A. COTTON.

AUTOMATIC STEAM JET FURNACE STOKER.

APPLICATION FILED JULY 29, 1911.

1,237,304.

Patented Aug. 21, 1917.

5 SHEETS—SHEET 1.

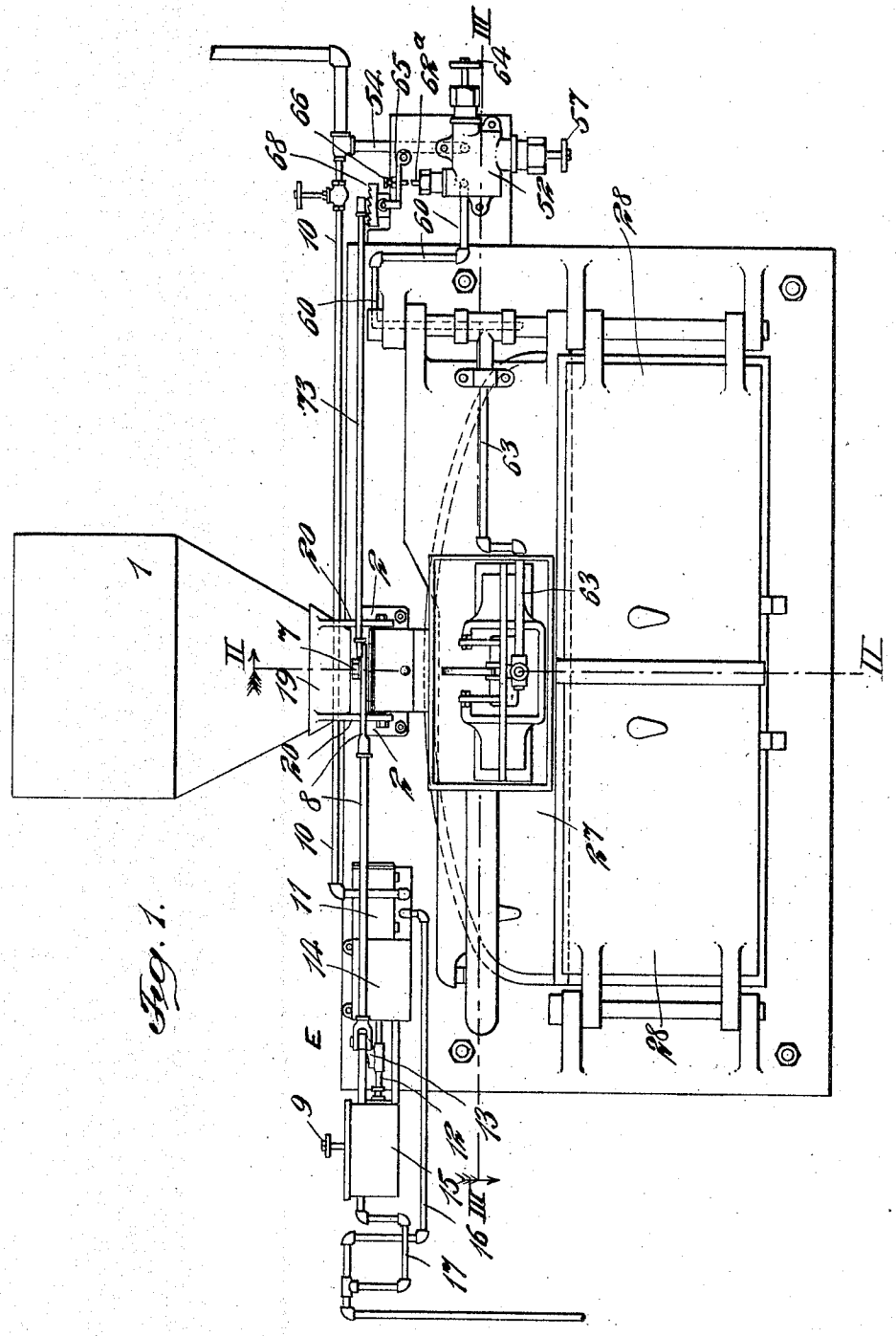

Fig. 1.

Witnesses:
Julius K. Mix
F. K. Miller.

Inventor
Alfred Cotton
By his Attorneys
Davis & Davis

A. COTTON.

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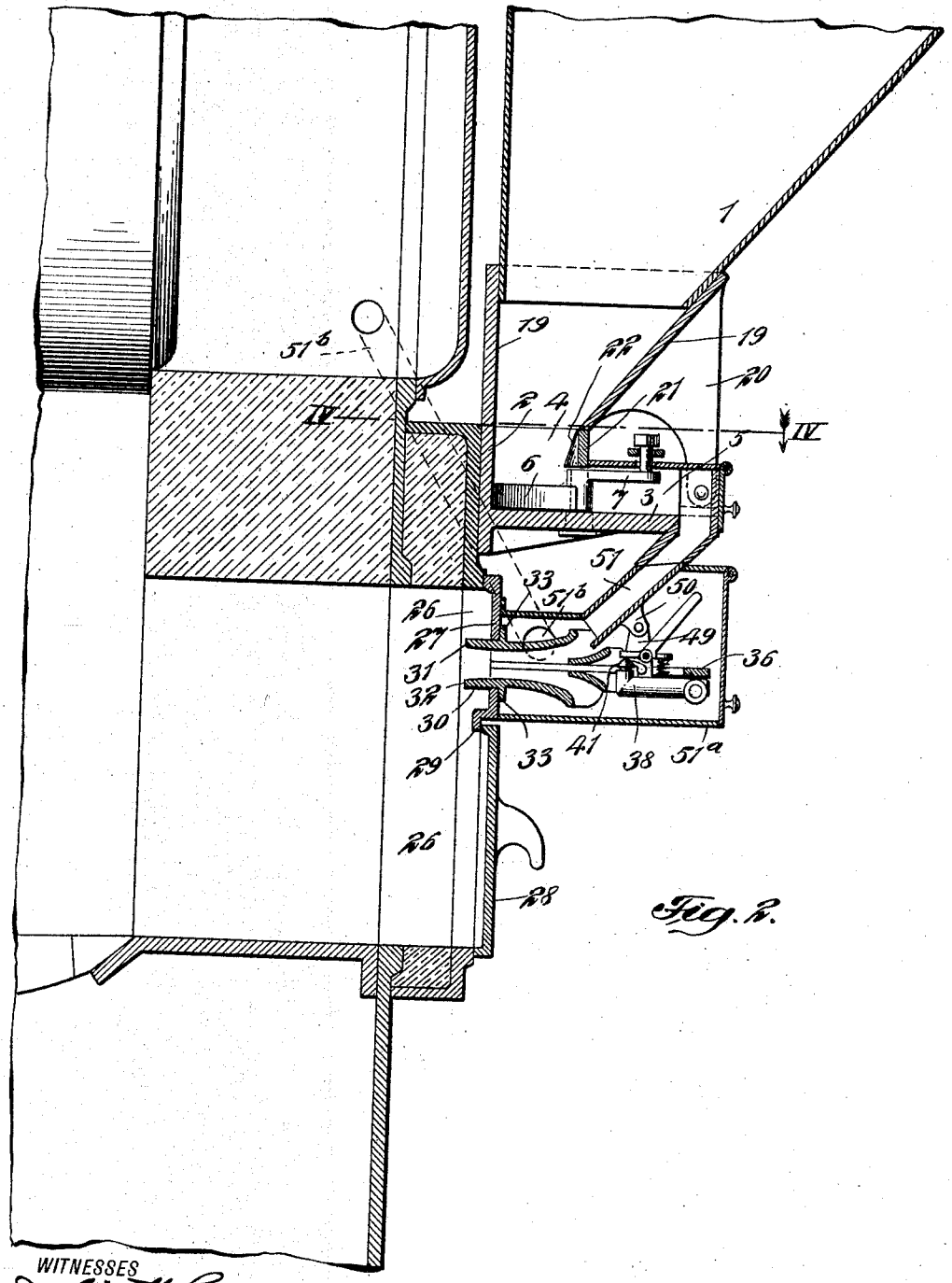

