(No Model.) 2 Sheets—Sheet 1.

W. M. RUSSELL.

APPARATUS FOR BURNING FINE FUEL.

No. 551,098. Patented Dec. 10, 1895.

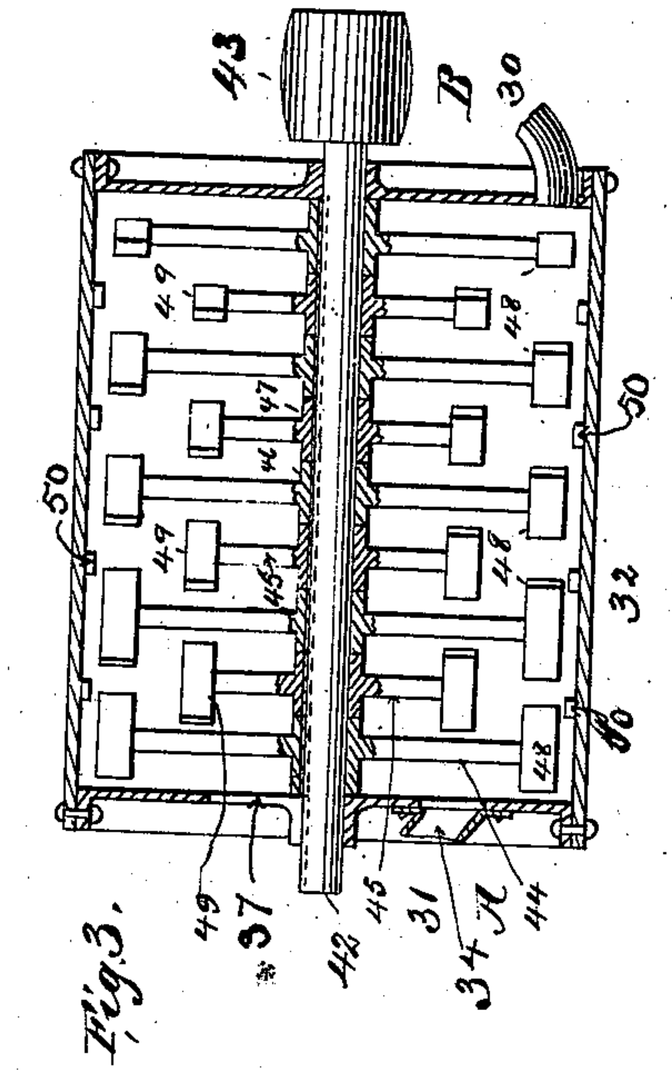

Fig. 3.

