(No Model.) 3 Sheets—Sheet 1.

E. C. SMITH.

MACHINE FOR PULVERIZING FUEL.

No. 564,033. Patented July 14, 1896.

Fig. 1.

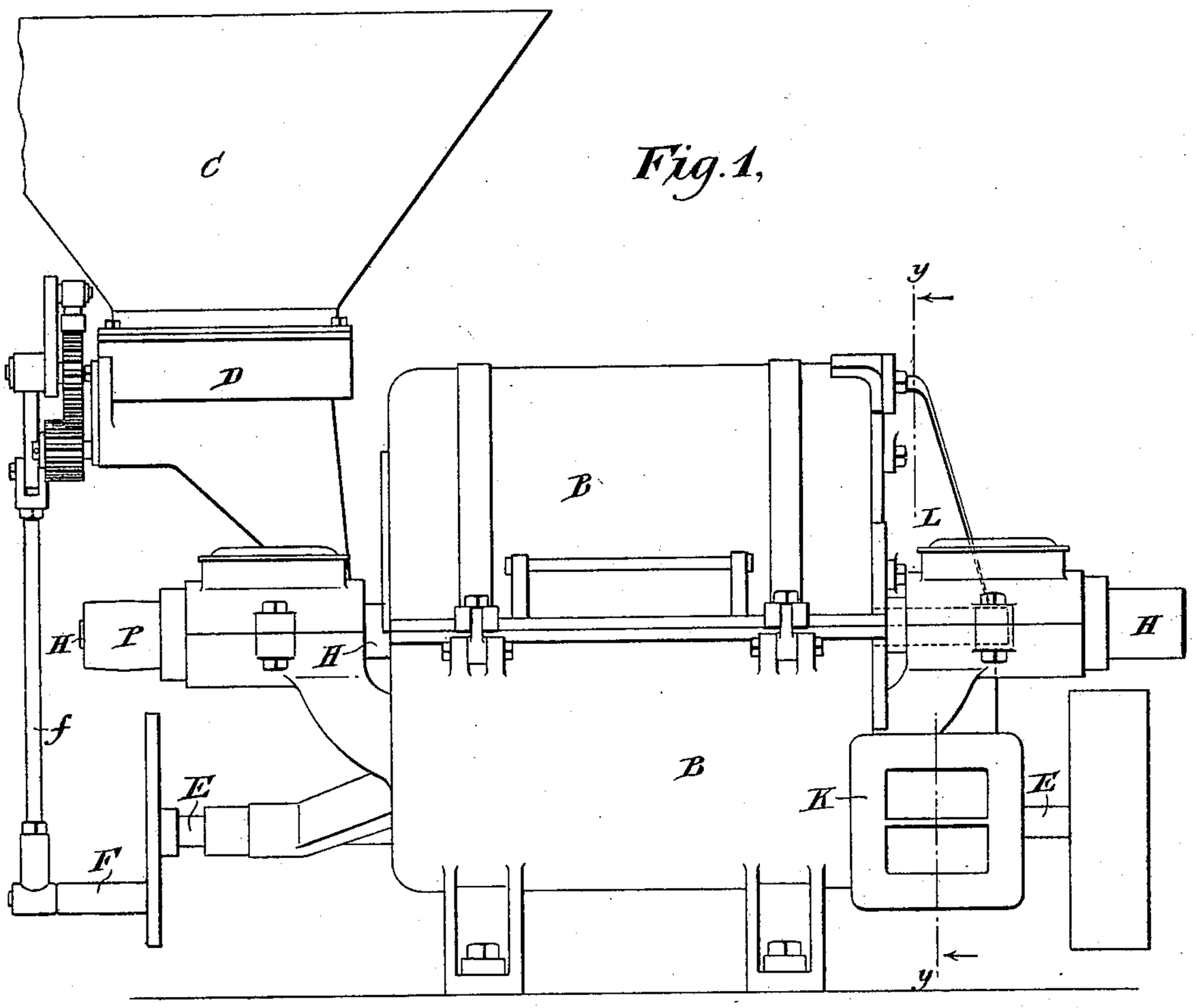


Fig. 2.

