(No Model.) 3 Sheets—Sheet 1.

H. RUDDICK.

APPARATUS FOR REDUCING AND PULVERIZING FUEL.

No. 388,375. Patented Aug. 21, 1888.

Fig. 5.

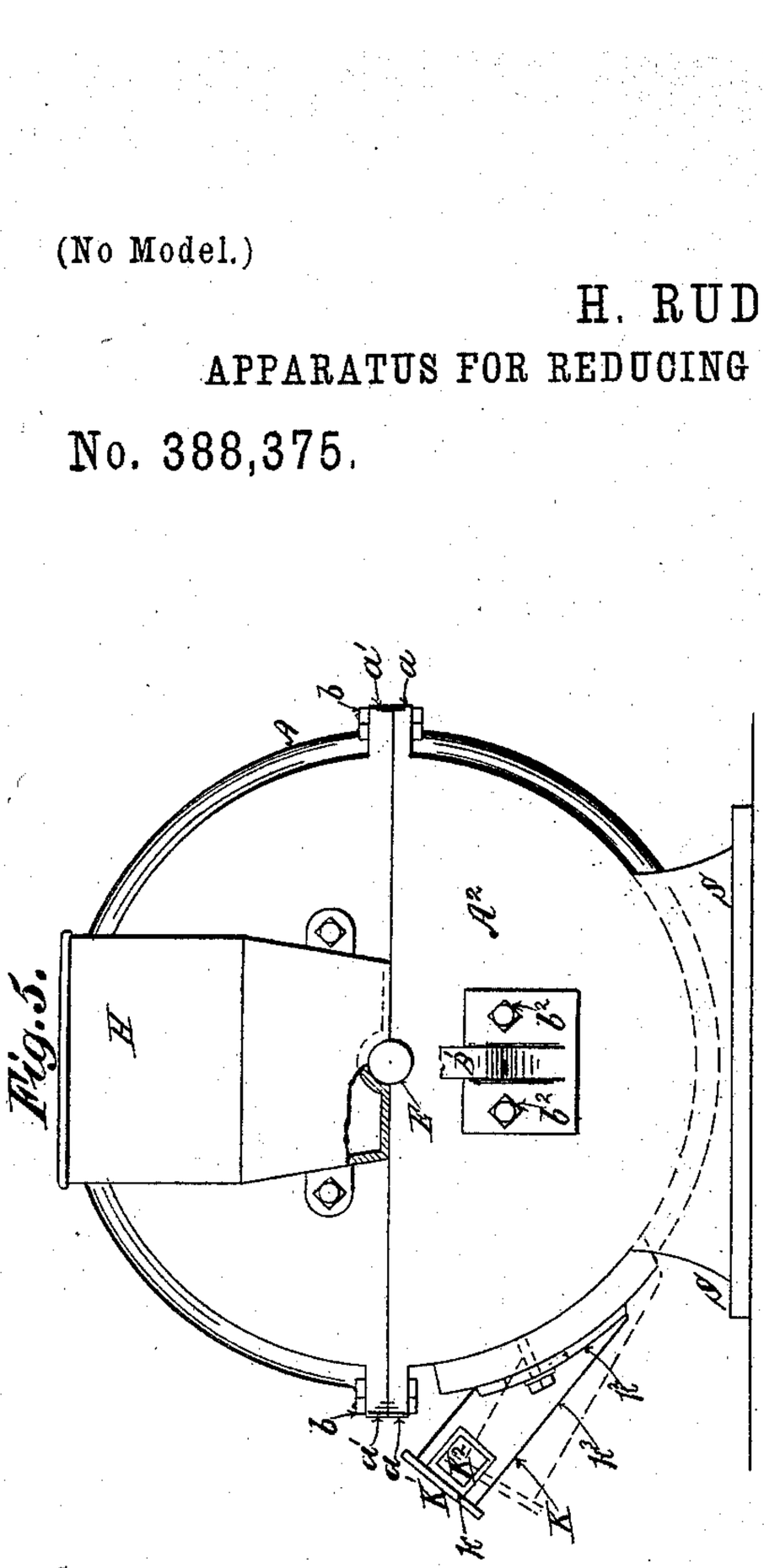


Fig. 6.