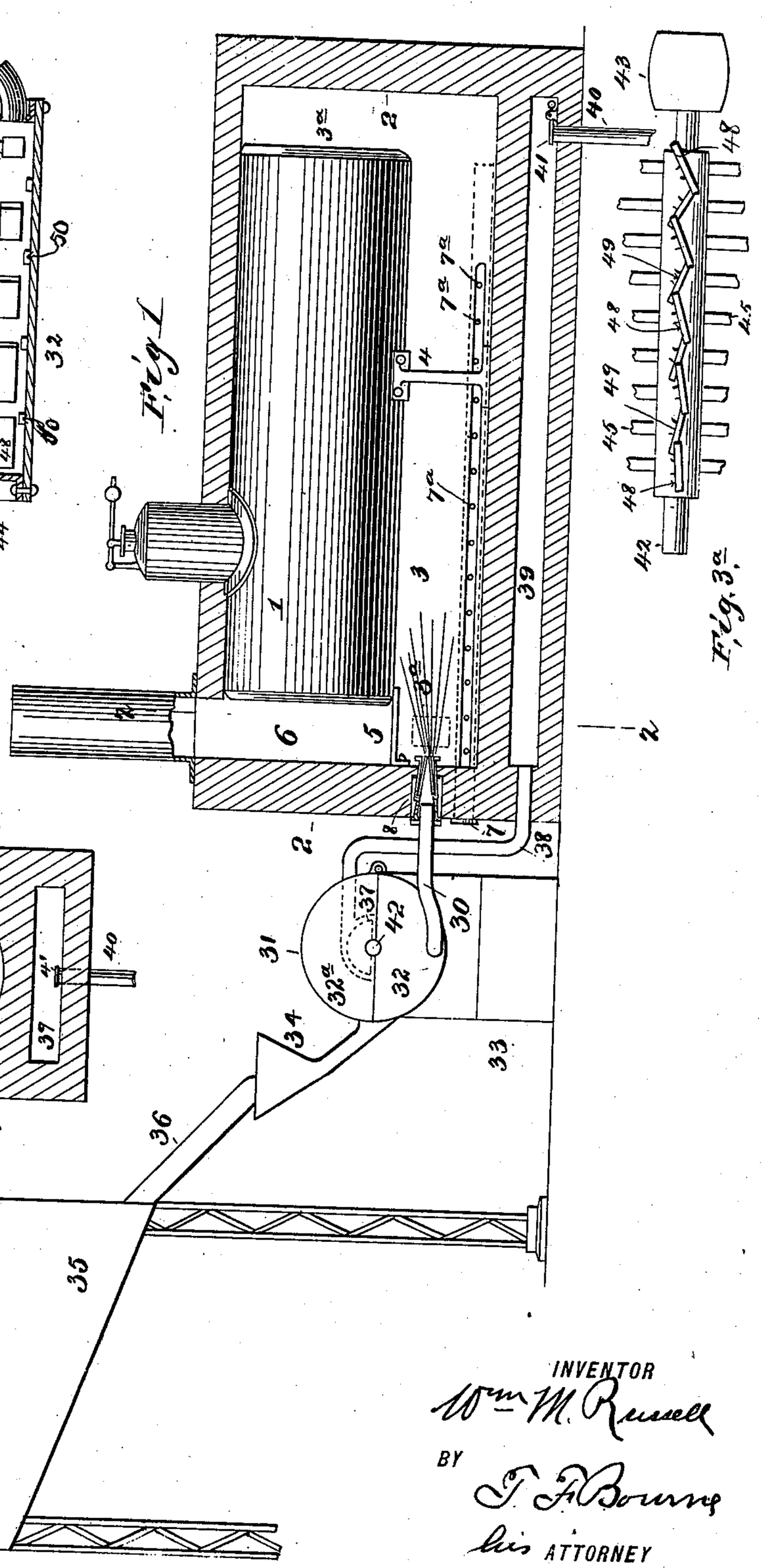

Fig. 1.

Fig. 2.

Fig. 3a.

WITNESSES:
C. W. Benjamin
M. F. Boyle

INVENTOR
Wm. M. Russell
BY
F. H. Bowers
his ATTORNEY

(No Model.) 2 Sheets—Sheet 2.

W. M. RUSSELL.

APPARATUS FOR BURNING FINE FUEL.

No. 551,098. Patented Dec. 10, 1895.

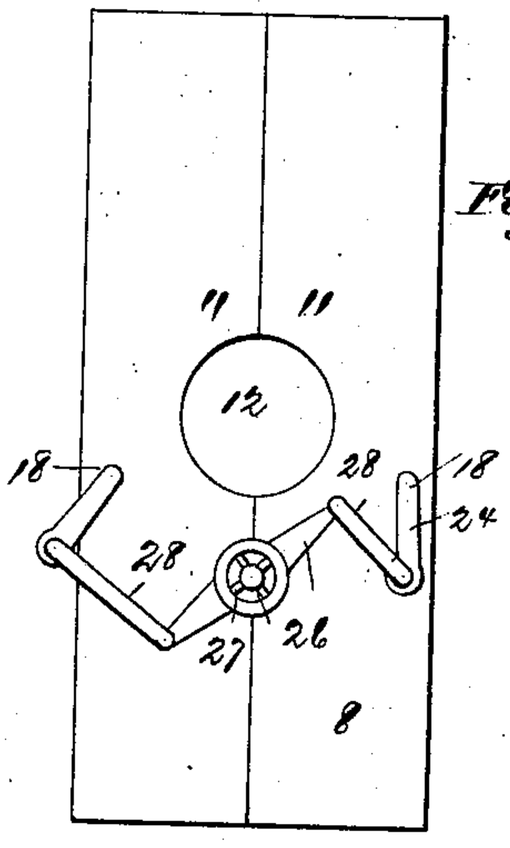

Fig. 6.