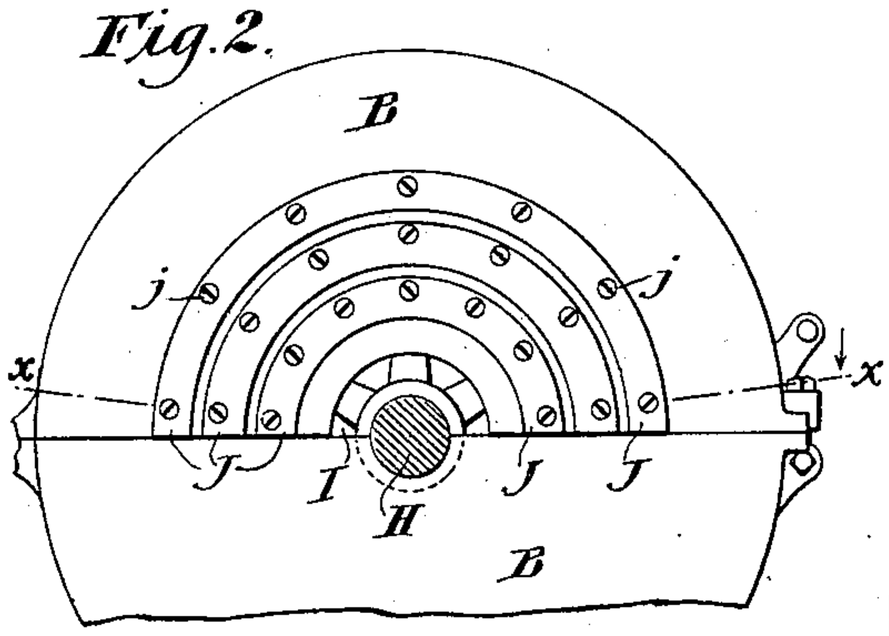


Fig. 3.

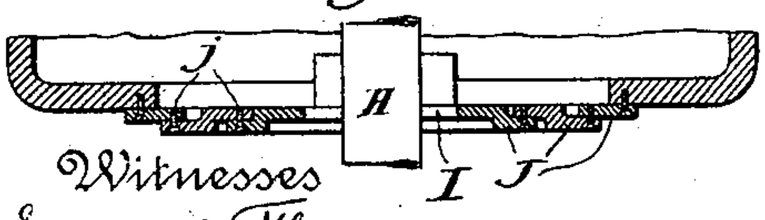
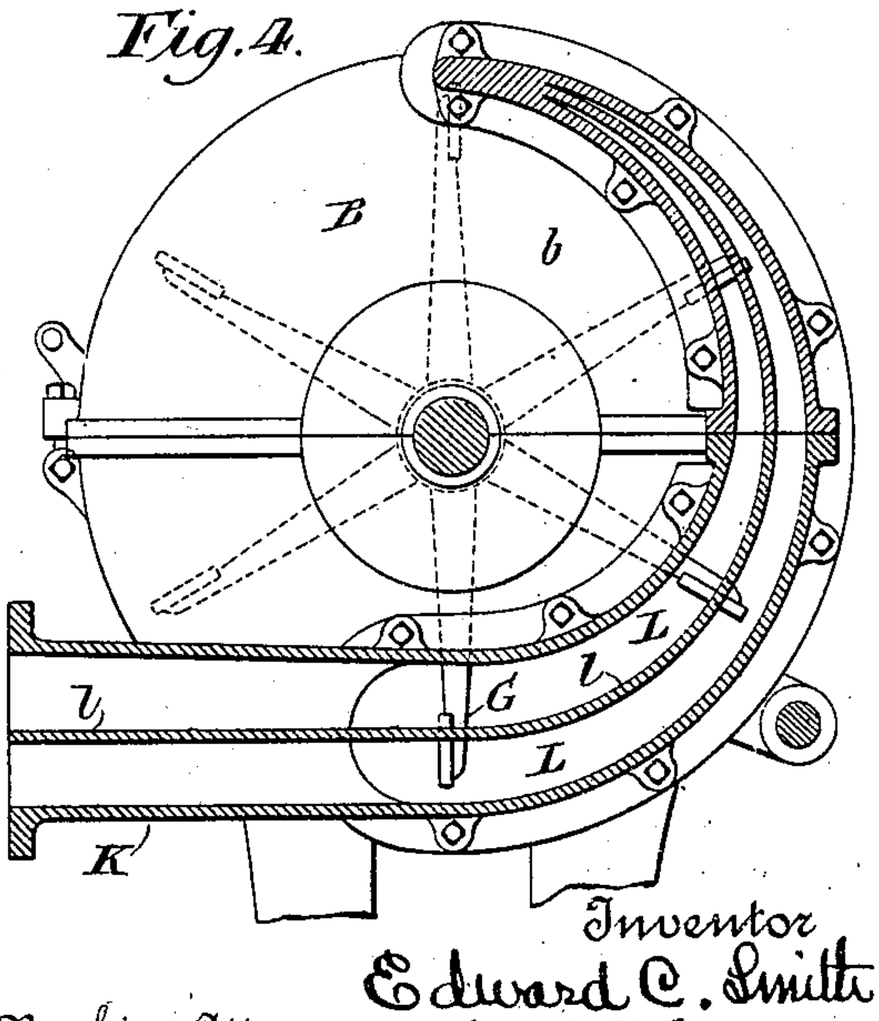


