May 3, 1927. 1,627,488

P. L. CROWE

BALL MILL

Filed Sept. 30 1925 3 Sheets-Sheet 1

Fig. 1.

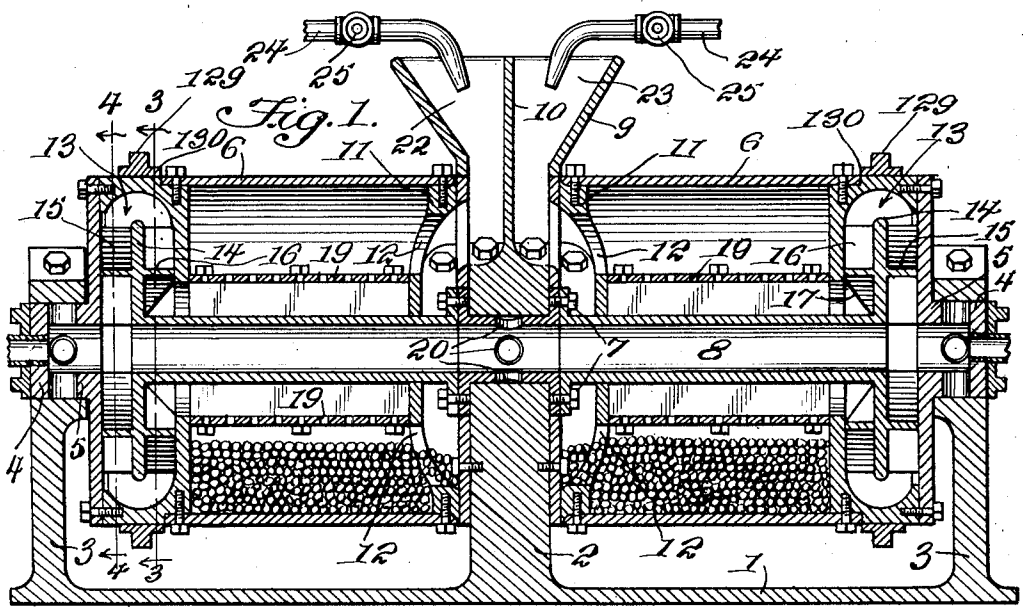


Fig. 2.

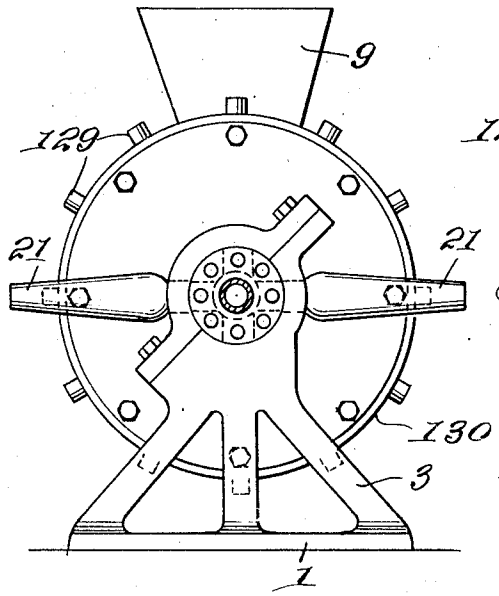


Fig. 3.

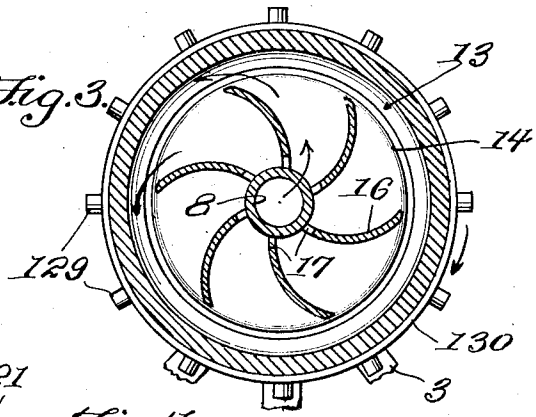
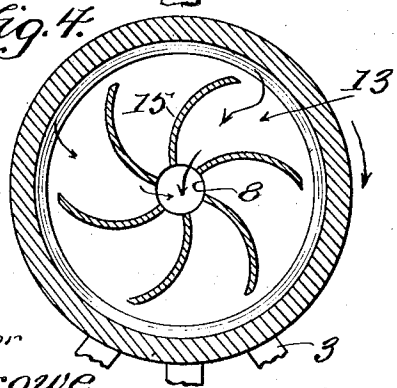


Fig. 4.



