J. A. WELTON.

APPARATUS FOR FEEDING FINE FUEL.

APPLICATION FILED MAR. 1, 1911.

993,929.

Patented May 30, 1911.

2 SHEETS—SHEET 1.

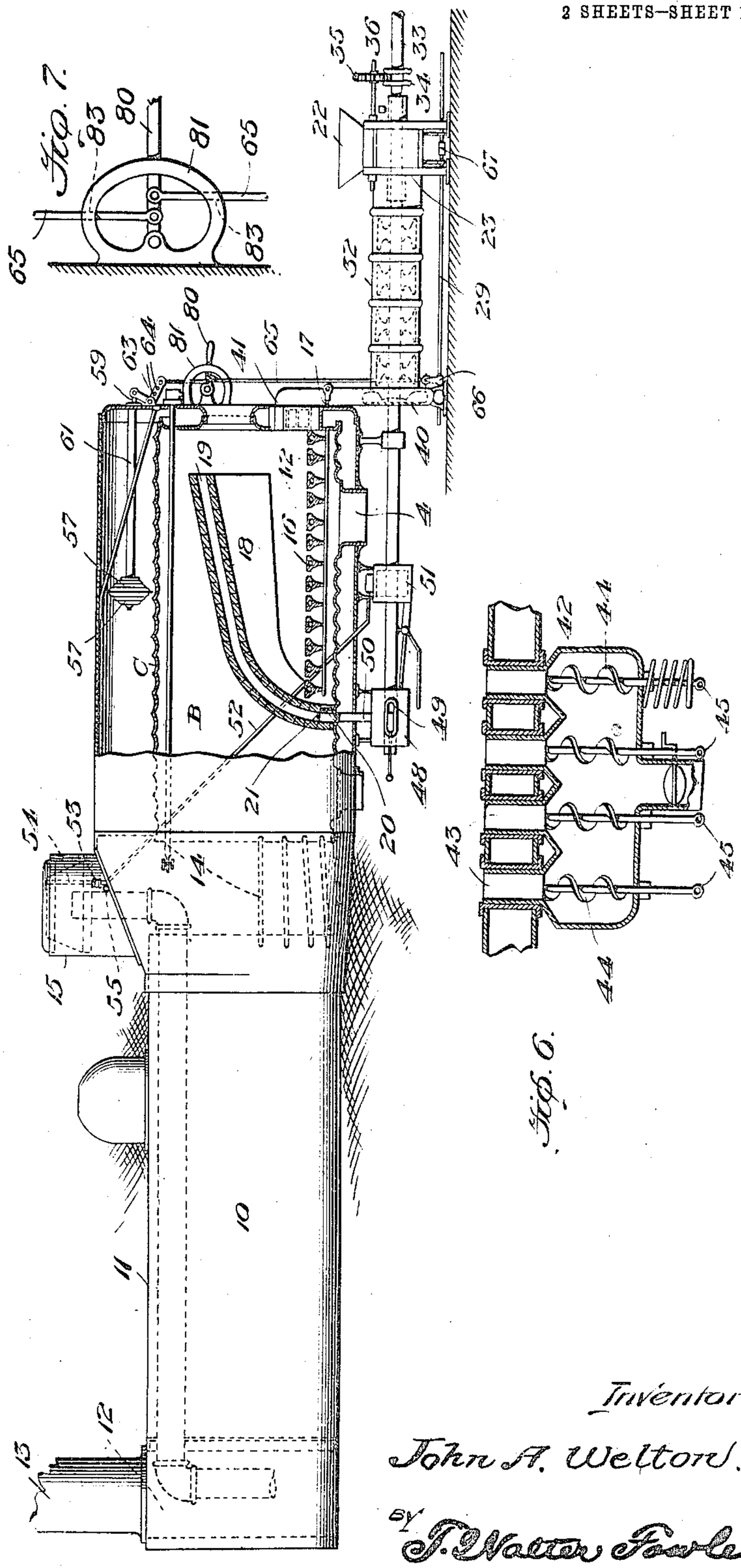

Fig. 1.

Fig. 6.

Witnesses
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2 SHEETS—SHEET 2.

Fig. 2.