Fig. 4.



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(No Model.) 3 Sheets—Sheet 2.

E. C. SMITH.

MACHINE FOR PULVERIZING FUEL.

No. 564,033. Patented July 14, 1896.

Fig. 5.

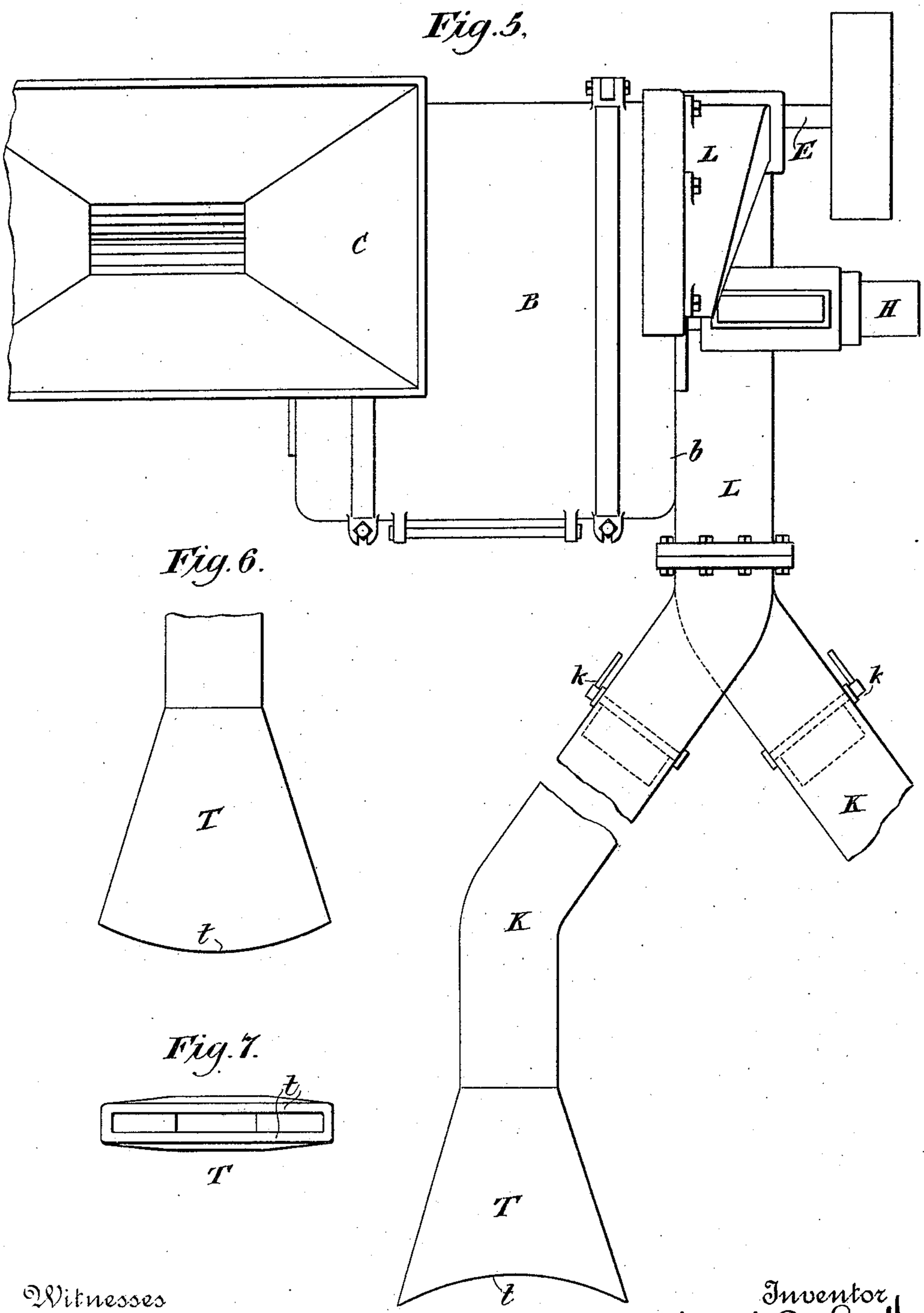

Fig. 6.

Fig. 7.

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(No Model.) 3 Sheets—Sheet 3.

E. C. SMITH.

MACHINE FOR PULVERIZING FUEL.

No. 564,033. Patented July 14, 1896.

Fig. 8.

