K. MIDDELBOE.

GRINDING MACHINE.

APPLICATION FILED MAY 28, 1919. RENEWED MAR. 8, 1921.

1,380,112. Patented May 31, 1921.

Fig. 1.

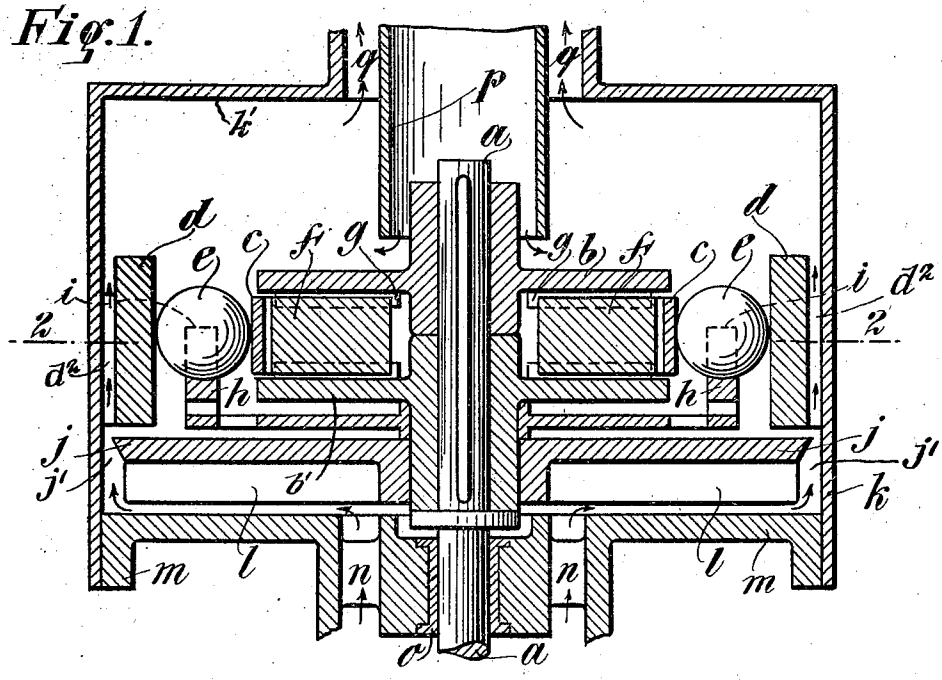
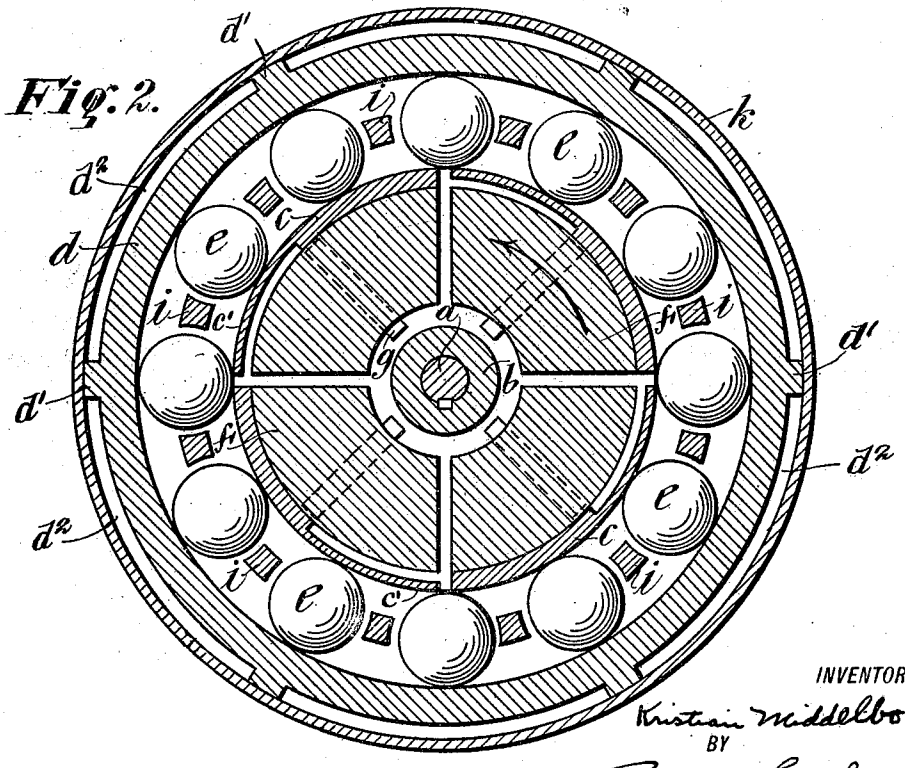


Fig. 2.



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GRINDING-MACHINE.

1,380,112. Specification of Letters Patent. Patented May 31, 1921.

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To all whom it may concern:

Be it known that I, KRISTIAN MIDDELBOE, civil engineer, a subject of the King of Denmark, residing at 14 Thorvaldsensvej, Frederiksberg, near Copenhagen, Denmark, have invented certain new and useful Improvements in Grinding-Machines, of which the following is a specification, reference being had to the accompanying drawing, forming a part hereof.

The invention relates to a grinding machine in which rolling grinding bodies are arranged between grinding guides forming a path for the grinding bodies, one of the guides being formed in sections and subjected to pressure to increase the grinding action.

