

No. 707,992.

Patented Aug. 26, 1902.

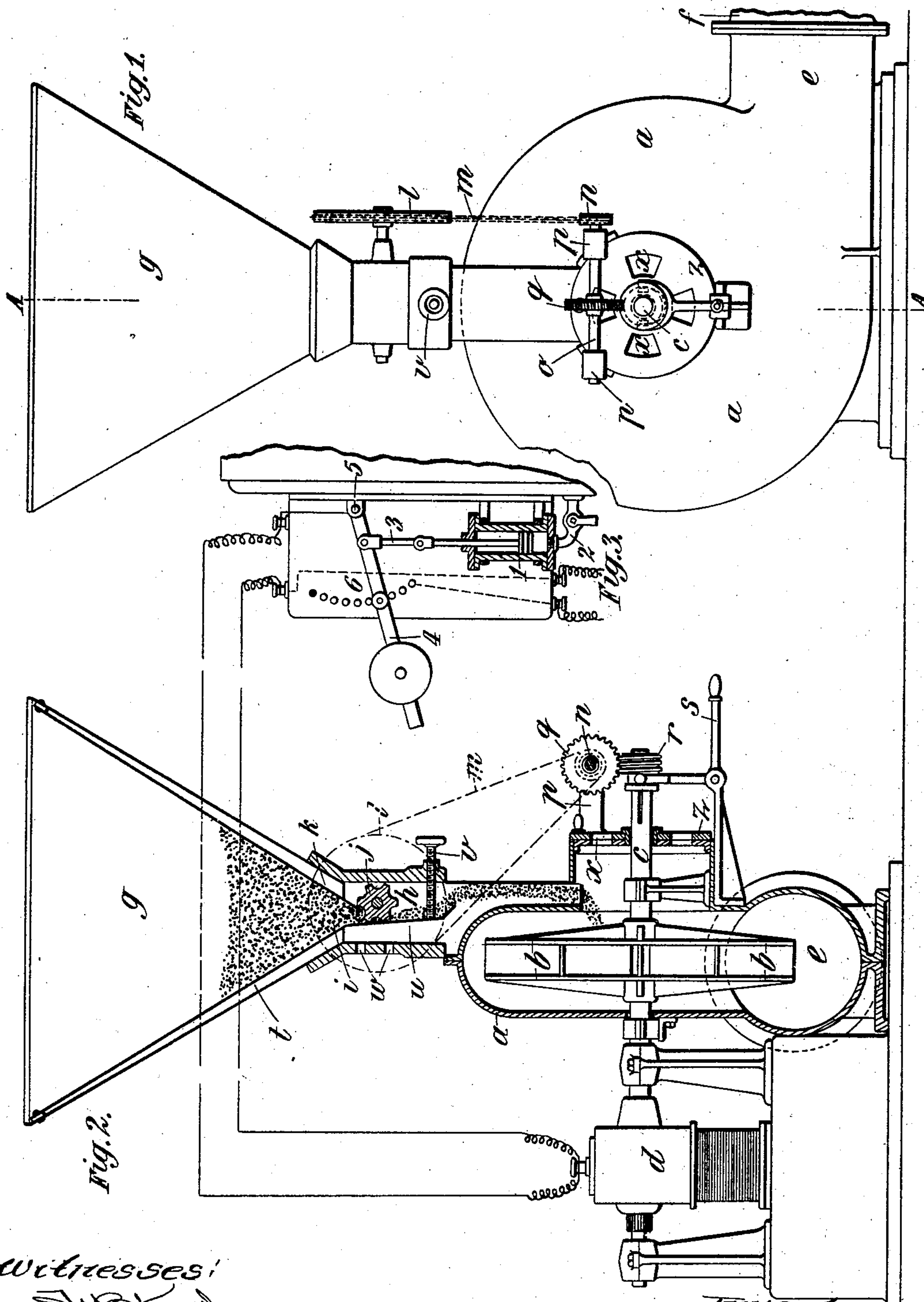
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(Application filed May 29, 1901.)