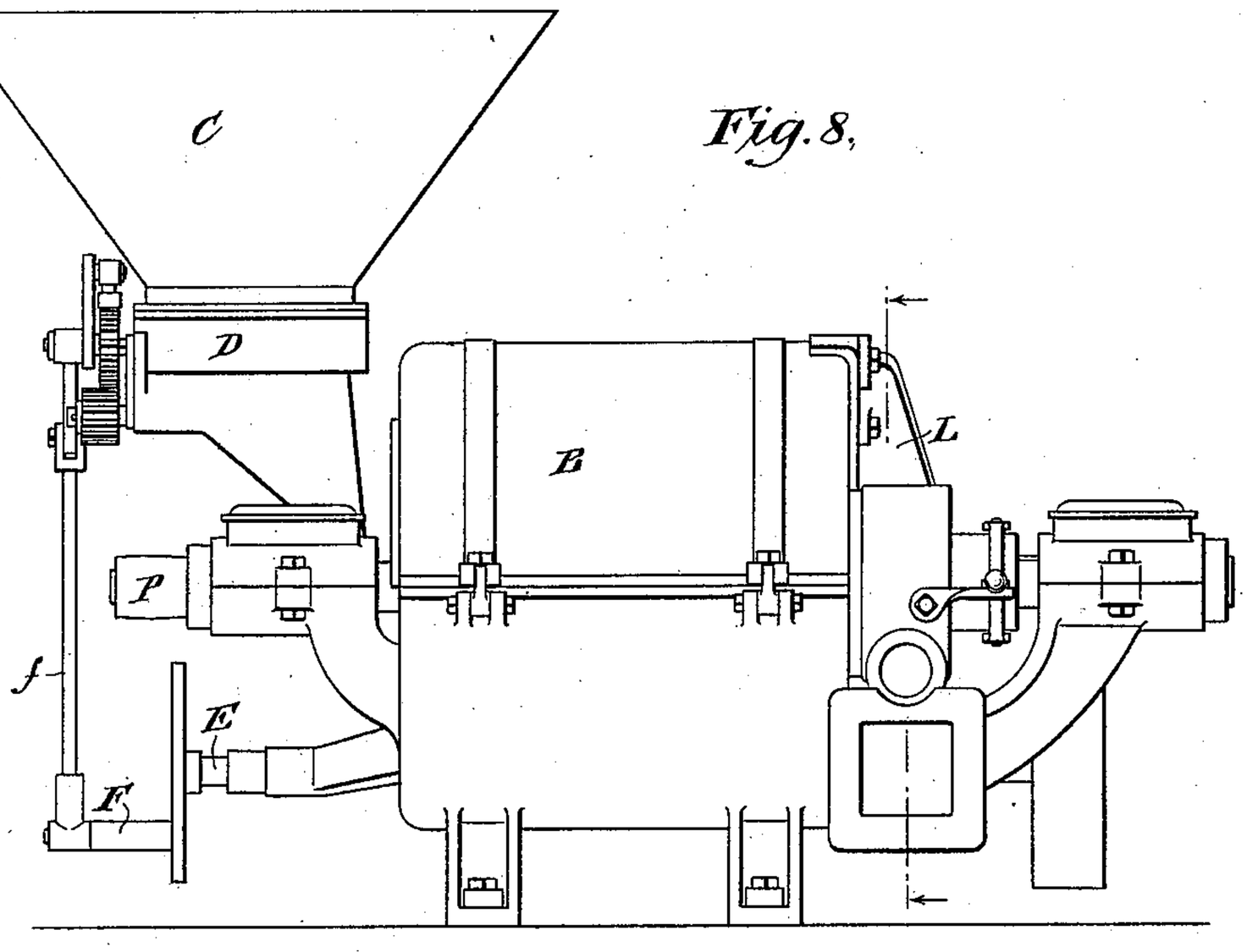
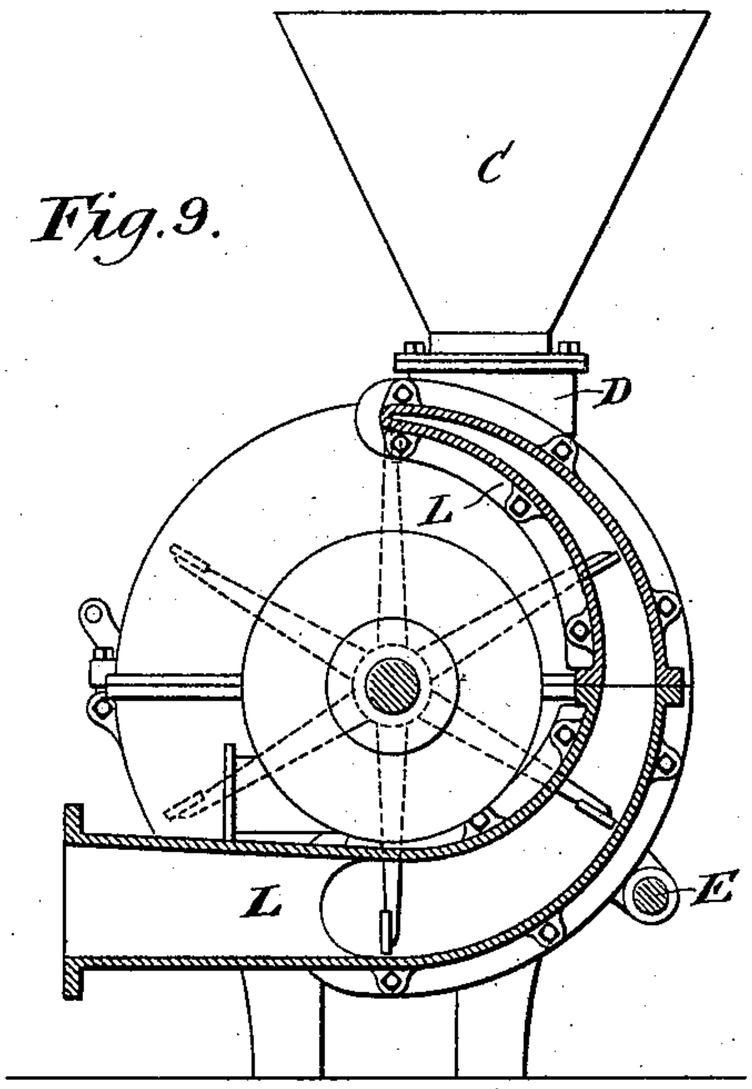


Fig. 9.



Witnesses
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By his Attorney

UNITED STATES PATENT OFFICE.

EDWARD C. SMITH, OF NEW YORK, N. Y., ASSIGNOR TO JAMES B. KINNEY, OF RED BANK, NEW JERSEY.

MACHINE FOR PULVERIZING FUEL.

SPECIFICATION forming part of Letters Patent No. 564,033, dated July 14, 1896.

Application filed August 14, 1894. Serial No. 520,306. (No model.)

