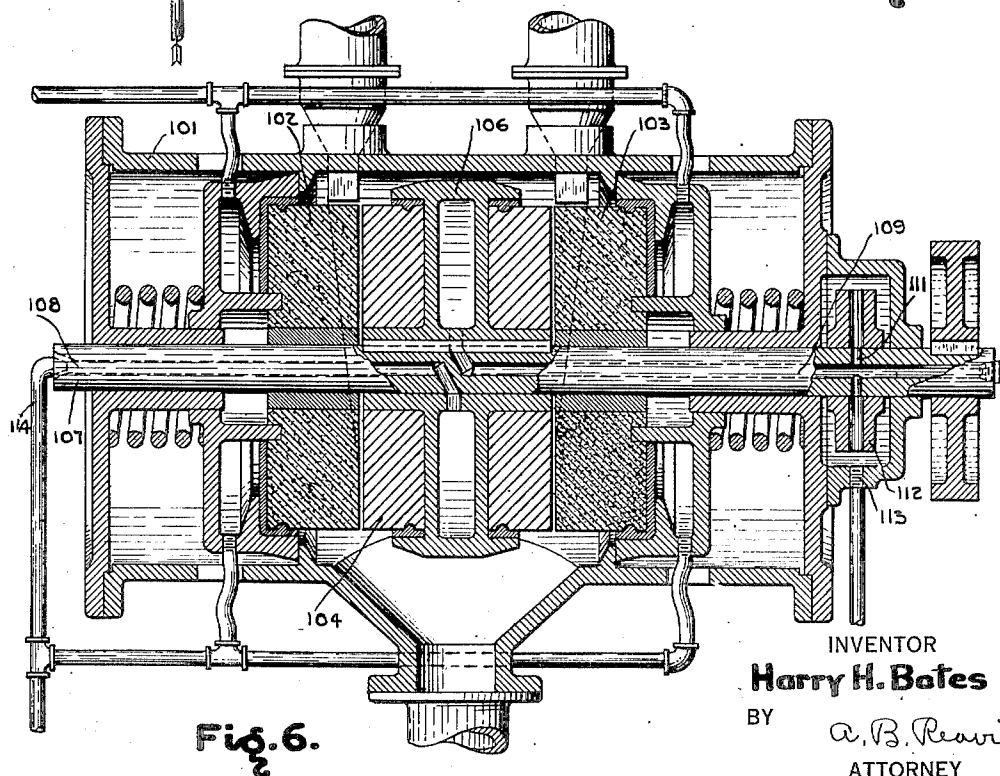
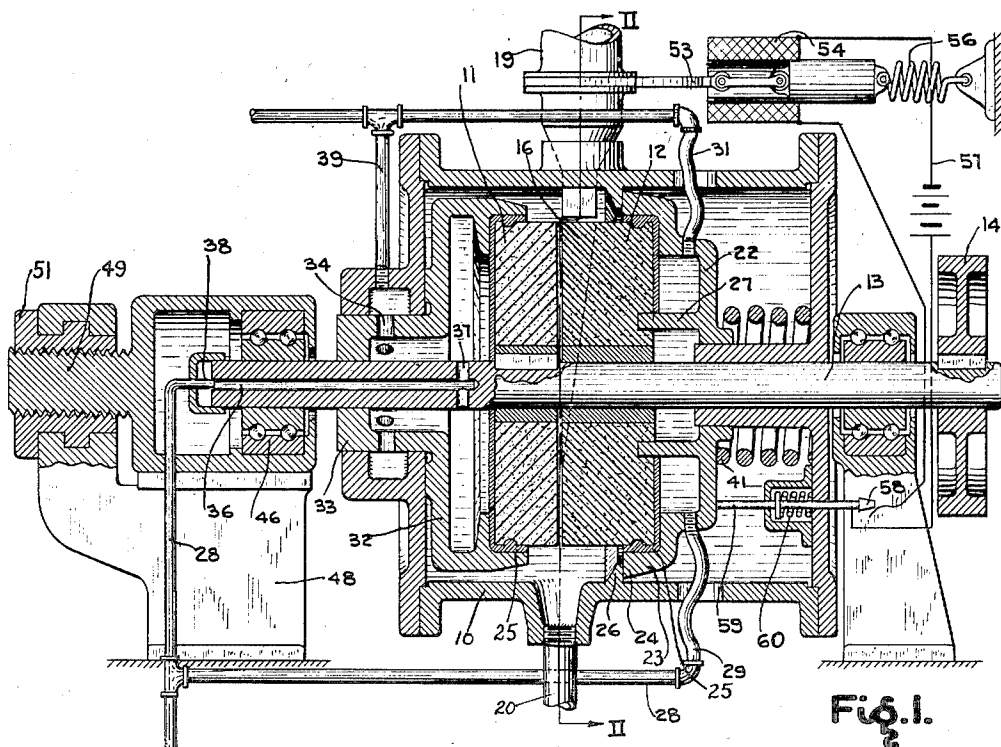