Fig. 2.

WITNESSES

J. R. Miller.

INVENTOR.

Alfred Cotton

BY

Davis & Davis

ATTORNEYS

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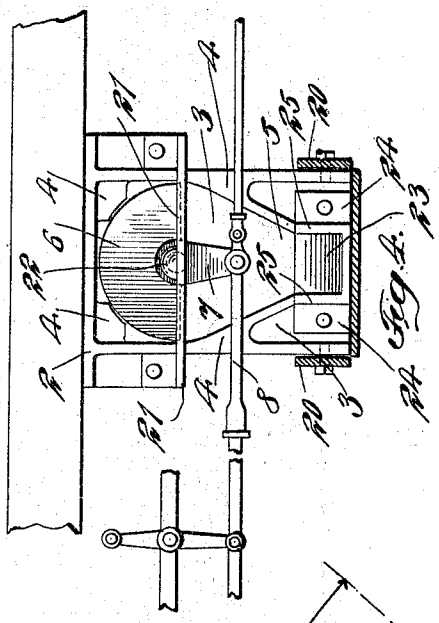

Fig. 4.

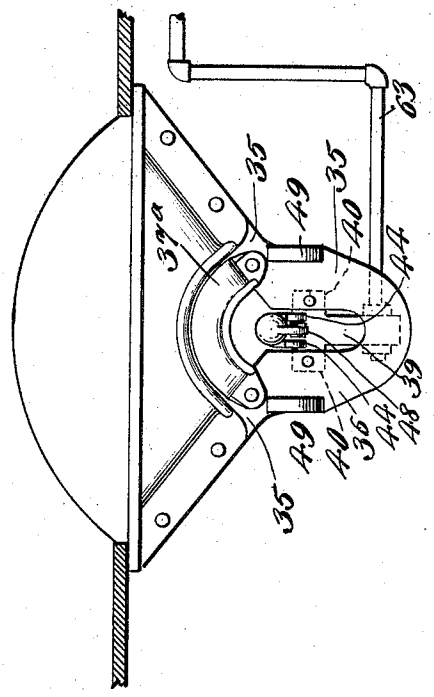

Fig. 5.

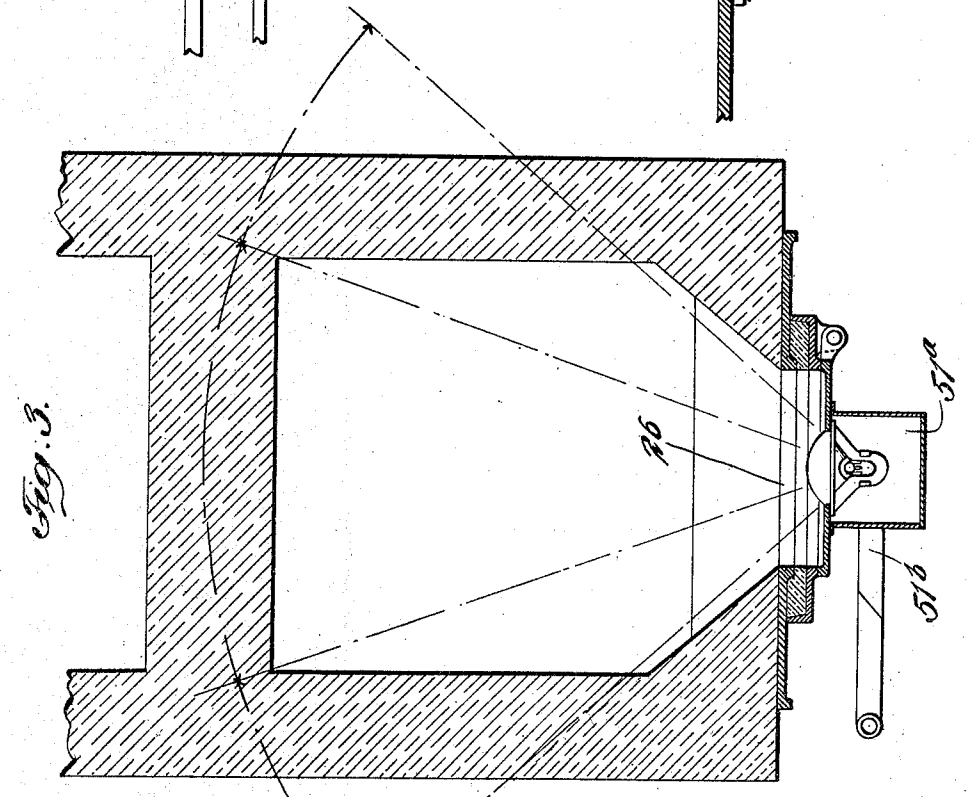

Fig. 3.