Inventor

Paul L. Crowe

BY Victor J. Evans

ATTORNEY

WITNESS: J. T. L. Wright

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P. L. CROWE

BALL MILL

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Fig. 5.

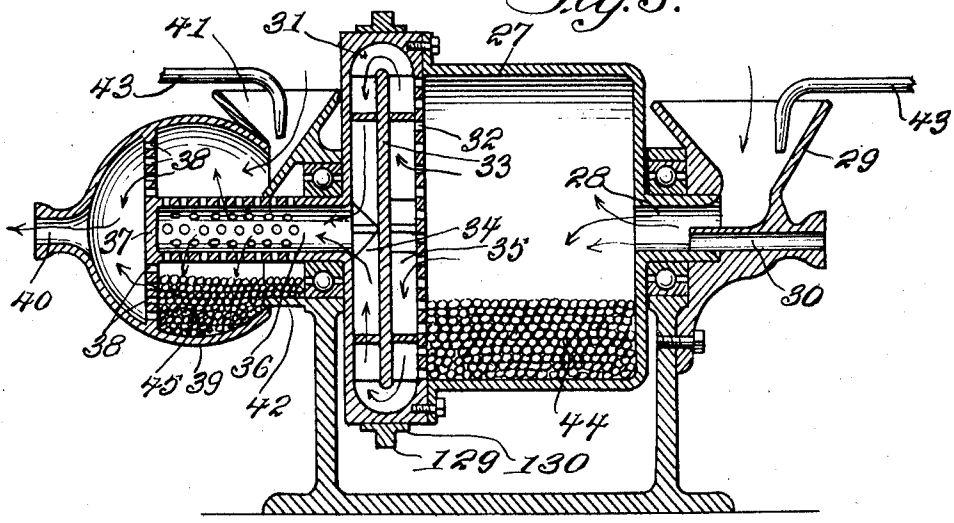


Fig. 6.

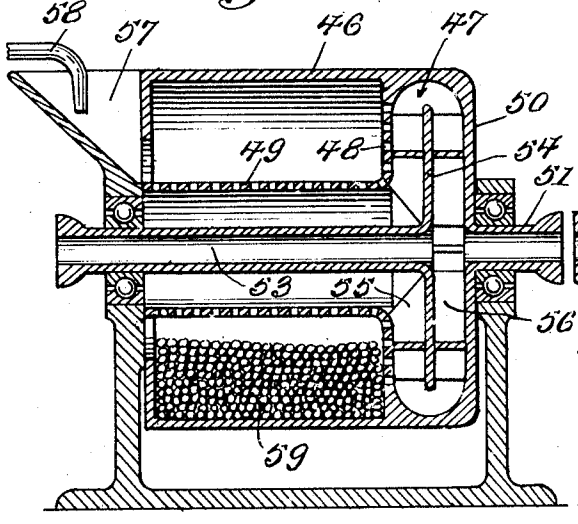
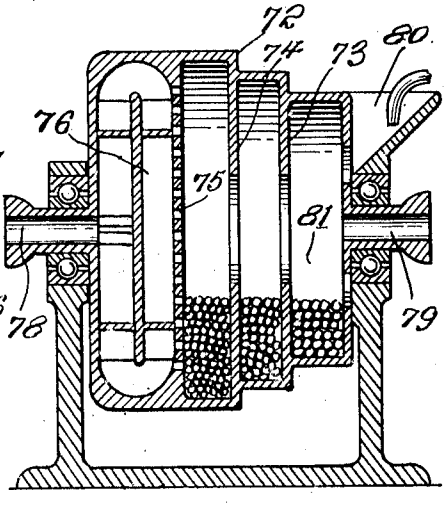


Fig. 8.