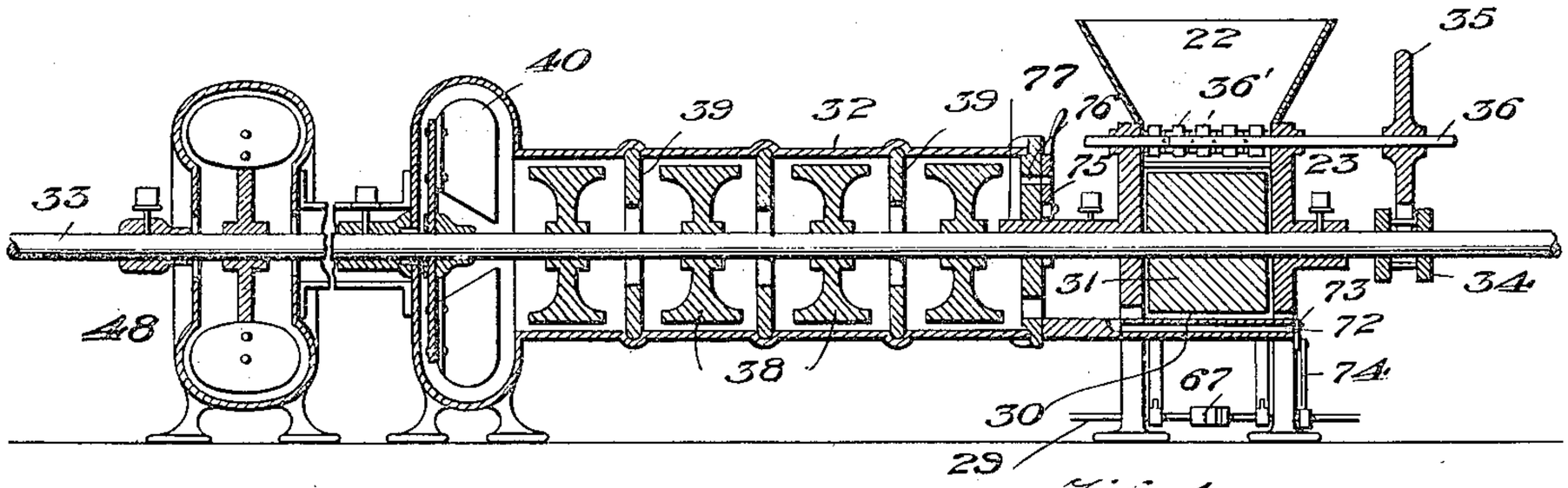


Fig. 4.

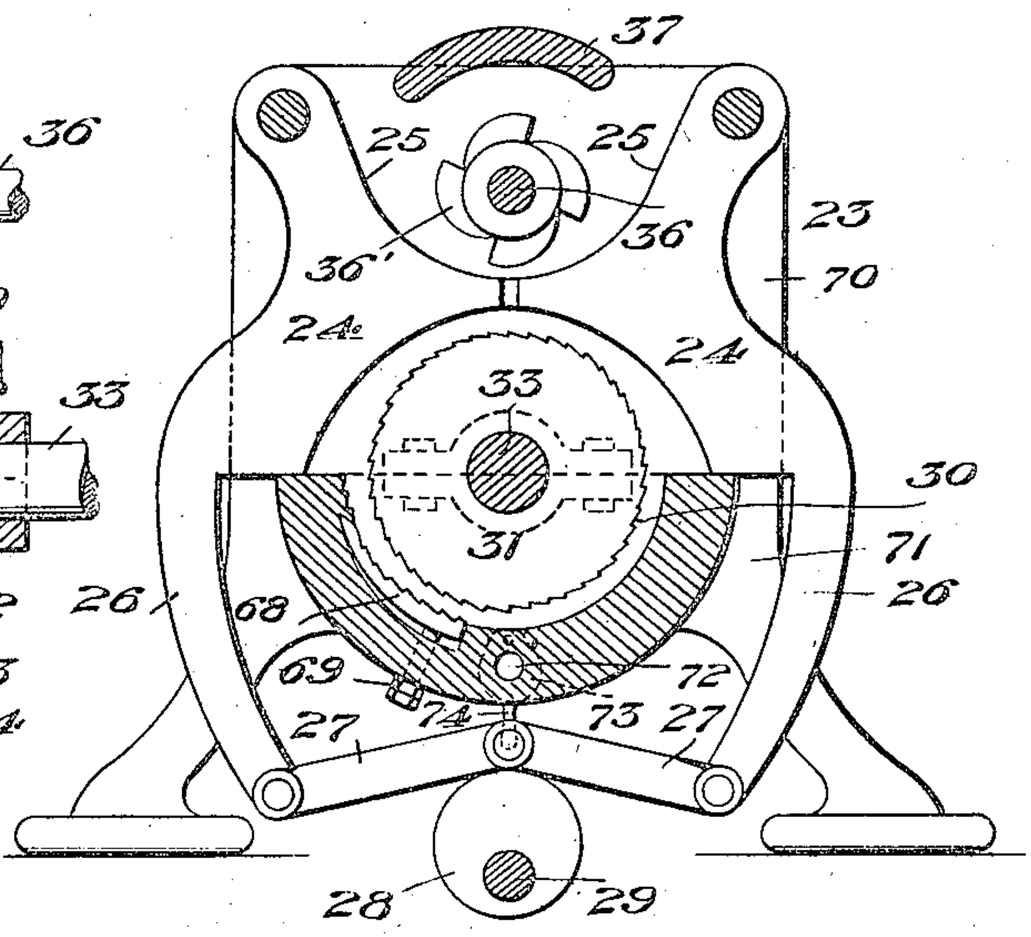


Fig. 3.

