No. 658,069. Patented Sept. 18, 1900.

F. H. LEWIS.

METHOD OF FEEDING PULVERIZED FUEL.

(Application filed Oct. 17, 1899.)

(No Model.) 2 Sheets—Sheet 1.

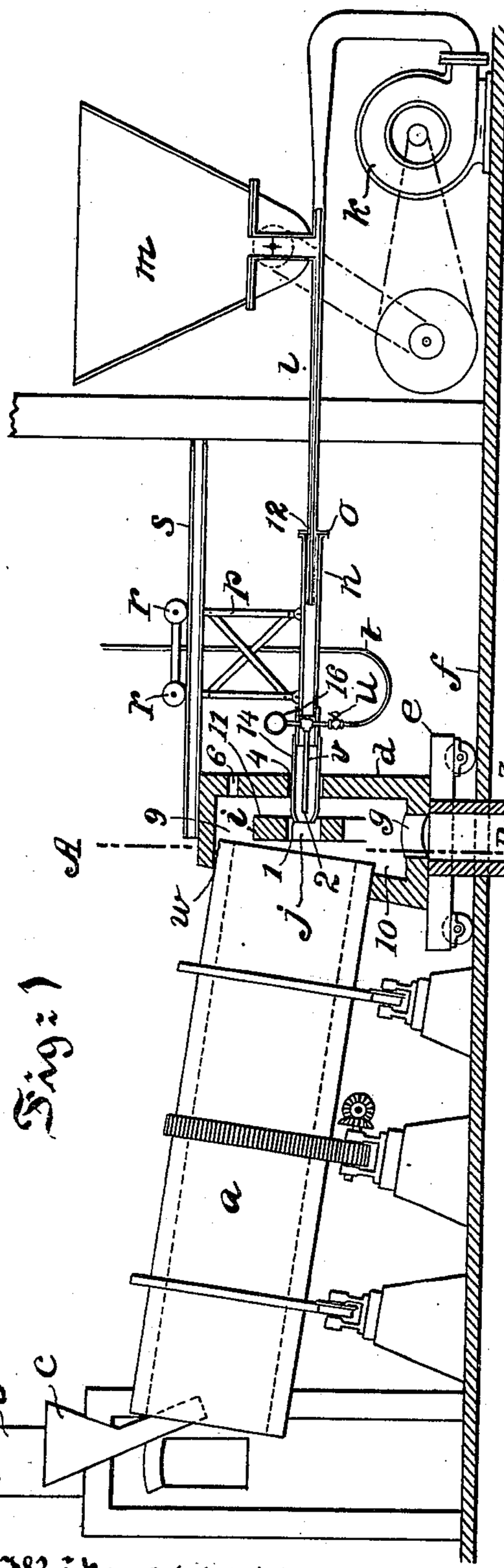