WITNESSES

J. R. Miller.

INVENTOR

Alfred Cotton

BY

Davis & Davis

ATTORNEYS

A. COTTON,

AUTOMATIC STEAM JET FURNACE STOKER.

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5 SHEETS—SHEET 4.

Fig. 6.

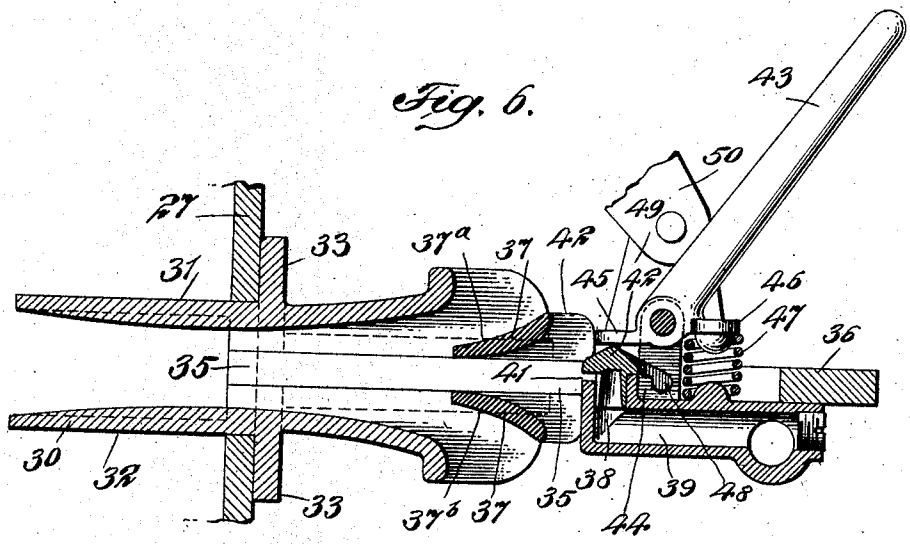


Fig. 7.

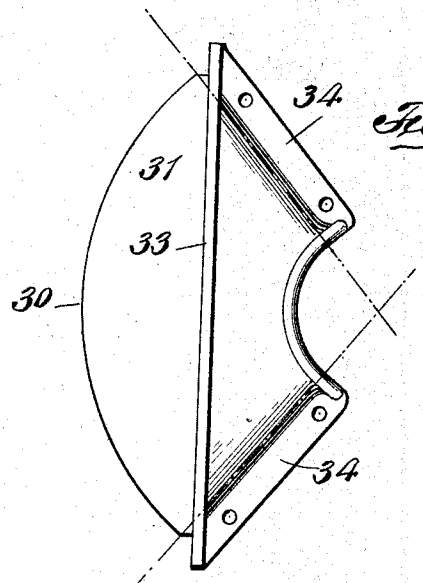
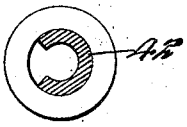


Fig. 11.



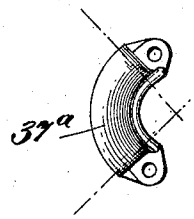


Fig. 8.

Witnesses:

F. R. Miller.

Inventor

Alfred Cotton

By his Attorneys

Davis Davis

A. COTTON.

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5 SHEETS—SHEET 5.

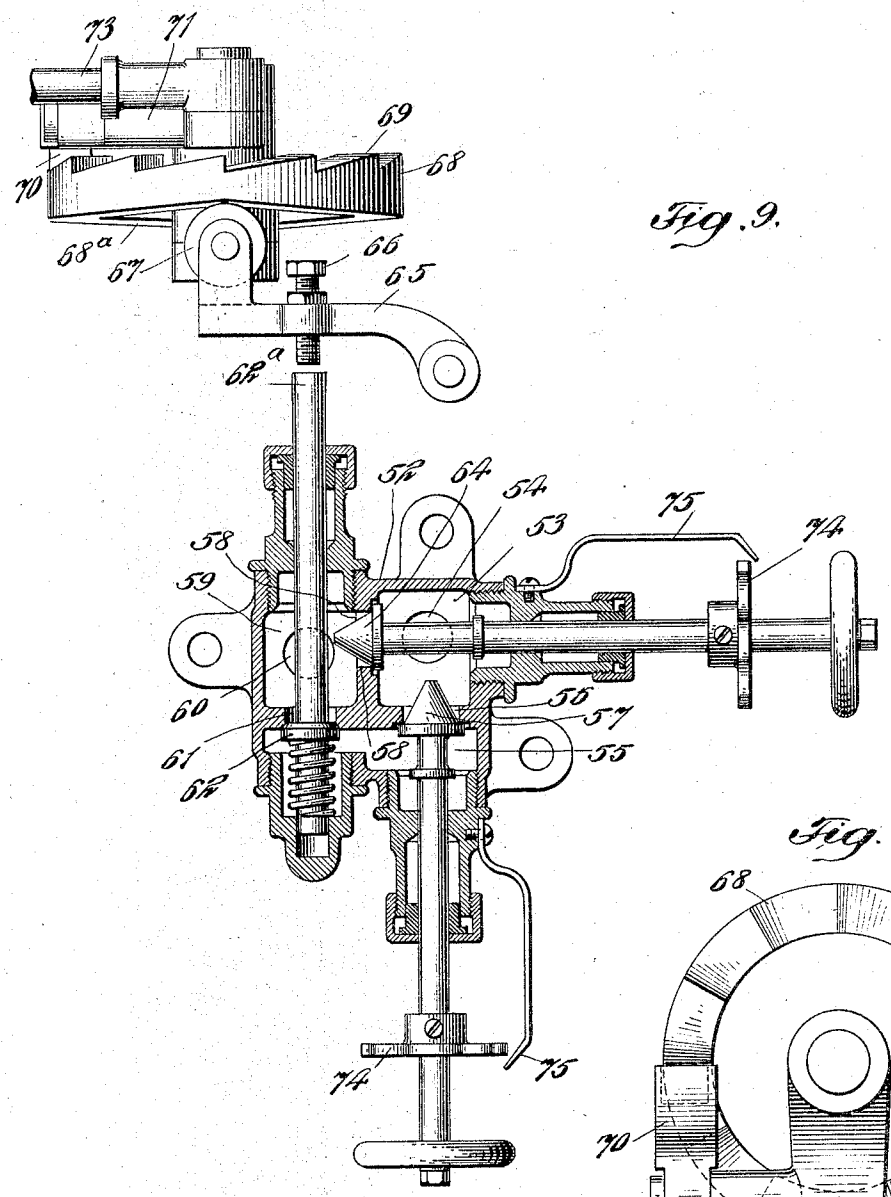

Fig. 9.