Paul L. Crowe

INVENTOR

BY Victor J. Evans

ATTORNEY

WITNESS: G. T. L. Dwight

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P. L. CROWE

BALL MILL

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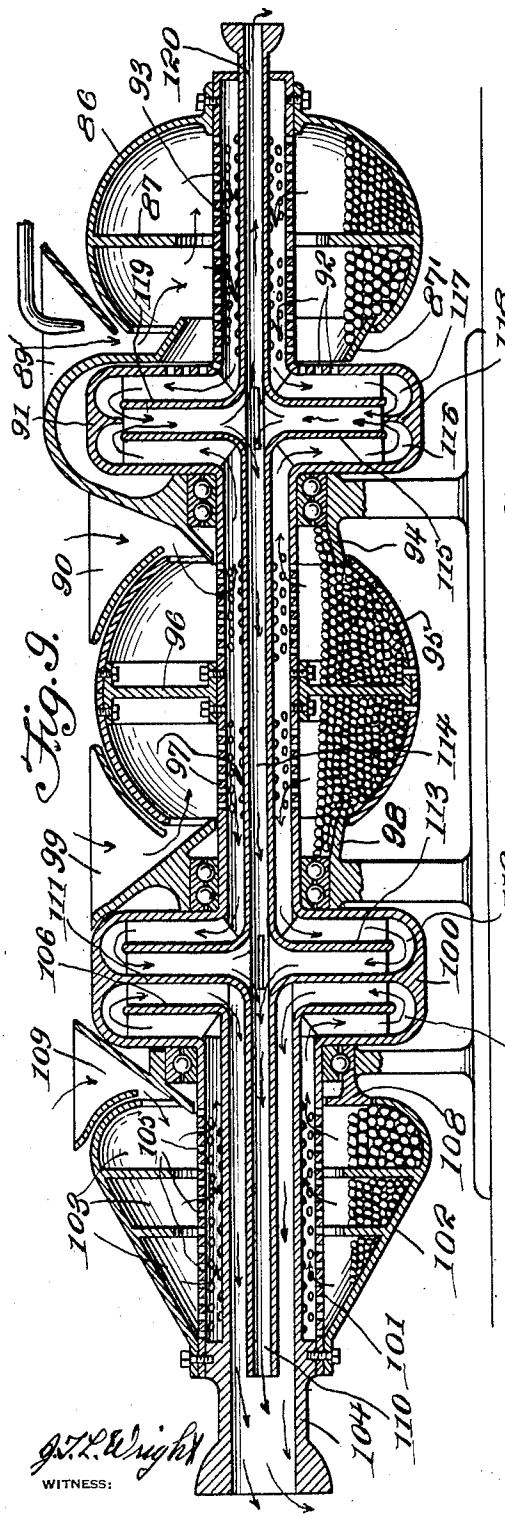


Fig. 9.

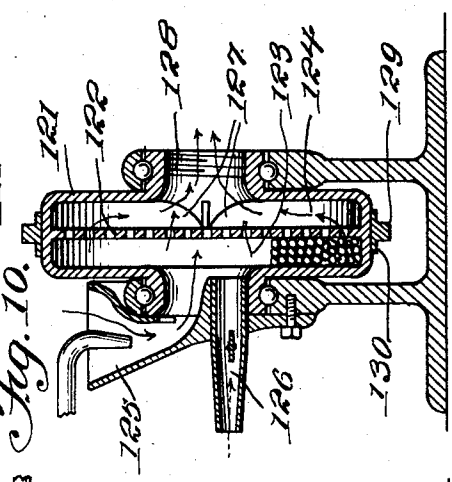


Fig. 10.