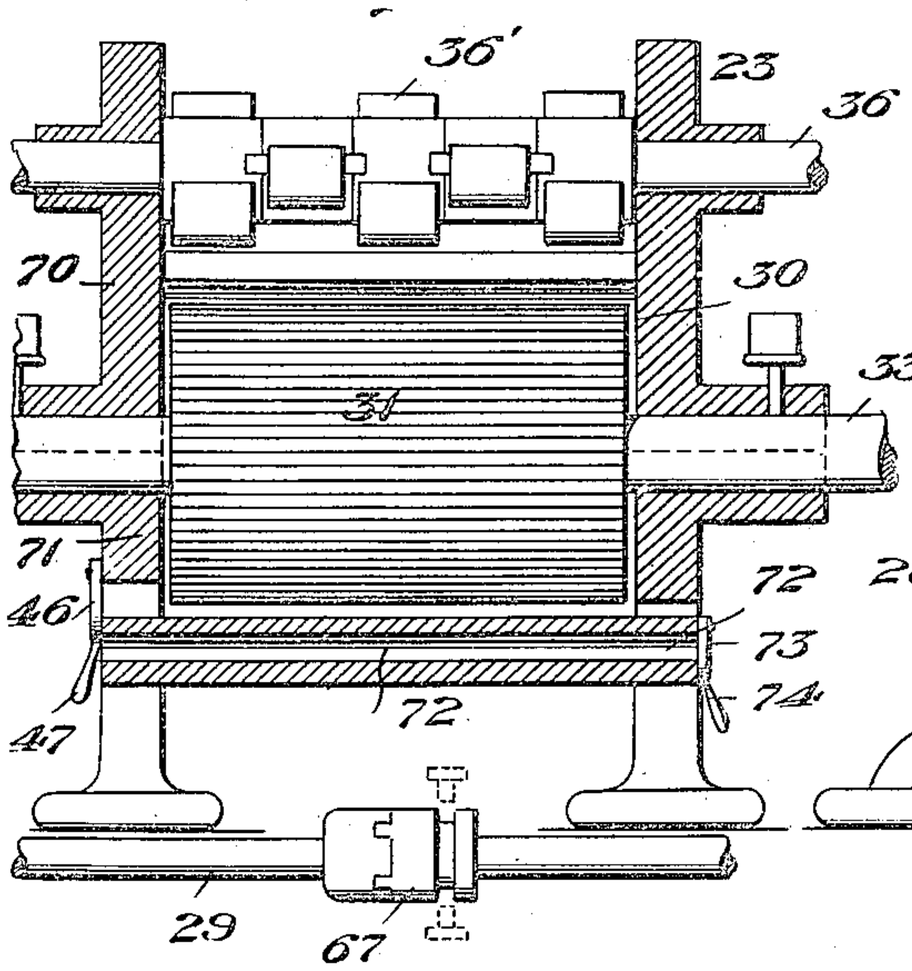
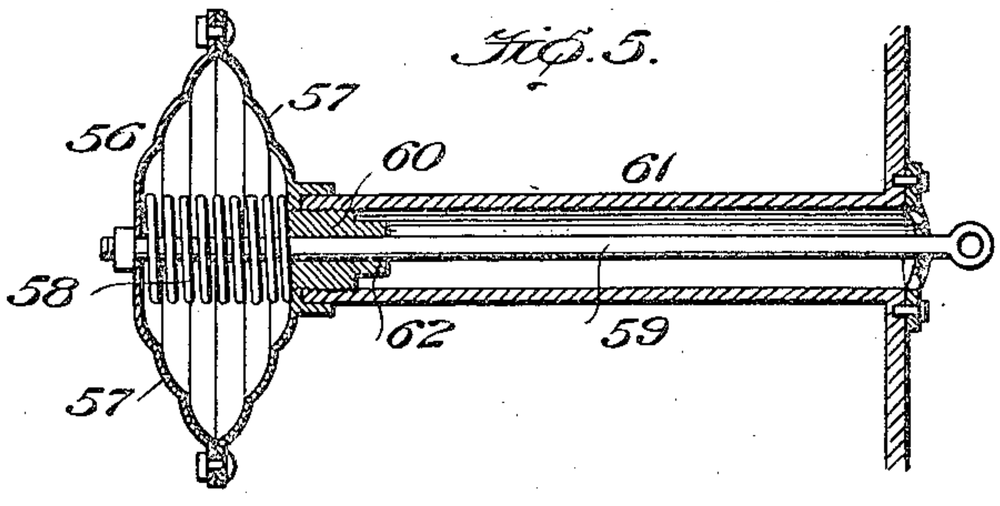


Fig. 5.