1,762,379

2 Sheets-Sheet 1



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June 10, 1930.

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1,762,379

COAL PULVERIZER

Filed April 25, 1927

2 Sheets-Sheet 2

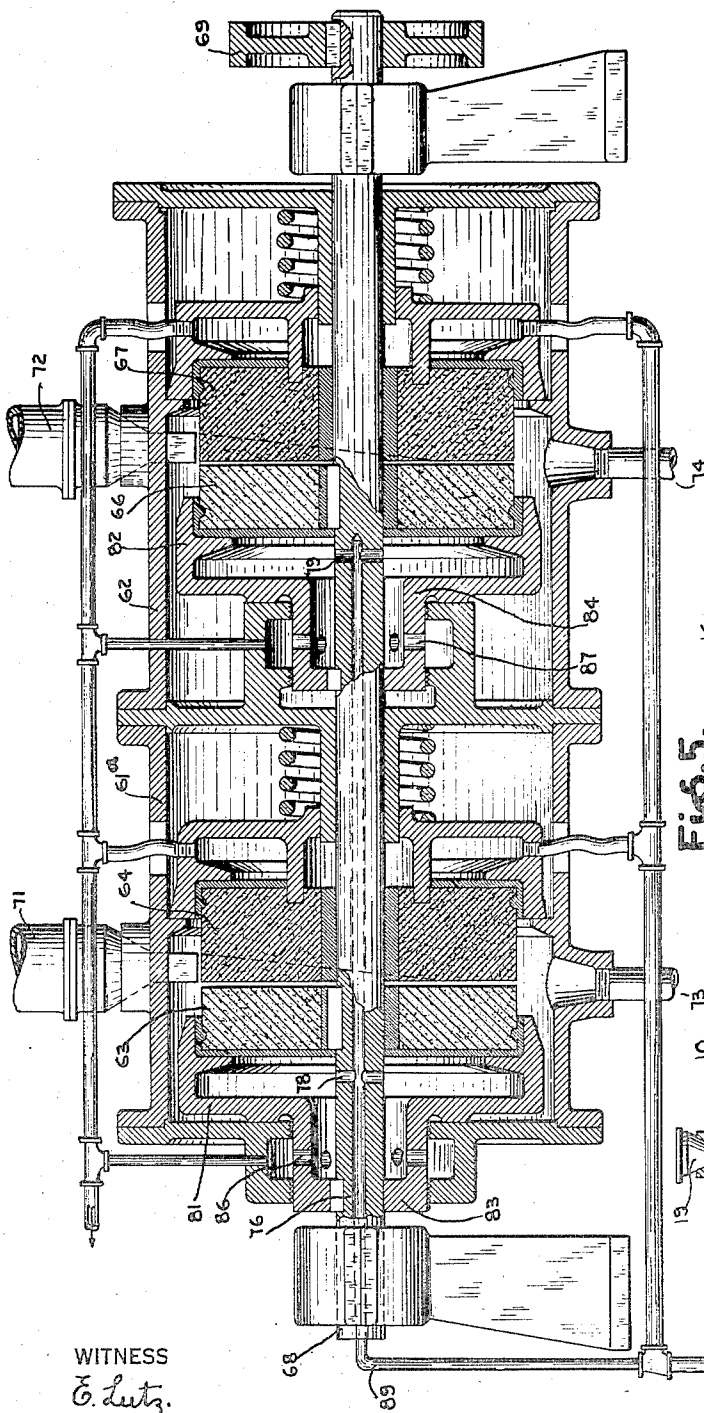


Fig. 1.

