

May 12, 1931.

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1,804,593

APPARATUS AND METHOD FOR HANDLING PULVERIZED FUEL

Filed May 10, 1926

3 Sheets-Sheet 1

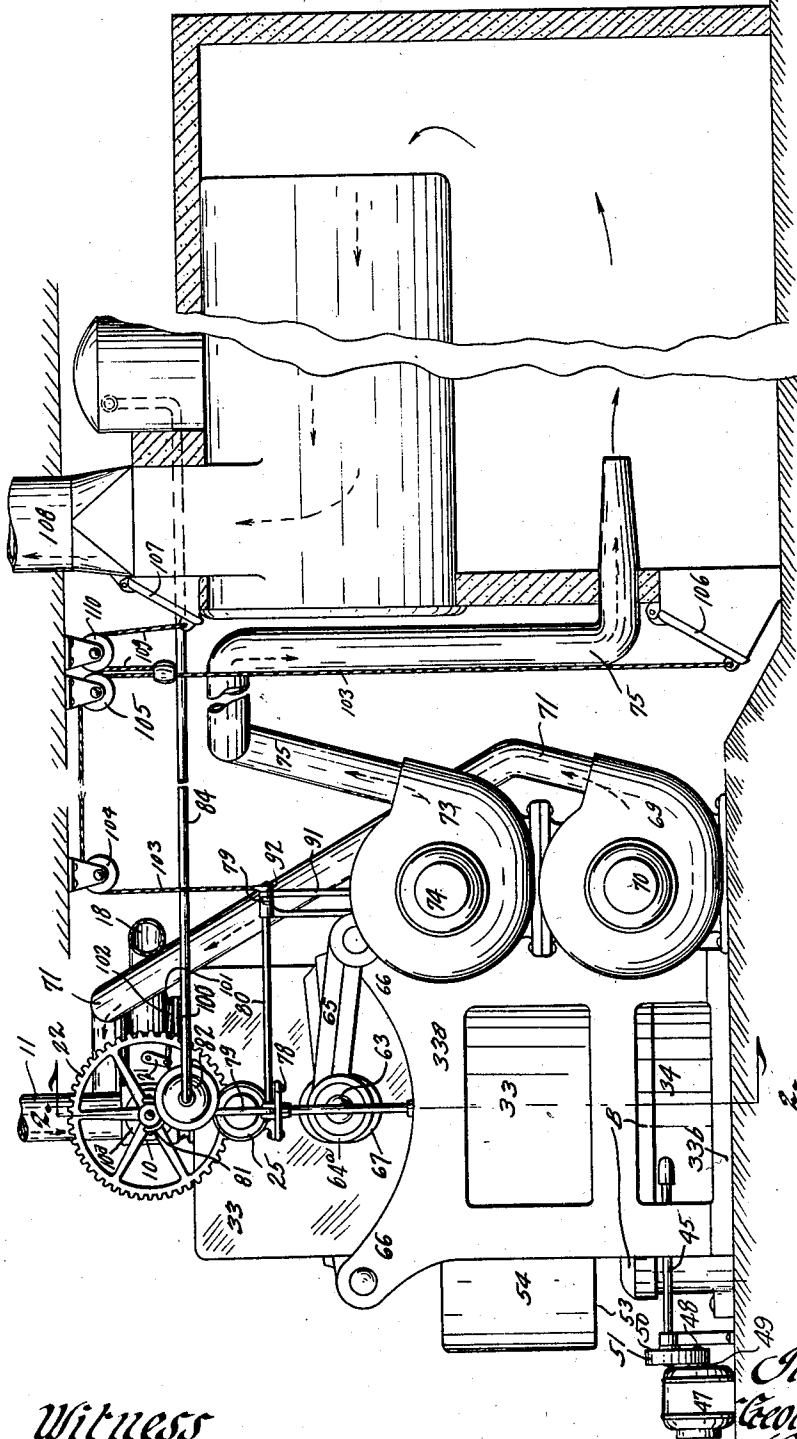


Fig. 1.