Witnesses

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APPARATUS FOR FEEDING FINE FUEL.

993,929. Specification of Letters Patent. Patented May 30, 1911.

Application filed March 1, 1911. Serial No. 611,594.

To all whom it may concern:

Be it known that I, JOHN A. WELTON, a citizen of the United States, residing at Canal Dover, in the county of Tuscarawas and State of Ohio, have invented certain new and useful Improvements in Apparatus for Feeding Fine Fuel, of which the following is a specification.

This invention relates to certain new and useful improvements in apparatus for feeding fine-fuel to steam boiler and other furnaces and regulating the feed of the fuel automatically by conditions of boiler pressure.

Among the objects of the present invention may be stated the following: First. The provision of improved means for grinding or reducing the fuel from a lump or coarse form to a pulverized condition to enable it to be injected into the furnace under pressure and in such quantities as the boiler conditions require. Second. The employment of improved means for automatically controlling the furnace fire according to the pressure in the boiler, the fuel supply being reduced when the boiler pressure rises above a predetermined point, and increased when the boiler pressure drops below this point. Third. The use of improved means for feeding air into the fire-box of the furnace and mixing the same with the gases and fuel, in order to secure more perfect combustion thereof. Fourth. The employment of a regulator exposed to the action of the steam in the boiler and the connection of this regulator to the means controlling the fuel-supply. Fifth. The provision of a fuel-supply hopper having a gate-controlled bottom or outlet the opening and closing of which is automatically controlled by connections from the pressure regulator.

With the above and other objects in view, my invention consists of the parts, and the constructions, arrangements and combinations of parts which I will hereinafter describe and claim.

In the accompanying drawing forming part of this specification and in which similar reference characters indicate like parts in the several views: Figure 1 is a part longitudinal sectional view and a part elevation of a locomotive boiler, showing the fuel-feeding mechanism in side elevation. Fig. 2 is an enlarged longitudinal sectional view of the fuel reducing and feeding means showing the pulverizing mullers, a steam turbine and a rotary air fan for directing the pulverized fuel and air under pressure to the furnace. Fig. 3 is a part elevation and part sectional view of the fuel hopper showing the crushing devices. Fig. 4 is an end view of the fuel hopper showing the exterior casing removed and showing the dampers or gate valves which form the bottom of the hopper, and means for operating the same. Fig. 5 is a sectional view of a pressure regulator. Fig. 6 is a sectional view of the distributing head for discharging the fuel into the furnace. Fig. 7 illustrates a means by which the cam shaft 29, may be manually operated.

While I have shown my invention in connection with a locomotive-boiler furnace, I wish it understood that the several improvements are capable of use with equal facility with a stationary boiler, and with any boiler furnace where the automatic regulation of the fire by boiler pressure is desired; except as indicated, the invention is therefore not limited to any particular style of boiler or furnace.

The locomotive boiler herewith shown for illustrative purposes may be of any approved type. It is shown as having a suitable boiler, 10, contained within the shell or casing, 11, said shell or casing having the usual smoke box, 12, leading to the stack, 13, and said shell may include any well known form of feed water heater, 14, and a steam dome, 15. These features form no essential part of my invention and accordingly are not illustrated in detail. The locomotive boiler shown is provided with a furnace and which furnace may also be of any appropriate type; for certain reasons I prefer to construct the furnace as shown, namely, with a fire-box, B, which is substantially cylindrical in cross section and has its shell, C, corrugated throughout its entire length, such a structure being substantially the same as that disclosed in my prior Patent No. 804,286, dated Nov. 14/05, and being shown in my former application, Ser. No. 526,436, filed Nov. 5/09.