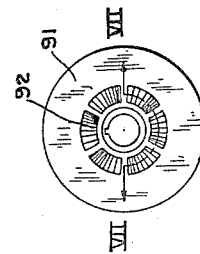


Fig. 2.

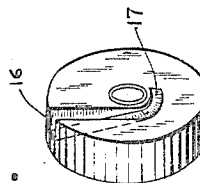


Fig. 3.



Fig. 4.



Fig. 5.

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COAL PULVERIZER

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My invention relates to grinding machines, for example, machines for grinding coal into pulverous form for use in furnaces, and has for its object to provide apparatus of the character designated which shall be relatively small and compact and which shall have a very high capacity for the weight thereof and the power required to drive the apparatus.

Another object of my invention is to provide a grinding machine employing relatively rotatable grinding elements and wherein the interaction of the elements is such as to first draw the material inwardly of the two stones, producing a crushing action of material against material, and finally grinding it to a pulverous state by attrition between the stones.

Apparatus embodying features of my invention is illustrated in the accompanying drawings, in which:

Fig. 1 is a longitudinal section view of apparatus embodying features of my invention;

Fig. 2 is a sectional view taken along the line II—II of Fig. 1 and looking in the direction of the arrows;

Fig. 3 is a perspective view of the stationary grinding stone employed in my invention;

Fig. 4 is a view, in elevation, showing a modified form of rotating grinding stone;

Fig. 5 is a sectional view similar to Fig. 1 but showing a grinding machine embodying a plurality of grinding units;

Fig. 6 is a view similar to Fig. 1 and showing a further modified form of my invention; and,

Fig. 7 is a fragmentary sectional view taken along the line VII—VII of Fig. 4.

Heretofore, in the design of grinding machines for pulverized fuel, among the difficulties to be overcome there has been that of producing a machine which is effective to reduce the fuel to a sufficiently finely divided state in one passage through the machine that it might be employed in a pulverized fuel burning furnace and also in providing a machine which has a relatively high output for the power required to drive it.

I have discovered that these and other

difficulties may be overcome by providing a machine embodying a stationary grinding element and a coaxially arranged rotary grinding element cooperating with the stationary element and in arranging the grinding elements with conjugate working faces. I provide, in the working face of the stationary element, a feed groove which forms one of the important features of my invention, and which extends from the periphery in a chordal direction, to one side of the axis of the stone and is so disposed that the action of the working face of the rotary element in passing the groove exerts an inward force on the material in the groove thereby producing a packing and crushing action on said material before it actually passes between the working faces of the two stones. The feeding groove is generally wedge-shaped and uniformly decreases in depth from the periphery inwardly of the stone. In order to provide sufficient length to the groove, it may be turned arcuately around the axis of the stationary element as it approaches inwardly of said element.

In order to avoid overheating of the stones in service, I provide them with hollow retaining members which embrace the stones and provide means for circulating a cooling fluid through the retaining members on the side opposite the working faces thereof. The stationary member is yieldingly held in a predetermined working relation with respect to the rotary member, and should some foreign material, such as iron or other hard material which would endanger the stones, accidentally pass into the machine, the yielding means permit a separation of the stones and thus prevent danger to the machine. I may also provide means effective upon such relative displacement of the stones to shut off the supply of material to be ground to the machine and thus prevent an undue amount of coarse material from passing through the machine.