Witness
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3 Sheets-Sheet 2

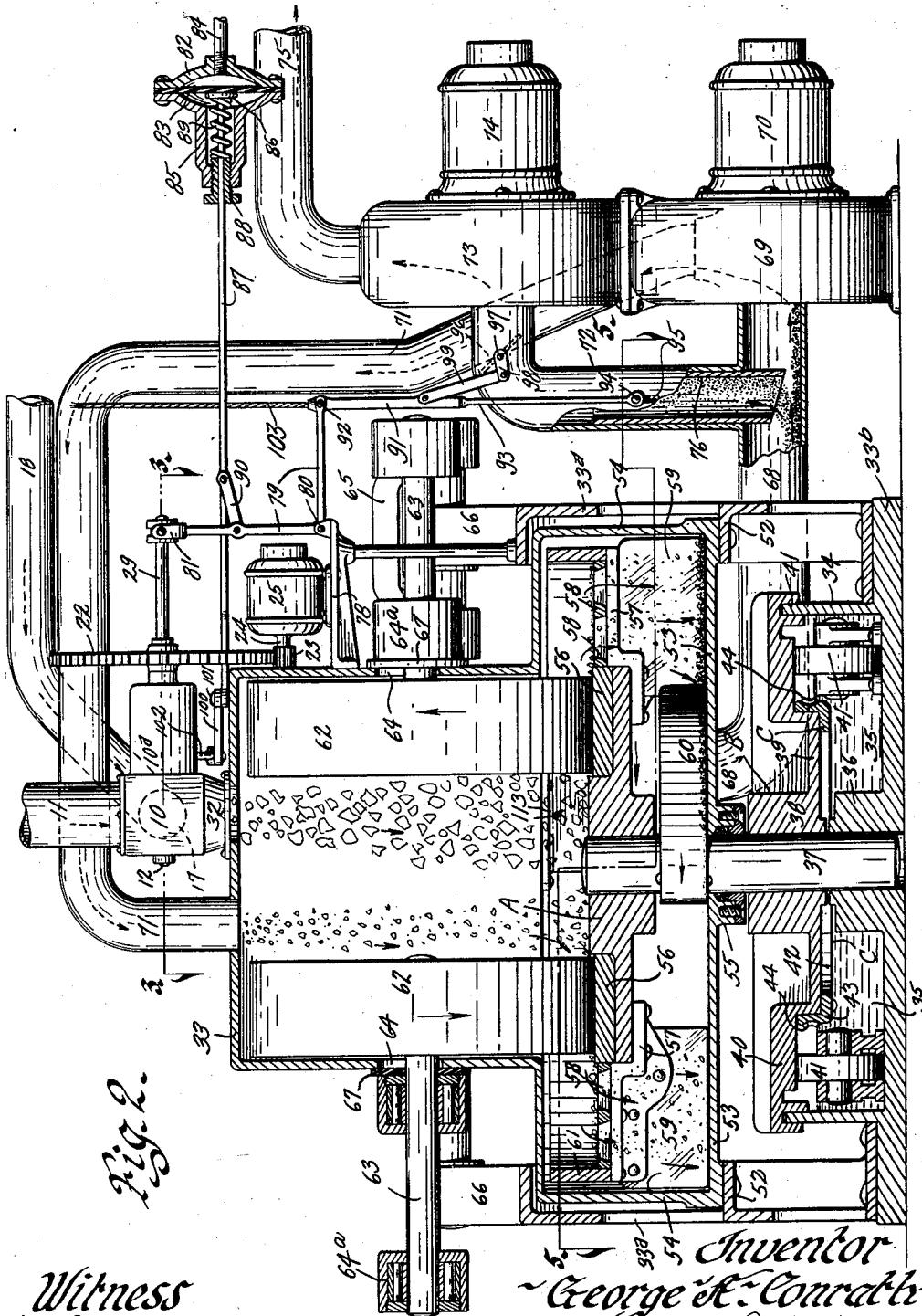


Fig. 2.

Witness
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May 12, 1931.

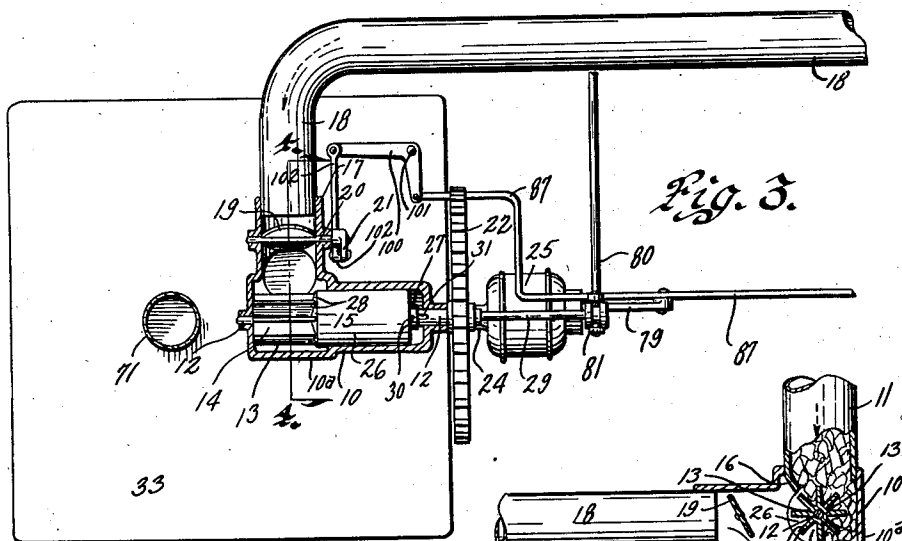
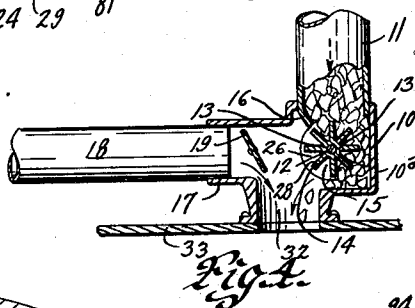
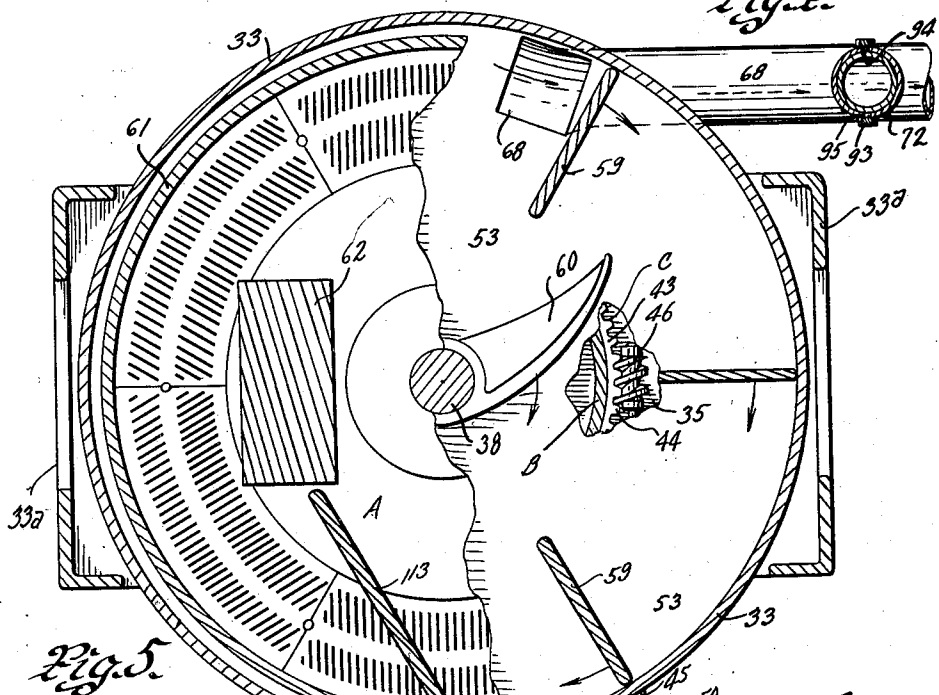
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Filed May 10, 1926