To all whom it may concern:

Be it known that I, EDWARD C. SMITH, of New York, State of New York, have invented a new and useful Improvement in Machines for Pulverizing Fuel or other Substances and Delivering the Same Mixed with Air in a Suitable Manner, of which the following is a description, referring to the accompanying drawings, which form a part of this specification.

My invention is in some respects similar to the devices illustrated in the patents to Bordman and to Ruddick, numbered, respectively, 416,252 and 388,375, and I will therefore refer to these patents for such details of the apparatus as are common to those devices and the present invention, restricting the description of the present invention more particularly to the novel features.

My machine may be used for pulverizing a great variety of material, but is more especially designed for the pulverization and utilization of fine coal and other fine fuel, particularly the culm or waste product of coal-mines, which is so finely divided that it has heretofore been of no practical commercial value, and has therefore been allowed to accumulate in great quantities in the neighborhood of the mines. Various attempts have been made to utilize such finely-divided fuel in connection with air-blasts; but the size and irregularity of the particles have rendered it difficult, if not impossible, to completely burn it, great quantities being carried up the chimney or beyond the useful heating portion of the fire-box or furnaces in which it has been used. As early as 1871 it was sought to overcome these difficulties by finely pulverizing the fuel in a rotary beater, in this way providing for a more thorough admixture with air, and a consequently more efficient combustion. In the Ruddick and Bordman patents, already referred to, apparatus is disclosed by which the coal is first finely ground and then admitted with more or less air into the rotary beater or pulverizer, the blades of which reduce the coal to an impalpable powder. In the case of soft coal, this resulting powder has an almost oily feeling when rubbed between the fingers. It is so finely pulverized that it may be readily carried along by a draft of air and burned like a combustible gas. The combustion under favorable circumstances is so complete that no smoke whatever escapes from the stack and very intense heat is generated. In connection with the improvements which form the subject-matter of this patent, I may employ the grinding apparatus and the rotary beaters or blades inclosed within the casing of the pulverizer, in all respects substantially similar to the Ruddick and Bordman machines. Great difficulty has, however, been experienced in the use of these machines for feeding large furnaces because it is very hard to get an air supply at all adequate to the supply of coal that may be readily fed through the machine.

My present invention, therefore, includes devices for admitting an increased supply of air to the pulverizing-chamber, and at the same time carefully controlling the amount of air admitted separately from the control of the amount of coal-dust admitted.

Another difficulty has occurred when a single pulverizer is used with two or more furnaces, for the increase of the draft in either furnace tends to cause an increase in the amount of fuel fed to that furnace, and this in turn reacts upon the draft and increases it, materially interfering with the proper and even regulation of two or more separate furnaces fed from a single feed-pipe. In my invention the pulverized fuel passes with the draft from the rear end of the pulverizer into entirely separate passages, one passage being preferably provided for each furnace which is to be supplied. In this way, although the increase of draft in one furnace may cause a slight increase of the flow of air and fuel into that furnace, it does not directly affect the amount fed to the other furnaces, and there is therefore less tendency to raise the temperature of that furnace above the others or to cause the increase of draft to continue. This subdivision of the outlet or feed passage, in conjunction with the peculiar shape in which it is made, which will hereinafter more fully appear, is of special importance where a battery of boilers is supplied from a single pulverizer. A thirty-inch pulverizer of my design will readily supply several large boilers, amounting in all to many hundred horse-power. In addition to the design of feed-pipe used I have found that combustion may be greatly facilitated and made more effective by expanding and then either spreading or contracting the flame as it enters the furnace;

and for this purpose I have designed forms of twyers which will concentrate the flame where concentrating effects are desired, or expand the flame where extensive heating effects are desired. In any case the blast of commingled air and fuel is spread out in a thin sheet on entering the furnace and then concentrated toward a point or expanded further according to requirements, the combustion being greatly facilitated by the flattened or expanded form of the jet or flame.

In another application filed with this I have described an alternative form of twyer and of feed-passages and apparatus by which effects somewhat similar to those contemplated in this application are produced.

Having now briefly indicated the objects and nature of my invention, I will describe it more at length in connection with the accompanying drawings, which show one embodiment of it, although it must not be understood that I am in any way limited to the precise details so shown and described.