Referring now to the drawings for a better understanding of my invention, I show, in Fig. 1, my improved grinding machine wherein a casing 10 surrounds a rotary grinding stone 11 and a cooperating stationary

grinding stone 12. The rotary grinding stone 11 is secured to a shaft 13 which may be driven by any suitable means as from a pulley 14. The rotary grinding stone 11 is preferably of much coarser texture than the stationary grinding stone 12. The stones are preferably both made of a highly refractory fast cutting grinding material such as silicon carbide.

10 The opposed working faces of the two stones are conjugate, that is, the opposed working faces are parallel throughout and are not dishd as has heretofore been common in the art.

15 In the working face of the stationary member 12, I provide a wedge-shaped groove 16 which extends from the perimeter inwardly to one side of the axis of the stone and which decreases uniformly in depth from the
20 perimeter to the end thereof where it merges into the working face of the stone. In order to provide sufficient length to this groove, I may also form it with an arcuate portion 17 which bends around the axis of the stone
25 and which is spaced away from the axis. The direction of rotation of the rotary grinding stone 11 is indicated in Fig. 2 by an arrow 18. It will be seen from Fig. 2 that the groove is disposed on that side of the axis
30 of rotation so that the direction of movement of the working face of the rotating stone passing in front of the groove exerts a force giving an inward component of motion to the material in the groove. The coal
35 to be ground is fed into the groove from a conduit 19 and passes thereto by gravity.

The texture of the stationary stone is made fine enough so as to impede as little as possible the flow of material through the groove
40 and the texture of the rotating stone 11 is made as coarse as possible, consistent with the degree of fineness sought, so as to exert the greatest degree of force on the material in the groove in its passage inwardly of the
45 working faces of the stones.

Thus the action of the rotary stone on the material while it remains in the groove is a packing action or one which causes the material to be crushed against other material
50 and the bounding walls of the groove during its passage inwardly. By the time it reaches the lower end of the groove 16 it is in a sufficiently finely divided state to pass between the stones whereupon it is subject to
55 a grinding action between the stones and with other material between the faces of the stones and is finally thrown out around the periphery of the stones in a finely divided state. After being thrown out from between the
60 stones, it passes by gravity through a discharge conduit 20 from whence it may be conveyed to any suitable place.

I have found with this machine that with stones no larger than 4 inches in diameter,
65 ordinary bituminous coal in the well-known

commercial form of slack may be pulverized in one passage so that it will pass through a mesh of 1/200 inch fineness. Furthermore, the action of the rotary stone in drawing the material into the groove is so rapid that
70 the capacity is relatively very high for the weight of the apparatus. I have furthermore found that coal may thus be ground with a remarkable reduction in power required per ton as compared with apparatus
75 heretofore known to me, the power required in the test above referred to being in the neighborhood of 2 k. w. hours per ton.

The stationary stone 12 is retained by a hollow member 22 having a ring portion 23
80 extending entirely around the periphery thereof. The ring portion 23 is joined to the stone by melting lead or other suitable material and pouring it between the stone and the ring portion as shown at 25. The
85 ring portion 23 is provided with a suitable number of protuberances or lugs 24 around its periphery which are adapted to engage with complementary stops 26 disposed
90 around the interior of the casing 10 and which hold the stationary member in a predetermined position within the casing. The hollow member 22 is provided with an annular partition 27 which is joined to the back
95 of the stationary member 12 in a fluid-tight manner. A water main is shown at 28 from which a flexible branch conduit 29 leads into the interior of the hollow member 22 for circulating water therethrough and cooling
100 the stationary stone 12. After passing through the hollow member 22 the water is discharged through a flexible conduit 31.

The rotary member 11 is similarly retained by a hollow member 32 joined to the rotary
105 member as previously described for the stationary member. The member 32 is provided with a hub-like portion 33 having openings 34 therein which, in effect, act as the vanes of a pump. The shaft 13 is provided with a passage 36 so that it is hollow and it is provided,
110 interiorly of the hollow member 32, with a plurality of passages 37. Cooling water from the main 28 is introduced into the end of the passage 36 of the shaft 13 at 38. The passages
115 37, upon rotation of the shaft 13 act as vanes of a pump and discharge the water from the passage 36 outwardly into the hollow member 32 cooling the rotary stone 11 after which it is pumped outwardly thereof by action of
120 the passage 34 in the hub portion 33 and is thence discharged through a discharge conduit 39.