3 Sheets-Sheet 3



Witness
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UNITED STATES PATENT OFFICE

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APPARATUS AND METHOD FOR HANDLING PULVERIZED FUEL

Application filed May 10, 1926. Serial No. 107,966.

My invention has to do with an apparatus and method for handling pulverized fuel.

There are a number of advantages in using fuel in pulverized form. When fuel is used in that form, it is possible to secure much higher thermal efficiency on account of the more complete combustion. The use of pulverized fuel permits great flexibility and reduces the standby and low banking losses. One of the great problems in handling pulverized fuel arises from the cost of operation and maintenance.

It is my purpose more particularly therefore to provide an apparatus and method whereby coal may be fed to a pulverizer by a suitable feeder, together with a supply of air, which is preferably preheated. The coal is pulverized and when taken from the pulverizer is separated or divided into the fine coal dust, which is conducted to the burner by air currents, and into the larger particles, which are carried by air back to the pulverizer or miller.

It is my purpose to provide in such a mechanism a simple, efficient and durable structure, which can be manufactured and maintained economically.

In order to reduce the labor cost in handling coal and maintain efficiency in carrying out the entire process, it is desirable that the various operations should be automatically controlled according to conditions in the furnace or the boiler.

It is therefore a further purpose of my present invention to provide means and a method for automatically controlling according to boiler pressure, for instance, the feeding mechanism, the air supply to the coal passing through the machine, the pulverizer, the coal separator means, and the supply of powdered coal to the combustion chamber.

It is not desirable to supply to the coal all of the air necessary for combustion, because when there is a sufficient supply of air for proper combustion, explosions are more likely.

It is therefore my purpose to provide in connection with my mechanism and as a part of my method, automatic control of the aux-

iliary supply of air to the furnace through the draft door in cooperation and synchronism with the other automatic controls mentioned above. I further connect the control mechanism with a damper located for instance in the stack. I thus eliminate as far as may be the necessity for constant supervision and reduce the labor cost incident to the practice of the process in the use of the apparatus.

It is my object in connection with such a mechanism to provide novel features of mechanism for accomplishing the various purposes thus outlined.

The feeder structure is shown in my co-pending application filed January 16, 1926, Serial No. 81,628.

With these and other objects in view, my invention consists in the steps of the process hereinafter explained and in the construction, arrangement and combination of the various parts of my apparatus, whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawings, in which:

Figure 1 is an elevation of an apparatus embodying my invention with which my method may be used.

Figure 2 is a side elevation of the same apparatus, whereby my method may be practiced, some parts being shown in section and other parts being broken away.

Figure 3 is a plan view of the feeder, with parts omitted and parts shown in section taken on the line 3—3 of Figure 2.

Figure 4 is a sectional view of the feeder taken on the line 4—4 of Figure 3; and

Figure 5 is a detail, sectional view taken on the line 5—5 of Figure 2.

Feeder

In the accompanying drawings, whereby I have illustrated an apparatus embodying my invention and with which my improved method may be employed, I have used the reference numeral 10 to indicate generally the fuel feeder, which receives the coal through a supply pipe 11 from a hopper or

other source of supply and discharges it into the pulverizer or muller.

Referring to Figures 3 and 4, it may be noticed that the feeder 10 comprises a suitable casing 10a, in which is journaled a shaft 12, which projects through one end wall of the feeder.

Fixed on the shaft 12 just below the fuel intake pipe 11 is a feed wheel 13, which is formed with the radially projecting blades 14, between which are formed the fuel conducting pockets 15.

Just above the feed wheel 13 is a deflector plate 16 for directing the fuel into the pockets and preventing it from dropping into the air intake inlet hereinafter referred to.

The feeder casing 10a has at one side the air inlet portion 17 to which the heated air is supplied through a suitable pipe 18.

For controlling the supply of air to the feeder, I provide the throttle valve 19, having the stem 20 projecting to a point outside the air passage and having on its outer end the arm 21, whereby the valve 19 may be controlled in a manner hereinafter more fully explained.

On the shaft 12 outside the feeder casing 10 is a gear 22. The gear 22 meshes with a smaller pinion gear 23, shown in Figure 2, on the shaft 24 of the motor 25.

It will be seen that power from the motor is transmitted to the shaft 12 through the gears 23 and 22.