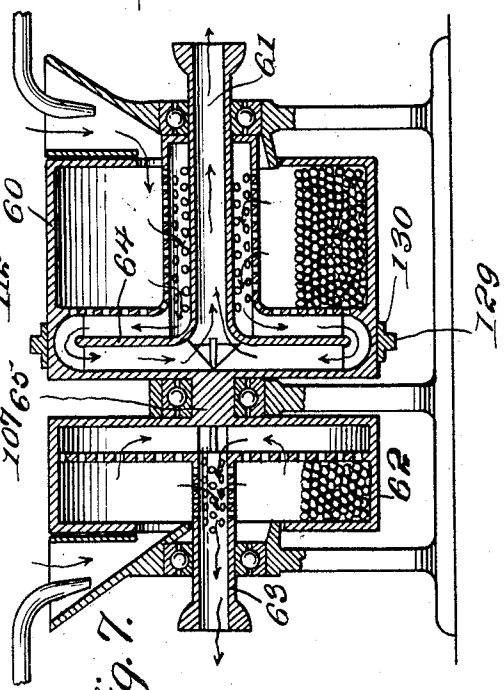


Fig. 7.

WITNESS: J. L. Wright

Paul L. Crowe
INVENTOR

BY Victor J. Evans
ATTORNEY

Patented May 3, 1927. 1,627,488

UNITED STATES PATENT OFFICE.

PAUL L. CROWE, OF BALTIMORE, MARYLAND.

BALL MILL.

Application filed September 30, 1925. Serial No. 59,542.

My present invention has reference to improvements in centrifugal pulverizing and blowing apparatus for combustible material, such as coal by the use of which the ground material can be fed to a furnace for its combustion and supplying the heat of combustion to a heating apparatus for various uses of heat in trade and resides in the operative relation of means of confining necessary adjuncts for the complete combination of parts necessary to create a unification thereof as a whole, in operating the parts and obtaining the desired results.

A further object is the reduction of fuel to the required fineness for its combustion in furnaces of any size, style or construction.

Another object is to supply the demand for any conditions of capacity.

Another object is the provision of a device of this character which may be arranged in any position that may be available and yet properly supply the demand for its heating capacity.

Another object is to supply the demand for quickness of service.

Another object is to supply a mill for the degree of fineness of combustion to fulfill the necessities of variable furnace constructions.

With these and other objects in view which may come to light in these specifications, the invention resides in the novel association of parts and in the unique construction hereinafter described and definitely claimed.

In the drawings:

Figure 1 is a central longitudinal sectional view through a mill in accordance with this invention.

Figure 2 is an end view thereof.

Figure 3 is a sectional view on the line 3—3 of Figure 1.

Figure 4 is a sectional view on the line 4—4 of Figure 1.

Figure 5 is a longitudinal sectional view through another form of the improvement.

Figure 6 is a sectional view through a further modified form of the improvement.

Figure 7 is a similar view of a further modification.

Figure 8 is a similar view of a still further modification.

Figure 9 is a similar view of a still further modification.

Fig. 10 is a similar view of a still further modification.

It will be noted as the description progresses that my invention consists in a ball mill furnace feeding device with such apparatus as is required to blow, induce, regulate, supply, collect, force, create, use, induct, impel, and repel, expel, propel, separate, contract, retract, extract, abrade, attrite, receive, produce, forward, deliver as well as generate power for feeding coal to and from the feeding and reduction apparatus to boilers and other furnaces in a refined combustible for refined combustion universally.

The principle involved in this invention is that coal is conveyed to and into the apparatus for the pulverizing thereof, the action of the process and method is centrifugal by the use of the impeller and the power behind it and also with the use of small balls and flint pebbles manufactured for the reduction of the material to be ground. As this process continues the coal is fed evenly, the fine particles being sufficiently ground to pass through a 95 to 98 of 100 screen mesh, the flow of air carries the ground fuel through the screen mesh into the impeller, and is in turn forced by the impeller into the feeding tube and into the furnace.

As the fuel particles are reduced in size in the mill compartment by the abrasion of the balls and pebbles, the weight and speed of, and the turning movement of the apparatus and mill compartment or chamber will cause the reduction of the fuel to a fineness best suited for the combustion thereof and for the furnace chamber requirements for which certain degrees of fineness of fuel may be adapted.

The mill chambers or compartments can be constructed to comply with the requirements of the consumer or the manufacturing plant, for quantities and capacities and for the dryness of the fuel to the degree of combustion requirements.