In the drawings, Figure 1 illustrates a side view of my pulverizer with subdivided discharge-pipe; Fig. 2, a front end view partly broken away and showing the air-admission plates; Fig. 3, a cross-section on the lines indicated in Fig. 2; Fig. 4, a rear end section on the plane indicated in Fig. 1, showing my subdivided outlet or feed passage for the commingled pulverized fuel and air. Fig. 5 is a plan view of my pulverizer with the feed-passages and my twyer shown. Figs. 6 and 7 are detail views of my twyers, and Figs. 8 and 9 longitudinal and end views of machine as constructed with single discharge or feed pipe.

Throughout the drawings like letters of reference indicate like parts.

At B is shown the shell or casing of the pulverizer, and at C the hopper or chute into which the culm or fine fuel is fed. From the hopper the coal is fed to the crushing-rolls inclosed in the casing D. These crushing-rolls are driven from the shaft E of the pulverizer by means of the adjustable wrist-pin F and pitman *f*. The wrist-pin may be adjusted diametrically across its disk and the stroke of the pitman thereby regulated, as described in the patents I have already referred to. From the crushing-rolls the coal is fed in a very finely divided or comminuted state into the front or left-hand end of the shell of the pulverizer B, where it is pulverized by the rotary paddles, blades, or beaters G. (Indicated clearly in Fig. 4.) As the culm or fuel becomes pulverized, the finer particles are carried along toward the rear end of the shell by the draft of air which is admitted near the shaft H.

In Figs. 2 and 3 I indicate the means by which the admission of air is controlled and proportioned to the amount of fuel admitted to the crushing-rolls. Owing to the tangential and peripheral discharge at the far end of the rear pulverizer, a suction is created within the pulverizer and causing the air to rush in through the opening I in the front of the machine. This opening, as clearly shown in the drawings, forms a half-circle above and around the shaft H and may be increased in size by successively removing one or more of the concentrically-fitted plates J. These plates are of half-annular form and of cross-section clearly shown in Fig. 3, so that they may be bolted or screwed together, as at *j*, and more or less air admitted at will. The amount of coal admitted may be regulated by adjusting the stroke of the pitman *f*, which in turn regulates the feed of the coal from the hopper C through the crushing-rolls. In this way separate and independent regulation of the coal and air is effected in addition to the joint control in the discharge or feed pipes K, which lead from the rear of the pulverizer to the several twyers within the furnaces.

In order that the rotary blades or beaters may serve both as pulverizers and as fans, I form on the rear or end plate *b* of the shell an outlet or tangential discharge L of the helical or spiral shape clearly indicated in Figs. 1, 4, 5, 8, and 9. In Figs. 1 and 4 this is shown subdivided by the spiral plate or division *l*, cast centrally within the discharge-passage. Where three or more subdivisions are desired, two or more partitions are of course employed in a similar manner.

The spiral shape of the discharge-outlet serves a very important function in that the passages are gradually enlarged from where they begin near the upper side of the machine to the point where they enter the feed pipe or passage proper, K, and at the same time they are gradually increased in depth longitudinally or axially, as the passage is carried farther out from the plane of the plate *b*. In this manner the finely-pulverized coal carried by the draft of air through the pulverizer enters the several divisions of the outlet in proportions approximately equal to the drafts of air entering each, so that if the supply of coal be increased without in any way disturbing the draft it will increase the amount delivered to each of these separate passages in a very nearly equal proportion, while if the draft or blast passing through either of the divisions of the discharge-pipe be varied the amount of pulverized fuel received will be proportionately increased or diminished by the variation of the draft into that passage without materially disturbing the amount received by the other. Heretofore it has been customary to carry the discharge from pulverizers directly out tangentially in the plane of one of the sets of rotary blades, or more usually from a separate blower-compartment containing blades designed particularly to act as fans. When this is done, such coarser particles as may have found their way to the rear end of the pulverizer are carried out with the finer particles and the air, the centrifugal force acting with the draft to throw the

particles into the discharge-pipe. By carrying the outlet or discharge opening spirally from the end plate B and entirely exterior to the plate only the finer particles carried by the air find their way into the outlet-passages, because the coarser particles are held by centrifugal force at the extreme periphery of the shell, and the draft is not sufficiently strong to draw them into the outlet. On this account a pulverizer constructed according to my invention may be formed in a single compact compartment, no diaphragms or other subdivisions of the shell being needed or desirable, and no separate blower-compartment being required. At the same time I get the greatest pulverizing effect combined with a suitably-controlled and properly-regulated draft.