It may be mentioned in this connection that a suitable clutch may be provided for this purpose.

I provide in connection with the feed wheel means for controlling the amount of fuel fed by the wheel to the pulverizer.

Mounted in the casing 10 and slidably arranged on the shaft 12 is a sliding sleeve drum member 26, having one end carried directly by the shaft 12, as at 27, and having the other end slotted as at 28, to snugly fit and slide along the blades 14. This sliding sleeve drum 26 is arranged to be slid longitudinally on the shaft 12 in such manner as to regulate the operating size of the pockets 15 by reducing or increasing their effective length.

The shaft 12 for a portion of its length is hollow and slidably receives an actuating rod 29, which is connected with the sliding sleeve drum 26 within the casing 10 by means of a pin 30, extending through a slot 31 in the wall of the hollow portion of the shaft 12.

The mechanism for controlling the rod 29 for thus adjusting the feeder will be hereafter referred to.

Pulverizer

Fuel is discharged from the pockets 15 through a passage 32 at the lower part of the feeder casing 10a into the casing 33 of the pulverizer, which latter casing is entirely

closed. The casing 33 is supported by side frames 33a resting on a base 33b.

On the base 33b is an upwardly extending, annular wall 34, which forms a compartment 35, serving as a lubricant container for certain parts of the mechanism.

Centrally arranged in the compartment 35 is a socket 36 in which is received the lower end of the rotatable post 37, which supports and rotates the pulverizer or muller pan A. On the post 37 above the socket 36 is a hub 38 from which projects a web or annular flange 39 terminating in a downwardly opening, raised, annular channel 40.

This whole device forms what may be called a supporting disc B for the shaft 37 and the pulverizer or muller pan A.

Arranged in a circle around the bottom of the casing 33 within the compartment 35 are rollers or wheels 41.

Near the periphery of the disc B on its under side is an annular groove or the like 41, which receives the upper edge of the wall 34 to make a joint sufficiently tight to retain lubricant within the chamber 35 and yet to permit free rotation of the shaft 37 and disc B.

On the disc B on the under side thereof is mounted a ring 42, having at its periphery an upwardly extending, annular flange 43, provided with teeth 44.

The device just described forms a worm wheel, which I have indicated generally by the reference character C.

A shaft 45 extends through the wall of the casing 33 and through the wall 34 and has on its inner end a worm 46, shown in Figure 5 in mesh with the teeth 44 of the worm wheel C. The shaft 45 is actuated from a motor 47 having the shaft 48 by means of pulleys 49 and 50 and the belt 51.

Resting upon lugs 52 on the frame members 33a is the bottom member 53 of the pulverizer casing 33. The bottom member has an annular, upwardly extending peripheral side wall 54.

The diameter of the casing 33 at its upper part is a little less than its diameter at its lower part, as shown.

The shaft 37 extends upwardly through the bottom 53 of the casing 33, and a suitable stuffing box structure 55 affords a joint, which will prevent the escape of coal dust.

The grinding pan A has inset into its upper surface an annular, sectional wear plate 56, the details of which are not here described. The grinding or pulverizing pan A has a series of radially projecting arms 57, which support, an annular, sectional slotted ring 58 through which the ground fuel may drop downwardly upon the bottom 53.

Certain of the arms 57 support downwardly, projecting scraper blades 59, the lower edges of which are adjacent to the bottom 53

for scraping the ground fuel to the discharge opening in the bottom.

Mounted on the shaft 37 just above the bottom 53 is a radially projecting scraper arm 5 60, which has the same purpose.

The arms 57 also carry an upwardly extending peripheral rim or wall 61, which really forms part of the pulverizing pan A.

Within the casing 33 are spaced muller 10 wheels 62, having shafts 63, projecting through the side walls of the casing 33. The side walls are provided with suitable slots 64 to permit limited up and down swinging movement of the shaft 63 and the muller 15 wheels. The outer ends of the shafts 63 are journaled in bearings 64a carried by the wheel carriers or yokes 65, which are suitably pivoted to the upstanding arms 66 on the frame member 33a.

20 The muller wheels 62 thus rotate freely and are permitted slight up and down movement.

The shafts 63 carry fiber plates 67 adjacent to the slots 64 for covering the slots and preventing the escape of fuel therethrough.

25 *Powder fuel handling mechanism*

A fuel pipe 68 extends from the bottom of the casing 33 near the center of the bottom member 53 laterally, as shown in Figure 2, 30 for conducting the pulverized fuel away from the pulverizer casing.

The pipe 68 leads to a fan casing 69, in which is a fan or the like of any suitable construction, not shown, operated from the motor 70. The fan casing 69 discharges into a conducting pipe 71 leading to the top of the pulverizing casing 33.

The powdered fuel, which travels through the pipe 68 is separated into the fine dust, 40 which is conducted to the combustion chamber, and the larger particles, which are driven by the fan structure 69 and the air current through the pipe 71 back to the pulverizer chamber.

45 The manner of accomplishing this separation will now be described.

A pipe 72 communicates with the top of the pipe 68 and leads to a fan structure 73, in which is a fan of any suitable construction, 50 not shown here in detail, operated from a motor 74.

From the fan structure 73, the fine dust is carried through a pipe 75 by air currents to the combustion chamber.

55 Mounted inside the lower end of the pipe 72 telescopically is a tubular sleeve 76, the lower end of which is cut on a bevel, as at 77 (see Figure 2), so that that portion of the sleeve 76 nearest the fan structure 69 extends 60 downwardly farther than does the opposite side of the sleeve 76.