The front of the fire-box has a suitable door and in this end of the fire-box is mounted a grate, 16, which if of the shaking character will be provided with an operating rod, 17. This grate does not extend the entire length of the fire-box, but it terminates short of the rear end thereof, and

between the rear of the grate and the rear of the fire-box and arranged substantially close to the rear end of the grate is the arch, 18, which rises from the bottom of the fire-box and extends in a curved upwardly and forwardly direction over the rear end of the grate, said arch having a straight portion extending at an incline toward the front of the fire-box, but terminating short thereof and also of the top wall of the fire-box so that the products of combustion may pass upwardly under the fire-box and over the upper front end thereof and through the space left between the fire arch and the wall of the fire-box. This arch extends throughout the entire width of the fire-box and will be constructed of fire-brick or other refractory material; it is formed with a checkered air passage, 19, opening at one end through the bottom of the fire-box and at the opposite end through the outer end of the arch and into the space between the arch and the inner walls of said fire-box. The passage, 19, through the arch is provided for the purpose of feeding air into the fire-box, to support combustion, and during the passage of this air through said arch the air comes into contact with the heated walls of the passage and is heated and after leaving the passage the air is thoroughly mixed with the gases and other products of combustion as they pass from under the grate into the space above the arch whereby these products are entirely consumed. This construction of the arch is desirable to the most economical and successful working of the invention, for the reason that in front of or under the arch a temperature can be maintained that will be low enough to prevent the burner terminals, hereinafter mentioned, from carbonizing and becoming choked by the fuel; with the construction shown I am enabled to keep a fire under the arch at a low temperature while in the chamber to the rear of the arch I can make as hot a fire as I may desire by the addition of as much heated air as may be required to complete the combustion. I, therefore, can produce a fire with a desired degree of intensity by the use of a fine fuel while I maintain the greatest temperature at a point back of the arch, the fire under the arch and immediately over the grate being at a comparatively low temperature.

Below the level of the grate the arch is provided with a damper, 20, which opens into the space below the grate and which damper when opened allows air to be delivered through the grate bars to the fires thereon; this relation of the parts is desirable when starting the fire, after which pulverized fuel is injected into the fire box, as I will presently describe and burned in suspension. In the flue passage is also placed a damper, 21, which is disposed above the damper, 20; upon closing the second named damper and opening the first named damper, 20, the air is cut off from the grate bars and delivered through the checkered air passage to be heated and discharged at the upper end of the arch in the presence of the products of combustion escaping from beneath the arch. Below the grate the bottom of the fire-box is provided with an opening, 4, of some appropriate character through which the ashes may be discharged from time to time.

I use fuel in a pulverized form and it is delivered into the fire-box under more or less pressure. The means for feeding the fuel which means constitute the leading feature of my invention, I will now describe.

The material is delivered in any suitable manner and from any suitable source of supply into a hopper, 22, Figs. 1, 2 and 4 which hopper is supported at the upper end of a suitable supporting frame or casing, 23. The hopper is formed of a pair of dampers or similar gates, 24, having curved upper surfaces, 25, jointly forming the bottom of the hopper and upon which surfaces the fuel is received. The dampers or gates are pivotally mounted at their upper ends and their lower portions are in the form of curved arms, 26, which extend downwardly curving toward each other and are connected by means of toggle-links, 27, pivoted together at their inner ends by means of a connecting rod, said rod resting in contact with the periphery of a cam or eccentric, 28, fixed to a horizontal shaft, 29, as shown in Figs. 2 and 4.

Each of the dampers or gates which constitute the bottom of the hopper may have the form shown in Fig. 4 and the curved surfaces, 25, which constitute the bottom of the fuel space of the hopper are designed to substantially meet so that the opening in the bottom of the hopper may be entirely closed, under certain conditions; the dampers or gates may also be swung about their pivots or caused to move away from each other to open up a space between them and which space forms a discharge through which the fine fuel is permitted, under other working conditions, to pass from the hopper into a grinding chamber, 30. This chamber is formed within the frame or casing, 23, and within the chamber operates a grinding roll, 31, the essential purpose of which is to reduce any lumps or material which may pass from the hopper into the chamber whereby the material is pulverized and placed in such condition that it may be readily forced under pressure into the fire-box, as I will now describe.

Connected with the casing which supports the hopper and grinding roller, is a cylinder, 32, which is horizontally disposed and through which cylinder passes a shaft, 33,

upon one end of which is mounted a pinion, 34, which meshes with a gear wheel, 35, on a shaft, 36, journaled in the casing and extending through the hopper space between the dampers or gates, 24, said second shaft having winged rolls, 36′, to assist in feeding the material through the hopper, and for keeping the material in a loose state in the hopper.

In order that the greater portion of the weight of the coal may be supported out of contact with the crushing and feeding rolls in the hopper and the weight removed from the dampers or gates, which form the bottom of the hopper, I place over the said crushing and feeding rolls any suitable form of shield, 37, upon which the weight of the coal is largely carried. This enables me to operate the dampers with less power than otherwise would occur.