Fig. 10.

Witnesses:
Julius Hoffmann
F. R. Miller.

Inventor
Alfred Cotton
By his Attorneys
Davis & Davis

UNITED STATES PATENT OFFICE.

ALFRED COTTON, OF NEWARK, NEW JERSEY.

AUTOMATIC STEAM-JET FURNACE-STOKER.

1,237,304. Specification of Letters Patent. Patented Aug. 21, 1917.

Application filed July 29, 1911. Serial No. 641,302.

To all whom it may concern:

Be it known that I, ALFRED COTTON, a subject of the King of Great Britain, residing in the city of Newark, county of Essex, and State of New Jersey, have invented certain new and useful Improvements in Automatic Steam-Jet Furnace-Stokers, of which the following is a specification.

This invention relates to that class of automatic stokers wherein granular fuel is automatically fed from a hopper to a propelling steam jet by which the fuel is distributed throughout the furnace grate area.

One of the main objects of this invention is to locate the steam jet in a blower whereby the said jet will draw air or furnace gases into said blower and mingle with it to form the propelling jet. The coal is delivered within the blower and will be propelled or projected over the furnace grate by the combined steam and air jet. By this means the velocity of the steam jet is somewhat reduced and the propelling jet is increased in volume. I have found this to be a much more satisfactory fuel propelling jet than a pure steam jet as a pure steam jet has too great a velocity and not sufficient volume to be accurately controlled for the proper distribution of the fuel.

Another object of the invention is to provide a peculiar shape of blower to be used in connection with the steam jet, whereby the proper distribution of the coal will be secured.

A further object of the invention is to provide a novel form of fuel feeding means for delivering the fuel to the blower apparatus.

A still further object of the invention is to provide a simply constructed and efficient means for controlling the supply of steam to the blower apparatus.

A further object of the invention is to construct the blower apparatus and the fuel feeding means, by which the fuel is fed to the blower, in such manner that the blower apparatus may be connected to a fire door and the fuel feeding means mounted upon the furnace front so that the door carrying the blower apparatus may be opened at any time without disarranging the feeding means.

There are other important objects and advantages of the invention, which will appear hereinafter.

I have found that in some furnaces the blower if open to the atmosphere will deliver too much air over the fire and in those cases I have arranged to deliver hot flue gases to the blower instead of air; or deliver the hot gases with air. This serves the purpose of giving volume to the jet and thereby reducing its speed, without introducing any cold air over the fire.

In the drawings:—

Figure 1 is a front elevation of a furnace with my stoker applied;

Fig. 2 a vertical longitudinal sectional view of the stoker and the front portion of the furnace on line II—II of Fig. 1;

Fig. 3 a horizontal sectional view of the furnace fire box and the blower approximately on a line III—III of Fig. 1, some of the parts being omitted;

Fig. 4 a detail horizontal sectional view of the fuel feeding means on the line IV—IV of Fig. 2, showing the feed ram in plan view;

Fig. 5 a plan view of the blower;

Fig. 6 a vertical longitudinal sectional view of the blower and the steam jet nozzle;

Fig. 7 a plan view of the blower;

Fig. 8 a similar view of the jet nozzle;

Fig. 9 a vertical sectional view of the valve mechanism for controlling the supply of steam to the jet nozzle, the valve operating means being shown in side elevation;

Fig. 10 a plan view of the valve operating cam and mechanism for rotating it.

Fig. 11 is a horizontal sectional view of the nozzle cap.

The apparatus consists of the hopper and means connected thereto for feeding the fuel to the blower apparatus; the blower apparatus by means of which the fuel is distributed over the fire; and the steam controlling means for supplying and automatically varying the force of the propelling jet. I will now describe the various mechanisms in the order in which I have stated them:

Fuel feeding means.

The hopper 1 is supported on the furnace front by means of a bracket 2 which is rigidly bolted thereto, the horizontal portion or plate 3 of said bracket forming the bottom of the fuel hopper. This bottom plate is formed with a curved upstanding flange 4 on its upper surface, said flange terminating at the front opening 5. Mounted upon a vertical stud projecting upwardly from this plate

is a horizontal, rotary reciprocating, semi-circular ram 6. This ram fits within the flange 4, its forward edge being radial to the center of the pivot of the ram and parallel with the front wall of the furnace, the curved outer edge of the ram fitting nicely within the curved flange 4. The hopper 1 delivers fuel on the top of the semi-circular ram, and as the ram is rocked or oscillated on its pivot, first the forward edge thereof on one side of the pivot is brought rearwardly to permit the coal to fall in front of it and is then carried forward by the reverse oscillation of the ram to force said fuel out through the opening 5 and into the delivery chutes, as will be hereinafter described. The ram is provided with a forwardly extending operating arm 7 which is arranged somewhat above the bottom plate 3 of the hopper supporting bracket, and to the outer end of this arm is pivoted a pitman or operating rod 8, one end of said rod being connected to the piston rod of an engine E. This engine may be a motor of any suitable form, but I prefer to use a simple form of steam engine having a water brake to regulate its speed, the speed of the engine being governed by means of a suitable form of valve in the water brake operated by the valve stem and handle 9. The engine may be of any suitable form and I have not deemed it necessary to illustrate it in detail herein. Steam is supplied to the engine valve through pipe 10 which is suitably connected to the valve chest 11. The pitman 8 is connected to the piston rod 12 of the engine by means of a bar 13 or any other suitable form of connection. The piston is arranged in the cylinder 14, and the water brake is arranged within the cylinder 15. The exhaust steam from the engine is delivered through pipe 16 to the ash pit, the water of condensation being delivered through pipe 17 to the water brake cylinder to replenish and maintain the water supply therein. The steam supply to the engine is regulated by the valve in the steam pipe 10. It is manifest that as the piston reciprocates in the engine cylinder the pitman 8 will be correspondingly reciprocated, thereby giving to the ram an oscillating or rotary, movement to deliver the fuel through the opening 5 at the front end of the ram compartment. The upstanding flange 4 on the hopper plate forms a ram compartment within which the ram is rotatively oscillated.