By adjusting the sleeve 76 upwardly and downwardly, the relative proportion of fuel drawn off through the pipe 72 may be regulated. 65

Automatic regulating structure

The motor 25 may rest upon a suitably supported shelf or the like 78. A bell crank lever 79 is pivotally mounted, as for instance 70 at 80, on the shelf 78. One arm of the bell crank lever 79 is connected as at 81 with the control rod 29 hereinbefore referred to, in such manner that the rocking of the bell crank lever will move the rod 29 longitudinally, but 75 will permit the free rotation of the rod. Thus by rocking the bell crank lever 79, the feed wheel may be controlled for regulating the amount of coal delivered to the pulverizer.

It is desirable that the various operations of the machine should be simultaneously automatically controlled for controlling the rocking of the bell crank lever according to the condition of the furnace and boiler.

I provide a diaphragm casing 82 having 85 therein a flexible diaphragm 83, subject on one side to steam pressure from the boiler through the pipe 84. On the other side of the casing 82 is a tubular extension 85.

The diaphragm 83 has a head 86 to which is 90 connected a rod 87 extended through the casing 82.

In the end of the extension 85 is an adjustable sleeve 88, having a threaded connection with the extension 85. A coil spring 89 is 95 mounted on the rod 87 within the extension 85 and casing 82 and bears against the head 86 and the adjustable sleeve 88.

By adjusting the sleeve 88, the tension of the spring 89 may be regulated. The spring 89 acts against the steam pressure on the diaphragm, so that the steam pressure will be effective only when it reaches a certain desired maximum.

The rod 87 is connected by a link 90 with 105 that arm of the bell crank lever 79, which actuates the rod 29. Thus when the steam pressure goes up to a certain height, the diaphragm 83 is actuated for moving the rod 87 longitudinally and rocking the bell crank lever 79 for adjusting the sleeve drum 26 for regulating the size of the pockets 15, and consequently the amount of coal fed to the pulverizer.

When the steam pressure goes down, the 115 operation of the parts is reversed by virtue of the action of the spring 89.

A rod 91 is pivoted to the other arm of the bell crank lever 79, as at 92 (Figure 2). At the lower end of the rod 91 is a yoke 93, the 120 arms of which extend downwardly on opposite sides of the pipe 72.

The arms of the yoke 93 are connected by pins 94 extending through slots 95 in the pipe 72 with the sleeve 76, so that by raising or lowering the rod 91, the sleeve 76 may be 125 raised or lowered.

It thus follows that when the bell crank lever 79 is actuated according to steam pressure, the sleeve 76 is slid up or down as the case may be. When the steam pressure goes 130

up, the sleeve 76 is raised, and less fuel will be drawn from the pipe 68 and delivered to the combustion chamber. On the other hand, when the steam goes down, the sleeve 76 will
 5 be lowered into the passing stream of fuel and air, with the result that more fuel will be drawn off to the combustion chamber.

In the pipe 72 is a butterfly control valve 96, the stem 97 of which projects from the
 10 pipe and carries an arm 98. The arm 98 is connected by a link 99 with the rod 91, so that when the bell crank lever is actuated by increasing steam pressure for decreasing the feeding of coal and raising the sleeve 76, the
 15 valve 96 will be moved accordingly toward closing position:

Provision is also made for simultaneously controlling the valve 19 in the pipe 18 which conducts air to the feeder and therethrough
 20 to the pulverizer.

Referring to Figures 2 and 3, it will be seen that a bell crank lever 100 is pivotally mounted as at 101. One arm of the bell crank lever 100 is pivoted to the rod 87. The other
 25 arm of the bell crank lever 100 is connected by a link 102 with the arm 21 on the stem 20 of the valve 19 in such manner that the movement of the rod 87, when it is actuated by the diaphragm on account of increasing
 30 the steam pressure, serves to rock the stem 20 for moving the valve 19 toward closing position.

Similarly when the steam goes down, and the spring 89 moves the rod 87, as shown in
 35 Figure 2, toward the right, such movement of the rod 87 serves to move the valve 19 toward open position.

It is not desirable, as has been said, to supply to the coal during its passage through
 40 my apparatus all of the air which is necessary for proper combustion. When enough air is supplied for that purpose, there is more danger of explosions due to the various causes, such for instance as sparks that might be
 45 created in the machine.

It is therefore desirable to have an auxiliary supply of air for the furnace, and it is, of course, desirable that this auxiliary supply be controlled automatically in connection
 50 with the other controls herein mentioned.

A flexible cable 103 is connected with the upper end of the rod 91 and extends over a suitably mounted pulley 104 and another pulley 105 to a furnace draft door 106. The arrangement
 55 of the parts is such that when the steam pressure goes up for actuating the automatic controls, the draft door will be closed or moved toward closing position, and when the pressure goes down, the draft door
 60 will be opened.

I also provide means for controlling a damper door 107, by which air is admitted to the stack 108. A flexible cable or the like
 65 109 is connected with the door 107 and extends around the pulley 110, and is then con-

nected with the cable 103 in such manner that when the door 106 is closed, the door 107 is opened, and vice versa when the door 106 is opened, the door 107 is closed.

I will now explain in greater detail the
 70 practical operation of my apparatus and the method which I practice in feeding pulverized coal to a furnace either with my present or a similar apparatus.