The cylinder, 32, houses a series of mullers, 38, which are fixed to the shaft, 33, and which mullers are separated from each other by transverse washers or flanges, 39, with central openings through which the material passes from one muller to the other. These washers or flanges and the shell of the cylinder constitute chambers in which the separate mullers operate, and the material reduced by the grinding roller in the cylinder, 32, is conveyed into the chamber containing the first muller and is further reduced and finally is passed through the successive chambers until it merges from the final chamber into the casing of a rotary fan, 40. This fan has a discharge pipe, 41, for delivering the now pulverized fuel into the furnace the said discharge pipe being connected with a discharge head, 42, mounted in the front wall of the furnace and which head is provided with an internal enlarged chamber from which lead a series of nozzles, 43, said nozzles being mounted in the front wall of the fire-box and adapted to discharge the material directly into the fire-box and into the space below the curved arch thereof. The construction and operation of this head do not depart materially from what is disclosed in my aforesaid application, the head having suitable screws, 44, mounted upon stems, 45, whereby a whirling motion may be imparted to the fuel as it is delivered through the nozzles into the furnace, said screws being axially in line with the nozzles and being so proportioned that they may be passed into the nozzles to serve as flue scrapers for removing any particles which might adhere to the walls of the said nozzles.

Between the casing, 23, and the inlet end of the cylinder in which the mullers operate, may be placed any suitable form of damper, 46, with operating stem, 47, for regulating the feed and consequently the fineness of the material entering the cylinder.

The shaft, 33, extends through the dust-fan casing and is mounted in appropriate bearings fixed to the furnace casing, as shown in Fig. 1, and on the inner end of this shaft is mounted the casing of an air fan, 48, having an inlet, 49, and a discharge, 50, which connects with a passage leading through the bottom of the fire-box and communicating with the passage, 19, in the hollow arch before mentioned. I also mount upon the shaft, 33, a steam turbine, 51, of some well known and appropriate character, which is operated by steam delivered through the pipe, 52, leading from the steam dome or steam space of the boiler, said pipe being controlled by a steam regulator, 53, of any approved type, having an adjustment tube, 54. A valve, 55, in this pipe will permit the turbine to be controlled independent of the regulator.

Above the fire-box and in the steam space of the boiler, is also mounted a pressure regulator, 56, of some appropriate character and which regulator may follow more or less closely the form shown in Fig. 5, namely the regulator may consist of two similar shells, 57, bolted together and corrugated, and inclosing between them a suitable spring, 58. Through the shells and spring passes a rod, 59, and on this rod is mounted a follower or nut, 60, threaded to the inside of a tube, 61, having a hexagonal or many-sided nut, 62, for the application of a wrench whereby the nut or follower may be adjusted to regulate the tension of the spring. Any well known form of pressure regulator either of the diaphragm or other type may be employed if desirable without departing from the spirit of my invention.

The tube, 61, which is connected with the regulator is open to the atmosphere at the outer end, and the rod, 59, extends through this open end and is connected to one arm of a bell crank lever, 63, pivotally mounted on the front of the furnace shell, the other arm of the bell crank lever being provided with a series of holes, 64, to any one of which may be pivotally connected the upper end of a rod, 65, whose lower end is likewise adjustably pivotally connected to a crank arm, 66, fixed to the cam-shaft, 29, before mentioned. The shaft, 33, may also be provided with some appropriate form of clutch mechanism, 67, Fig. 2, to enable me to disengage the dampers which control the feed of the material from the hopper, from the damper-regulator to enable me to manually increase, when desired, the supply of coal to take care of a temporary overload.

In order that the grinding roll may properly reduce the material to a sufficient degree of fineness I mount in the wall of the cylinder in which this roll operates, a hardened steel strip or die, 68, which is adjustable toward and from the roll, by means of a screw,

69, whereby the fineness of the material may be regulated, the surface of this die or plate and the periphery of the roll being serrated or toothed or otherwise formed to produce the best grinding effect.

The ends of the hopper formed by the upper curved surface of the dampers or gates, 24, are formed by the vertical sides of the casing, 23, which casing is shown in Fig. 3 as formed of upper and lower sections, 70 and 71, the line of division being in the plane of the axis or bearing shaft of the grinding roll, and the parts being secured together by flanges and bolts as shown. In the lower part of this casing and communicating in some appropriate manner with the grinding cylinder or with the cylinder in which the mullers operate, is an air inlet, 72, controlled by an appropriate shutter, 73, having an arm, 74, which is actuated to open and close the shutter by a suitable cam on the regulating shaft, whereby the supply of air is automatically controlled. If desired I may also employ an air shutter, 75, controlling an opening or passage, 76, leading into the front end of the muller cylinder and which shutter may be operated by hand to admit air to the cylinder when desired, and proximate to this air opening I fix within the cylinder a shield, 77, to prevent the dust from being blown out of the opening by the first muller wheel.