Fig. 1

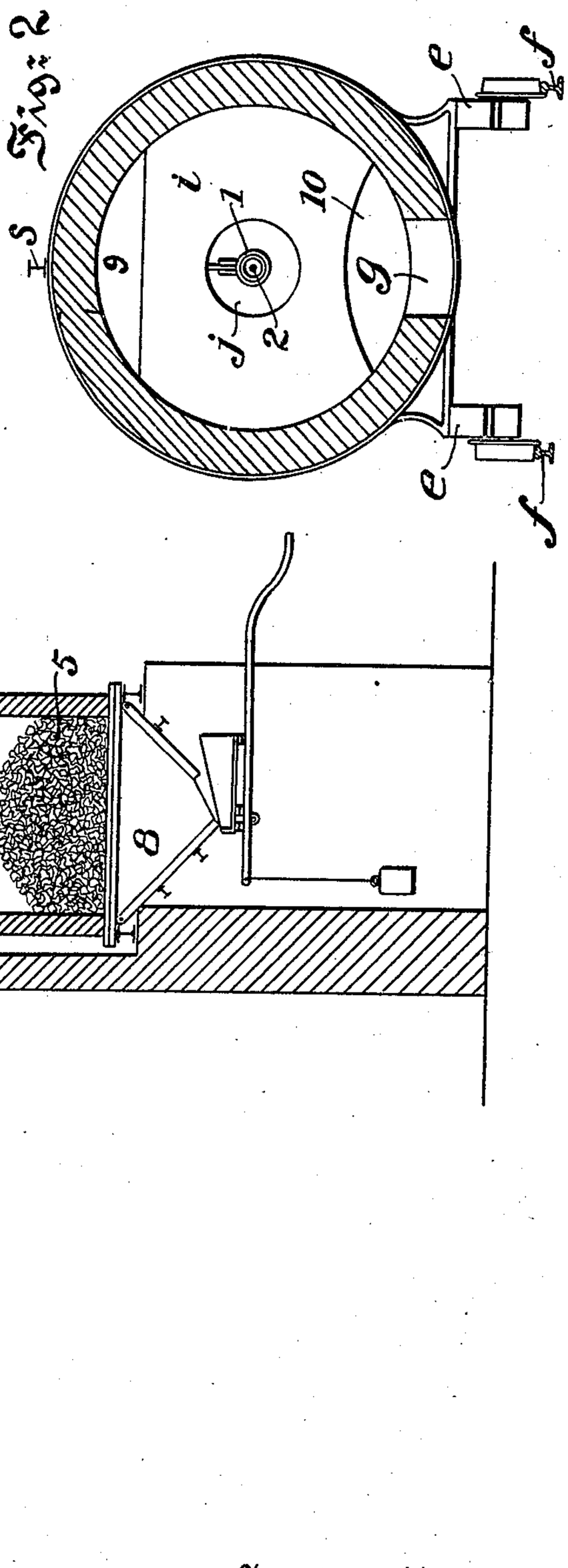

Fig. 2

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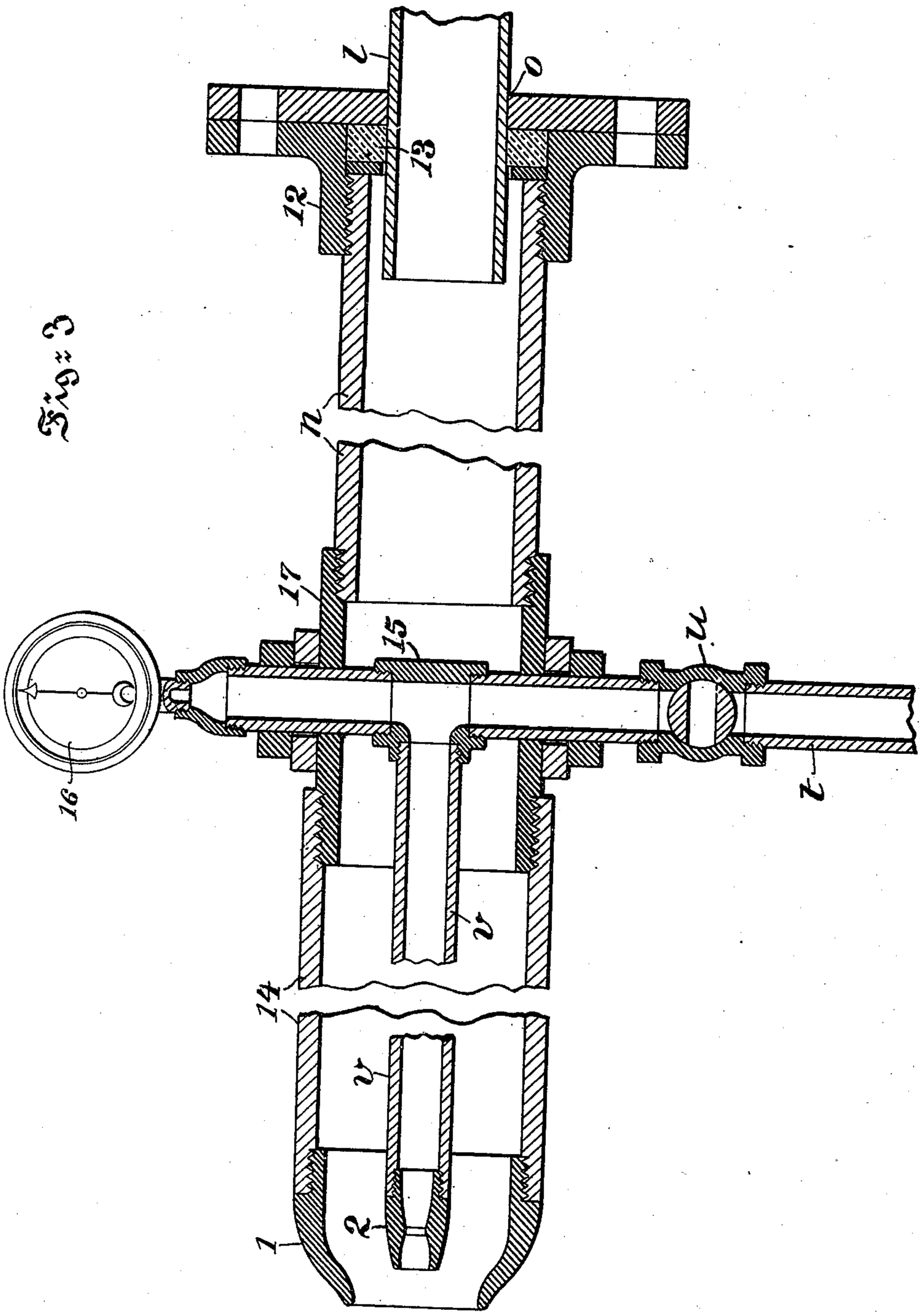
Fig. 3.