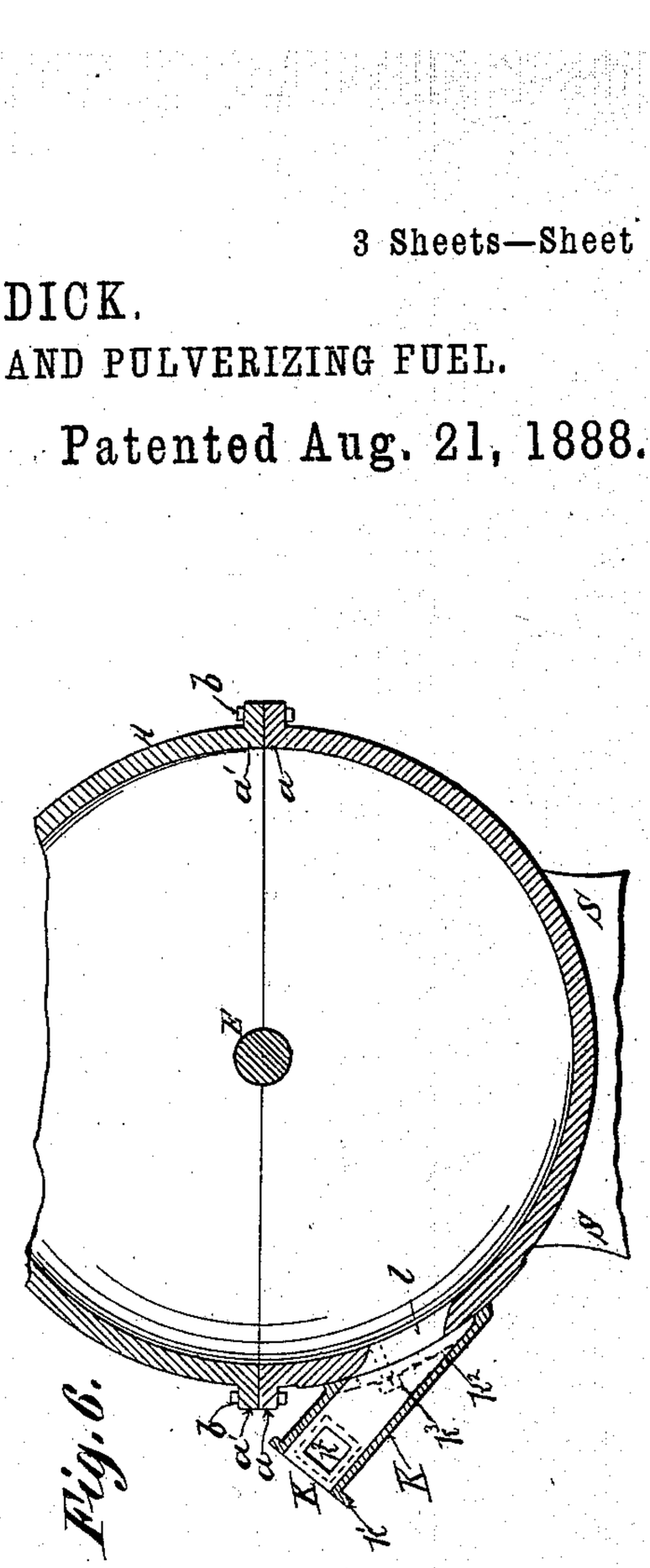


Fig. 1.

