Dec. 30, 1941. A. J. GRINDLE 2,267,729

FUEL PULVERIZER

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Fig. 1

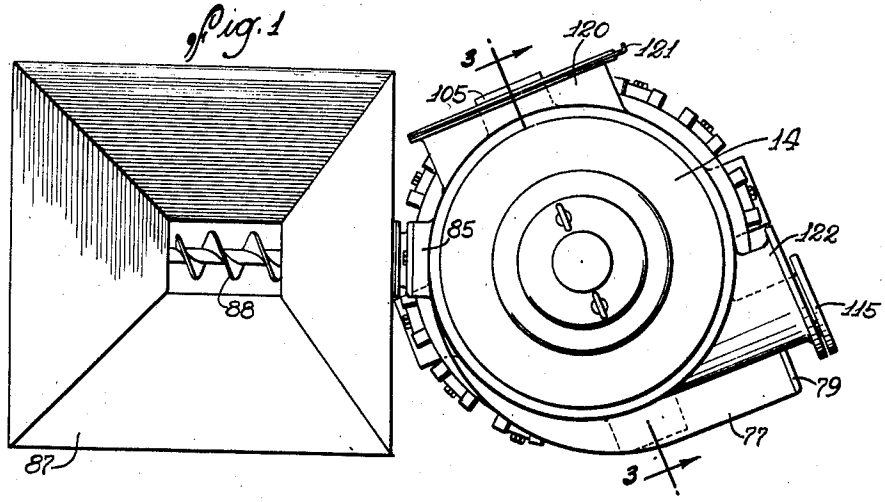
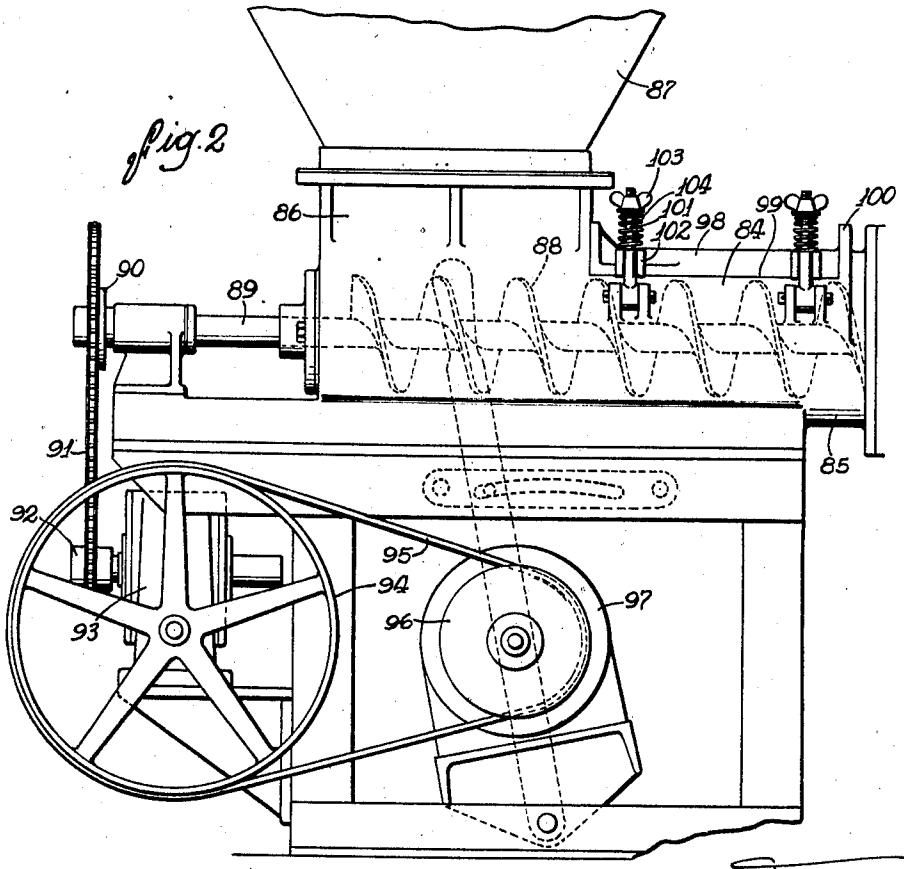