Referring now to the drawings in detail and Figures 1 to 4 in particular, the numeral 1 designates a suitable base having a central upright or standard 2 and end uprights or standards 3. All of the standards terminate in bearings which are preferably cut at an angle and have fixed thereon removable bearing sections or caps. The bearings are preferably provided with raceways for anti-frictional elements, the end bearings being closed, as at 4, and receive therein the uprights 5 on the outer ends of mill casings 6. The bearing for the central standard

2 receives therethrough a short hollow shaft whose flanged ends are bolted, as at 7, to longer hollow shafts centrally between the two mills. The removably connected hollow shaft sections present a unitary structure, which is indicated by the numeral 8 when connected together.

The bearing for the central standard 2 also supports thereon an upwardly disposed hopper 9. This hopper is divided by a central partition 10 into opposite compartments. The inner heads of the mill bodies 6 are in the nature of removable discs which are inwardly concaved. These heads are indicated for distinction by the numeral 11 and each of the said heads has a plurality of preferably equi-distantly spaced openings 12 therethrough. The outer hollow head of each of the mill bodies provide impeller chambers 13.

The portions of the hollow shaft 8 disposed centrally in the impeller chambers 13 are formed with disk flanges 14, and in the impeller chambers at or on the opposite faces of the flanges there are oppositely directed curved fan blades 15 and 16, respectively. The inner fan blades 16 have their inner ends reduced by being cut angularly toward the discs 14, as indicated by the numerals 17, for the passage of air.

The heads 11 of the respective mill casings 6 have arranged between and connected to or formed with one of the confronting faces thereof a tubular screen 19 of fine mesh. The screens are preferably formed of segmental plates having reduced lapping edges which are bolted together. The tubular screens 19, that form the outer hollow shafts, surround the hollow shaft and star wheels or spiders are preferably secured on the hollow shaft 8 and to the arms of which the screen plates are bolted. The central portion 7 of the hollow shaft 8 is provided with right angularly disposed openings 20 designed to register with oppositely disposed openings in the central bearing. These last mentioned openings are provided with oppositely extending flow tubes for distribution of the fuel. The space between the ends of the hollow shaft 8 and the closed ends 4 of the outer bearings has the wall provided thereby also formed with oppositely directed aligning openings, and screwed or otherwise secured in these openings there are flow tubes 21.

The compartments 22 and 23 provided in the hopper 9 have arranged in the mouths thereof, the nozzle ends of pipe members 24 which are connected to the furnace lining and through which the impeller draws sufficiently warm air to raise the temperature in the mill to the degree for the proper dryness and combustion of the pulverized fuel. The passages through the pipes 24 are controlled by valves 25.

The mill chambers are partly filled with impact, attrition balls and pebbles of all sizes and the coal is fed through one or both of the hoppers into the mill compartments, and while the mill is in operation and introducing air inward through the flow tubes or other means not shown for the reception of air, the air and the combined material is forced through the screen 19 and is induced, by the fan blades in the impeller chambers into the said impellers and is lifted by the inner fan blades onto the outer fan blades and the powdered fuel is further induced by the impellers into the central hollow shaft and finds an outlet through the flow tubes in the second direction from the apparatus and the said fuel is from thence directed through suitable pipes connected to flow tubes to burners in the furnace. The burners may be directly connected to the flow tubes, should the furnaces be in close proximity to the mill, and any burner, conventional or special may be employed. Heated air is sucked by the impellers into the mill chamber to dry the coal before and after pulverization and to render the same in a better combustible state.

The grinding compartments in the mills are closed at their inner periphery and outer wall by headed cast iron plates which have reduced overlapping edges that are fastened together and to the impeller body. The pulverizing is, of course, effected by the turning movement of the impeller and the effect of the attrition balls and the compartment walls in the mill, the larger diameter having the effect of more economy in the motor power and such difference in construction as shown is necessary in the manufacture of the pulverizer in different sizes.