(No Model.)

2 Sheets—Sheet 1.



Witnesses:
J. B. Keeler
Geo. W. Rea.

Inventor
George W. Warner
By James L. Norris

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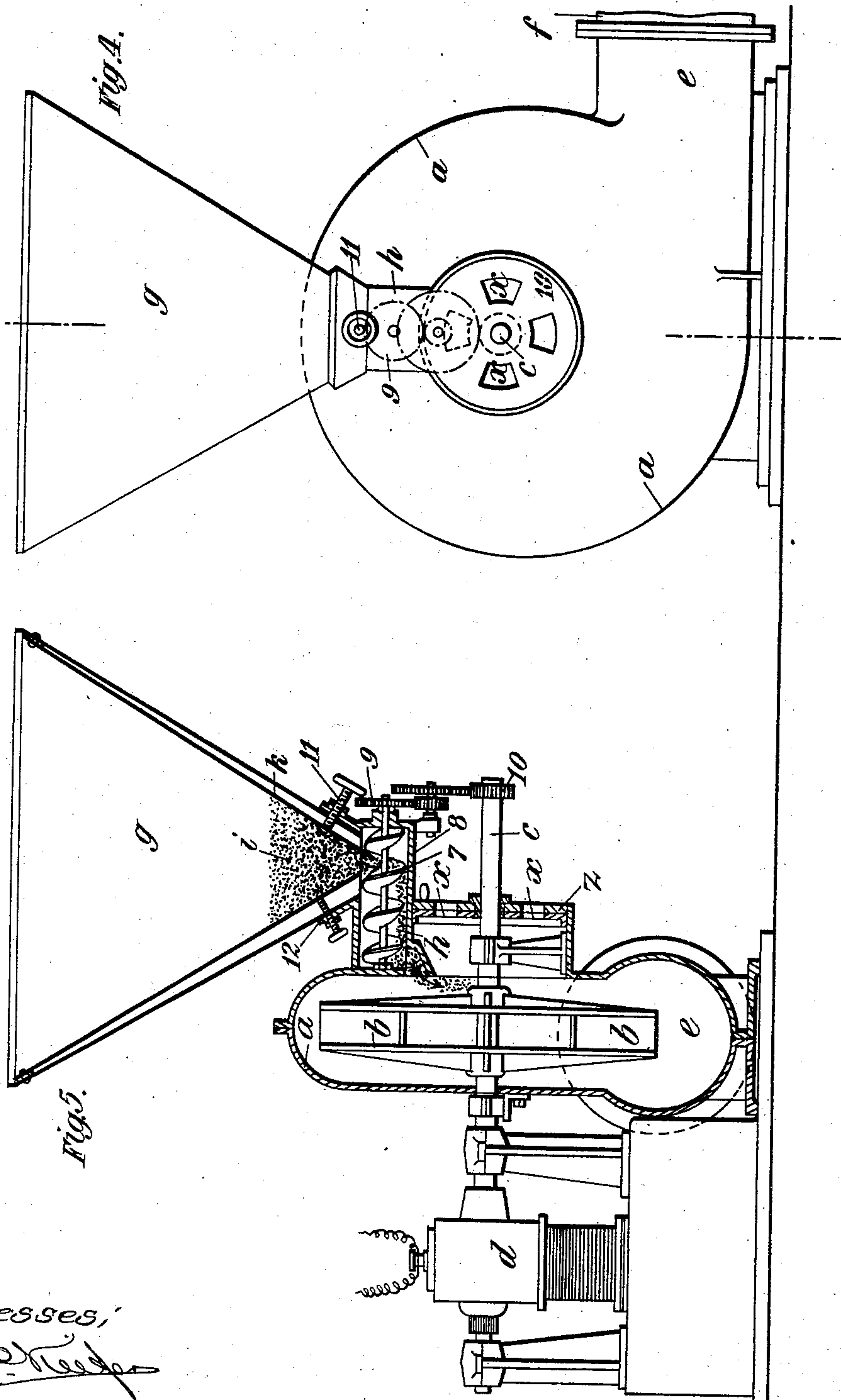
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2 Sheets—Sheet 2.