The lower portion of the hopper is formed by a tubular casting 19 which is provided on its forward face, near each side thereof, with a depending pivot lug 20. Through the lower ends of these lugs extend pivots which enter the side flanges formed on the bottom plate 3 of the supporting bracket. The lower edge of the chute 19 rests on the upstanding flange of the plate 3 and on a cross bar 21 secured to said plate, said cross bar being arranged above the ram and its operating arm, as shown clearly in Fig. 2 of the drawing. This bar is formed at its center with a rearwardly extending conical projection 22, the base of said conical projection being directly over the pivot of the ram and serving to deflect the fuel and prevent it lodging on the ram pivot. The pivotal arms or lugs of the chute are so arranged that the preponderance of weight of the hopper and its contents will be in the rear of said pivots and thereby serve to hold the hopper in its upright position. The hopper, however, is free to be swung forwardly and downwardly whenever it may be desired to have access to the ram compartment.

Connected to the hopper supporting plate, or hopper base and arranged to receive the fuel from the opening 5 is a downwardly and rearwardly inclined chute 23, said chute directing the fuel into a somewhat similar chute or channel piece carried by the propelling mechanism, as will be more fully hereinafter described, said piece being provided with horizontal side flanges 24 which rest upon the base plate 3 of the hopper support. This chute is also formed with the upstanding flanges 25 which register with the flange 4 of the base plate, as shown clearly in Fig. 4 of the drawings.

While I have described a steam actuated motor for reciprocating the ram it is to be, of course, understood that I may use any desired form of motor for this purpose. It will also be understood that I may use any form of regulating means for governing the speed of the ram and regulating the number of throws or operations in a given time.

Jet propelling mechanism.

In the front wall of the furnace just below the hopper support is the opening 26 into the fire box and above the grate, as shown clearly in Fig. 2. This firing opening, as illustrated in the drawings, is closed by three doors, one long horizontal upper door 27, which I shall term the stoker door; and two lower doors 28 which may be used when feeding fuel by hand or whenever it may be desired to manipulate or work over the fire with hand tools. These doors are independent of each other and may be opened independently, if desired. I preferably arrange the firing doors in such a manner that they overlap and lock in place the stoker door, this latter door being provided with a depending flange 29 along its lower edge, and over which the upper edges of the hand firing doors over-lap when they are in their closed positions. The jet propelling mechanism is so mounted upon the stoker carrying door that the said door may be swung outwardly without disarranging or in any manner disconnecting the said mechanism from the door or from its operating

parts. I find this to be a very convenient and very desirable arrangement of doors and of the jet propelling mechanism. Should the automatic stoking mechanism be out of order the furnace may be readily fired by hand without the necessity of in any way disconnecting the automatic stoking apparatus, and further whenever it may be desired to have access to the jet propelling mechanism the stoker carrying door may be swung outwardly and into a position giving easy access to all the parts.

The stoker door is formed with a long, narrow, horizontal opening at its middle through which extends the rear end of a blower 30. This blower is formed of an upper plate 31 and a lower plate 32. These plates are each formed with the outwardly extending flanges 33 near their rear ends, said flanges fitting against the outer surface of the stoker door and serving as a means by which the blower sections are secured to said door. These plates are also formed with forwardly extending converging side flanges 34. The forward and rear edges of these plates are arcs struck from a center at the point where the converging side flanges would meet if continued as clearly indicated in Fig. 7. The inner surfaces of the plates 31 and 32 are shaped to produce a broad flat, fan-shaped blower arranged with its greatest dimension horizontal and enlarging rearwardly, in order to deliver into the furnace a flat, propelling jet which will enlarge laterally or fan shaped in the fire box of the furnace. The inner surfaces of the upper and lower walls of the blower gradually approach each other to a point a short distance rearwardly beyond the attaching flanges and then very gradually separate. The side walls of the blower diverge from their forward edges to their rear edges on lines radial to the center from which the front and rear edges of the blower sections are struck. The forward end of the blower may be open to permit air to flow freely therein, or where furnace gases are fed to the blower the said forward end will be inclosed and connected to a suitable source of furnace gases as hereinafter more fully described.

Secured between the side flanges of the upper and lower members of the blower is a yoke 35, said yoke bridging the space between the forward ends of the side flanges of the blower sections and projecting forwardly a considerable distance to form a supporting plate 36 forward of the open end of the blower. Secured to this yoke adjacent the forward end of the blower and projecting into the blower a short distance is a jet nozzle 37. This nozzle is formed of an upper member 37^a and a lower member 37^b. These members are comparatively broad and flat and are connected to the upper and lower sides of the rearwardly diverging arms of the yoke 35, the inner edges of such arms forming the rearwardly diverging inner side walls of the nozzle. The inner surface of the members 37^a and 37^b of the nozzle approach each other from their forward edges toward their rear edges and form the rearwardly contracted nozzle, said nozzle having its smallest dimensions at its rear or exit end, or approximately at that point, its largest dimensions being at its forward open end. The front and rear edges of the members of the jet nozzle are curved to correspond with the curved forward edges of the upper and lower members of the blower. The rear edge of the jet nozzle projects slightly into the forward end of the blower, ample space being provided between the exit end of the jet nozzle and the inlet end of the blower to permit of full supply of air or furnace gases to the blower. It is manifest that from a jet nozzle of this construction a rearwardly enlarging thin fan-shaped jet will be produced, said jet enlarging rearwardly to correspond with the shape of the rearwardly enlarging blower.

It is manifest that this jet nozzle may be made in any suitable manner to produce the flat horizontally arranged jet fan-shaped and enlarging rearwardly into the furnace.

The forward end of the jet nozzle is open and receives the steam jet from the steam nozzle 38. The steam nozzle consists of a body part 39 having horizontal flanges 40 by which it is secured to the under side of the supporting frame 36, as shown clearly in Fig. 5, and an upwardly extending delivery portion 41 at its rear end, the upper edge of said delivery portion being in a horizontal plane with the center of the jet nozzle. Fitting in the delivery portion of the steam nozzle is a nozzle cap 42 having a recessed portion on its rear side, the side walls of said recess radiating from the center of the cap whereby the recess is fan-shaped. The cap is formed with a hollow stem so that steam rising through the delivery portion of the nozzle may enter the recess and pass therefrom into the jet nozzle so that the steam from the steam nozzle issues in a fan-shaped jet; passes through the fan-shaped jet nozzle and continues to enlarge laterally within the blower, drawing into the blower at the forward end thereof air or hot flue gases, as the case may be, and then passing into the furnace fire box.