In Figure 5 I have illustrated another form of the improvement in which both fine and coarse combustible material is simultaneously pulverized. The mill body 27 has one end formed with a hollow shaft 28 that is journaled in suitable bearings on the supporting frame. Removably secured at this end of the mill there is a hopper 29 that communicates with the bore of the hollow shaft 28, the said hopper being formed with a flow pipe 30. The opposite end of the mill body is provided with an impeller chamber 31. The inner wall of the impeller chamber is closed by a screen 32. The impeller comprises a central portion or disc 33 on whose opposite faces there are arranged oppositely directed fan blades 34 and 35. This end of the mill is also formed with a hollow shaft 36 which is reticulated outward of its bearing to provide a screen. The hollow screen shaft 36 is closed by the central non-reticulated portion of a disc 37. The portion of the disc outward of the hollow screen shaft is formed with annular series of restricted apertures 38 and provides a second screen.

The mesh of both of the screens is fine for pulverizing. A hollow spherical body member 39 encloses the reticulated portion of the tubular screen and the screen disc and the body 39 is formed at its outer end with a flow tube 40 and this tube is provided with a burner or has a pipe leading therefrom directed to a burner in the furnace. The bearing through which the hollow screen shaft 36 passes has arranged thereover a hopper 41 that communicates with the interior of the body member 39. A guard ring 42 is received in the inner or mouth end of the body member 39 to protect the outflow of material fed into said body member into the hopper and likewise to hold the attrition balls 45 in the said body member. The mill body 27 has also arranged therein attrition balls 44 and preferably communicating with the hoppers 29 and 41 there are the nozzle ends of pipe members 43 that are connected to the furnace linings. The operation is similar to that previously described. The turning of the impeller and the body 39 causes the attrition balls to act upon the material fed into the mills, and likewise causing the impeller to act upon the said material for sucking both atmospheric and heated air.

In Figure 6 the mill body 46 has an impelling chamber 47 at one end thereof and divided from the mill chamber by a screen 48. The screen 48 has a tubular extension in the nature of a hollow shaft 49 which is reticulated at its periphery. The impeller includes a disc 54, on whose opposite faces there are fan blades 55 and 56, respectively. The inner edges of the fan blades 55 are cut at an inward angle and the disc 54 is formed on a central hollow shaft 53 that finds bearings on a support. The second end of the central hollow shaft finds a bearing in the second support for the mill body. The mill body is formed at its end, opposite the impeller, with a hopper 57 that has a hot air pipe 58 communicating therewith. In the mill body there are arranged attrition balls 59. The operation of this mill is also similar to that previously described.

In Figure 7 the mill construction, on the right hand side of the said figure is similar to that disclosed in Figure 6. This mill body 60, however, has one end of its hollow shaft 61 closed, and on the end of the said mill body there is a central shaft 65 that finds a bearing in the central upright of the supporting frame, the hollow shaft 61 finding a bearing in one of the end uprights of the frame. The second mill body 62 has a hollow shaft 63 that finds a bearing in the second end upright of the frame. The hollow shaft 63 has its inner portion reticulated to provide a screen and the end of the hollow shaft is formed with a disc flange 64 which is apertured to provide a second screen. Attrition balls are arranged in both of the mill bodies and both of the said mill bodies are provided with hoppers for the inlet of material. The hoppers have arranged therein pipes which communicate with a source of hot air, which air is induced into the mill bodies by the impellers.

In Figure 8 the mill body 72 is stepped throughout the length thereof and is interiorly formed in align with the said steps, with ring partitions 73 and 74, the ring partition 74 being disposed opposite the screen 75 that forms the inner wall of the chamber for the impeller 76. The compartments provided by the partitions have arranged therein attrition balls of varying weights and sizes. The central member of the impeller has arranged on its sides oppositely directed fan blades, as previously described, and the ends of the body 72 are provided with hollow shafts 78 and 79 that find bearings in the supporting frame. Communicating with the body there is a hopper 80 supported from one of the frame members and communicating with the compartment 81 in the mill chamber. The operation is similar to that previously described, except that the material is more quickly acted on by being subjected to the successive force of impact by the different sized balls in the several compartments. Air is forced into the mill by the impeller and material is delivered through the hollow shaft 78 to a suitable burner. A multiplicity of grinding mills is illustrated in Figure 9 which may be either simultaneously or independently operated. The mills have their hollow shafts journaled in suitable bearings on the supporting frames. One of the end mill bodies 86 is substantially spherical. This mill has a central ring partition 87 therethrough and has received in its inner and open face an inclined ring guide 87'. The ring guide is integrally formed on one face of a guard 88. The guard 88 has formed on both of its faces hoppers 89 and 90, respectively. The guard 88 is arranged over the upper portion of a cylindrical casing 91. The casing 91 has its wall next to the mill body 86, and that portion thereof opposite the guide 87', apertured, as at 92. The screen 92 is integrally formed with a hollow shaft 93 which is also apertured to provide a second screen and this hollow screen shaft passes through a flange that surrounds an outer opening in the mill body 86 and is fixed to this flange. The lower portion of the hopper is formed with a ring guide 94 that is received in one of the open sides of the intermediate spherical mill body 95. This mill body has centrally secured therein a partition 96, the said partition being also secured to a hollow shaft 97 that is fixed on the inner wall of the impeller chamber 91 and provides an extension of the hollow shaft 90.