Witnesses,
J. B. Rea
Geo. W. Rea.

Inventor
George M. Warner
By *James L. Norris*

UNITED STATES PATENT OFFICE.

GEORGE M. WARNER, OF BROOKLYN, NEW YORK, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE CENTRAL CYCLONE COMPANY, LTD., OF LONDON, ENGLAND, A CORPORATION.

APPARATUS FOR SUPPLYING FUEL TO FURNACES.

SPECIFICATION forming part of Letters Patent No. 707,992, dated August 26, 1902.

Application filed May 29, 1901. Serial No. 62,415. (No model.)

To all whom it may concern:

Be it known that I, GEORGE M. WARNER, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented new and useful Improvements in Apparatus for Supplying Fuel to Furnaces, of which the following is a specification.

This invention relates to apparatus of the kind employed for supplying to steam-generator or other furnaces coal or other appropriate fuel in a finely-divided condition intimately mixed with a sufficient quantity of air to insure complete combustion.

The chief objects of the invention are to provide novel means for feeding, mixing, agitating, and regulating the feed of the pulverized fuel and also to so construct the apparatus that the amount of air forced or drawn through the said apparatus regulates the quantity of fuel supplied to the furnace.

In the accompanying drawings I have illustrated a convenient manner of carrying my invention into practice.

Figure 1 is a side elevation, and Fig. 2 a vertical transverse section taken approximately on the line A A of Fig. 1, showing a fan driven by an electromotor for supplying the pulverized fuel from a hopper situated above the said fan. Fig. 3 is a vertical section of a device which is in communication with the steam in the steam-generator and is connected electrically with the aforesaid electromotor. Figs. 4 and 5 are respectively a side elevation and a vertical cross-section showing a modified form of the apparatus.

In all the figures like characters of reference indicate similar parts.

a is the casing of the fan inclosing the rotary vanes *b*, which are of any ordinary construction mounted upon a shaft *c*, which in the examples illustrated is directly connected with an armature-shaft of the electromotor *d*. *e* is an outlet from the said fan leading through a nozzle *f* to the furnace of the steam-generator.

g is the hopper, which is supported above the fan by a chute or conduit *h* and communicates with the latter through an opening *i*. The pulverized coal or other fuel is supplied

through the hopper *g* from any suitable crushing or pulverizing machine, preferably one of the kind known as the "Cyclone" pulverizer.

Referring more particularly to Figs. 1 and 2, *j* is a fluted or corrugated drum or roller situated near the upper end of the chute or conduit *h*. This fluted or corrugated drum or roller operates in conjunction with a vibrating plate *k*, which is arranged within the said hopper *g* at an inclination to the vertical, so as to guide the pulverized fuel toward the fluted roller. The said plate is preferably made of flexible metal and fixed at its upper end to the said hopper. Its lower edge bears upon the said fluted roller *j*, so that as the said roller revolves the plate *k* is caused to vibrate, thereby agitating the pulverized fuel within the hopper and preventing it from clogging or choking the conduit leading to the fan. The shaft of the said roller *j* is provided with a sprocket-wheel *l*, to which is geared by a chain *m* another sprocket-wheel *n*, mounted on a shaft *o*. The shaft *o* is mounted in bearings carried by a bracket *p* and is furnished with a worm-wheel *q*, gearing with a worm *r*, which is mounted on the aforesaid motor-shaft *c*. The aforesaid sprocket-gearing is so arranged that the speed at which the roller *j* is driven from the shaft *c*, as aforesaid, will cause the pulverized fuel to enter the fan in a definite ratio relatively to the air forced by the fan through the aforesaid nozzle *f*, this ratio being well understood by persons acquainted with this class of apparatus. It will therefore be obvious that by the aforesaid sprocket and worm gearing connecting the said roller *j* with the said shaft *c* the amount of pulverized fuel fed to the fan by the roller *j* will vary in accordance with the speed at which the shaft *c* of the fan is driven, the correct ratio between the pulverized fuel and air being at all times maintained. The aforesaid worm *r* is so mounted on the shaft *c* that by sliding it along said shaft by the movement of a clutch-lever the feed-gearing can be thrown into or out of action when desired. In addition to the aforesaid vibrating plate *k* the hopper *g* is provided with another flexible metal plate *t*, which is secured to said hopper at its upper