Fig. 2



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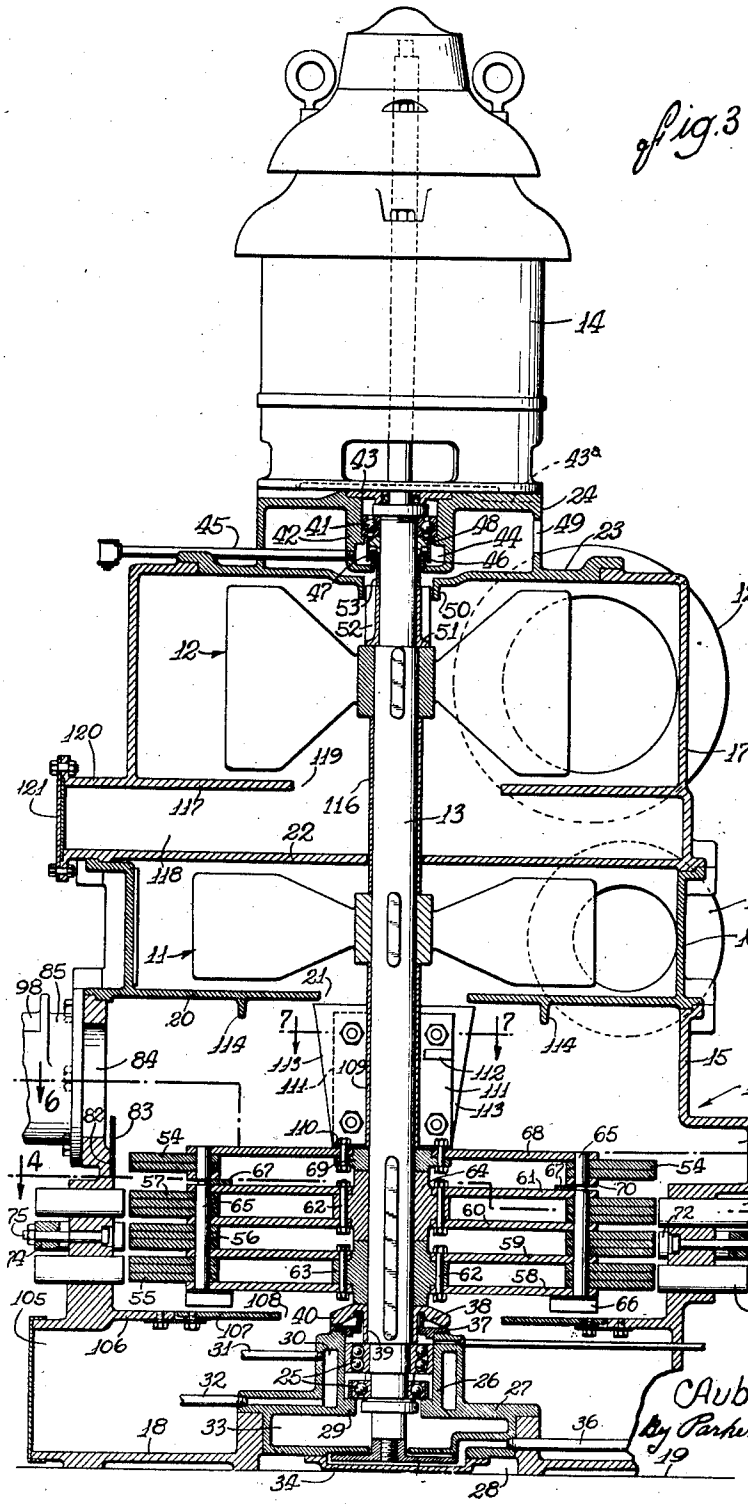
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Fig. 3