From this description it will be seen that the feed of the fine fuel is automatically regulated and controlled by boiler conditions; that the turbine is operated by steam taken from the steam space of the boiler and that this turbine operates the shaft which carries the mullers and grinding features; that the regulator is provided for actuating the cam shaft and thereby opening and closing the dampers, which control the fuel feed in response to boiler pressure; and that a throttle valve is employed to control the speed of the turbine independent of the regulator, to take care of a temporary overload. The coal is ground at the time of using it, thereby avoiding a surplus which might possibly cause an explosion, and the feed of this fuel together with the feed of air is at all times automatic and responds to boiler conditions.

The clutch, 67, may not be essential under all conditions and especially when using the features shown in Fig. 1. These features include the lever, 80, which is pivoted at one end and slidably operates over a quadrant, 81. To this lever at different distances from the axis thereof, are pivoted the inner ends of the two parts of the rod, 65, which slide through appropriate guides, 83, on the quadrant. By means of this construction it is possible for the fireman to regulate the quantity of coal going into the fire box as the cam, 66, can by means of the parts described, be thrown a distance sufficient to obtain all the benefit of the cam's eccentricity, without the clutch. The fireman therefore has as good control of heat generation as the engineer has of the steam after it is generated.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. In apparatus for feeding fine fuel, the combination of a steam-boiler furnace; a fuel receiver; a fuel conduit leading from the receiver to the fire-box of the furnace; fuel reducing elements arranged to operate on the fuel as it passes through said conduit; means for supplying air to the furnace with the fuel; a pressure regulator exposed to boiler pressure and operable thereby; a pair of connected dampers movable toward and from each other controlling the outlet from the fuel receiver; and connections between the pressure regulator and said dampers whereby the dampers are opened and closed automatically in response to variations in boiler pressure, said connections including a cam-shaft and means connecting the same with the pair of dampers.

2. In apparatus for feeding fine fuel, the combination of a steam boiler furnace, a fuel receiver having a pair of connected oppositely movable dampers controlling the outlet therefrom, a fuel reducing mechanism connecting directly with the fuel receiver, a fuel conducting mechanism between the reducing mechanism and the fire box of the furnace, a pressure regulator exposed to the action of boiler pressure, and connections between the pressure regulator and the pair of dampers whereby the area of said outlet is increased and diminished in response to variations in boiler pressure, said connections including a rock shaft and a cam and devices connecting the same with the pair of dampers.

3. In apparatus for feeding fine fuel, the combination of a steam-boiler furnace; a fuel receiver; a fuel conduit leading from the receiver to the fire-box of the furnace; fuel reducing elements arranged to operate on the fuel as it passes through said conduit; means for supplying air to the furnace with the fuel; a pressure regulator exposed to boiler pressure and operable thereby; a pair of connected dampers controlling the outlet from the fuel receiver, and connections between the pressure regulator and said dampers whereby the dampers are opened and closed automatically in response to variations in boiler pressure; said connections including a cam-shaft and devices between the same and each of said dampers, and means controlled by the pressure regulator for varying the supply of air in response to boiler pressure.

4. In apparatus for feeding fine fuel, the combination with a steam boiler furnace, of

fuel-reducing elements, fuel-feeding means connecting with the fire-box of the furnace, said means comprising a pair of dampers pivoted at their upper ends and having upper portions fashioned to form the bottom of a receiver for the fuel, said dampers having extended portions which approach each other to increase or decrease the fuel discharge passage, a pressure regulator exposed to the boiler pressure, and connections between the regulator and the extended portions of the damper for moving said dampers in unison in opposite directions in response to variations in boiler pressure.

5. In apparatus for feeding fine fuel, the combination with a steam boiler furnace, of fuel-feeding means connecting with the fire-box of the furnace, said means comprising a pair of dampers pivoted at their upper ends and having upper portions fashioned to form the bottom of a receiver for the fuel, said dampers having extended portions which approach each other at the lower ends, and being movable toward and from each other to increase or decrease the fuel discharge passage, a pressure regulator exposed to the boiler pressure, and connections between the regulator and the damper for moving said dampers in unison in response to variations in boiler pressure, said connections comprising a regulating shaft having a cam, and a toggle-link connection between the free ends of the dampers and engaged and operated by said cam, and connections between the pressure regulator and the regulating cam-shaft.