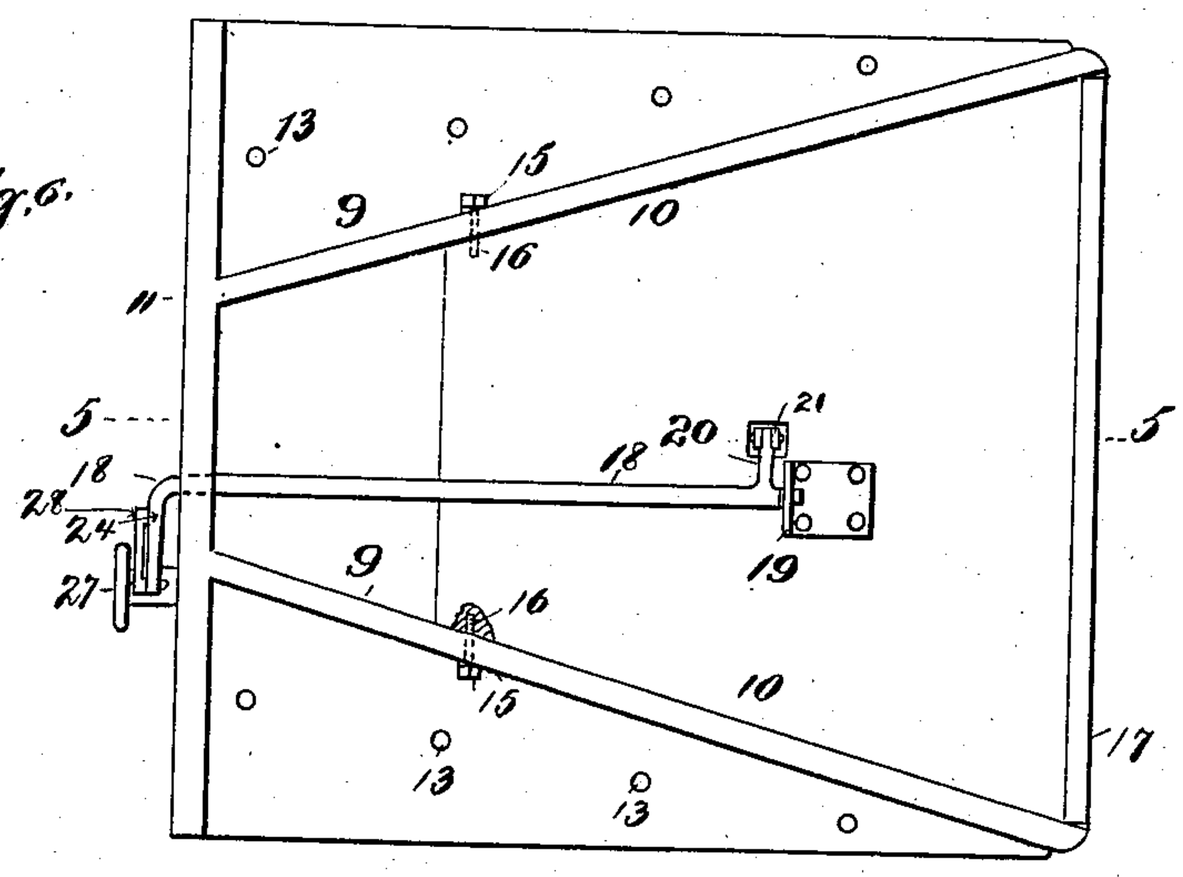

Fig. 4.

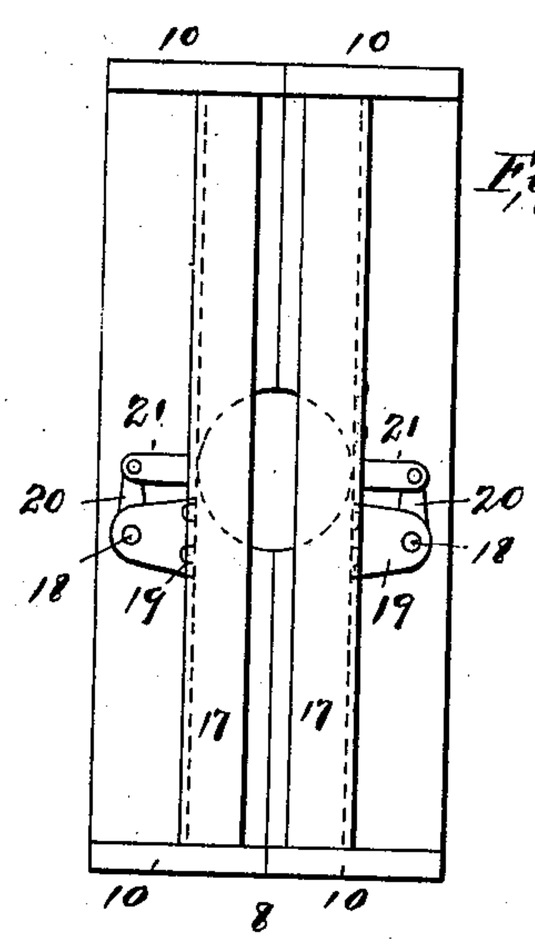

Fig. 7.