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Fig. 4

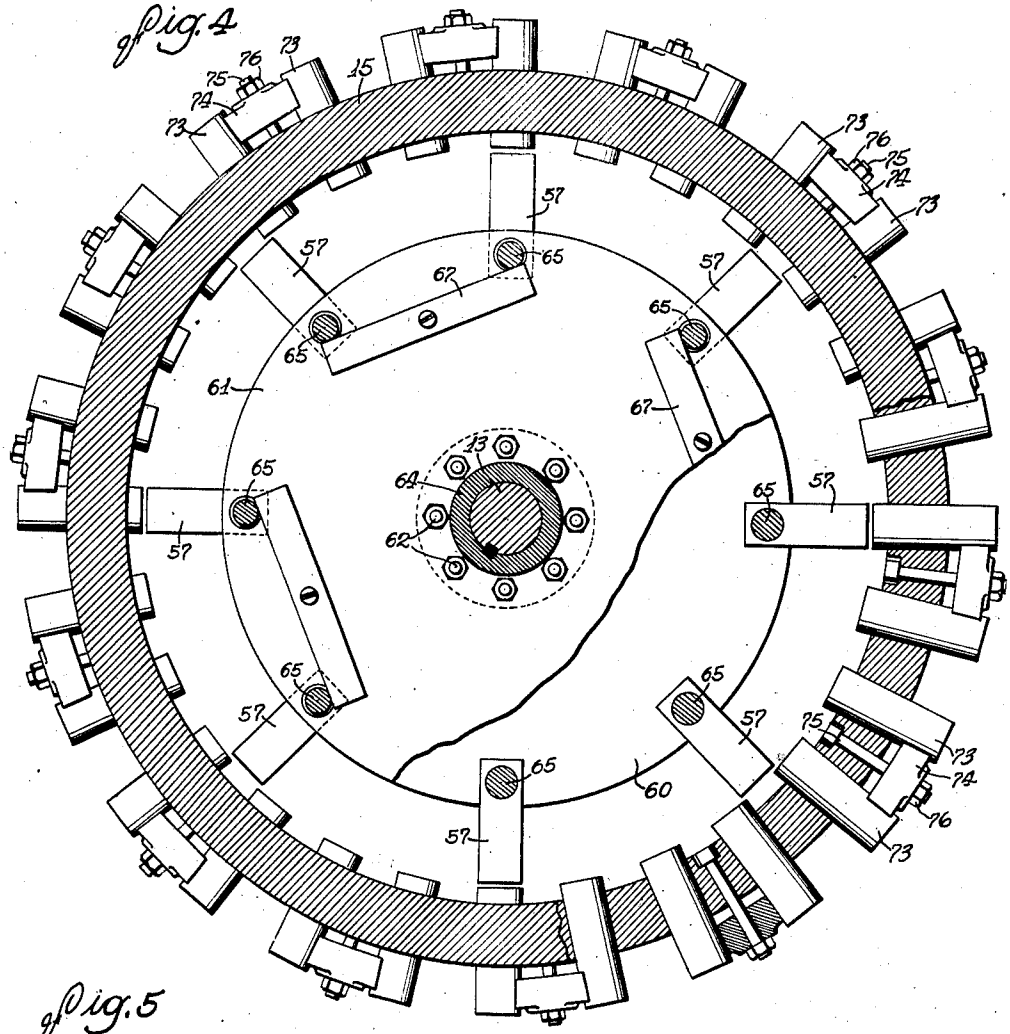
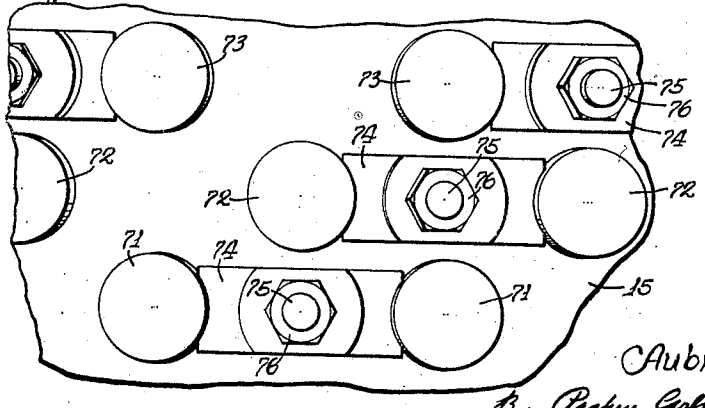