The coal is supplied to the pipe 11 in any
 75 suitable manner. Certain kinds of coal, such for instance as what is called "steam coal", come in such sizes as to need no breaking up before passing to the feeder. If larger chunks
 80 of coal are the source of supply, they may be broken up in any suitable way before being conducted to the feeding mechanism. It may be desirable to use a magnetic separator for taking "tramp" iron out of the coal, before
 85 the coal reaches the feeder.

The supply of coal passes into the feeder casing 10 and into the pockets 15 of the feeder wheel. The effective size of the pockets will depend upon the position of the sleeve drum
 26. If that is at the right-hand limit of its
 90 movement, as shown in Figure 3, the pockets will take and handle a large amount of fuel. If the sleeve drum is moved farther to the left, this will obviously reduce the size of the
 95 pockets and therefore reduce the capacity of the feeder and reduce the amount of coal discharged from the pockets 15 through the passage 32 into the pulverizer.

It will, of course, be understood that the position of the sleeve drum 26, which controls
 100 the supply of coal fed to the pulverizer will be regulated by the control mechanisms, hereinbefore described and hereinafter more particularly referred to, according to the boiler demand.

Air is admitted to the feeder casing 10 through the inlet passage 17 and the supply
 105 pipe 18. The air used is preferably preheated in some suitable way, as for instance by taking it from the breeching or the hollow walls of the furnace.

It will be understood, of course, that the air used is fresh air.

The use of the heated air in this manner serves two desirable purposes. In the first
 115 place, it helps to take moisture out of the fuel, and in the second place, all of the waste heat units thus used effect so much of a saving.

The supply of air through the pipe 18 is controlled by means of the valve 19. This
 120 valve 19 is actuated according to boiler demand in cooperation and simultaneously with the control of the feeder.

The coal passes from the feed wheel 13 through the passage 32 into the pulverizer or
 125 miller. It is, of course, obvious, that the air supplied to the feeder casing passes into the pulverizer casing with the coal. The pulverizer casing is substantially airtight.

The coal drops upon the grinding pan A 130

and by the rotation of the pan comes directly into the path of the muller wheels 62. Scraper blades 113 are suitably supported on the pulverizer casing and in cooperation with the pan serve to move the coal inwardly, so that it will be in the paths of the muller wheels.

The pan is rotated from the motor 47, the shaft 48 of which transmits power to the pulley 49, the belt 51, the pulley 50 and the worm shaft 45. The worm 46 on the shaft 45 meshing with the teeth 44 rotates the supporting disc B and the pulverizer pan shaft 37 and the pulverizer pan A.

The coal is ground by the muller wheels 62 and the wear plate 56. The muller wheels are permitted to rock up and down for a limited distance on account of the pivoted mountings of the carriers 65 on the arms 66.

The fine coal dust drops downwardly through the screens 58. The scraper blades 113 stand perhaps one-sixteenth of an inch above the pan bottom, so that very finely ground fuel may pass under them.

The finely ground fuel drops onto the bottom 53 and is shoved around by the blades 59 and 60 and drops into the pipe 68, through which a current of air is constantly passing during the operation of the fan devices 69 and 73.

As the current of ground coal and air passes through the pipe 68, the very fine fuel is drawn upwardly through the sleeve 76 and the pipe 72 and passes through the fan structure 73 and thence through the pipe 75 to the combustion chamber. The coarser coal passes out of the discharge end of the pipe 68 and thence through the fan structure 69, by which it is blown through the pipe 71 back to the pulverizer.

In order to insure the working of the machine with the maximum of efficiency and to reduce the cost of labor and superintendence to a minimum, I have provided the automatic control mechanisms hereinbefore described.

It is obviously desirable that when there is an ample supply of steam in the boiler, the furnace fire should be reduced, and that when the steam supply goes down, the furnace fire should be increased. The increasing or decreasing of the fire is accomplished by controlling the amount of coal fed to the pulverizer, and the amount of pulverized coal supplied to the combustion chamber.

The feeding mechanism is controlled from the diaphragm 83 in the manner hereinbefore described.

The amount of coal supplied to the combustion chamber is dependent upon the force of the draft of air through the pipe 68 and the pipe 72 and the adjustment of the sleeve 76. The draft of air through the pipes just mentioned is regulated by the valve 96 in the pipe 72, which valve is controlled in the man-

ner hereinbefore described from the diaphragm 83. The sleeve 76 is similarly controlled from the diaphragm.

It has been found that it is highly desirable to control also the inlet of air to the pulverizer, and this is accomplished by the mechanism hereinbefore explained for controlling the valve 19.

It is obvious that it would be difficult to accurately control the supply of fine coal to the furnace, if all the coal ground should be conducted to the furnace. It would, of course, not be desirable to have the coal supply choke up, and I have therefore provided the means herein described, comprising the fan structure 69 and the return pipe 71 for conducting back to the pulverizer, the coal not used for the furnace.

The step of my process, which involves carrying back to the pulverizer, some of the coal, is also important because it is desirable to use for combustion only the coal which has been ground the finest.

It will, of course, be understood that the coal, which has been ground the finest is subject to the most complete combustion. Some coarser particles of coal will be discharged from the pulverizer, and these coarser particles are carried back for another grinding.

I have already explained that it is desirable to supply auxiliary air to the combustion chamber. It is of course obvious that it is desirable to control this auxiliary air supply in accordance with boiler demand, and this is accomplished by means of the automatic control for the door 106, which has already been described.

It is well-known that in any furnace, it is desirable to control the stack door, and I have provided for the automatic control of that door 107 as hereinbefore explained.

A general advantage arises from the flexibility which is possible in the use of my apparatus and process.