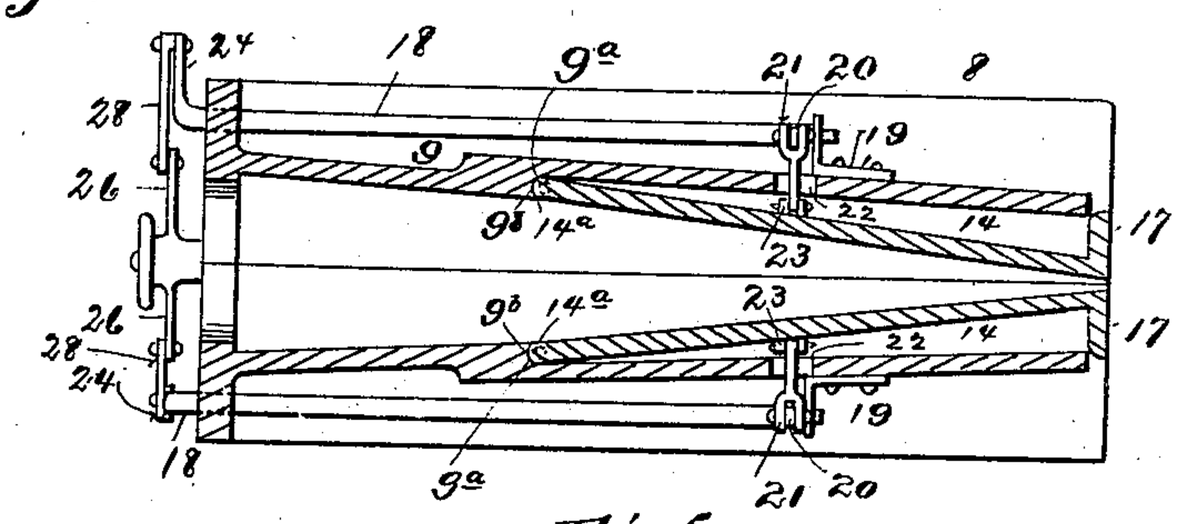

Fig 5

WITNESSES:
C. W. Benjamin
M. L. Boyle

INVENTOR
Wm. M. Russell
BY
T. A. Bowers
his ATTORNEY

UNITED STATES PATENT OFFICE.

WILLIAM MELVIN RUSSELL, OF NEW YORK, N. Y.

APPARATUS FOR BURNING FINE FUEL.

SPECIFICATION forming part of Letters Patent No. 551,098, dated December 10, 1895.

Application filed April 18, 1895. Serial No. 546,186. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM MELVIN RUSSELL, a citizen of the United States, residing in the city and county of New York, in the State of New York, have invented a certain new and useful Improvement in Means for Burning Fuel, of which the following is a specification.

My invention relates more particularly to means for burning pulverized fuel, such as fine coal and coal-dust; and it has for its object to reduce the fuel to as finely-divided a state as possible, while at the same time mixing such fine fuel with a proper quantity of air, and then delivering such mixture of fuel and air into a combustion-chamber, where said fuel and air mixture is ignited.

In carrying out my invention I provide a novel pulverizer for dividing fuel into a fine condition, the operative parts of the pulverizer being so arranged as to draw in the proper amount of air to mix it with the fuel being pulverized, the said operative parts of the pulverizer at the same time acting to force the mixture of fine fuel and air into a combustion-chamber. This pulverizer embraces a casing and a series of rotative blades or bats within it, so arranged as to toss the fuel about within the casing and to gradually pass the fuel along from the intake end to the outlet, the fuel meanwhile being in a state of suspension within the casing and gradually becoming finer as it passes along from one set of blades to another.

The invention further embraces a novel construction of nozzle or outlet for the mixture of fuel and air, said nozzle being so arranged as to spread the outgoing fuel into a thin sheet or film. This nozzle is provided with novel means for increasing and diminishing the size of its outlet or opening, so as to regulate the amount of fuel being fed in accordance with the desired amount of heat to be produced.

I have shown my invention as applied to a stationary boiler, wherein the nozzle opens into the combustion-chamber beneath the boiler, means being provided to supply said chamber with the requisite amount of fresh air to support combustion throughout the length of the chamber. In the brickwork of the boiler-setting I have also shown a heating-chamber, which serves to supply heated air to the pulverizer above mentioned.

The invention further consists in the novel details of improvement and the combinations of parts that will be more fully hereinafter set forth, and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming part hereof, wherein—

Figure 1 is a central longitudinal section of a boiler-setting, showing my improved appliances for supplying fuel to the combustion-chamber. Fig. 2 is a cross-section on the line 2 2 in Fig. 1. Fig. 3 is a horizontal section of the pulverizer and mixer. Fig. 3ª is a detail sectional plan view. Fig. 4 is a plan view of the nozzle for passing the fuel into the combustion-chamber. Fig. 5 is a longitudinal section on the line 5 5 in Fig. 4. Fig. 6 is an end view of the nozzle looking from the left in Fig. 4, and showing means for regulating the size of the delivery end of said nozzle. Fig. 7 is an end view of the nozzle looking from the right in Fig. 4, showing the outlet end thereof.

In the accompanying drawings, in which similar numerals and letters of reference indicate corresponding parts in the several views, 1 indicates a boiler, which may be of suitable or well-known construction, and 2 is a boiler-setting or brickwork inclosing the same, which may also be suitably constructed.