end and is formed at its lower end with an extended portion *u*, which projects below the plane of the said roller *j* and lies in contact with a set-screw *v*, carried by the chute or conduit *h*. By means of this adjusting-screw the position of the said plate relative to the said roller can be regulated, and consequently the quantity of pulverized fuel admitted to the fan by the roller *j* can be readily controlled by the person in charge of the apparatus in order to bring about the aforesaid correct ratio between the pulverized fuel and air, as aforesaid. This plate *t* may be kept pressed toward the roller and set-screw by its own resiliency or by a suitably-arranged spring. The flexible nature of the said plate *t* permits any large pieces of fuel which may on rare occasions inadvertently enter the hopper to pass the said roller *j* without damaging the apparatus or interfering with its proper action. *w w* are openings in the wall of the chute or conduit *h* through which air can pass and enter the said chute or conduit, so as to mix with the fine particles of the pulverized fuel prior to their entering the fan, so that they will enter the latter in the form of a cloud or dust, which greatly assists in preventing an accumulation or deposit of the fuel at the bottom of the fan-casing. If desired, these openings *w* may be controlled by an adjustable plate, so that the quantity of air passing through them can be regulated. *xx* are the openings in the fan-casing through which the main supply of air is drawn into the fan, these openings being regulated by the rotary plate *z*, as is well understood.

In order to regulate the speed of the electromotor *d* in accordance with the steam-pressure in the generator, I may employ apparatus of the kind represented in Fig. 3, which comprises a cylinder 1, connected with the steam in the generator by a pipe 2 and containing a piston, having a rod extending through a suitable gland and stuffing-box on said cylinder. The outer end of this piston-rod is coupled by links 3 to a weighted or spring-controlled lever 4, having its fulcrum at 5. This weighted lever works in conjunction with a rheostat-catch 6 6 and the contact-points of the said rheostat being connected with the aforesaid electromotor *d* and with the dynamo employed for driving the said motor. It will therefore be seen that as the said weighted lever is shifted up or down by the action of gravity in one direction and by the pressure of the steam acting through the piston in the cylinder 1 in the opposite direction more or less electric current will be permitted to flow to the motor and its speed thereby be increased or diminished. As already stated, the speed at which the shaft *c* of the motor is driven regulates the speed at which the speed of the roller *j* works, and consequently the pressure of the steam within the generator will regulate the quantity of fuel and air supplied to the furnace of said generator.

Referring now more particularly to Figs. 4 and 5, I have there shown a modified form of the feed-roller *j*, which comprises a revolving worm or Archimedean screw 7, contained within the casing 8, which is connected with or forms part of the chute or conduit *h*. The shaft of this worm or screw is provided with a toothed wheel 9, which is connected by intermediate gearing to a toothed wheel 10 on the shaft *c*. The lower end of the aforesaid vibrating plate *k* rests between or engages with the teeth or threads of the worm or screw, so that as the latter revolves the said vibratory plate will be permitted to fall or escape from one thread to another, thereby giving rise to the aforesaid vibratory movement of this plate. 11 is a set-screw for adjusting the position of the lower end of this plate *k* relatively to the worm or screw 7. The other plate with which the said hopper *g* is provided does not, as in the previous example, extend below the plane of the feed device, but terminates at a short distance above the same. It is, however, provided with a set-screw 12, so that the lower edge thereof can be brought nearer to or farther from the plate *k*, thereby regulating the opening in the hopper through which the pulverized fuel reaches the worm or screw 7. In other respects the apparatus illustrated by these figures is similar to that already described with reference to Figs. 1 and 2.