Fig. 5



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Fig. 6

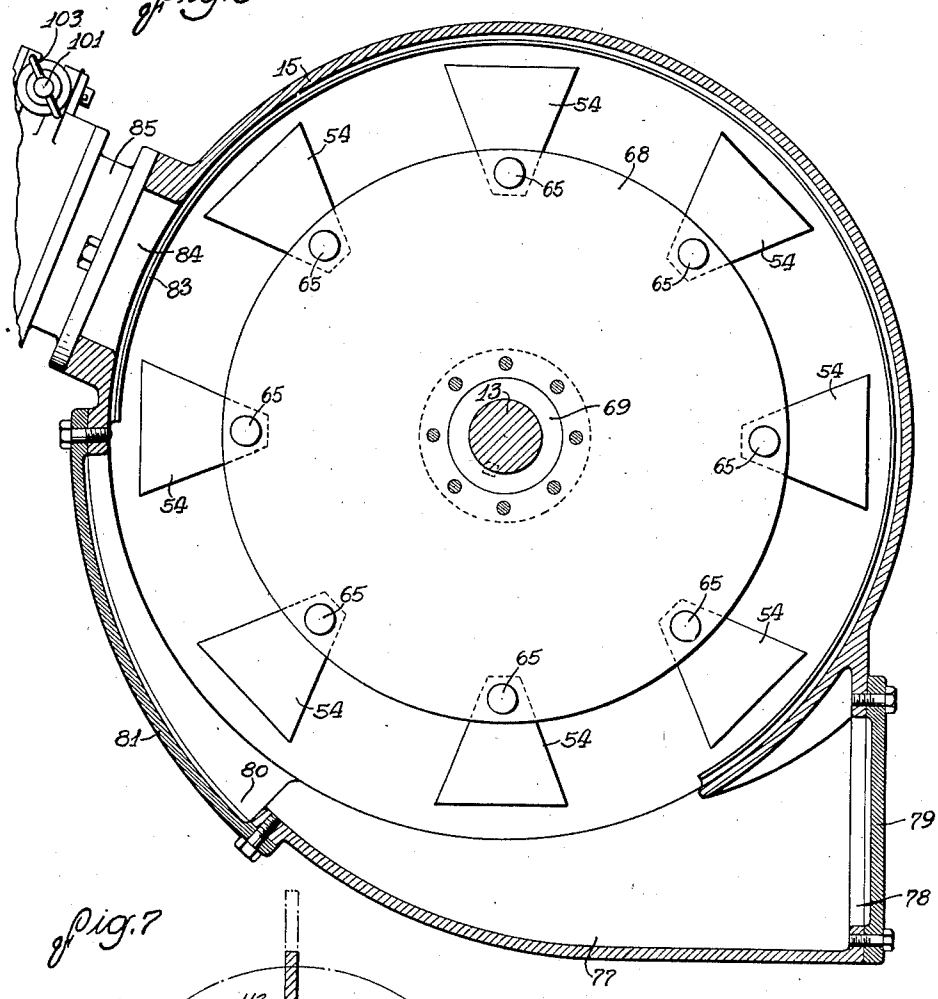
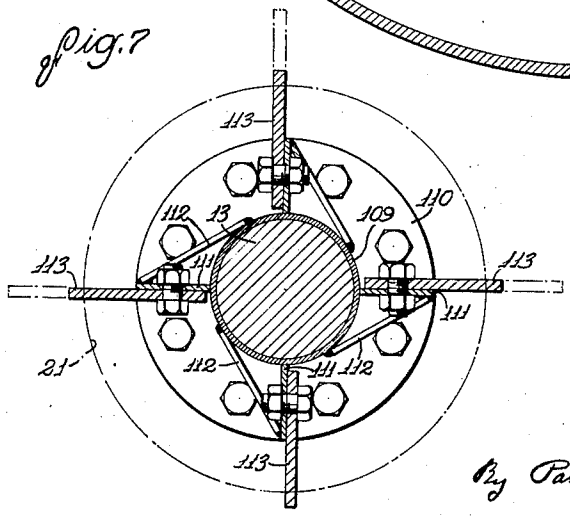


Fig. 7



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2,267,729

FUEL PULVERIZER

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Application April 3, 1937, Serial No. 134,754

4 Claims. (Cl. 83—11)

The present invention relates to improvements in fuel pulverizers, and has particular reference to new and improved means for producing comminuted or powdered coal adapted to be supplied in a stream of air directly to combustion apparatus or to be placed in storage.

An object of the invention resides in the provision of a novel fuel separator for baffling the stream of fuel laden air induced by the primary air propeller to control and maintain a predetermined fineness of fuel regardless of wear and tear in the pulverizing unit.

Another object resides in the provision of novel means for cooling and lubricating the bearings for the pulverizer shaft.

Further objects and advantages will become apparent as the description proceeds.

In the accompanying drawings, Figure 1 is a plan view of a pulverizer embodying the features of my invention.

Fig. 2 is a side elevational view on an enlarged scale of a fuel feeder for the pulverizer.

Fig. 3 is a vertical sectional view of the pulverizer taken in the plane of line 3—3 of Fig. 1.

Fig. 4 is a horizontal sectional view on an enlarged scale taken along line 4—4 of Fig. 3.

Fig. 5 is a fragmentary side elevational view of the pulverizer.

Fig. 6 is a horizontal sectional view taken substantially along the line 6—6 of Fig. 3.

Fig. 7 is a horizontal sectional view taken substantially along line 7—7 of Fig. 3.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawings, the pulverizer constituting the exemplary embodiment of the invention is adapted primarily for comminuting solid fuel, such for example as coal, to produce what is commonly known in the trade as "powdered coal," and is also adapted to supply the comminuted fuel in intimate suspension in a stream of air, at a predetermined fuel-air ratio, to a burner for immediate combustion. Preferably, the pulverizer is of the vertical type, and comprises in general a pulverizing unit 10, a suitable blower or propeller 11 for creating a stream of primary air having a substantially constant velocity and adapted to entrain granules of fuel of a predetermined fineness from the pulverizer unit 10, and a second suitable blower or propeller 12 for creating a stream of secondary air adjustable in volume in accordance with combustion requirements. Preferably, the foregoing elements are driven by a single vertical shaft 13 common to all and connected at the top to a suitable source of power, such as an electric motor 14.