3 is a combustion-chamber beneath the boiler and having a vertical space 3ª at the back thereof leading to the flues of the boiler.

4 is a suitable bridge adapted to assist in supporting the boiler, and 5 is a suitable support at the forward part of the boiler, arranged to form a space 6 for the passage of the heated products of combustion from the flues of the boiler, the space 6 being entirely separated from the combustion-chamber 3. The arrangement for this purpose can be changed from that shown in any desired or suitable manner.

The combustion-chamber 3 is kept closed during operation, and in order to supply the requisite quantity of air thereto to properly support combustion I have shown pipes 7, which extend longitudinally of said chamber at its lower part and on opposite sides, as in Fig. 2, these pipes 7 leading from the back of the brickwork 2, where they are supplied

with fresh air. The pipes 7 have a series of apertures 7^a, through which air is delivered into the combustion-chamber 3, and said pipes are shown as partially buried in the brick-work surrounding the combustion-chamber, so as to keep them from being injured by the heat within the combustion-chamber. These apertures 7^a preferably extend the major portion of the length of the combustion-chamber 3 from its forward end backwardly. Suitable means may be provided at the forward end of the combustion-chamber to permit access thereto, as by a suitably-closed door 3^a, as shown in dotted lines in Fig. 1.

The combustion-chamber 3 will be supplied with fuel in a finely-divided state at its forward end through a suitable nozzle 8, which will be placed in the front wall of the brick-work 2. This nozzle 8 is shown more clearly in Figs. 5 and 7 and presents a narrow elongated opening to the interior of the combustion-chamber.

The construction of the nozzle 8 is as follows: 9 9 are horizontally-arranged plates having inwardly-extending webs 10, the edges of which are placed together, so as to form a space between the plates 9 9, as shown in Fig. 5. These webs 10 10 diverge outwardly, as shown in Fig. 4, and at the inner ends of said webs the plates 9 9 have end pieces 11 11, which meet on their inner edges, as shown in Fig. 6, an aperture 12 being formed between the end pieces 11 for the entrance of fuel into the nozzle. The plates 9 9 are fastened together, as by bolts or screws 13. The space between the plates 9 9 is narrow and wide, the wider end being the delivery end for the fuel, from which the fuel when blown through the nozzle will be delivered in a thin wide sheet or film, which gradually spreads outwardly before it passes from the nozzle, in accordance with the divergence of the walls or webs 10 10, forming the sides of the nozzle. In order to decrease or increase the size of the outlet-opening of the nozzle on a line passing through the center of the nozzle, while at the same time preventing an obstruction from being formed within the nozzle, I place within said nozzle two plates 14 14, which are oppositely disposed, one plate being pivotally carried by the corresponding plate 9, as shown in Fig. 5. For this purpose the plates 9 are recessed, forming a shoulder 9^a, extending across them, to receive the inner ends of the plates 14, the edges of the plates 14 diverging to correspond with the divergence of the webs 10. (See Fig. 4.) Suitable means may be provided for pivoting the plates 14 within the space bounded by the plates 9 9 and webs 10 10, and for this purpose I have shown screws 15 as entering pivotal sockets 16 in the edges of the plates 14, (see Fig. 4,) the screws being close to the shoulders 9^a. The shoulders 9^a are preferably curved at 9^b to meet the correspondingly-curved ends 14^a of the plates 14, so as to sustain a tight joint at that part, the inner portion of the plates 9 and the plates 14 thereby constituting a substantially continuous wall for the passage of the fuel through the nozzle, and when said plates 14 are turned on their pivots their forward ends will approach or separate to decrease or increase the width of the opening at the end of the nozzle, the delivery-opening for the fuel thereby being formed by the plates 14. At the forward ends the plates 14 have flanges or lips 17, which cover the ends of the plates 9. (See Fig. 5.)

Any suitable means may be employed for moving the plates 14 toward or from each other. I have shown convenient means for this purpose, consisting of shafts 18, passing along the plates 9 and suitably journaled thereon, as by brackets 19, at their forward ends, the inner ends of the shafts 18 being journaled in the end pieces 11. On the shafts 18 are cranks 20, to which are pivoted links 21, which pass through openings 22 in the plates 9 and are pivoted to the outer faces of the plates 14, as by brackets 23, carried by said plates 14. By this means as the shafts 18 are rocked the plates 14 will be moved inwardly and outwardly. At the outer ends of the shafts 18, contiguous to the inlet-opening 12 of the nozzle, are crank-arms 24, by which the shafts 18 can be operated.