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METHOD OF FEEDING PULVERIZED FUEL.

SPECIFICATION forming part of Letters Patent No. 658,069, dated September 18, 1900.

Application filed October 17, 1899. Serial No. 733,863. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK H. LEWIS, a citizen of the United States, and a resident of the city and county of Philadelphia, State of Pennsylvania, have invented certain new and useful Improvements in Methods of Feeding Pulverized Fuel, of which the following is a specification.

My invention relates to improvements in processes of feeding pulverized fuel; and it consists in certain improvements particularly applicable to kilns of the rotary-cylinder type for roasting cement-rock or other materials.

The object of my invention is to secure a more complete combustion and consumption of powdered fuel in processes of the class referred to, whereby more economical and superior results are attained as compared with present processes.

The usual rotary-kiln process of roasting cement-rock consists in introducing the raw material or rock to the upper end of an inclined rotary cylinder, whereby the material passes through said cylinder and drops out at the lower end thereof. In its passage through the cylinder the material is constantly tumbled by the revolution of said cylinder, thus bringing all of its particles into contact with the flame. This flame is produced by the combustion of finely divided or powdered coal, which is injected into the lower or delivery end of the cylinder by means of an air-blast. The powdered fuel is fed from a hopper or bin into a duct which leads into the furnace, an air-blast being employed to convey the fuel from said hopper into and through said duct into the cylinder. Introduced in this way the coal burns uneconomically. With a moderate blast it burns in a long flame extending through a considerable part of the length of the kiln, while with a stronger blast combustion is imperfect and large quantities of unconsumed coal escape from the chimney. These methods are both objectionable, the first because the zone of high temperature is unnecessarily long, and the second because a large percentage of fuel is wasted by being blown out of the stack unconsumed. Both methods are wasteful of fuel and productive of smoke, soot, and cinders. My improved method involves some of the steps of the well-known process just referred to and also certain additional steps, which will now be described. I make use of a moderate air-blast to carry the finely-divided fuel from the storage bin or hopper to the rotary cylinder; but in addition to this feed-blast I will employ what I will term an "inducing-blast." This is a blast of air of small diameter as compared to the feed-blast and of high pressure, introduced into the duct which conveys the fuel to the kiln a short distance to the rear of the delivery end or nozzle of said duct, and the chief function of which is to induce a current of air in front of the nozzle of said duct sufficient to supply oxygen for securing practically-complete combustion of the fuel in the lower portion of the cylinder. One important feature of my improved method is that most of the induced air created by the inducing-blast is drawn in through the hot clinker-bed below the furnace and that it is thus heated before reaching the kiln and is, in fact, a hot blast, whereby a maximum of heat is secured with smaller fuel consumption. By this process sufficient air is supplied to support combustion of the pulverized fuel without imparting such force to such fuel as will project it through the combustion-chamber into the chimney.

In the accompanying drawings I have illustrated a suitable apparatus in which my improved process may be practiced.