The pulverizer (see Fig. 3) has an outer housing consisting of superimposed housing sections 15, 16 and 17 rigidly connected to provide an integral structure. All of these sections are generally circular in horizontal cross-section as illustrated in Figs. 4 and 6. The lowermost or base housing section 15 encloses the pulverizer unit 10, and has a bottom wall 18 adapted to rest on a suitable support or foundation indicated at 19. The intermediate housing section 16, which rests on the section 15, encloses the propeller 11 and has a bottom wall 20 formed with a central inlet opening 21, and closing the top of the section 15 except at the aforesaid opening. The top housing section 17 encloses the propeller 12, and rests on, and has a bottom wall 22 closing the top of, the section 16. At the top, the section 17 is closed by a plate 23 which is formed on its upper side with a central bearing casing 24 on which the motor 14 is rigidly mounted.

The shaft 13 extends centrally through the pulverizer housing and forms a component part of the unit 10 and the propellers 11 and 12. At the lower end, the shaft 13 is supported in antifriction bearings 25 of the radial and end thrust type which are mounted in a sleeve 26 integral with a plate 27 resting on and closing a flanged opening 28 in the base wall 18. Of the lowermost bearing 25, the outer raceway rests on an inner peripheral flange 29 in the lower end of the sleeve 26, and the inner raceway supports the inner raceway of the other bearing 25. Preferably, the sleeve 26 is water cooled, and to this end is formed with an annular internal space 30 connected at the upper end to a water pipe 31 from any suitable source (not shown) and at the lower end to a drain pipe 32.

Provision is also made for lubricating the bearings 25. Thus, the plate 27 is formed with an oil reservoir 33 which extends into the opening 28, and which opens at the bottom to a pump casing 34 thereon. The lower end of the shaft 13 extends through the reservoir 33 into the casing 34, and in the latter has fixed thereto a rotary pump element or disk 35. Opening

from the periphery of the pump casing 34 is an oil line 36, shown in fragment, which discharges to the upper end of the sleeve 26 at a point above the bearings 25. Oil from the sleeve 26 drains back into the reservoir 33. The top of the sleeve 26 is substantially closed to keep out foreign matter. The preferred means for this purpose consists of a fixed plate 37 with a central opening surrounded by an upstanding flange 38 through which the shaft 13 extends. Keyed to the shaft 13 is a sleeve 39 extending through the flange 38 into engagement with the bearing 25. A disk 40 integral with the sleeve 39 is grooved on the underside to receive the flange 38 and closely overlies the plate 37.

The upper end portion of the shaft 13 is journaled in an anti-friction bearing 41 seated in a bearing sleeve 42 projecting into the casing 24. A cover 43 serves to close the top of the sleeve 42. The motor 14 preferably is of the deep-well shaft type, and hence sets down over the upper end of the shaft 13 as indicated in dotted outline. Radial grooves 43a formed in the top of the casing 24 provide air passages for the lower end of the motor.

To provide means for lubricating the bearing 41, the sleeve 42 is enlarged internally to define an oil well 44 connected to a supply pipe 45, and is provided about the lower opening for the shaft 13 with an annular flange 46 projecting upwardly to above the normal oil level. An annular oil flinger 47 is secured to the shaft 13 for rotation therewith by a collar 48, and projects downwardly about the flange 46 into the body of oil. The flinger 47 is tapered downwardly, and hence tends to throw the oil upwardly.

The casing 24 has an opening 49 in its peripheral wall communicating with the atmosphere, and also communicates with the interior of the housing section 17 through a flanged opening 50 for the shaft 13 in the plate 23. Fixed on the shaft 13 within the housing section 17 and projecting at its upper end into the opening 50 is a cooling fan element preferably in the form of a sleeve 51 formed externally with longitudinal ribs 52. A spacer 53 is interposed on the shaft 13 between the head 48 and the fan element 51. It will be evident that the element 51 will cause the flow of a small stream of cooling air from the atmosphere into the casing 24 and about the bearing sleeve 42 to the housing section 17.