On the outer side of the hollow member 22 there is arranged a spring 41 abutting against
125 the casing 10 and exerting a force for holding the lugs 24 of the member 22 against the stops 26, so that the stationary member is yieldingly held in a predetermined position with respect to the rotary member. By this
130 yielding means, the stones are relatively dis-

placed whenever any material, such as iron, is accidentally introduced with the coal, and which would endanger the grinding stones should their relative positions be rigidly fixed. In such circumstances the spring 41 yields, permitting such material to be thrown outwardly from between the two stones without endangering them.

The position of the rotary member with respect to the stationary member is adjustable by means of a thrust bearing 46 which is movable longitudinally of a holding pedestal 48 by means of a screw and nut connection 49 and 51.

In case there should be axial movement of the stationary member 12 such as when iron or other hard foreign material is inadvertently fed into the mill, it will be obvious that a considerable amount of unpulverized material might pass through the mill. In order to obviate this as much as possible, I provide a gate or valve 53 in the feed conduit 19 and control the closing of the gate 53 by an electromagnetic device, or solenoid, 54. The gate 53 is normally held in an open position by means of a spring 56. The solenoid 54 is included in an electrical circuit 57 which is controlled by a switch 58. The switch 58 has a sliding stem 59 bearing against the outside of the member 22 and held thereagainst by action of a spring 60. Upon axial movement of the stone 12 the switch 58 is closed, completing the circuit 57, energizing the solenoid 54, and effecting a closing of the gate 53 and thus shutting off the supply of material to be ground to the machine. As soon as the stationary stone 12 has regained its normal position, the circuit 57 is again opened by the spring 60 and the spring 56 reopens the gate 53, permitting the machine to resume operation. The clearance between the switch points is preferably made such that the gate 53 is held closed as long as the stationary stone 12 is only slightly displaced axially with respect to the rotative stone 11.

Referring now to Fig. 5, I show a grinding machine embodying a plurality of grinding units. In this machine, the casing is divided into compartments, such as 61^a and 62, each similar to the casing 10 already described. Disposed within the compartment 61^a is a rotary grinding stone 63 and a stationary grinding stone 64 similar to the grinding stones already described. Likewise, in the section 62 there is disposed a rotary grinding stone 66 and a stationary grinding stone 67. The rotary grinding stones 63 and 66 are secured to a common shaft 68 which may be driven by a pulley 69. Material to be ground is admitted to the compartment 61^a through a conduit 71 and to the compartment 62 through a conduit 72. Pulverized material, after passing through the grinding elements is discharged through discharge conduits 73

and 74, from whence it may be conveyed to points of use.

The shaft 68 is provided with an interior passage 76 which opens through passages 78 and 79 to hollow retaining members 81 and 82, both similar to the retaining member 32 previously described. The retaining members 81 and 82 are provided with hollow hub portions 83 and 84, the hollow hub portions being provided with outlet ports 86 and 87. When the machine is running, water is admitted to the passage 76 from a conduit 89 from whence it is pumped by action of the rotating shaft, as previously described, into the interior of the retaining members and from thence outwardly by the pumping action of the hub portions thereof so as to cool the rotating stones 63 and 66. The stationary stones are cooled in the same manner as described for the single unit.

From the example shown, it will be apparent that my improved grinding apparatus may comprise any desired number of units, all driven from a common shaft. Thus it may be designed for any desired capacity by selecting the required number of units.

In Figs. 4 and 7, I show a modified form of a rotating grinding stone which may be capable of more effectively causing the fuel in the feed groove 16 to pass between the relatively rotating faces of the stones. In these figures the rotating stone is indicated at 91. In its working face there is provided a series of pockets 92. The pockets 92 are of such radial depth that their outer boundaries are conjugate with the outer boundary of the feed groove 16 of the stationary stone. The effect of these pockets 92 passing before the feed groove is to draw the material near the lower end of the groove and further inwardly of the groove and thus increase the rate of grinding of the unit.