In Figs. 8 and 9 I have shown the simplest form of my spiral discharge or feed pipe L, no partition or division being employed in this form. The gradual enlargement of the opening through the end plate of the shell and the gradual increase in the depth and cross-section of the spiral are clearly shown. While, however, I claim, broadly, such a discharge passage or pipe whether subdivided or single, the distributing effect of the division *l* where one is used makes the subdivided discharge more than a mere reduplication of the single passage, and therefore I have made specific claims for the subdivided form without, however, intending in any way to restrict the other claims not expressly so limited.

Where the subdivided discharge is employed, the two (or more) separate passages of the discharge-pipe are preferably carried away from each other as distinct and separate pipes K, Fig. 5, leading to the several furnaces or several parts of a common furnace, according to requirements. Within these separate pipes are valves or dampers *k*, by which the draft and the admission of the commingled air and fuel are controlled for the individual furnaces or twyers. At the points where these feed-pipes enter the furnace they are flattened out horizontally into the mouth or twyer, of the shape clearly shown in Fig. 7, the extreme edge being either concave, as in Fig. 5, where it is desired to concentrate the flame, or convex, as in Fig. 6, where it is desired to spread the flame. In either case the commingled pulverized fuel and air enter the furnace in a flattened jet, which insures a far better combustion and more intense heat than is possible where no such provision is made.

I do not of course claim any novelty in feeding gases or other fuel to furnaces, but I believe I am the first to expand the flame in entering the furnace and at the same time either concentrate or spread the point of application of the flame by the concave or convex mouth of the twyer and treating and regulating the commingled fuel and air as though it were a true gas.

Many modifications may of course be made in my invention and in its several details without departing from the principles involved, and I have purposely omitted the enumeration of minor details and of the many modifications which readily suggest themselves, because to set these forth at length would obscure rather than make clear the more essential features of the invention.

I claim, however, and desire to secure by these Letters Patent of the United States, together with all such modifications, improvements, or variations as may be made by mere skill in the art, and with only the limitations and restrictions as expressed or by law implied in view of the state of the art, the following:

1. In combination in or with a rotary pulverizing apparatus, means for feeding finely-divided fuel or other material thereto, and one or more removable plates J for regulating the admission of air, and a spirally-formed tangential discharge-pipe exterior to the end plate or shell of the said pulverizing apparatus, whereby the said apparatus may operate both as a pulverizer and as a blower and whereby the admission of fuel, or other material, and of air, may be separately controlled and regulated, substantially as set forth.

2. In combination in apparatus for pulverizing fuel, or other material, the rotary blades or beaters G, the shell or casing B, and an outlet or discharge passage through the end plate *b* of the said shell, the said outlet or discharge passage extending spirally from the said end plate and of gradually-increasing cross-section, substantially as set forth.

3. In combination in apparatus for pulverizing fuel, or other material, the rotary blades or beaters G, the shell or casing B, and an outlet or discharge passage through the end plate *b* of the said shell of spiral form and exterior to the said plate *b*, substantially as set forth.

4. In combination in apparatus for pulverizing fuel or other material, the rotary blades or beaters G, the shell or casing B, an outlet or discharge passage through the end plate *b* of the said shell, the said outlet or discharge having one or more partitions or divisions and feed pipes or passages K for each of the subdivisions of the said discharge, substantially as set forth.

5. In combination in apparatus for pulverizing fuel or other material, the rotary blades or beaters G, the shell or casing B, an outlet or discharge passage through the end plate *b* of the said shell, and a spiral partition or division *l* in the said discharge, substantially as set forth.

In testimony whereof I have hereunto set my hand, at the city of New York, this 9th day of August, 1894.

EDWARD C. SMITH.

Witnesses:
JAMES B. KINNEY,
HAROLD BINNEY.