The pulverizer unit 10 (see Figs. 3, 4 and 6) comprises a rotary hammer structure mounted on the shaft 13 for rotation therewith, and an encircling stationary liner structure. In the preferred form, the rotary hammer structure or rotor consists of an upper set of peripherally spaced radially projecting hammers 54, and three axially spaced sets of similarly arranged lower hammers 55, 56 and 57. Each of the lower hammers consists of three superimposed elongated rectangular plates, and each of the upper hammers 54 consists of two generally triangular plates with their wide or base ends projecting outwardly. The lower sets of hammers 55, 56 and 57 are clamped at the inner ends of the hammers respectively between the outer marginal edge portions of a series of parallel annular disks 58, 59, 60 and 61 suitably secured to the shaft 13. Thus, the lower two disks 58 and 59 are rigidly secured by means of bolts 62 to opposite sides of a spacer or hub 63 keyed to the shaft 13 and resting on the disk 40. Similarly, the upper two disks 60 and 61 are attached by means of bolts 62 to opposite sides of an intermediate spacer or hub 64 keyed to the shaft 13, and resting on the hub 63. A plurality of peripherally spaced pins or shafts 65 extend through the disks 58 to 61 and respectively through the superimposed hammers of the three sets. The lower ends of the pins 65 engage respectively with a series of short radial angle bars 66 secured to the under side of the disk 58. The upper ends of the pins 65 are notched peripherally to receive the ends of a plurality of locking bars 67 (see Fig. 4) removably secured against the top of the disk 61. Thus, each of the bars 67 serves to secure two contiguous pins 65 in position.

The hammers 54 of the upper set are clamped to the underside of an annular disk 68 bolted to a spacer or hub 69 which is keyed to the shaft 13 and rests on the hub 64. A ring 70 underlies the hammers 54, and rests on the bars 67. The upper ends of the pins 65 are extended to project through the ring 70, the hammers 54 and the disk 68.

By reason of the foregoing construction, all of the upper and lower hammers 54 to 57 are rigidly connected in one unitary structure fixed on the shaft 13 for rotation therewith in the lower portion of the housing section 15.

The liner structure or stator encircles and coacts with the lower hammers 55 to 57, and preferably is adjustable to permit an accurate arrangement of the parts and take-up for wear. In its preferred form, the structure comprises three sets of peripherally spaced wearing pins or plugs 71, 72 and 73 which project radially through the peripheral wall of the housing section 15 into the planes of and for coaction respectively with the hammers 55, 56 and 57. The plugs 72 of the intermediate set are staggered relative to the plugs of the other two sets as shown in Fig. 5. Each of the plugs of the three sets is adjustable in the supporting wall into proper spaced relation to the circle of revolution of the associated hammers. As wear occurs, the plugs may be adjusted inwardly.

Suitable means for clamping the plugs in position of adjustment is provided. This means (see Figs. 4 and 5) preferably comprises a plurality of wedge clamping blocks 74 each of which is adapted to engage the adjacent sides of two peripherally contiguous plugs. Each of the blocks 74 is apertured centrally to receive the shank of a draw bolt 75 which extends through and has its head anchored in the inner surface of the peripheral wall of the housing section 15. A nut 76 on the outer end of the bolt 75 affords means for forcing the associated block 74 inwardly into wedge clamping engagement with the associated plugs.

The peripheral wall of the housing section 15 is enlarged at one side and in the plane of the upper hammer structure to provide a pocket 77 adapted to receive heavy foreign matter such as tramp iron. The pocket 77 (see Fig. 6) is spirally enlarged, and terminates in a tangential outlet 78 normally closed by a removable cover plate 79. An opening 80 is also formed in the wall of the pocket 77 at the shallow end, and normally is closed by a removable cover plate 81. It will be evident that tramp iron collecting in the pocket 77 may be removed through one or the other of the openings 78 and 80. Seated in a notch 82 in the inner peripheral surface of the housing section 15, and concentrically encircling the major portion of the upper hammer structure, except in the region of the pocket 77, is a frag-

mentary liner strip or ring 83 of a suitable wear resisting material. The spacing of the ring 83 and the hammers 54 is somewhat greater than that of the plugs 71, 72 and 73 and the lower hammers 55, 56 and 57.

The coal or fuel to be powdered is introduced into the upper portion of the housing section 15, and is adapted to be acted on by the hammers 54 to 57. Thus, the section 15 has a fuel inlet opening 84 in one side immediately above the liner strip 83 and adjacent the shallow end of the pocket 77. The opening 84 communicates with a duct 85 which may be connected to any suitable source of fuel, such for example as the fuel feeder illustrated in Fig. 2.

In the present instance, the fuel feeder has a hopper base 86 with which the duct 85 is connected. A hopper 87 is mounted on the base 86. Extending through the hopper base 86 into the duct 85 is a conveyer screw 88 for discharging fuel to the pulverizer. The screw 88 has a shaft 89 which may be driven from any suitable source of power, and which is herein shown connected through a sprocket wheel 90, a chain 91, a sprocket wheel 92, a speed reduction mechanism 93, a pulley 94, a V-belt 95, and a self-adjusting pulley 96 to an electric motor 97.

