for supplying additional flowable fuel, and means cooperating between said pipe and the second series of holes for passage from said pipe of said additional fuel.

13. The method of controlling and directing flowable fuel during combustion which consists in projecting the burning fuel into a zone of temporary confinement, projecting into said zone substantially in the line of projection of the burning fuel and at a point in said zone inwardly from the point of discharge of the burning fuel in said zone gaseous fluid of greater velocity than the velocity of the burning fuel for drawing along therewith the burning fuel for controlling and directing the same, supplying air to said zone substantially in the line of projection of the burning fuel, supplying air to said zone transversely to the line of projection of the burning fuel at a point in the zone inwardly from the point of discharge therein of the gaseous fluid, and supplying additional flowable fuel transversely to the line of projection of the burning fuel at a point between the point of discharge in said zone of the gaseous fluid and the point of admission of said transverse air supply.

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