To yieldingly hold the nozzle cap down on the upper edge of the nozzle a lever 43 is pivoted in lugs 44 on the body of the nozzle, said lever being formed with a rearwardly extending lug 45 which rests on the top of the nozzle cap, and with a forwardly extending lug 46 between which and the horizontal body of the nozzle is interposed a spring 47, said spring serving to hold the

nozzle cap in position. By moving the lever forwardly and downwardly the nozzle cap will be relieved and permitted to be raised by the steam pressure. The spring normally holds the cap in position against the steam pressure. The nozzle cap is formed with a forwardly extending guide piece 48 which fits between the lugs on the nozzle and holds said cap piece against rotation, thereby always maintaining the nozzle orifice in its proper relation to the blower nozzle.

On the supporting frame 36 is formed two upwardly extending supporting lugs 49 between the upper ends of which are secured lugs 50 of the fuel chute or channel piece 51. This fuel chute inclines forwardly and downwardly, receiving the fuel from the hopper chute and delivering it into the space between the blower and the jet nozzle. This fuel chute is preferably formed of readily bendable material so that upon the installation and during the preliminary working of the stoker apparatus said chute may be so bent and shaped as to deliver the fuel into the blower in the proper position for even distribution over the grate. In each installation there will be different conditions to be met, and the propelling jet for each blower will have slightly varying propelling forces. To meet these conditions and to so distribute fuel to the propelling jet as to secure an even distribution of it over the fire I so form the delivery chute that it may be readily shaped during the installation and testing of the stoker, and subsequently if conditions should require it.

When feeding furnace gases to the blower instead of air, I inclose the fuel feeding apparatus by means of a box 51^a, as shown clearly in Fig. 2 and connect the interior of said box with the flue space of the boiler by means of a pipe 51^b. I also inclose that portion of the fuel feeding means carried by the lower end of the hopper, as is also shown in said figure to exclude air from the blower. Any air entering the box 51^a through the coal in the hopper or through the joint between the hopper mechanism and the mechanism carried by the stoker door will be too small to affect the efficiency of the furnace. It is manifest that the suction of the blower will be sufficient to prevent the escape of any flue gases through the joints in the casings surrounding the mechanism on the door and the fuel feeding means supported on the furnace. It is manifest that there must be some form of joint in the pipe leading from the box 51^a to the furnace flues. A suitable form of joint is indicated in Fig. 3 of the drawings, the two members of the pipe fitting closely together when the stoker door is closed. As soon as the fuel is within the forward end of the blower it will be drawn in by the suction of the steam jet and will be thrown forward into the furnace by the propelling jet.

The object of yieldingly holding the nozzle cap in position and providing means for relieving it and permitting it to be lifted slightly by steam pressure is to permit the steam pressure to clear the nozzle of any material which may lodge in the nozzle orifice.

It will, of course, be understood that the jet nozzle is flat and is arranged horizontally to correspond with the forward end of the blower. This nozzle is so formed that the jet issuing therefrom will enlarge rearwardly and along the lines of the side walls of the blower, as clearly indicated in Fig. 3 of the drawings.

Means for supplying steam to the propelling jet.

At any suitable point on the boiler front is mounted a valve mechanism for controlling the steam supply to the steam nozzle. This valve mechanism consists of a valve casing 52 having a main steam chamber 53 to which the steam supply pipe 54 is connected. This pipe may take steam from any convenient point. The valve casing is formed with a supplemental or high pressure steam chamber 55 in communication with the main steam chamber through a port 56, said port being controlled by a high pressure conical valve 57. The main steam chamber is also provided with a steam port 58 leading into an outlet chamber 59 to which is connected an outlet pipe 60. Said outlet chamber is also provided with an inlet port 61 leading to the high pressure steam chamber and controlled by a self-seating spring-pressed valve 62. The stem 62^a of this valve extends upwardly through the outlet chamber, its upper end being in position to be engaged by a suitable valve opening device, which will be hereinafter described. The steam pipe 60 leads through hollow trunnions of the stoker door to the pipe 63 carried by the stoker door and connected to the steam nozzle. By so arranging the steam pipes the stoker door may be swung to its open position without disarranging the steam pipe connections. I have found this arrangement much more desirable than the use of a flexible pipe for the reason that the parts are rigid; are not liable to injury and do not in any way interfere with the swinging movement of the stoker door. The port 58 leading from the main steam chamber into the outlet chamber is controlled by a low pressure valve 64.

The low pressure valve 64 is opened sufficiently to permit a constant supply of steam to the jet nozzle said supply being so regulated that it will give to the propelling jet a minimum of power. The object of this

arrangement is to provide a constant supply of steam of only sufficient force to give to the propelling jet its minimum throwing power so that with this supply of steam alone the fuel will be dropped in front of the fire door. To gradually increase the power of the propelling jet I provide means for opening the push valve variable distances. This mechanism I preferably arrange so that the opening of said valve is gradually increased and then gradually diminished to its closed position. For this purpose I provide a valve-operating lever 65 pivoted above the push valve stem and provided with an adjustable screw 66 arranged to engage the upper end of the push valve stem when the lever is depressed. This screw rests upon the upper end of the push valve stem, and the free end of the operating lever is provided with upwardly extending lugs between which is journaled a roller 67. Mounted in suitable bearings above the operating lever is a horizontal rotatable cam disk 68, said cam having on its upper surface ratchet teeth 69. These teeth are adapted to be engaged by pawl 70 secured to a vibrating lever 71, said lever being connected by means of a rod 73 to the ram-operating rod of the steam motor. By means of this, the lever carrying the pawl will be vibrated simultaneously with the ram-moving rod. The cam disk 68 is provided on its under side with a cam 68ª which engages the roller 67 of the valve-operating lever. This cam gradually rises from zero to its highest point and then gradually returns to zero, the high point of the cam being diametrically opposite the zero point so that the push valve will be opened to its greatest extent and then returned to its closed position during each rotation of the cam disk. The throw of the lever carrying the pawl 70 may be so arranged that any desired number of ram movements may be required for each rotation of the cam disk. It is manifest that the extent of opening of the push valve will be varied for each pair of ram movements and consequently that the amount of steam flowing to the nozzle through the port controlled by the push valve will be varied for each pair of fuel feeding movements of the ram; and that this variation will be either increasing the power of the propelling jet or decreasing it.

It is manifest that the constant supply of steam flowing to the jet nozzle will be reinforced by the additional amount of steam flowing through the push valve port. It will, of course, be understood that the steam supply to the jet nozzle may be varied in any suitable manner, the object being to secure an even distribution of the fuel by an intermittently varied feed.