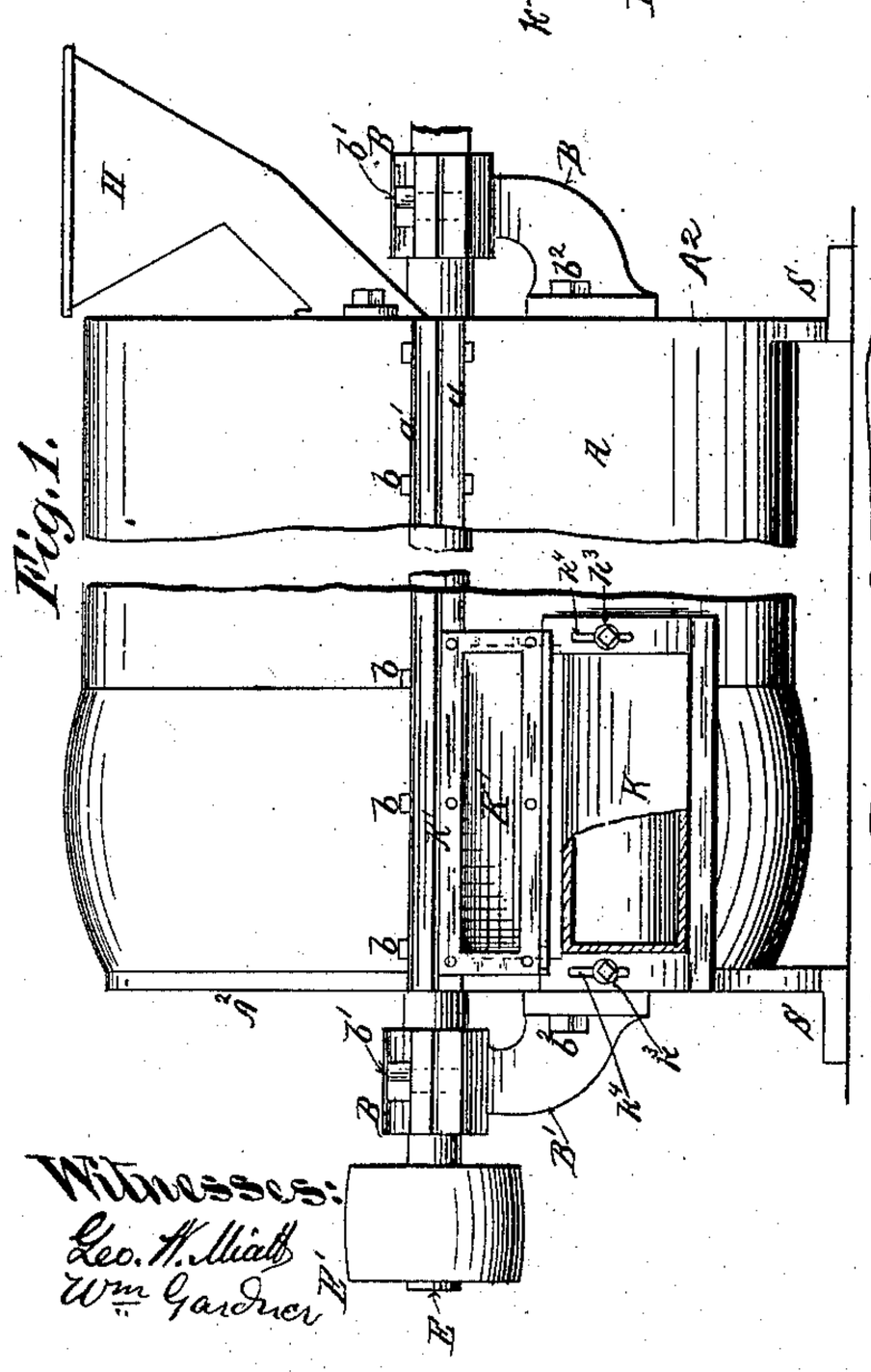
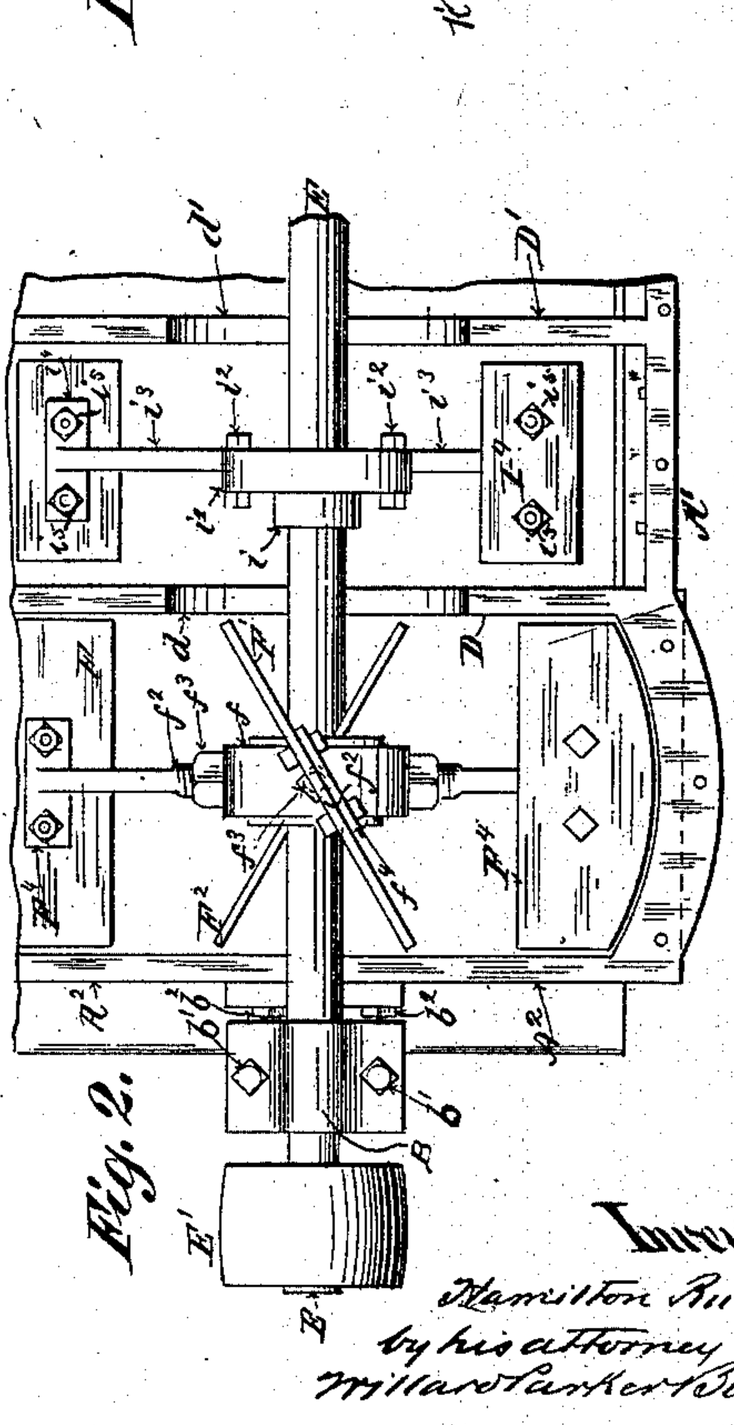


Fig. 2.



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(No Model.) 3 Sheets—Sheet 2.

H. RUDDICK.

APPARATUS FOR REDUCING AND PULVERIZING FUEL.

No. 388,375. Patented Aug. 21, 1888.

Fig. 3.