6. In apparatus for feeding fine fuel, the combination with a steam boiler furnace, of fuel-feeding means connecting with the fire-box of said furnace, said means comprising a casing, a pair of similar dampers within the casing and pivotally mounted at their upper ends, said dampers having upper curved portions adapted to form the bottom of a fuel receiver, and being movable toward and from each other to increase or decrease the size of the fuel outlet, crushing devices within the casing below said fuel receiver and receiving fuel directly therefrom, said dampers having their lower ends extended, a toggle-link connection between the lower ends of the dampers, a regulating shaft having a cam for operating the toggle-levers whereby the dampers are opened and closed relative to each other, a pressure regulator exposed to boiler pressure, and connections between the regulator and the said shaft whereby the shaft is turned to move the damper and vary the feed of the fuel in response to variations in the boiler pressure.

7. In apparatus for feeding fine fuel, the combination of a fuel receiver comprising a casing and a pair of similar dampers having curved upper portions forming the bottom of the receiver, said dampers being movable toward and from each other to vary the size of the fuel outlet, and having extended lower portions, a rotary feeder and agitator in the fuel receiver, between the curved upper surfaces of the damper, a shield above the rotary feeder for sustaining a part of the weight of the fuel and maintaining the fuel out of contact with the upper portion of the feeder, a pressure regulator exposed to boiler pressure, and a rock shaft and connections between the regulator and the extended portions of the pair of dampers for operating the dampers in unison in response to variations in boiler pressure.

8. In apparatus for feeding fine fuel, the combination of a fuel receiver having a damper-controlled outlet, fuel reducing means with which the outlet connects, a pressure regulator exposed to boiler pressure, a cam-shaft and connections between the regulator and the damper-controlled outlet of the fuel receiver for increasing or decreasing the size of the outlet in response to variations in boiler pressure, damper-controlled means for admitting air to mix with the fuel after it has been reduced, and means connecting with said shaft whereby the damper of the air-admission means may be actuated in response to variations in boiler pressure.

9. In apparatus for feeding fine fuel, the combination of a steam boiler furnace, a fuel receiver having a damper controlled outlet, a pressure regulator exposed to boiler pressure, a cam-shaft and connections between the pressure regulator and the dampers of the receiver for operating the latter in response to variations in boiler pressure, reducing agents to the action of which the fuel is subjected after leaving the receiver, a horizontal cylinder provided with revoluble mullers, means connecting with said shaft for admitting air to said cylinder for admixture with the fuel, a fan casing at the discharge end of said cylinder having a discharge leading to the furnace fire-box, and a rotary fan in said casing for delivering the fuel through said discharge and into the fire-box.

10. In apparatus for feeding fine fuel, the combination of a steam boiler furnace, a fuel receiver having a damper controlled outlet, a pressure regulator exposed to boiler pressure, a cam-shaft and connections between the pressure regulator and the dampers of the receiver for operating the latter in response to variations in boiler pressure, reducing agents to the action of which the fuel is subjected after leaving the receiver, a horizontal cylinder provided with revoluble mullers, means connecting with said shaft for admitting air to said cylinder for admixture with the fuel, a fan casing at the discharge end of said cylinder having a dis-

charge leading to the furnace fire-box, and a rotary fan in said casing for delivering the fuel through said discharge and into the fire-box, said fire-box having a distributing head, into which the discharge from the fan casing delivers and said head having nozzles through which the fuel is injected into the fire-box to be burned in suspension.

11. In apparatus for feeding fine fuel, the combination of a steam boiler furnace, a fuel receiver, a fuel conduit leading from the receiver to the fire-box of the furnace, fuel reducing elements arranged to operate on the fuel as it passes through said conduit, means for supplying air to the furnace with the fuel, a pressure regulator exposed to boiler pressure and operable thereby, dampers controlling the outlet from the fuel receiver, a cam shaft and connections between the pressure regulator and said dampers whereby the dampers are opened and closed automatically in response to variations in boiler pressure, a steam turbine for operating the fuel reducing elements, a steam regulator in the boiler and connections between the same and the turbine for controlling the latter in response to variations in boiler pressure.

12. In apparatus for feeding fine fuel, the combination of a fuel receiver, a casing therefor, grinding devices in said casing for reducing the fuel, a casing extending horizontally from one side of the first casing, having a horizontal shaft extending through it, mullers fixed to said shaft, said casings connecting so that the reduced material may pass into the second casing, means for admitting air to the second casing along with the fuel, washers or partitions in the second casing between the mullers and forming chambers for said mullers, said washers being open at the center to permit the material to be advanced successively through the casings, and a shield proximate to the first muller and the air inlet and serving to prevent the dust from being forced out of said inlet.

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

JOHN A. WELTON.

Witnesses:
IVOR HARRIS,
HARRY H. HOSTETLER.