The hollow shaft 97 is apertured to provide a screen. The second open end of the mill body 95 receives therein a downwardly inclined ring guide 98, the upper portion of which merging into a hopper 99. At the opposite sides of the hopper 99 there is a chamber 100 for impellers, and the hollow shaft 97 merges into this casing. The second end of the casing is formed with an outwardly directed hollow shaft 101 that is received in a hollow substantially pear-shaped mill body 102. This mill is divided by flanged partitions into a plurality of compartments 103. The outer and open end of the mill 102 has secured therein a non-apertured hollow shaft 104. The portions of the hollow shaft 101, communicating with the compartments 103 in the mill 102 are apertured, as at 105. The hollow shaft 104 extends longitudinally through the mill 102 and is enclosed by the screen shaft 101. The hollow shaft 104 has an angle disc flange 106 that is received in a compartment 107 in the chamber 100. The widened and centrally open end of the mill 102 has received therein a directing ring 108, and the said ring has arranged thereon or has secured thereto a hopper 109. The passage through the hopper 109 communicates with the upper portion of the mill 102.

Centrally received through the hollow shaft 104 there is a flow pipe 110. This flow pipe merges into a central partition 11 that divides the compartment 107 and the chamber 100 from a second compartment 112 in the said chamber. Received in the compartment 112 is a disc flange 113 that is formed on one end of a flow pipe 114 the same size as the flow pipe 110. The flow pipe 114 passes centrally through the hollow screen pipe 97 and has its second end formed with a disc flange 115 that is received in a compartment 116 in the chamber 91. The second compartment in the chamber 91 is indicated by the numeral 117 and is divided from the chamber 116 by only a ring flange 118. In the compartment 117 there is received a disc flange 119 formed on the inner end of a flow pipe 120. The flow pipe 120 extends centrally through the tubular screen 93 in the mill 86. In all of the mills and in the compartment 103 in the mill 102 there are weighted breaker elements, such as steel balls or the like. The balls in the several compartments vary in size and consequently in weight. The several mills are revolved in a manner as will be presently described and the material is acted upon by the weights, the centrifugal force incident to the turning of the mills and the act of attrition as well as by the impellers and the air drawn into the mills by the impellers. The arrows indicate the directions taken by the material in the pulverizing thereof in the mills.

In Figure 10 the body of the mill 121 is of cylindrical shape. The mill is centrally divided by a screen partition 122 into compartments 123 and 124, respectively. The compartment 123 has communicating therewith the intake opening of a hopper 125, and the hopper has an opening below its inlet in which is arranged a flow pipe 126. In the compartment 124 there are impeller blades 127. Similar fan or impeller blades may be arranged in the compartment 123. The mill has central hollow shafts upon its opposite faces and the powdered material finds an outlet through the hollow shaft 128. The operation of the device is similar to that previously described.

It is to be noted that the parts of my improvement are assembled for repairing and facility in performing such repairs and that one end of the mill can be operated without the other end and one motor can operate all of the mills.