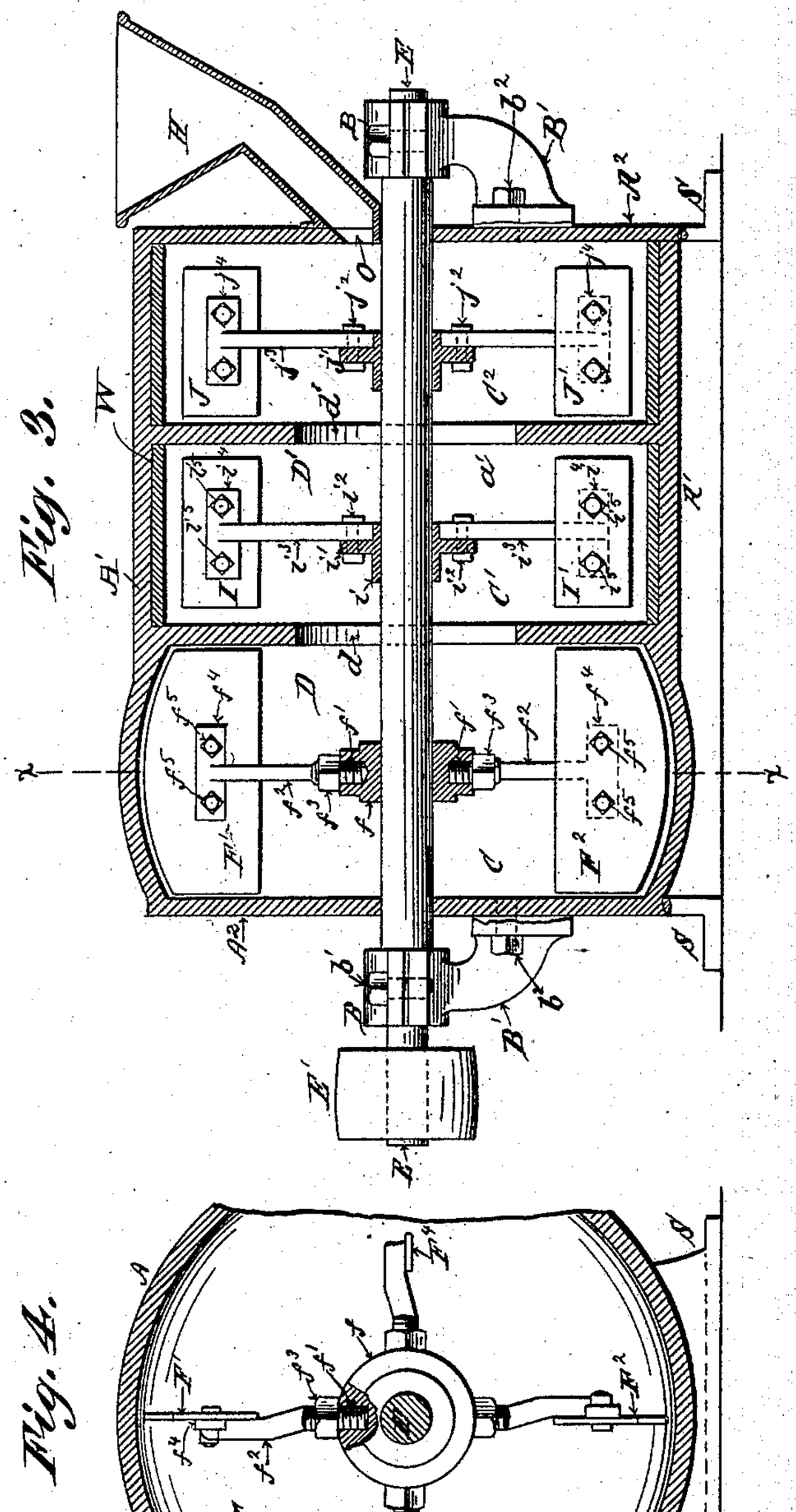

Fig. 4.

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(No Model.) 3 Sheets—Sheet 3.

H. RUDDICK.

APPARATUS FOR REDUCING AND PULVERIZING FUEL.

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Fig. 9.

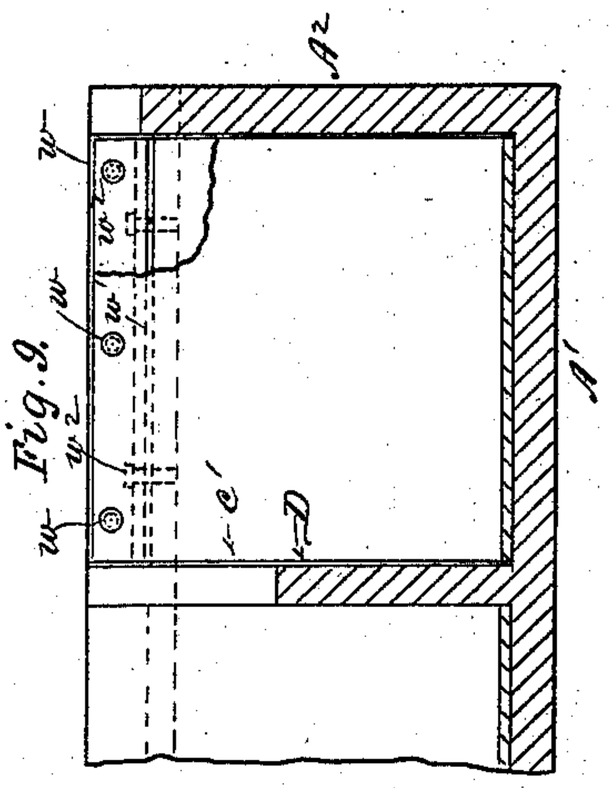


Fig. 10.

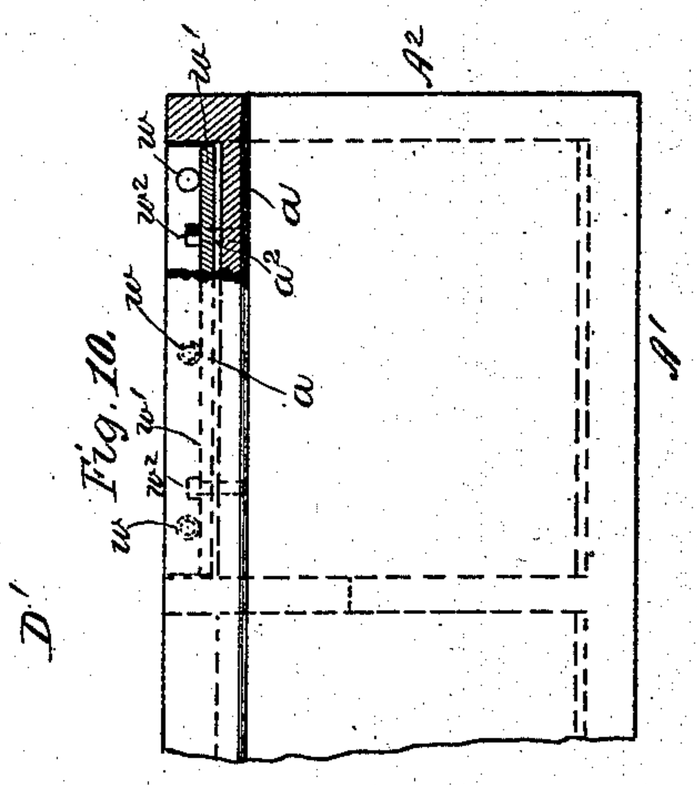


Fig. 7.