By preference the two shafts 18 are operated simultaneously, so that the plates 14 will be moved toward each other simultaneously and likewise separated at the same time, as the case may be, to keep the center of delivery on a horizontal line. Suitable means may be provided for thus operating the crank-arms 24 together for the purpose stated. I have shown a centrally-pivoted lever or arm 26, having a suitable handle 27, by which it can be turned, the lever 26 being pivoted at its opposite ends to links 28, which are also pivoted to the crank-arms 24, (see Fig. 6,) whereby as the lever 26 is turned in one direction the shafts 18 will be rotated to move the plates 14 together to reduce the size of the outlet of the nozzle, and when the lever 26 is turned in the opposite direction the motion of the plates 14 will be reversed, so as to increase the size of the nozzle-outlet. The nozzle 8, thus constructed, will be located within the brickwork 2 around the furnace in line with the forward end of the combustion-chamber, and the crank-arms 24 will project through the forward face of the wall of the brickwork.

The nozzle 8, constructed and supported as above specified, is connected at its opening 12 with a pipe 30, which leads to a pulverizer and blower 31, which is adapted to receive the fuel in a coarse state, then pulverize it and mix it with air and deliver said mixture, under pressure, to the nozzle 8, from which it passes into the combustion-chamber 3. (See Fig. 1.)

The pulverizer and blower 31 is arranged as follows: 32 is a casing, preferably cylindrical, having a hinged top 32^a, to permit access to the interior, the casing being supported by legs 33, or in any suitable manner.

The pipe 30 enters the casing 32 on its lower side at the forward or delivery end. The opposite end of this casing 32 is connected with a hopper or spout 34, which receives fuel from a suitable receptacle 35 and chute 36. At the intake end of the casing 32 is an opening 37 for the entrance of air. The opening 37 is shown connected by a pipe 38 with a hot-air chamber 39 in the brickwork 2 of the boiler-setting. The chamber 39 is shown located beneath the combustion-chamber 3, so that the bricks that are heated by the fuel in said combustion-chamber will heat air in the chamber 29 to supply hot air to the pulverizer and blower 31. The chamber 39 has an air-inlet 40, shown in the form of a pipe leading to the outer air and provided with a suitable valve to permit air to enter the chamber 39 and to prevent it from escaping therefrom through the pipe 40. Within the casing 32 is a horizontal shaft 42, carried in suitable bearings and having a pulley 43, by which it can be rotated by a belt from a suitable source. Rigidly mounted upon the shaft 42 are a series of arms 44 45. The arms 44 extend outwardly nearly to the casing 32, while the arms 45 are shorter and are located between the arms 44, all as in Fig. 3. The arms 44 45 are shown carried by hubs or sleeves 46 47, mounted on the shaft 42 and secured thereto by screws, splines, or other desired holding means. On the outer ends of the arms 44 45 are blades or bats 48 49, which consist of flat plates suitably secured to said arms. The plates or blades 48 49 are shown in rectangular form, and the inner edges are placed at an angle to the shaft 42, so that they diverge outwardly from a line parallel with the shaft 42 from the back or inlet end A of the casing 32 toward the delivery or front end B of said casing. The angles of divergence of these blades or bats 48 are different, ranging from the back A to the front B of the casing—that is to say, the angles of the blades gradually increasing, as shown in Fig. 3ª. The angles of divergence of the inner blades or bats 49 are the reverse of the angles of the blades or bats 48—that is to say, they diverge outwardly from the front B to the back A of the casing relatively to the shaft 42. It will be understood that all the arms 44 45 and blades or bats 48 49 rotate together or in the same direction, and on account of their peculiar inclinations they act to draw in air from the back A of the casing and to propel it forward through the casing and out of the front B thereof with considerable force or pressure, causing it to pass out through the pipe 30.

The operation of the pulverizer and blower is as follows: The shaft 42 is rotated and the fuel is fed into the casing 32, the fuel preferably consisting of fine coal or dust. The fuel is first met by the first series of blades 48 and is struck a sharp blow by them, which tosses it against the next series of blades or bats 49, which act to drive part of the fuel back against the blades 48, which again toss the fuel forward. As a circulation of air is induced by the rotating blades or bats from the back A toward the front B of the casing, the fuel will be gradually carried forward. The second series of blades 48 also act to toss the fuel forward, and so on as the blades 48 encounter the fuel, gradually carrying it forward toward the front B of the casing, the bats 49 more particularly serving to strike the larger particles of fuel to drive them back against the bats 48. This continued tossing of the fuel from one blade or bat to and against the next series gradually pulverizes the fuel, until it issues from the casing in a finely-divided state, the attrition of the blades on the fuel, as well as one particle of fuel against another, serving to crush or divide it. The farther the fuel passes from the back A to the front B of the casing the smaller it becomes, and therefore the more readily the current of air in the casing can carry the fuel along to deliver it. The whirling of the fuel within the casing and the current of air passing therethrough, together with the moving blades, cause the fuel to remain in suspension, so that it will at all times be in a position to be struck by the blades or bats 48 49. On account of the outward and forward divergence of the bats 48 the fuel is continually thrown forward until when it reaches the front B of the casing it is forced through the pipe 30; but this will not occur until it is in the desired finely-divided state. This whirling of the fuel also intimately mixes it with the air in the casing, so that when it passes through the pipe 30 it is properly mixed with the air to permit of its ready ignition in the combustion-chamber 3.