Referring now to Fig. 6 of the drawing, I show a further modified form of my invention, wherein a grinding machine embodying two grinding units of the general character heretofore described, are embodied within a single casing. In this figure, a casing 101 encloses a pair of stationary grinding elements 102 and 103. Both of these stationary grinding elements are similar to those heretofore described and do not require further description. The working faces of the stationary stones 102 and 103 are arranged facing toward each other, and between the two is located a two-faced rotating element 104, with its two faces cooperating with the stationary stones 102 and 103. The rotating element 104 is provided with a hollow retaining member 106 mounted on a shaft 107. The shaft 107 has a passage 108 extending therethrough and terminating in the interior of the retaining member 106. A second passage 109 also extends through the shaft from the interior of the retaining member 106 and termi-

nates near the other end of the shaft in cross passages 111. Secured to the shaft 107, at the passages 111, is a centrifugal pump 112 arranged to discharge the fluid from the interior of the retaining member 106 through an outlet 113. Whenever the machine is in operation, water under pressure is admitted from a conduit 114 into the passage 108 from whence it is discharged into the interior of the member 106. After passing into the interior of the member 106 and cooling it, it is pumped outwardly thereof by the action of the pump 112.

The stationary grinding stones 102 and 103 are arranged to be cooled in the same manner as previously described and need not be again repeated.

From the foregoing, it will be apparent that I have devised an improved grinding machine which is compact, efficient, and which requires the minimum of power for its operation.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall, be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

I claim:

1. In a grinding machine, a rotary grinding stone, a hollow retaining member having a ring portion embracing and retaining the stone and a hollow hub-like portion with openings in said hub-like portion, a hollow rotary shaft secured to the rotary member and having passages from the hollow thereof opening into the hollow of the retaining member, and means for introducing a cooling fluid into the hollow shaft whereby it is pumped into the hollow retaining member by rotation of the shaft and outwardly thereof by the rotation of the hub portion of the retaining member.

2. In a grinding machine, means for feeding material to be ground to the machine, a pair of coaxially arranged relatively rotatable grinding members having conjugate working faces, means for fixedly holding one of the members against movement longitudinally of its axis, yielding means for holding the other member against movement longitudinally of its axis, means for shutting off the supply of material to the machine, an electro-magnetic device for controlling the shutting off means, an electric circuit for the electro-magnetic device, and means effective upon longitudinal movement of the yielding means for completing the electric circuit and closing off the supply of material.

3. In a grinding machine, the combination of a stationary grinding element, a rotary grinding element of relatively coarser texture

than the stationary grinding element, said grinding elements having cooperating working faces, the stationary grinding element having a groove in its working face extending in the general direction of rotation of the rotary grinding element, said groove being of progressively decreasing depth in said general direction, and means for feeding the material to be ground to the deeper portion of said groove.

4. In a grinding machine, a rotary grinding stone, a stationary grinding stone cooperating with the rotary grinding stone and having its working face conjugate with the working face of the rotary stone, said stationary stone being provided with a wedge-shaped feed groove in its working face extending parallel to and spaced from a radius of the stone and extending from the outer periphery inwardly and being curved in the direction of rotation of the rotary stone as it approaches the inner area of the stationary stone, said groove being so arranged with respect to the rotating stone and to its direction of rotation that the action of the rotating stone draws the material to be ground inwardly from the periphery of the stationary stone, said rotary stone being of coarser texture than the stationary stone.

5. In a grinding machine, the combination of a pair of relatively-movable grinding elements having cooperating working faces, one of said grinding elements having an elongate feed groove in the working face thereof, said groove extending in the general direction of relative movement of the other grinding element and being of decreasing depth in said direction, the other of said grinding elements being of a coarser texture than the one grinding element, and means for feeding the material to be ground to the deeper portion of said groove.

In testimony whereof, I have hereunto subscribed my name this nineteenth day of April, 1927.

HARRY H. BATES.