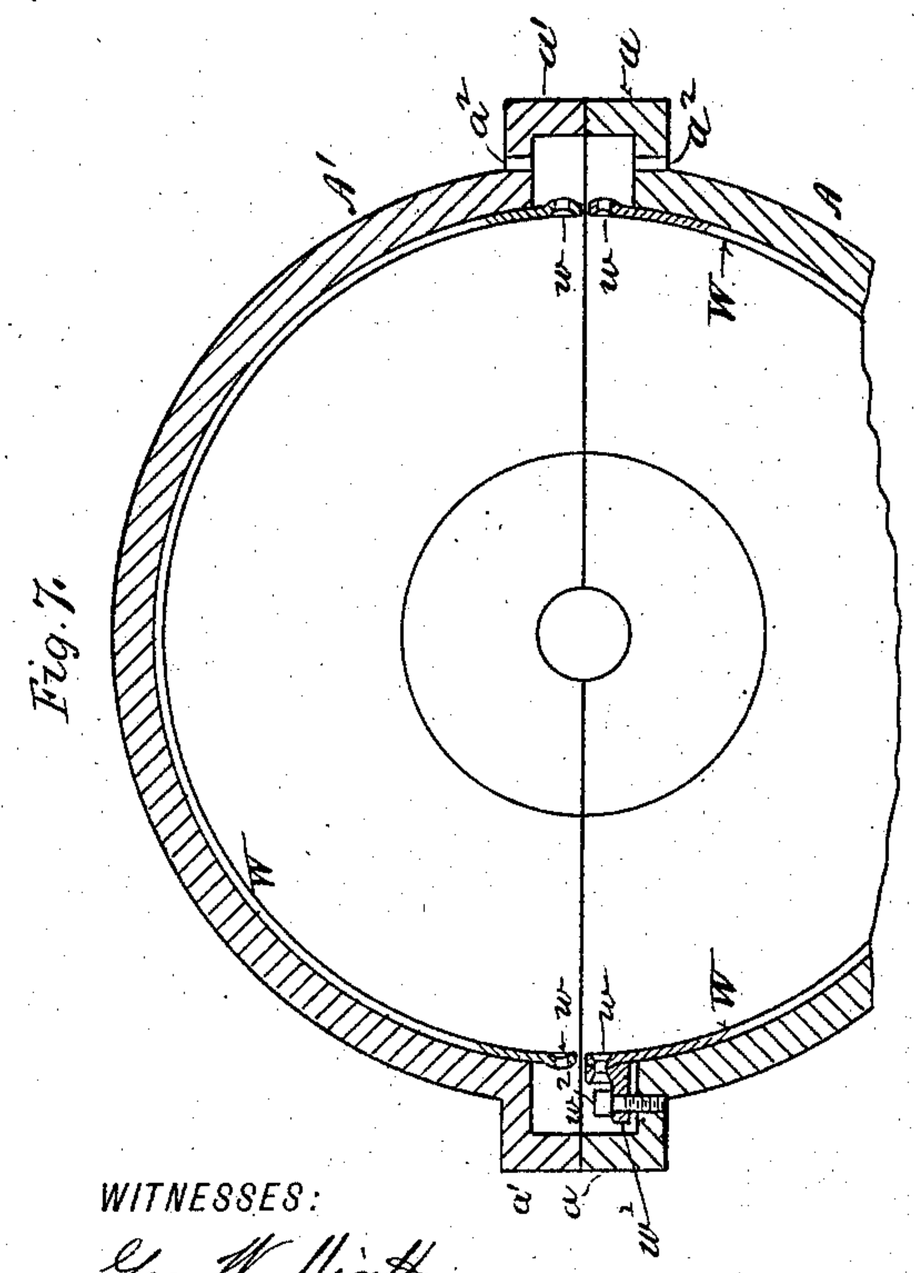


Fig. 8.

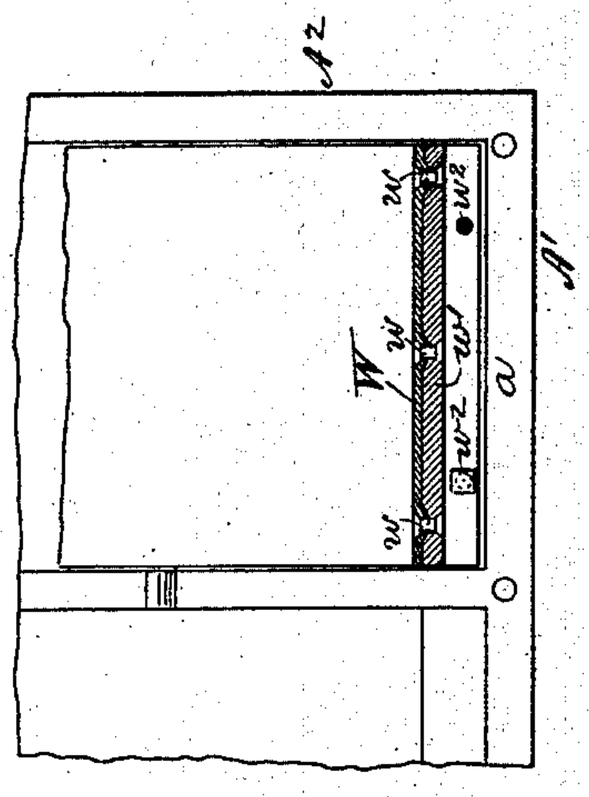
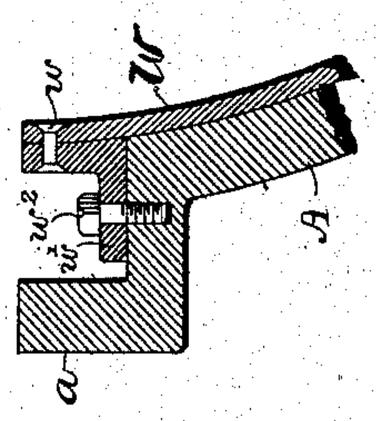