One of the primary features of the feeder consists of a yieldably held plate 98 normally forming part of the wall of the duct 84, and on occasion movable out of position to permit the passage of tramp iron or other foreign matter which otherwise would tend to jam the conveyer 88. As shown in Figs. 2 and 6, the top of the duct 84 is formed with a longitudinal opening 99 extending from the outlet of the hopper base 86 to a guide flange 100. The plate 98 normally closes the opening 99 to closely embrace the upper portion of the conveyer 88 and to define the upper marginal portion of the outlet from the hopper base 86, and is guided between the base 86 and the flange 100 for vertical movement away from the duct in the event of engagement by a foreign obstruction impelled by the conveyer. To provide means for clamping the plate 98 yieldingly in normal position, a plurality of pins 101, two on each side, are pivotally connected to the sides of the fixed portion of duct 84. The pins 101 extend upwardly through bifurcated lugs 102 on the opposite side edges of the plate 98, and are provided with wing nuts 103 on their free ends. Coiled compression springs 104 are disposed on the pins 101, and bear at opposite ends against the lugs 102 and the nuts 103 to hold the plate 98 in closed position.

The finely comminuted fuel is entrained in a stream of air flowing upwardly through the housing section 15 to the propeller 11. Thus, the bottom portion of the section 15 has an air inlet opening 105 in one side communicating with the atmosphere. Formed on the interior of the section 15 just below the hammer structure is an annular flange 106. A flat ring 107 is removably mounted within the flange 106, and defines a central opening 108 through which the air from the bottom of the section 15 passes upwardly about the shaft 13. The internal diameter of the flange 106 is such that the plate 27 may be inserted downwardly therethrough in the assembly operation when the ring 107 is removed. After passing through the opening 108, the air is caused to flow outwardly along the bottom of the disk 58, and then about and between the hammers 54 to 57 to the opening 21. The flow is induced by the propeller 11 and is assisted by the angle bars 66 which tend to create a suction at the opening 108. It will be evident that the flange 106 and the ring 107 define a baffle preventing the air from passing directly to the fuel crushing zone, and confining any particles of fuel falling through the zone to the path of a high velocity stream of air. In passing through the crushing zone, the air tends to entrain all particles of fuel of a predetermined fineness or less, and to carry same through the opening 21 to the propeller 11.

A separator of novel and advantageous construction (see Fig. 7) is disposed at the opening 21 for preventing substantially all particles of fuel above a predetermined size from passing with the air to the air propeller 11. Preferably, this separator is adjustable to vary the size of the fuel particles that will be discharged. Thus, the separator may be adjusted to pass in excess of 90 percent 300 mesh powdered fuel.

In its preferred form, the separator is in the nature of a rotary or centrifugal baffle driven by the shaft 13. More particularly, the separator comprises an elongated sleeve 109 on the shaft 13 and with a lower end flange 110 bolted to the hub 69. A plurality of uniformly peripherally spaced radial mounting vanes or plates 111 are rigid with and extend along the sleeve 109. Preferably, the vanes 111 are supported and reinforced by inclined braces 112. Removably secured respectively to the leading faces of the vanes 111 are a plurality of deflector or separator blades 113, four in the present instance. Each of the blades 113 is flat and radial, and projects above and radially outward of the vanes 111. The upper end of each blade 113 terminates just below and overlaps the marginal edge of the opening 21, and the longitudinal outer edge is inclined upwardly and outwardly so that the centrifugal action imparted thereby to the fuel increases upwardly. While the blades 113 may be secured in position by any suitable means, they are shown as bolted to the vanes 111.

The coal laden air tends to pass upwardly between the blades 113 to the opening 21, and hence is subjected to a swirling action. The heavier fuel particles hence are thrown outwardly by centrifugal force, and only particles of a predetermined fineness are allowed to pass to the opening 21. Since the centrifugal force is dependent on the radius of the circle of revolution of the blades 113, the size of the selected particles may be varied by adjusting the blades radially. This may be accomplished by substituting blades of different width. If blades of greater width are substituted, the entrained fuel leaving the pulverizer unit will be relatively fine. If the effective throw of the blades is reduced, the entrained fuel will be relatively coarse.

A depending annular flange 114 is formed on the under side of the wall 20 in concentrically spaced relation about the opening 21 and the separator. This flange serves to prevent fuel from jumping over the blades 113.

The propeller 11 may be of any suitable form, and is shown in the drawings as a radial blade fan keyed to the shaft 13 for rotation within the housing section 16. The hub of the fan engages the upper end of the sleeve 109. The housing section 16 has a tangential air outlet 115 which may be connected to a storage bin (not shown) or a burner (not shown). It will be understood that fuel laden air enters the housing section 16 through the opening 21, and is discharged through the outlet 115.

The propeller 11 serves to induce a constant flow of high velocity air through the pulverizer unit. When the outlet 115 is connected to a burner, the propeller thus supplies a substantially constant volume of primary air. Preferably, the flow is maintained constant regardless of adjustments of the ultimate fuel-air ratio or of the amount of fuel supplied so as to retain under all conditions an efficient entraining action.