I will now call attention to some of the features of my apparatus and machine by which these advantages are obtained.

I have already explained how the coal feed is controlled and how the air supply is controlled. I mention particularly here the fact that the air is supplied to the coal even before the coal reaches the pulverizer. This method of supplying the air, especially when the air is heated, takes considerable moisture from the coal before the grinding operation takes place.

Attention is called to the arrangement of the parts wherein a pulverizer or muller of this kind is contained within a substantially airtight casing which I believe to be a novel feature of structure, and which makes possible the use of air in the manner herein explained.

It will, of course, be understood that the particular form of mechanism, which I have

shown here, is intended to be illustrative, and that I do not desire to limit myself to the specific form of mechanism disclosed.

I claim:

- 5 1. In an apparatus of the class described, a pulverizer, fuel feeding mechanism for supplying fuel thereto, means for supplying air to the feeding mechanism to be mixed with the fuel before the fuel enters the pulverizer, means for withdrawing fuel from the pulverizer, and means for simultaneously controlling the feeding mechanism, the supply of air to the feeding mechanism and the drawing of fuel from the pulverizer.
- 10 2. In an apparatus of the class described, a pulverizer, fuel feeding mechanism for supplying fuel thereto, means for supplying air to the feeding mechanism, means for drawing fuel from the pulverizer, and separating it into finer and coarser portions, and means for cooperatively controlling the feeding mechanism, the supply of air to the feeding mechanism, and the drawing of fuel from the pulverizer and the separating of the fuel.
- 15 3. In an apparatus of the class described, a pulverizer, means for feeding fuel thereto, means for withdrawing fuel from the pulverizer and separating the finer from the coarser fuel, and means for simultaneously, cooperatively controlling the feeding means and the fuel withdrawal and separating means whereby a demand for more fuel will cause coarser fuel to be drawn with the fine fuel in the separating means.
- 20 4. In an apparatus of the class described, a pulverizer, fuel feeding mechanism for supplying fuel thereto, means for supplying air to the feeding mechanism, means for drawing fuel from the pulverizer and returning it to the pulverizer, means for separating the finer portions from the fuel being returned to the pulverizer, and means for cooperatively controlling the feeding mechanism, the supply of air to the feeding mechanism, and the drawing of the finer portions of the fuel from the fuel drawing and returning means.
- 25 5. In an apparatus of the class described, a steam plant having a combustion chamber, means for separating crushed fuel into finer and coarser parts and conducting the finer fuel to the combustion chamber, comprising a conducting pipe, a means for creating air currents therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, a means for creating a draft of air through the second pipe away from the first pipe, a sleeve in the second pipe, means for adjusting the sleeve for inserting it to different distances of projection into the first pipe, a valve in the second pipe, and means for cooperatively controlling the sleeve and valve.
- 30 6. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, a fuel crusher, means for separating crushed fuel into finer and coarser parts and returning the coarser parts to the crusher, means for conducting the finer parts to the combustion chamber, comprising a conducting pipe, means for creating a draft of air therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe away from the first pipe, a sleeve in the second pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a valve in the second pipe, a draft door for controlling auxiliary air supply to the combustion chamber, and means for cooperatively controlling the valve and the draft door.
- 35 7. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion chamber, comprising a conducting pipe, a means for creating a draft of air therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe away from the first pipe, a sleeve in the second pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a valve in the second pipe, a draft door for controlling auxiliary air supply to the combustion chamber, and means for cooperatively controlling the valve, the draft door and the sleeve.
- 40 8. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion chamber, comprising a conducting pipe, means for creating a draft of air therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe, a sleeve in the second pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a draft door for controlling auxiliary air supply to the combustion chamber, a fuel pulverizer, a means for feeding fuel thereto, and means for cooperatively controlling the sleeve, the draft door and the feeding means.
- 45 9. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion

chamber, comprising a conducting pipe, means for creating a draft of air there-through, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe, a sleeve in the second pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a draft door for controlling auxiliary air supply to the combustion chamber, and means for cooperatively controlling the sleeve and the draft door according to the steam condition in the boiler.

10. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion chamber, said means comprising a horizontal conducting pipe, means for creating a draft of air therethrough, a vertical pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe, means for supplying auxiliary air to the combustion chamber, a sleeve in said vertical pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a device for controlling said supply of auxiliary air to the combustion chamber, a fuel pulverizer having discharge connection with said conducting pipe, a means for feeding fuel thereto, and means for cooperatively controlling the sleeve, the device, and the feeding means according to the steam condition in the boiler.

11. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion chamber, comprising a conducting pipe, means for creating a draft of air therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe away from the first pipe, a sleeve in the second pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a draft door for controlling auxiliary air supply to the combustion chamber, a fuel pulverizer, a means for feeding fuel thereto, and means for cooperatively controlling the feeding means, the valve, sleeve and the draft door according to the condition of steam in the boiler.

12. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion chamber, comprising a conducting pipe,

means for creating a draft of air there-through, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe, a sleeve in said second pipe, means for adjusting said sleeve for projecting it different distances into the first pipe, a device for controlling auxiliary air supply to the combustion chamber, a fuel pulverizer having discharge connection with said conducting pipe, a means for feeding fuel thereto, means for cooperatively controlling the feeding means, the sleeve and the auxiliary air control device, means for supplying air to the feeder, and means for simultaneously controlling such air supply in cooperation with said first controlling means.

13. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts and conducting the finer parts to the combustion chamber, comprising a conducting pipe, means for creating a draft of air therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe away from the first pipe, a sleeve in the second pipe, means for adjusting the sleeve for projecting it different distances into the first pipe, a valve in the second pipe, a draft door for controlling auxiliary air supply to the combustion chamber, a fuel pulverizer having discharge connection with said conducting pipe, a means for feeding fuel thereto, means for cooperatively controlling the feeding means the sleeve, the draft door and the valve, means for supplying air to the feeder, and means for simultaneously controlling such air supply in cooperation with said first controlling means.

14. In an apparatus of the class described, a steam plant having a combustion chamber and boiler, a pulverizer, fuel feeding mechanism for supplying fuel thereto, means for supplying air to the pulverizer, means for drawing fuel from the pulverizer and supplying it to the combustion chamber, and means for simultaneously controlling the feeding mechanism, the supply of air to the pulverizer, and the drawing of fuel from the pulverizer, according to the pressure of the steam in the plant.

15. In an apparatus of the class described, a steam plant including a combustion chamber and boiler, a pulverizer, mechanism for supplying fuel to the pulverizer, means for supplying air to the pulverizer, means for conducting pulverized fuel away from the pulverizer, means for separating such fuel and conducting the finer fuel to the furnace and the coarser fuel back to the pulverizer, and means for simultaneously cooperatively,

controlling the feeding mechanism, air supplying means and separating means.

16. A method of handling coal comprising the supplying of air to the coal before it is pulverized and during the pulverizing operation, the removal of the coal from the point of pulverizing and the simultaneous cooperative controlling of the supply of coal for pulverizing, the supply of air to the coal, and the removal of the coal from the point of pulverizing.

17. In a process of pulverizing coal, feeding the raw coal to a pulverizing zone and pulverizing the same, supplying air to the coal before it is pulverized and during the pulverization thereof, removing the fuel from the pulverizing zone, and simultaneously and cooperatively controlling the supply of air and fuel withdrawal.

18. The process of feeding coal for pulverizing, pulverizing the coal, supplying air to the coal before and while it is being pulverized, withdrawing the coal from the point of pulverizing, and separating it into finer and coarser portions, and simultaneously, cooperatively controlling the supply of coal for pulverizing, the air supply to the coal and the withdrawal and separation of the coal.

19. The process of preparing and feeding fuel to a steam plant having a combustion chamber and a boiler, comprising feeding the fuel to a pulverization zone, pulverizing the fuel, supplying air to the fuel before and while it is being pulverized, withdrawing the fuel from the point of pulverization, conveying it to the combustion chamber, and simultaneously, cooperatively controlling the air supply, the operation of the fuel withdrawal and movement of the fuel to the combustion chamber according to the pressure of steam in the boiler.

20. The process of preparing and feeding fuel to a steam plant having a combustion chamber and a boiler, comprising pulverizing the fuel, supplying air to the fuel before and while it is being pulverized, conveying the fuel to the combustion chamber, and simultaneously, cooperatively controlling the air supply and the operation of the fuel conveyance to the combustion chamber and the supply of fuel for pulverizing.

21. The process of preparing and feeding fuel to a steam plant having a combustion chamber and a boiler, comprising pulverizing the fuel, supplying air to the fuel before and during the pulverizing, conveying the pulverized fuel to the combustion chamber, and simultaneously, cooperatively controlling the air supply and the movement of the pulverized fuel to the combustion chamber, and also simultaneously, cooperatively regulating, controlling and supplying an additional amount of air to the combustion chamber.

22. The process of preparing and feeding fuel to a steam plant having a combustion

chamber and a boiler, comprising feeding the fuel to a pulverization zone, pulverizing the fuel, supplying air to the fuel as it is fed and while in the pulverization zone, withdrawing the fuel from the pulverization zone and separating the finer from the coarser pulverized fuel and conveying it to the combustion chamber, the coarser fuel being returned to the zone of pulverization and further treated therein for pulverization, and simultaneously, cooperatively controlling the air supply, the supply of fuel to the combustion chamber, the supply of fuel to the pulverization zone, and the separation operation.

23. The process of preparing and feeding fuel to a steam plant having a combustion chamber and a boiler, comprising pulverizing the fuel, supplying air to the fuel before and during the pulverizing, conveying the pulverized fuel from the point of pulverizing to the combustion chamber, and simultaneously, cooperatively controlling the air supply and the movement of the pulverized fuel to the combustion chamber, and simultaneously, cooperatively controlling, regulating and supplying an additional amount of air to the combustion chamber, the coarser particles of fuel being separated from the finer particles and returned for further pulverizing as the fuel is conveyed along toward the combustion chamber.

24. In an apparatus of the class described, a steam plant having a combustion chamber and a boiler, means for separating crushed fuel into finer and coarser parts conducting the finer parts to the combustion chamber, comprising a conducting pipe, means for creating a draft of air therethrough, a second pipe leading from the upper part of the first pipe for taking off the finer fuel and conducting it to the combustion chamber, means for creating a draft of air through the second pipe, a sleeve slidably mounted in said second pipe, means for adjusting said sleeve for projecting it different distances into the first pipe, a device for controlling auxiliary air supply to the combustion chamber, and means for cooperatively actuating the sleeve adjusting means and the device, a fuel pulverizer having discharge connections with said conducting pipe, a means for feeding fuel thereto, and means for cooperatively controlling the feeding means, and the sleeve, means for supplying air to the feeder, and means for simultaneously controlling such air supply in cooperation with said first controlling means.

Des Moines, Iowa, April 16, 1926.

GEORGE A. CONRATH.