Fig. 7.a



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UNITED STATES PATENT OFFICE.

HAMILTON RUDDICK, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE PULVERIZED COAL AND FURNACE COMPANY, OF NEW YORK.

APPARATUS FOR REDUCING AND PULVERIZING FUEL.

SPECIFICATION forming part of Letters Patent No. 388,375, dated August 21, 1888.

Application filed November 6, 1885. Serial No. 181,995. (No model.)

To all whom it may concern:

Be it known that I, HAMILTON RUDDICK, a citizen of the United States, and a resident of the city of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Machines for Reducing and Pulverizing Fuel, of which the following is a specification.

My invention relates to improvements in machines for reducing and pulverizing mineral fuels, and for supplying the same mixed with sufficient air to insure perfect combustion to all classes of furnaces used in all varieties of economic purposes.

In preparing coal and other fuels for the market it has been found that a very large amount of the fuel is wasted by becoming broken into fine dust. In the case of coal this fine material is produced by the blasting out and the handling of the coal, and by breaking and preparing the various sizes in which it is sold. It accumulates in enormous quantities, and in most cases where attempts have been made to utilize the same such attempts have been usually unsuccessful, for the reason that such material is usually in too fine a state of division to permit of an ordinary draft being passed through it and a quantity of air sufficient to support active combustion being supplied, or to permit of a strong draft being used without lifting the fire from the grate and carrying a large portion of the fuel up the smoke-stack.

The object of my invention is to effect by mechanical means the utilization of all classes of low-grade fuels which have hitherto been wasted, as well as to effect more perfect combustion of, and consequently a diminution of, the consumption of all classes of fuels ordinarily used for all varieties of economic purposes. I accomplish these objects by means of a particular form of machine into which the crushed and pulverized coal or other fuel is fed, and in which it is then reduced into an impalpable dust, together with a quantity of air sufficient to produce perfect combustion, and which finally discharges the air and pulverized fuel at any point where the same may be conveniently consumed in any desired direction and in any convenient quantity. This machine reduces the fuel, after being introduced into the machine in a crushed condition to an impalpable or floated dust, and draws in air and mixes the same with the fuel automatically, so that each particle of fuel as it passes from the machine and enters the fire-box shall be surrounded by air sufficient for its combustion; and, lastly, it discharges the fuel and air automatically in desired quantities.

My invention will be best understood by reference to the accompanying three sheets of drawings, forming part of this specification, in which—

Figure 1 is an elevation of the machine; Fig. 2, a plan view of the interior of a part of the pulverizing-cylinder; Fig. 3, a vertical section of the entire pulverizer; Fig. 4, a vertical cross section upon the line *x x* of Fig. 3; Fig. 5, an end view of the pulverizer, showing the feeding-hopper partly broken away; Fig. 6, a vertical cross-section upon the line *x x* of Fig. 3, omitting the pulverizing and fan mechanism. Fig. 7 is a horizontal section of the cylinder, showing, generally, the arrangement of the lining fastening. Fig. 7ª is an enlarged detail view of the means for securing the lining. Figs. 8, 9, and 10 are views of details and show the manner of attaching the lining of the machine.

Similar letters refer to similar parts throughout the several views.

The machine is made in the form of a hollow cylinder, A, terminating at one end in the form of a section of a sphere, as shown in Figs. 1, 2, and 3. This cylinder and the hollow spheroid will vary in diameter according to the size of the machine. The end walls of the machine are parallel planes.

In the views, A′ represents the peripheral walls of the machine, and A^2 the end walls. The machine is made of cast-iron or any other convenient material, and the walls may be of any convenient thickness. In practice it will be found convenient to cast the cylinder in two horizontal sections, which are placed upon each other, as shown in Figs. 1, 5, 6, and 7. The lower section is cast with standards S at either end, and with a flange, *a*, at its upper surface, upon which rest corresponding flanges, *a*′, cast

upon the lower face of the upper section, as shown in the views. The two sections are held together by means of a series of screw-bolts, *b b*, passing through openings in the flanges, or in any other convenient manner. In practice, however, the cylinder may be composed of any convenient number of sections fastened together in any suitable manner.