The propeller 12, which is provided to supply secondary air, is in the form of a radial blade fan keyed to the shaft 13 for rotation within the housing section 17. The hub of the fan 12 is separated from the hub of the fan 11 by an interposed spacer sleeve 116 on the shaft 13, and underlies the small propeller 51. An internal partition wall 117 in the section 17 defines an air chamber 118 and an axial inlet opening 119 therefrom to the fan 12. One side of the chamber 118 has an air inlet opening 120 communicating with the atmosphere and provided with an adjustable damper 121. The section 17 has a tangential air outlet 122 which is adapted to be connected to the burner (not shown). The amount of air required for combustion may be adjusted by means of the damper 121 to vary the amount of secondary air while maintaining the flow of primary air constant.

In operation, the shaft 13 is driven by the motor 14 to operate the fuel crushing hammers 54 to 57 and the blowers 11 and 12. As a result, primary air is drawn upwardly through the crushing zone and discharged through the primary air outlet 115, and secondary air is discharged through the secondary air outlet 122. Fuel is supplied through the duct 85 and is crushed by the hammers 54 to 57. Any foreign matter, such as tramp iron, tending to jam between the blade of the conveyer 88 and the plate 98 acts to lift the plate against the action of the springs 104, and thereupon to pass with the fuel to the pulverizer. Upon reaching the latter, the foreign matter is collected in the pocket 77 from which it may be removed through one or the other of the openings 78 and 80. The primary air in passing through the crushing zone entrains the fine particles of fuel. Fuel particles above a predetermined size are baffled out of the air by the blades 113 of the separator before reaching the opening 21.

The pulverizer is simple and inexpensive in construction and adapted for ready assembly and disassembly. The wearing pins 73 may be readily adjusted, and the blades 113 may be provided in different widths so as to insure that the entrained fuel leaving the pulverizer is of a predetermined fineness. The bearings for the shaft 13 are cooled and lubricated. If the motor 14 is in need of repair or reconditioning, it may be readily removed from the shaft 13 without disturbing the rest of the pulverizer.

I claim as my invention:

1. In a fuel pulverizer, in combination, a pulverizing unit for comminuting the fuel, an air propeller having an axial inlet opening vertically from the top of said unit and operable to induce the flow of fuel laden air from said unit through said inlet, a vertical drive shaft for said unit and said propeller extending axially through said inlet, and a fuel separator mounted within said unit on said shaft for rotation thereby and having a plurality of generally radial blades extending across the underside of said inlet to baffle out the relatively heavy particles of fuel entrained in the air flowing to said inlet, each blade having a longitudinal outer edge inclined upwardly and outwardly relative to said shaft.

2. In a fuel pulverizer, in combination, a pulverizing unit having a stator and a rotor on a vertical axis defining a crushing zone and having an outlet at the top, an air propeller on said unit for inducing an upward flow of air through said zone to said outlet to entrain finely comminuted fuel, a shaft extending centrally of said outlet for driving said unit and propeller, a sleeve fixed on said shaft above said rotor and below said outlet, and a plurality of generally radial fuel and air separating blades removably mounted on and extending longitudinally of said sleeve with the external circle of revolution of said blades increasing toward said outlet, the fuel laden air passing to said outlet from between said blades.

3. In a pulverizer, in combination, an external housing, a rotor and a stator mounted on a vertical axis in the lower portion of said housing and defining a fuel crushing zone, a vertical drive shaft for said rotor, a hollow bearing casing on the top of said housing and having an air inlet from the atmosphere and an air outlet to said housing, a bearing sleeve in and depending from the top wall of said casing and receiving the upper end of said shaft and formed with an internal upstanding annular flange about said shaft to define an oil well in the lower portion, a bearing in said sleeve for supporting said shaft, means operable by said shaft and overlapping said flange for flinging oil from said well over said bearing, and a suction fan on said shaft within said housing for creating the flow of a small stream of air through said casing about said sleeve.

4. In a pulverizer, in combination, an external housing, a rotor and a stator mounted on a vertical axis in the lower portion of said housing and defining a fuel crushing zone, a vertical drive shaft for said rotor, a hollow bearing casing on the top of said housing and having an air inlet from the atmosphere and an axial air outlet to said housing, a bearing sleeve in said casing and receiving the upper end of said shaft, a bearing in said sleeve for supporting said shaft, an air propeller on said shaft in said housing and having an axial inlet at the bottom and a tangential air outlet, and a suction fan on said shaft above said propeller and within said axial outlet for creating the flow of a small stream of air from said first mentioned inlet through said casing about said sleeve and through said first mentioned outlet to the top of said propeller.

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