I wish it to be understood that although I have illustrated my apparatus constructed with a rotary fan for supplying the pulverized fuel and air to the furnace and have shown said rotary fan as being driven by an electromotor I do not desire to be limited thereto. For instance, instead of a rotary fan I may employ a blower or any other device for creating the requisite current of air, and such device may be driven by a steam-engine, gas-engine, or other appropriate motor. I also wish it to be understood that I do not desire to confine myself to the specific form of feeding device with which the apparatus is provided, as there are a variety of means whereby the feeding of the fuel from the hopper to the fan or other air-supplying device can be regulated.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan for supplying the air, of a hopper, of a feeding device located between the hopper and the said fan and normally supporting the body of fuel, of a device for agitating the fuel in said hopper and in contact with and operated directly by said feeding device and of means whereby the quantity of fuel supplied from the hopper to the furnace is determined by the speed of the fan, for the purpose specified.

2. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan for supplying the air, of a hopper,

of a feeding device located in said hopper, of an agitating device between the hopper and the said fan and normally supporting the body of fuel in contact with and operated directly by said feeding device and of means whereby the quantity of fuel supplied to the furnace from the hopper is determined by the speed of the motor-fan for the purpose specified.

3. In apparatus for supplying pulverized fuel and air to furnaces the combination of a motor-fan for supplying the air, of a hopper, of a feeding device located between the hopper and the said fan and normally supporting the body of fuel, of an agitating device in said hopper in contact with and operated directly by said feeding device, of adjustable means for regulating the outlet of said hopper and of means whereby the quantity of fuel supplied to the furnace from the hopper is determined by the speed of the motor-fan.

4. In an apparatus for supplying pulverized fuel and air to furnaces the combination of a motor-fan, a hopper, a feeding device between the hopper and the said fan and normally supporting the body of fuel, an agitating device situated in said hopper and in contact with and operated directly by said feeding device and of gearing coupling the motor-fan with the feeding device for the purpose specified.

5. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan, of a hopper, of a feeding device between the hopper and the said fan and normally supporting the body of fuel, of an agitating device situated in said hopper and in contact with and operated directly by said feeding device, of adjustable means for controlling the quantity of fuel delivered from said hopper, and of gearing coupling the motor-fan with the feeding device for the purpose specified.

6. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan, of a hopper, of a feeding device located between the hopper and the said fan and normally supporting the body of fuel, of a conduit situated between said hopper and said fan, of an agitating-plate situated in said hopper and in contact with and operated directly by said feeding device, of an adjustable plate for controlling the outlet of said hopper and of means working in conjunction with the said fan and the said feeding device for the purpose specified.

7. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan, of a hopper, of a fluted roller located in said hopper, of a conduit situated between said hopper and the fan, of a flexible plate situated in said hopper and having its lower edge engaging with said roller, of an adjustable flexible plate situated in said hopper for regulating the outlet of said hopper and of gearing connecting the axle of said

roller and the driving-shaft of said fan for the purpose specified.

8. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan, of a hopper, of a fluted roller located in said hopper, of a conduit situated between the said outlet and the fan and having air-inlet openings in its walls, of a flexible plate situated in said hopper and having its lower edge engaging with said fluted roller, of an adjustable flexible plate situated contiguous to the outlet of said hopper and said roller, of gearing connecting the said roller to the driving-shaft of the fan for the purpose specified.

9. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan, of a surrounding casing for said fan having suitable air-inlet openings in its walls, of means for adjusting said inlets, of a hopper, of a fluted roller located in said hopper, of a conduit situated under the outlet of said hopper and communicating with the fuel-inlet of said fan, of a flexible plate situated in said hopper and having its lower end in engagement with said fluted roller, of an adjustable flexible plate for regulating the outlet of said hopper and of gearing connecting the axle of said roller with the driving-shaft of said fan for the purpose specified.

10. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan, of a surrounding casing for said fan having suitable air-inlet openings in its walls, of a movable perforated plate for adjusting said openings, of a hopper, of a fluted roller located in said hopper of a conduit communicating with the outlet of said hopper and with the fuel-inlet of said fan, of a flexible plate situated in said hopper and having its lower edge in engagement with said fluted roller, of an adjustable flexible plate for regulating the outlet of said hopper and of gearing connecting the axle of said roller with the driving-shaft of said fan, for the purpose specified.

11. In apparatus for supplying pulverized fuel and air to furnaces, the combination of a motor-fan for supplying the air, of a casing surrounding said fan having air-inlet openings in its walls, of a movable perforated plate for adjusting said openings, of a hopper, of a fluted roller located in said hopper, of a conduit communicating with the outlet from the hopper and with the fuel-inlet in said fan-casing, of a flexible plate situated in said hopper and having its lower edge in engagement with said roller, of an adjustable flexible plate in said hopper for regulating the said outlet, of a screw for adjusting the position of said plate relatively to said roller and of gearing connecting the axle of said roller with the shaft of said fan for the purpose specified.

12. In a machine for feeding pulverized fuel, the combination with a fan-casing and a spout communicating therewith, of a grooved feed-

roller mounted in the spout, and a spring-bar having one end secured above the roller and its lower end located within the spout and extending into one or the other of the grooves of said roller, substantially as described.

13. In a machine for feeding pulverized fuel, the combination with a fan-casing and a spout communicating therewith having a hopper, of a grooved feed-roller mounted in the spout and a spring-bar mounted in the hopper and adapted to be continuously vibrated by the feed-roller, substantially as described.

14. In a machine for feeding pulverized fuel, the combination with a fan-casing and a spout communicating therewith, of a grooved feed-roller mounted in the spout and an adjustable spring-arm having a free, depending straight portion bearing with a yielding pressure against the surface of said roller, substantially as described.

15. In a machine for feeding pulverized fuel, the combination with a fan-casing and a spout communicating therewith, of a grooved feed-roller mounted in the spout, a spring-arm normally bearing against the surface of said roller and having a free depending portion extending below the same and a set-screw adapted to engage said depending portion for adjusting the position of said arm relative to the roller, substantially as described.

16. In a machine for feeding pulverized fuel, the combination with a fan-casing and a spout communicating therewith, of a horizontally-disposed grooved feed-roller mounted in the spout, a spring-arm having a depending, vertical portion normally bearing intermediate its end against the side of said roller, and a set-screw having its end engaging the free end of said spring-arm for adjusting the position of the spring-arm relative to the roller, substantially as described.

17. In a machine for feeding pulverized fuel, the combination with a fan-casing and a spout communicating therewith, of a grooved feed-roller mounted in the spout; a spring-bar having a free end extending into one of the other

of the grooves of the roller, a spring-arm normally bearing with a yielding pressure against the surface of said roller, and means for adjusting the position of said arm relative to said roller, substantially as described.

18. In a machine for feeding pulverized fuel, a fan-casing, a housing surrounding the suction-opening of said fan-casing, and having an air-inlet, a chute communicating with the interior of said housing at one end, and having a feed-hopper at its opposite end, a feed-roller mounted in said chute, a rotary fan in said casing, and a driving connection between said fan and said roller, substantially as described.

19. In a machine for feeding pulverized fuel, a fan-casing, a housing surrounding the suction-opening of said fan-casing and having an air-inlet, a chute mounted upon said casing, and having above the casing an air-opening and communicating at its lower end with the interior of said housing and having a feed-hopper at its upper end, a feed-roller mounted in said chute, a rotary fan in said casing and a driving connection between said fan and said roller, substantially as described.

20. In a machine for feeding pulverized fuel, a fan-casing, a housing surrounding the suction-opening of said fan-casing and having a damper-controlled air-inlet, a chute mounted upon said casing and having above the casing an air-opening and communicating at its lower end with the interior of said housing and having a feed-hopper at its upper end, a feed-roller mounted in said chute, a rotary fan mounted in said casing, and a driving connection between said fan and said roller, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

GEORGE M. WARNER.

Witnesses:

ELIZ. V. REILLY,

WM. LAWRENCETHORN.