The interior of the machine is divided into any convenient number of independent compartments or chambers, C C′ C², by means of a series of parallel vertical diaphragms, D D′. The first of these diaphragms D is placed at the point where the spherical walls intersect the walls of the machine, as shown in Figs. 2 and 3. In practice, two diaphragms are used which divide the cylinders into three compartments, as shown in the views. The compartments are connected with each other in the interior of the machine by means of one or more circular openings, *d d′*, in the diaphragms. Through the center of the cylinder, and consequently through the openings *d d′*, in the diaphragms, passes a horizontal shaft. E, which is supported upon exterior bearings, B B, made of anti-friction metal, which are carried upon brackets B′ B′, attached by the bolts b^2 b^2 to the vertical end walls, A^2 A^2, of the machine. The shaft may be of any convenient diameter, but must have sufficient strength to carry the rotary blowing-fan F and the rotary beaters I′ J′, and the bearings and their brackets will vary in size according to the size of the pulverizer and the weight of the rotary blowing-fan and the rotary beaters. Each compartment of the cylindrical portion of the machine contains a rotary beater of the general character shown in the drawings. Any number of rotary beaters may be arranged radially around the shaft E. In practice, however, four will be found most convenient, as shown in the views. In the blowing compartment C, at the closed end of the machine, the blades of the rotary blowing-fan are mounted on adjustable radial arms, as shown in the views, so that their plane surfaces may be adjusted laterally at any angle to the axis of the main shaft E, upon which the rotary blowing-fan rotates. The object of this adjustment is to facilitate and regulate the draft of air through the machine from the feed-hopper to the discharge-spout on the periphery of the blowing-compartment.

The arrangement of the rotary blowing-fan in the compartment C is shown in Figs. 2 and 3. In the drawings, F′, F^2, F^3, and F^4 represent the four blades, and in Fig. 2 they are represented as having their flat surfaces adjusted longitudinally to the axis E at an angle of about thirty degrees. It is immaterial how the blades of the fans are radially mounted or by what means they are laterally adjusted. In practice, however, it will be found most convenient to adjust them in the manner shown in the views. In these *f* represents a cast-iron collar or hub bolted or keyed to the shaft E, containing four screw-holes, *f′ f′ f′ f′*, drilled at right angles to each other. The blades are mounted upon radial arms f^2 f^2 f^2 f^2, which terminate at one end in screw-threads and at the other end in flattened cross-heads, and screw into the openings *f′ f′ f′ f′*. They are attached to the arms f^2 f^2 f^2 f^2 by means of a series of ordinary bolts, f^5 f^5 f^5 f^5, passing through openings in the flattened cross-heads f^4 f^4 f^4 f^4 of the radial arms f^2 f^2. Each arm carries upon it a screw-nut, f^3, screwing over the upper part of the screw-thread, by means of which the blades can be held firmly in the collar *f* at any angle. In changing the adjustment of the blades the nut f^3 is in each case unscrewed and the radial arm of the fan-blade turned to the desired angle, and the nut then screwed down fast with a wrench. To admit of this adjustment, the side walls of the compartment are made partially spherical, as shown in the views, and the extremities of the fan-blades correspondingly curved to permit of their being turned.

In the cylindrical portion or pulverizing compartment of the cylinder C′ C² the rotary beaters are mounted rigidly upon the axis of rotation and with their flat surfaces parallel thereto. They may be attached to the rotating axis or shaft E in any convenient manner; but in practice the manner of fastening shown in the views will be found most simple. Fig. 3 shows a cylinder divided interiorly into two compartments, each provided with a set of rigidly-mounted rotary beaters, I I′, in one compartment, and J J′ in the adjoining one; and Fig. 2 shows, for the sake of convenience, a single compartment of such a cylinder only. In this view, *i* represents a collar or hub provided with the flange *i′*, keyed or bolted to the shaft E.

I′ I^2 I^3 I^4 represent four rotary beaters rotating in the compartment. These are carried upon the radial arms i^3 i^3 i^3 i^3, the extremities of which fit into grooves cut in the face of the flange *i′* and are secured thereto by the bolts i^2 i^2 i^2 i^2. The outer extremities of the radial arms i^3 i^3, &c., terminate, as in the case of the rotary blowing-fan in the compartment C, in flat cross-heads, to which the rotary beaters are fastened by means of the bolts i^5 i^5 i^5. The dimensions of all the parts will vary according to the size of the cylinder and of the compartment, and they may be made out of any convenient material.

The discharge of the machine is effected by means of a rectangular pipe, K, Figs. 1, 5, and 6, terminating in a curved and flanged bottom, k^2, fitting over an opening in the curved walls of the compartment C. The side flanges of the bottom contain slots k^4 k^4, through which pass bolts k^3 k^3, which penetrate the main walls of the cylinder A. In this way the discharge-pipe K assumes a tangent to the circumference of the pulverizer, and by unscrewing the nuts upon the bolts k^3 k^3 and sliding the discharge-pipe up and down over the opening in the curved surface of the cylinder by means of the slots on the bolts the inclination of the tangent

may be varied at pleasure, as shown by the dotted lines in Fig. 5. The outer extremity of the pipe K terminates in a flange, k', as shown in Figs. 1, 5, and 6. In one of the side walls of the pipe K is placed an opening covered by glass or other translucent material for the purpose of affording inspection of the interior of the discharge-pipe.

The interior of the cylinder A is lined with a lining of boiler-plate, W, or other desirable material, arranged in the manner shown in Figs. 7, 7ª, 8, 9, and 10. The sheets of lining correspond in size to the shape and dimension of the section of the cylinder to which they are to be fitted. In the views the cylinder is shown to be composed of two sections, and the lining is likewise made in two sections of a similar size. In Figs. 7, 8, 9, and 10, A′ represents a section of the cylinder-walls, and W a section of the lining. The extreme longitudinal edges of the lining W contain any number of countersunk bolt-holes, w w w, as shown in the views. The lining is attached by bolts passing through these holes to angle-irons w' w', Figs. 7 and 7ª, placed longitudinally along the longitudinal edges of the sections. The sections of A A′ of the cylinder are cast with the longitudinal double flanges a' a', Figs. 7, 8, 9, and 10, containing the holes a^2 a^2, through which the bolts b b, &c., Fig. 1, are passed for the purpose of holding the sections together. The longitudinal angle-irons w' are set into the space formed between the two flanges a' a' when the sections A′ A′ are bolted together, and are bolted to the sections A′ A′ in manner similar to that shown by w^2 in the views.