The motive power for driving the mills is preferably electrical and preferably by induction, and preferably in a motor generating set. The poles for the motor to operate the mill may be located at any convenient face of the body portion of the mill most available and suitable for such application. In the showing of the drawings the poles 129 are located on the periphery of the rotating or impelling portion of the apparatus and the generator is invariably located as near the center of rotation of the mill or impeller as is possible and convenient for its application. The motor poles can be located as desired to perform their functions electrically and in this case around the periphery of the rotor, the same being electrically applied and connected electrically to the generator in the condition which will permit of the motor receiving its current from and through the generator, and as the motor operates the mill it also causes the generator to generate to the limit of the distance the motor is located from the generator center or from the generator to the motor peripherally. Thus it will be noted that the power current will be controlled so that the supply of power current will be permitted to supply only the amount of power current necessary to keep up the speed to its required degree of rotation and load or in other words the power current will be regulated in quantity to only the amount necessary between the current needed by the motor which is not supplied to it by the generator. It will be understood also that although some impellers and ball mills are small others may be larger in diameter and sufficiently contracted in width to curtail the use of power current, both as to a bill mill and its impeller for the application of the principle involved in this application and the use of power generally as applied to various constructions of appliances in general.

The application of the motor generator set consists of a ring or disc 130 which may be used as the rotor or starter core for the respective windings. The core or disc may be located on either one or both of the chamber peripheries closing the chambers or utilizing the ring for the motor or other purposes such as forcing or inducing the air from or to the compartments.

The nature of the invention is such as to necessarily render the same susceptible to changes in form, design, material employed, etc. Therefore, I do not wish to be confined to the structural embodiments herein set forth and hold myself entitled to make such changes therefrom as fairly fall within the scope of what I claim without departing from the spirit or sacrificing any of the advantages of the improvement.

Having described the invention, I claim:—

1. A ball mill for pulverizing coal and like combustible material and for delivering the powdered material to a burner, comprising a plurality of mill chambers, a hollow shaft for the mills, bearings for the shaft, weighted balls in each mill chamber, a screen in each mill chamber, hoppers communicating with the chambers outward of the screens and through which the material is introduced, an impeller chamber in each mill, impellers in the chambers comprising oppositely directed curved fan blades, a partition associated with the hollow shaft and arranged between the fan blades, the outer series of fan blades communicating with the hollow shaft, oppositely directed tubes communicating with the hollow shaft, and means for simultaneously or independently revolving the mills, as and for the purpose set forth.

2. Means for pulverizing coal or like combustible material, comprising a mill having hollow shafts projecting from the sides thereof, bearings for the shaft, said mill having an impeller chamber therein, a screen forming the inner wall of the chamber, a second screen arranged longitudinally in the mill chamber and connected with the first mentioned screen, attrition balls in the mill chamber, an impeller in the impeller chamber comprising a disc member connected with the hollow shaft and oppositely curved fan blades on the sides of the disc, as and for the purpose set forth.

3. Means for pulverizing coal or like combustible material, comprising a plurality of revoluble mills, a hollow shaft for the mills, bearings for the shaft, said shaft and the portions thereof received in the respective mills, being apertured to provide screens, casings formed on the confronting ends of the shaft between the mills, a second hollow shaft arranged centrally in the first mentioned hollow shaft and projecting through a closed end of the said first mentioned shaft, said second mentioned shaft having angle flanges extending in the casings and provided with impeller blades, certain of said mills being divided by ring discs into separate compartments, weighted balls of different sizes in the respective compartments and means for independently or simultaneously imparting circumferential movement to the mills, as and for the purpose set forth.

4. A revoluble ball mill, for pulverizing coal or like combustible material, having hollow shafts, bearing members for the shafts, said mill being divided by a screen into a ball compartment and into an impeller chamber, a fan impeller in the chamber, a core disc arranged around the mill, and poles for an induction motor extending from the core, as and for the purpose set forth.

5. A revoluble ball mill for pulverizing coal or like combustible material having hollow shafts and having attrition means for pulverizing the material, a screen, and impelling means for drawing the pulverized material through the screen and delivering the same to a burner, and means for driving the mill, comprising peripheral poles for an electric motor and poles at the center of the mill connected to the generator for the motor.

In testimony whereof I affix my signature.

PAUL L. CROWE.