By operating the push valve as described the feed ram will make two feeding movements for each vibration in the position of the push valve. During one movement of the feed ram pawl 70 will slide over the teeth 69, while during the other movement of the ram the pawl will engage teeth 69 and move the cam disk. The push valve will, therefore, remain in a fixed position during one feeding movement of the ram. By this means the fuel will be distributed uniformly on both sides of the fire box. It is manifest that if the ram were directly connected to the push valve so that the said valve would be opened for each ram movement, there would be a tendency for the pressure peaks and valleys to occur always at the same period of the ram stroke, and cause unequal distribution of the fuel. It is also manifest that the pressure of the jet would be varied for each ram movement. With the arrangement shown and described the jet pressure will be varied at the end of each pair of movements, thereby securing a very even distribution of fuel over the grate.

I preferably provide the stems of the high and low pressure valves with indicator disks 74 and secure to the valve casing suitable indicator points or fingers 75 in order that the operator may know the extent of the opening of said valves.

It is manifest that by means of the high and low pressure valves and the push valve the supply of steam to the nozzle may be very nicely regulated to secure an even distribution of the fuel over the furnace grate. It is also manifest that by employing a blower in connection with the steam jet the air or flue gases, whichever may be used will give the desired volume to the propelling jet and at the same time reduce its velocity so that the fuel will be carried into the furnace evenly and properly distributed over the grate. In steam jet stokers heretofore used in which the steam jet alone was used for driving the fuel inwardly the jet was of small volume and high velocity with the result that it was practically impossible to properly distribute the fuel. In this class of stoker the jet, if it were intermittent would strike the fuel charge at such a velocity as to drive it toward the sides of the furnace, whereas by means of my jet blower apparatus the speed of the jet is reduced and its volume increased so that the action of the propelling jet is to carry the fuel into the furnace with the jet instead of striking the fuel charge and driving it in.

The minimum strength of the jet is governed by the position of the low pressure valve 64 while the maximum propelling jet is governed by the position of the high pressure valve 57. The variation between the

minimum and maximum propelling jets is secured by means of the variably opening push valve.

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

1. A stoker comprising a fluid pressure jet, means for feeding fuel intermittently in substantially uniform quantities to said jet, means for supplying fluid under pressure in progressively varying quantities to said jet, a motor, means connecting said motor to the fuel supplying means and to the fluid pressure supplying means to simultaneously and intermittently operate said fuel supplying means and fluid pressure supplying means.

2. A stoker comprising a fluid pressure jet, means for feeding fuel intermittently in substantially uniform quantities to said jet, means for automatically supplying fluid under pressure in progressively varying quantities to said jet, a motor, means connecting said motor to the fuel supplying means and to the fluid pressure supplying means to simultaneously and intermittently operate said fuel supplying means and fluid pressure supplying means.

3. A stoker comprising a fluid pressure jet, means for feeding fuel intermittently in substantially uniform quantities to said jet, means for automatically supplying fluid under pressure in varying quantities to said jet, a motor, means connecting said motor to the fuel supplying means and to the fluid pressure supplying means to simultaneously and intermittently operate said fuel supplying means and fluid pressure supplying means.

4. A stoker comprising a fuel hopper, a fuel feeding means, a blower, a fluid pressure jet for said blower, a source of fluid under pressure, means for controlling said fluid pressure and admitting it to the fluid pressure jet, said means consisting of a main pressure chamber connected to the fluid pressure supply, an outlet chamber, a valve controlling communication between the said chambers and regulating the constant supply of steam to the outlet chamber, a high pressure chamber in communication with the main chamber and the outlet chamber, an adjustable valve for controlling the constant supply of steam from the main chamber to the high pressure chamber, a self-seating valve controlling communication between the high pressure chamber and the outlet chamber to intermittently admit high pressure steam to the outlet chamber, and means for intermittently opening said self-seating valve.

5. A stoker comprising a fuel hopper, a fuel feeding means, a blower, a fluid pressure jet for said blower, a source of fluid under pressure, means for controlling said fluid pressure and admitting it to the fluid pressure jet, said means consisting of a main pressure chamber connected to the fluid pressure supply, an outlet chamber, a valve controlling communication between said chambers and regulating the constant supply of steam to the outlet chamber, a high pressure chamber in communication with the main chamber and the outlet chamber, an adjustable valve for controlling the constant supply of steam from the main chamber to the high pressure chamber, a self-seating valve controlling communication between the high pressure chamber and the outlet chamber to intermittently admit high pressure steam to the outlet chamber, means for intermittently opening said self-seating valve and for progressively varying the extent of the opening of said valve, and means for operating the valve opening means.

6. A stoker comprising a fuel hopper, a fuel feeding means, a blower, a fluid pressure jet for said blower, a source of fluid under pressure, means for controlling said fluid pressure and admitting it to the fluid pressure jet, said means consisting of a main pressure chamber connected to the fluid pressure supply, an outlet chamber, a valve controlling communication between said chambers and regulating the constant supply of steam to the outlet chamber, a high pressure chamber in communication with the main chamber and the outlet chamber, an adjustable valve for controlling the constant supply of steam from the main chamber to the high pressure chamber, a self-seating valve controlling communication between the high pressure chamber and the outlet chamber to intermittently admit high pressure steam to the outlet chamber, means for intermittently opening said self-seating valve, and means connected to the fuel feeding means for operating said valve opening means.

7. A stoker comprising a fluid pressure jet, means for feeding fuel to said jet, a fluid pressure supply, means to admit a constant supply of fluid under pressure to said jet, and an intermittently operating means for supplying an additional amount of fluid under pressure to said jet.

8. A stoker comprising a fluid pressure jet, means for feeding fuel to said jet, a fluid pressure supply, means to admit a constant supply of fluid under pressure to said jet, means for supplying an additional amount of fluid under pressure to said jet, and means for automatically and progressively varying the amount of said additional fluid pressure.

9. A stoker comprising a fuel hopper, intermittently operating fuel feeding means to feed fuel in substantially uniform quantities, a blower to receive the fuel, a fluid

pressure jet in said blower, means for supplying fluid pressure to said jet, means for automatically increasing the amount of fluid under pressure supplied to said jet for each operation of the fuel feeding means to progressively increase the power of the jet through a series of operations.