The method of operation of the machine is as follows: The pulley E′ is attached by a driving-belt to any convenient form of motor that will enable the shaft E and the beaters attached thereto to be driven at the rate of speed varying from two thousand two hundred to two thousand five hundred revolutions per minute. The fuel in the form of a fine powder enters the pipe H, where it becomes mingled with any desired amount of air and falls into the interior of the box A at O, where it is at once caught up by the beaters and subjected to further reduction. This reduction is accomplished by the whirlwinds of air moving at a very high velocity, generated in the cylinder by the rotary beater rotating rapidly, and to the violent interaction of the rapidly-rotating beater-blades and the interior surface of the shell or casing. Owing to the peculiar form of the chambers these whirlwinds, which are generated by the rapid rotation of the beaters, revolve on their axis with still greater velocity, carrying with them the particles of coal and whirling them in swift spirals. The friction of the particles of fuel upon each other produces an impalpable dust or powder. The finer particles of fuel as they become reduced into a fine powder will be drawn by the suction of the blowing-fan F into the compartment C, while the coarser particles, being much heavier, are not affected by the action of the fan and will remain in the reducing-compartments until they are thoroughly reduced. In this way a separation of the finer particles from the coarser particles is effected in the machine. The quantity and quality of dust furnished by the machine will depend upon the degree of movement that can be communicated to the air and material in the pulverizing-cylinder and the quantity of material which can be kept in motion at any one time. The escape of the dust is effected by means of the fan-blades F′, F², F³, and F⁴, and the amount of dust escaping will vary according to the amount of air admitted. The dust and air are expelled through the mouth K′ of the tangential pipe K by the action of the fan-blade F′, and the other material coming through is forced through by the air entering at the opposite end of the mill. The discharge-pipe K may be made to assume any desired angle of inclination by simply unscrewing the bolts K³ k^3, Figs. 1, 5, and 6, and sliding it upward or downward on the slots k^4 k^4 in the curved flange k^2, Figs. 1, 5, and 6, and then tightening the bolts k^3 k^3.

For the purpose of observing the conditions within the machine the opening K² is provided in the side walls of the tangential discharge-pipe K. This opening is covered by a plate of glass, which may be removed at pleasure. From the discharge-spout the fuel may be conducted to the furnace by any convenient form of pipe attached in any convenient manner.

It is also possible to make use of this form of pulverizer for purposes other than that of reducing fuels. It may be adapted for reducing almost all kinds of materials, and even for triturating liquids, and I do not limit the invention to any one particular use, although it is primarily adapted to the process of saving fuel.

I claim as my invention—

1. In a machine for pulverizing fuels, &c., the combination, substantially as hereinbefore set forth, with the pulverizing-chamber, of a blowing-compartment having spherical side walls, and a rotating shaft carrying one or more rotary fans having laterally-adjustable blades which are curved on their peripheries to correspond to the walls of the blowing-compartment.

2. In a machine for pulverizing fuels, &c., the combination, substantially as hereinbefore set forth, with the cylindrical pulverizing-chamber, the shaft, and rotary beaters, of a blowing-compartment having spherical side walls placed at one end of said chamber and connected therewith, and a rotary blowing-fan rotating upon the same shaft as the rotary beaters, and having laterally-adjustable blades the peripheries of which are curved to correspond to the walls of the blowing-compartment.

3. In a machine for pulverizing fuels, &c., the combination, substantially as hereinbefore set forth, with the pulverizing-chamber, of a blowing-compartment having spherical side

walls, and a rotary blowing-fan in its interior, the blades of which are laterally adjustable and curved on their peripheries to correspond to the walls of the compartment.

4. In a machine for pulverizing fuels, &c., the combination, substantially as hereinbefore set forth, with the blowing-compartment, of a sliding tangential discharge-pipe, whereby the angle of discharge of the pulverized material may be varied at pleasure.

5. In a machine for pulverizing fuels, &c., the combination, with the pulverizing-chamber, of a blowing-compartment connected therewith, and rotary blower-fan, the blades of which are adjustable at any angle to the axis of rotation.

6. In a machine for pulverizing fuels, &c., the combination, substantially as hereinbefore set forth, with the blowing-compartment, of an adjustable tangential discharge-spout, whereby the angle of discharge may be varied at pleasure, provided with a curved flange fitting over the periphery of said compartment, said flange being formed with slots in its side, and bolts in the side walls of the compartment passing through the said slots, whereby the said discharge-spout may be caused to slide upward or downward at pleasure.

7. In a machine for pulverizing fuels, &c., the combination, substantially as hereinbefore set forth, with the exterior shell of the machine, composed of removable sections, of a removable sectional lining fitting into and corresponding with the sections of the shell, and having the longitudinal edges countersunk to receive bolt-heads, and a series of angle-irons bolted into recesses in said cylinder-sections to which the longitudinal edges of said lining are bolted.

Signed at New York, in the county of New York and State of New York, this 12th day of October, A. D. 1885.

HAMILTON RUDDICK.

Witnesses:

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