In said drawings, Figure 1 is a view, partly in side elevation and partly in vertical central section, of the entire apparatus. Fig. 2 is a section on the line A B of Fig. 1 on an enlarged scale. Fig. 3 is a view, on a still larger scale, of the discharge end or nozzle of the fuel-duct, the same being shown in longitudinal vertical central section and with the central portion of the same broken away.

The apparatus which I have herein illustrated is constructed as follows:

The rotary open-ended cylindrical kiln *a*, supported and operated in the usual manner, is constructed at its upper end with a stack *b* and a feeding-hopper *c* for containing the material to be roasted. The lower or delivery end of the cylinder communicates with and is surrounded by a hood *d*, having an opening *w* in one end through which the delivery end of the cylinder projects when the hood is in its operative position. The hood is mounted

upon a truck *e*, adapted to travel back and forth upon a track *f*. By this construction the hood may be moved into proper operating position, or it may be withdrawn to expose the end of the cylinder, thus giving easy access to the same when desired. So far as described the apparatus is of the usual and well-known description, and it will be unnecessary to further illustrate or describe the details thereof.

In accordance with my invention a clinker-pit 5 is located beneath the delivery end of the cylinder and below the level of the track *f*, on which the hood-supporting truck *e* is adapted to travel. Projecting from the top of said clinker-pit and communicating therewith is a chute 7, which registers with an opening *g* in the bottom of the hood *e* when the same is in position to close the delivery end of the cylinder. After the hood is in position the joint between it and the chute 7 may be made tight by fire-clay mortar. The hot roasted rock or clinker falling from the revolving cylinder will drop through the opening *g* and chute 7 into the clinker-pit 5, which is simply a shallow chamber with an open grate 8 below. A partition or arch *i* is located within the hood *d* and extends from side to side thereof. There is a space 9 between the top of said partition and the top of the hood, a space 10 between the bottom of said partition and the bottom of the hood, and a space 11 between the partition and the closed end of the hood. The partition is also provided with a central aperture *j*, which is opposite an opening 4 in the closed end of the hood. The purpose of the partition *i* will be explained farther on.

The powdered fuel is fed to the cylinder through a duct *l*, which communicates with a hopper *m*, located above the duct, near the end thereof farthest from the cylinder. A blower of any suitable form or construction, but in this instance shown as consisting of an ordinary fan-blower *k*, is provided at the outer end of the duct for forcing the powdered fuel into the kiln, as is common in furnaces of this character. This blower will be hereinafter referred to as the "feed-blower."

The discharge end of the duct *l* is provided with an ejector, the details of which are best illustrated in Fig. 3. This ejector consists of a fuel-ejector nozzle 14, having telescopic connection with the duct *l*, the said duct passing through a sleeve 12, secured to the rear end of the nozzle and provided with suitable packing 13. The front end of the nozzle passes through the before-mentioned opening 4 in the closed end of the hood, and consequently comes opposite to or enters the central aperture *j* of the partition *i*. The nozzle 14 is preferably supported by means of a hanger *p*, which is suspended from a track *s*, the hanger being capable of being moved along the track by means of rollers *r r*. In this way the nozzle is not only supported in the proper vertical position, but it may be horizontally adjusted relatively to the cylinder or moved entirely away therefrom for the purpose of inspection or repairs or whenever the hood *d* is moved away from the cylinder, as before described. An air-nozzle *v* is placed concentrically within the fuel-nozzle 14 and has suitable connection with some source of air under high pressure. The air-nozzle *v* is shown as being connected to and communicating with a cross-pipe 15, which passes transversely through the fuel-nozzle some distance in rear of its front end. Connected to one end of this cross-pipe is a supply-pipe *t*, which connects with any suitable supply of compressed air, which is not herein shown. A stop-cock *u* may be located in the pipe *t*, if desired, for turning on and off and regulating the amount of air supplied to the air-blast nozzle. A pressure-gage 16 may be connected to the opposite end of the cross-pipe 15, if desired. Obviously the air-blast nozzle may be supported within the fuel-ejector nozzle and connected with the air-supply in any desired manner, and the stop-cock *u* and the pressure-gage 16 may be dispensed with.