10. A stoker comprising a fuel hopper, an intermittently operating fuel feeding means to feed fuel in substantially uniform quantities, a blower to receive the fuel, a fluid pressure jet in said blower, an intermittently operating means for supplying fluid under pressure to said jet and progressively increasing the power of the jet through a series of operations.

11. The combination of a blower, a fluid pressure jet for said blower, a source of fluid under pressure, means for controlling said fluid pressure and admitting it to the fluid pressure jet, said means consisting of a main pressure chamber connected to the fluid pressure supply, an outlet chamber, a valve controlling communication between the said chambers and regulating the constant supply of steam to the outlet chamber, a high pressure chamber in communication with the main chamber and the outlet chamber, an adjustable valve for controlling the constant supply of steam from the main chamber to the high pressure chamber, a self-seating valve controlling communication between the high pressure chamber and the outlet chamber to intermittently admit high pressure steam to the outlet chamber, and means for intermittently opening said self-seating valve.

12. A flat, fan-shaped blower open at both ends and enlarging from its intake to its outlet end and formed with two broad walls and two narrow walls, the latter walls diverging from the intake end of the blower to the outlet end thereof, and a fluid pressure jet nozzle open at both ends and arranged at the intake of said blower, said jet nozzle being fan-shaped and formed with a narrow delivery orifice arranged to deliver a thin diverging pressure jet into the blower, and a steam nozzle arranged to deliver a thin jet of steam into the jet nozzle.

13. A blower open at both ends and comprising two broad, comparatively flat walls arranged opposite to each other and two narrow side walls connecting the broad walls to form a tubular blower or conveyer, the narrow side walls diverging from the intake end of the blower or conveyer to the outlet end thereof, whereby the blower is flat and fan-shaped, a fluid pressure jet nozzle open at both ends and arranged in the intake end of the blower, said nozzle being formed of two broad walls and two narrow walls, the broad walls being substantially parallel with the broad walls of the blower and the narrow walls diverging toward the outlet end of the jet on lines corresponding to the similar diverging walls of the blower, said jet being formed with a narrow outlet orifice and with a comparatively broad inlet, whereby the fluid pressure jet issuing from said nozzle will be fan-shaped and correspond with the fan-shaped interior of the blower, and a steam nozzle arranged in front of the jet nozzle and adapted to deliver a steam jet therein.

14. A blower or conveyer open at both ends and having two broad opposed walls, the narrow walls diverging from the intake to the outlet end of the blower, a pressure jet nozzle within the intake end of the blower and formed with its two ends open and with two broad walls and two narrow walls, the narrow walls diverging on lines corresponding with the diverging side walls of the blower and the broad walls of said jet curving inwardly toward each other from the intake to the outlet end thereof, whereby said jet will be fan-shaped interiorly and formed with a long narrow outlet orifice coincident with a plane passing through the centers of the narrow side walls of the blower, whereby said jet nozzle will deliver a thin, diverging pressure jet into the blower on a plane passing through the centers of the side walls of said blower, and a steam nozzle arranged to deliver a jet of steam into the jet nozzle.

15. A blower or conveyer consisting of a yoke having diverging side arms, two broad opposed walls secured to opposite sides of the said diverging arms of the yoke, said broad walls being fan-shaped and the yoke arms diverging from the intake to the outlet end of the blower, a pressure jet nozzle open at both ends and arranged within the intake end of the blower and formed with two broad walls secured to the arms of the yoke, said arms forming the narrow diverging side walls of the said jet nozzle and the broad walls of said jet curving inwardly toward each other from the intake to the outlet end thereof, and a steam nozzle carried by the said yoke and arranged to deliver a steam jet into the jet nozzle.

16. A blower or conveyer consisting of a yoke having diverging side arms, two broad opposed walls secured to opposite sides of the said diverging arms of the yoke, said broad walls being fan-shaped and the yoke arms diverging from the intake to the outlet end of the blower, a pressure jet nozzle open at both ends and arranged within the intake end of the blower and formed with two broad walls secured to the arms of the yoke, said arms forming the narrow diverging side walls of the said jet nozzle and the broad walls of said jet curving inwardly toward each other from the intake to the outlet end thereof, a steam nozzle carried by the said yoke and arranged to deliver a

steam jet into the jet nozzle, and a nozzle cap for said steam nozzle, and means for yieldingly holding said nozzle cap in position.

17. A blower or conveyer consisting of a yoke having diverging side arms, two broad opposed walls secured to opposite sides of the said diverging arms of the yoke, said broad walls being fan-shaped and the yoke arms diverging from the intake to the outlet end of the blower, a pressure jet nozzle open at both ends and arranged within the intake end of the blower and formed with two broad walls secured to the arms of the yoke, said arms forming the narrow diverging side walls of the said jet nozzle and the broad walls of said jet curving inwardly toward each other from the intake to the outlet end thereof, a steam nozzle carried by the said yoke and arranged to deliver a steam jet into the jet nozzle, a nozzle cap for said steam nozzle, means for yieldingly holding said nozzle cap in position, and means for releasing said nozzle cap to permit it to move outwardly under steam pressure.

18. A steam jet stoker comprising a blower, a steam jet nozzle arranged to deliver steam into said blower, a nozzle cap, yieldable means for holding said cap in position against the steam pressure, means for permitting said cap to be lifted by the steam pressure to clear the nozzle and means for delivering fuel within the blower.

19. A stoker comprising a fuel hopper, an intermittently operating fuel feeding means to feed fuel in substantially uniform quantities, a blower to receive the fuel, a fluid pressure jet in said blower, means for supplying fluid under pressure to said jet, a motor for operating the fuel feeding means, means operated by said motor for varying the fluid pressure supply to the jet.

20. A steam jet stoker comprising a blower, a steam jet nozzle arranged to deliver steam into said blower, a nozzle cap, yieldable means for holding said cap in position against steam pressure, means for supplying steam to said nozzle in constantly varying quantities, and means for relieving the holding pressure on the nozzle cap, to permit said cap to be raised by steam pressure.

21. A steam jet stoker comprising a blower, a steam jet nozzle arranged to deliver steam into said blower and formed with an outwardly yieldable wall to vary the nozzle aperture, pressure means for normally holding said yieldable wall in its inner position with the nozzle aperture of its smallest dimensions, means for relieving said pressure means to permit the yieldable wall to be moved outwardly by steam pressure to enlarge the nozzle aperture, and means for intermittently delivering fuel to the blower.

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

ALFRED COTTON.

Witnesses:
WM. R. DAVIS,
F. R. MILLER.