If desired, the blades or bats 49 could be omitted and only the blades 48 used. On the inner surface of the casing I also, by preference, place ribs 50, against which the fuel can strike as it is propelled through the casing; but these ribs do not form chambers in which the blades rotate, as they are outside of the ends of said blades. The complete operation is as follows: If the boiler 1 is used to supply steam for rotating the shaft 42, and there is no steam in the boiler, a suitable fire can be made in the chamber 3 until the requisite amount of steam is produced, or the shaft 42 can be temporarily rotated by any suitable means to supply the pulverized fuel to the combustion-chamber until the required amount of steam is generated to keep said shaft rotating; but if there is steam left in the boiler it can be used to rotate the shaft 42. In either case the required amount of fuel is fed from the receptacle 35 to the pulverizer and blower 32, the rotating blades or bats of which pulverize the fuel, as before explained. These rotating blades also act to draw hot air from the air-chamber 39 into the casing 32 and to thoroughly mix it with the fuel being pulverized. The rotating blades thereupon blow or force the mixture of air and fuel into and through the nozzle 8 and thence

into the combustion-chamber 3, where it is ignited. (To first ignite the fuel in said chamber, a small wood fire can be kindled therein.) The mixture of air and fuel thus passing into the chamber 3 under pressure and issuing from the narrow elongated outlet of the nozzle spreads out in the combustion-chamber in a long thin sheet or film, and the particles of fuel mixing with the air in the chamber 3 quickly ignite and burn with an intense heat. By forcing the mixture of fuel and air into the combustion-chamber under sufficient pressure it will be carried back on a horizontal plane the full length of the boiler, thereby forming a flame the full length of the boiler, the flame, in fact, passing up into the space 3^a at the back of the boiler and entering the flues thereof. As heated air is delivered into the combustion-chamber 3 with the fuel, and as other heated air is delivered to said chamber by the pipes 7, quick and perfect combustion of the fuel is caused and about all the combustible portions of the fuel and air are instantly ignited and burned. The mixture of pulverized fuel and air burns like a gas-flame, creating an intense heat. The proper proportion of air and fuel to be mixed is regulated, as the rotation of the blades 48 49 propels an amount of air and fuel commensurate with their rate of rotation and with the feeding of the fuel. A suitable device may be provided to cause the right amount of fuel to be fed to the pulverizer in accordance with the rate of rotation of the blades, so that if a small amount of heat is desired the blades can rotate at the proper speed and be supplied with less fuel and thus propel the proper quantity of air with the fuel, and if great heat is required the blades can be rotated faster and thereby secure more fuel and propel more air. By this means the amount of steam to be produced can be easily regulated by the rotation of the blades of the pulverizer and blower; also, when a small quantity of fuel is fed the outlet of the nozzle is reduced in size by adjusting the plates 14 14 toward each other, and as it is desired to increase the heat the height of said opening is increased, by which means the thickness of the sheet or film of fuel passed into the chamber 3 is regulated in accordance with the amount of fuel passing. By this means, also, proper combustion of the fuel is regulated, because the thickness of the film of fuel is regulated in accordance with the heat to be produced and the ability of all particles of fuel to be consumed that may be issuing from the nozzle.

If the outlet of the nozzle were always of one size, it would occur that if a small quantity of fuel were issuing it would not be projected with sufficient force to properly spread it into a sheet or film of the proper dimensions to quickly cause its ignition, and thereby part of the fuel would be wasted. My improved nozzle is therefore of importance in regulating the conditions of the sheet of issuing fuel, and is specially useful in connection with my improved pulverizer and blower, which has the three functions of pulverizing the fuel, mixing it with air, and forcing it from the nozzle, so that as the delivery of fuel from the casing 32 is regulated by the rate of rotation of the blades the size of the sheet of fuel issuing from the nozzle will be regulated by the size of the outlet thereof.

It will be understood that the outlet of the nozzle will always remain on a line drawn through its center by moving both plates 14 14 toward and from each other equally and together. By this means the fuel will issue on a horizontal plane at all times and not be directed upwardly against the boiler nor downwardly against the bottom of the combustion-chamber.

Having now described my invention, what I claim is—

1. The combination of a pulverizer and a pipe leading thereto from an air heating chamber, means to deliver fuel to said pulverizer to cause said fuel to be pulverized by the mechanism of said pulverizer, said mechanism being arranged to mix said fuel with air while pulverizing it and to create a current of air to force said mixture from said pulverizer and means for delivering said mixture of hot air and pulverized fuel together to a combustion chamber, substantially as set forth.