The ends of the fuel and air nozzles are shown as provided with nosepieces or nipples 1 and 2, respectively, which are connected thereto by screw-threads in order that any desired size, shape, or character of nosepieces may be employed to meet varying conditions and requirements. I prefer to construct the fuel-ejector nozzle in sections, the front section 14 having screw-threaded connection with the rear section *n* through the instrumentality of an intermediate or union section 17, through which the cross-pipe 15 is shown as passing. The chief advantage of this construction is that the nosepiece of the outer nozzle may be adjusted relatively to the nosepiece of the inner nozzle for the purpose of obtaining the best results.

When the parts of the apparatus are in working position, as illustrated in Fig. 1, the fuel-ejector nozzle passes through the opening 4 in the closed end of the hood *d*, and as the central aperture *j* of the partition *i* is in alinement with said opening 4 the said nozzle is in position to deliver the fuel through the aperture and may be adjusted relatively thereto to produce the best and most economical results.

In the operation of an apparatus such as I have described it will be seen that the feed-blast created by the blower *k* is sufficient to carry the pulverized fuel to the cylinder and that the inducing-blast of high pressure issuing from the nozzle *v* causes induced currents of extraneous air to flow into the flame. Owing to the novel location and construction of the clinker-pit 5 the induced air is caused to pass through the hot clinker contained in said pit, and the air is thereby heated before mingling with the fuel issuing from the ejector-nozzle. Of course some of the induced

air will be drawn in through the spaces between the cylinder and the hood, and, if desired, a hole or holes 6 may be made in the hood for the entrance of air at a normal temperature. The induction of air is greatly facilitated by the employment of the apertured partition *i*, which serves to confine the blast of fuel-laden air after it leaves the nozzle. As before explained, the position of the nozzle relatively to the aperture in the partition may be adjusted by means of the sliding or telescopic connection between the nozzle and the fuel-duct and the hanger carrying said nozzle. It will further be seen that by my improved process a considerable reduction in the cost of roasting cement-rock, &c., is attained over former methods, because not only is there greater economy in the consumption of fuel, but because complete combustion occurs in the lower end of the kiln. Obviously with the present methods the fuel is merely blown in and burns only as it may come in contact with heated air in the kiln-chamber. Hence it is either not fully consumed or else combustion occurs throughout the length of the kiln instead of at the lower end, where practically-complete combustion should take place to secure the proper and economical roasting of cement-rock in the manner which is accomplished by my improvements.

It will of course be understood that my improved process may be effected with any suitable form of apparatus and that my invention is not confined to the details herein shown and described.

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

1. The art of feeding the fuel elements to a zone of combustion to produce heat for an industrial purpose, which consists in introducing powdered carbonaceous fuel and oxygen to said zone by the joint action of impinging blasts of air projected into said zone simultaneously in the same direction at different velocities, to wit: a forced blast of comparatively-low velocity and large volume carrying the powdered fuel in suspension, an inducing-blast of high velocity and small volume, and an induced blast for the main supply of oxygen.

2. The art of feeding the fuel elements to a zone of combustion to produce heat for an industrial purpose, which consists in introducing powdered carbonaceous fuel and oxygen to said zone by the joint action of impinging blasts of air projected into said zone simultaneously in the same direction at different velocities, to wit: a forced blast of comparatively-low velocity and large volume carrying the powdered fuel in suspension, an inducing-blast of high velocity and small volume, and an induced heated blast for the main supply of oxygen.

3. The art of feeding the fuel elements to a zone of combustion to produce heat for an industrial purpose, which consists in introducing powdered carbonaceous fuel and oxygen to said zone by the joint action of impinging blasts of air projected into said zone simultaneously in the same direction at different velocities, to wit: a central inducing forced blast of comparatively-high velocity and small volume, a forced blast of comparatively-low velocity and large volume, surrounding the central inducing-blast and carrying the powdered fuel in suspension, and an induced blast of large volume outside the blast carrying the powdered fuel.

4. The art of feeding the fuel elements to a zone of combustion to produce heat for an industrial purpose, which consists in introducing powdered carbonaceous fuel and oxygen to said zone by the joint action of impinging blasts of air projected into said zone simultaneously in the same direction at different velocities, to wit: a central inducing forced blast of comparatively-high velocity and small volume, a forced blast of comparatively-low velocity and large volume, surrounding the central inducing-blast and carrying the powdered fuel in suspension, and an induced heated blast of large volume outside the blast carrying the powdered fuel.

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