2. The combination of a casing, a pipe leading thereto at one end for conducting air into said casing a pipe or hopper leading into said casing at the same end as the air pipe to deliver fuel thereto, mechanism within said casing arranged to pulverize fuel while at the same time mixing it with the air entering said casing, the said devices which pulverize the fuel being arranged to create a current of air to force the fuel from the entering end of the casing out through the opposite end thereof, and means for conducting the mixture of air and fuel from said casing to a combustion chamber, substantially as specified.

3. The combination of a boiler and a setting therefor, having a combustion chamber for said boiler and a hot air chamber within said setting beneath said combustion chamber, and an inlet for air into said hot air chamber whereby air will be heated by radiation from said setting, with a combined pulverizer and blower having one end connected with said hot air chamber by a suitable pipe, the opposite end being connected by a suitable pipe with said combustion chamber, said pulverizer and blower containing blades and bats which are arranged to pulverize fuel and mix it with hot air from said hot air chamber, the said blades which pulverize the fuel being arranged to create a current of air within said pulverizer to force the said mixture of fuel and hot air into said combustion chamber, substantially as set forth.

4. The combination of a boiler and a setting

therefor, having a combustion chamber, a hot air chamber within said setting and means to permit entrance of air into said hot air chamber, and to prevent its exit through said entrance with means for pulverizing and blowing fuel into said combustion chamber, and a pipe leading from said hot air chamber to conduct hot air to the means for blowing the fuel into said combustion chamber, substantially as herein set forth.

5. The combination of a boiler and a combustion chamber therefor, with a nozzle opening into said combustion chamber, said nozzle having means for contracting and enlarging its outlet in equal degrees from a normally central line through said nozzle, means for holding the delivery end of the nozzle in any position to which it may be adjusted, means for supplying pulverized fuel to said nozzle and for forcing it from said nozzle into said combustion chamber, substantially as herein specified.

6. A nozzle consisting of a hollow casing having outwardly diverging walls and means for contracting and expanding the delivery end of said nozzle equally on a line passing centrally through said nozzle, whereby a sheet or film of fuel can be forced through said nozzle on a horizontal plane, so as to spread out laterally after leaving the nozzle, substantially as herein specified.

7. A nozzle consisting of a hollow casing having outwardly diverging side walls and two plates within said casing having correspondingly diverging edges, and means for moving the outer ends of said plates toward and from each other, so that fuel passing from the nozzle can be delivered in a sheet or film which spreads out laterally after it issues from the nozzle, substantially as set forth.

8. A nozzle consisting of a hollow casing having oppositely disposed shoulders 9^b and two plates respectively abutting against said shoulders to afford a smooth surface within said casing, and means for moving the outer ends of said plates toward and from each other at the delivery end of said nozzle, substantially as herein specified.

9. A nozzle consisting of two plates, side walls or webs adapted to be brought together on their edges to form a space within said nozzle, rear walls carried by said plates adapted to close the back of said nozzle, said walls forming an inlet opening, and two plates carried within said first-mentioned plates and means for moving said plates equally toward and from each other at their outer ends, substantially as set forth.

10. A nozzle consisting of two plates and means for holding them at a distance apart to form a space between them, two plates pivotally carried within the space formed by said first mentioned plates, rock shafts journaled on the first mentioned plates and having cranks and links connected with the movable plates for operating the latter, and means for rocking said shafts to move the inner plates toward and from each other, substantially as herein specified.

11. A nozzle consisting of two plates and means for holding them at a distance apart to form a space between them, two plates pivotally carried within the space formed by said first mentioned plates, rock shafts journaled on the first mentioned plates and having cranks and links connected with the movable plates for operating the latter said rock shafts having crank arms 24 and means connected with said crank arms for moving them conjointly so as to move the outer ends of said movable plates toward and from each other equally and simultaneously to contract and increase the distance between the outer ends of said movable plates equally, as and for the purposes set forth.

12. A nozzle consisting of two plates 9, webs 10, 10, carried by said plates and adapted to register on their edges whereby a space is formed between said plates and webs, means for clamping said plates together, walls at one end of said plates forming an inlet opening, two plates 14 within said nozzle and respectively pivotally connected at their inner ends with said plates 9, and means for rocking said plates 14 on their pivots to move their outer ends toward and from each other, substantially as set forth.

13. A nozzle consisting of a hollow casing and plates 14 therein, said plates 14 having pivots at their inner ends so arranged that said plates when turned on their pivots will always present a smooth inner surface within the nozzle casing while their outer ends move toward and from each other, substantially as set forth.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

WILLIAM MELVIN RUSSELL.

Witnesses:
JAMES M. TULLY,
T. F. BOURNE.