Among the various machines which have been employed for crushing and grinding materials two types are particularly prominent, namely mills in which the crushing and grinding action is produced by the fall of the grinding bodies and mills in which the action is produced by the rolling action of the grinding bodies.

In the former type of mill the material to be crushed and ground imparts potential energy to loose grinding bodies by lifting them to a certain height so that in falling from this height they effect the crushing and grinding. While mills of this type have great advantages, they are dependent somewhat on the proper supply of the material to be treated and require considerable power even when running idle.

In mills of the other type referred to in which the crushing and grinding action is produced by rolling bodies coacting with guiding means and may be increased by centrifugal force acting on the rolling bodies or by loading them by weights or springs, the construction is more complicated and expensive than in mills of the falling body type but this is compensated for by the fact that they require less power to operate them particularly when the mill is running empty. The capacity of mills of this type is, however, rather limited because the number of grinding bodies employed is necessarily small and they must be of relatively large size and must move in a path of relatively small diameter and at considerable speed so that there is a considerable waste of power in overcoming friction.

The present invention has for its object to provide a mill of the rolling body type in which the advantages of this type of mill will be utilized and the disadvantages heretofore found in this type will be overcome and has particularly for its object to provide a mill of this type in which the grinding bodies roll between guiding surfaces which do not rotate at the same speed.

With the above described objects and other objects hereinafter explained in view my invention consists in the construction and combination of elements hereinafter described and claimed.

Referring to the drawings,

Figure 1 is a vertical sectional view on the plane of the axis of the operating shaft, and

Fig. 2 is a horizontal sectional view on the line 2—2 of Fig. 1.

In the construction shown a indicates a vertical operating shaft which may be driven by any convenient means and b, b' indicate a holder for loading blocks f, comprising an upper disk b and a lower disk b' both keyed to the operating shaft. The loading blocks f are carried between the disks b and b' and are radially movable being provided with radial grooves to receive radial guide ribs g on the disks. The loading blocks f, here shown as four in number, are each provided on its periphery with a section c of an annular ring which forms the inner guiding path for the grinding bodies here shown as balls e. The outer guide for the grinding bodies comprises a ring d which is supported on the inner face of a cylindrical casing k by lugs d' by which the outer face of the ring is so spaced away from the casing as to leave spaces d^2 for free passage of ground material as hereinafter described. The balls e thus roll between the inner ring formed by the sections c and the outer ring d and in contact with them. The sections c are each provided on their forward ends, that is the ends which are forward in the rotation, with a resilient portion c' formed by cutting away the inner surface of the section so as to leave a space between it and the periphery of the loading block f, so that as this forward end of a section c comes in contact with a ball e it will yield sufficiently to avoid any thrusting action on the ball. The balls e are spaced apart by arms i carried by and extending upward from a spider h the hub of which has its bearing on the hub of the lower holder disk b'.

Below the spider h is arranged a bottom plate or disk j which is carried by and rotates with the hub of the lower holder disk b'. This bottom plate or disk j is of such diameter that its outer edge is only a slight distance from the inner face of the casing k so as to leave between it and the casing a narrow annular space j' and it carries on its under side a series of radial wings l the lower edges of which rotating a slight distance from the horizontally arranged bottom m of the casing act to produce a blower effect to suck air through openings n in the bottom m and force it upward through the annular space j' and the spaces d^2 between the outer face of the outer ring d and the casing.

A bearing o for the operating shaft a is formed in the bottom m. Through the top plate k' of the casing extends a pipe p through which the material to be treated is introduced. The lower end of this pipe surrounds but is spaced away from the hub of the upper holder disk b so as to leave between it and the hub a passage of sufficient size to admit material freely. In the top plate k' about the pipe p is an annular opening q for free escape of air.

The upper edge of the outer ring d is a substantial distance above the plane of the upper face of the upper holder disk b. Material to be treated introduced through pipe p falls on the upper face of the upper holder disk b and as this is rotated at considerable speed the material will, by centrifugal action, be thrown off the edge of the disk and into the space in which the balls e are rolling. The height of the upper edge of the outer ring d prevents any of the material from being thrown against the casing and insures its passing into the space in which the balls e are rolling. The material thus supplied to the grinding balls receives its first crushing as it passes downward through the space in which the grinding balls are rolling and falls on the bottom plate or disk j. As this is rotating with the shaft a and the parts keyed to it, it acts to throw the material outward by centrifugal action into the path of the air current created by the wings l and, by this current, the material, now partially ground, is carried upward through the spaces d^2 into the space above the outer ring d and holder b b'. This space being quite large the air current passing through it to escape through the openings q loses its lifting force in this space to such an extent that it will permit the coarser particles to drop and will carry with it through the openings q only the very finely ground particles the coarser particles dropping back into the space in which the balls e are rolling and being again subjected to their crushing and grinding action. This action will be repeated until the material is reduced to such a condition of fineness that it will be carried out of the mill by the air current, the material thus carried out being, of course, treated to separate any material not of the required degree of fineness and which requires further grinding.

The centrifugal action of the bottom plate or disk j is of sufficient force to cause the finer particles of the ground material to separate from the coarser particles overcoming any tendency to adhere together so that the separation in the space above the upper ends of the spaces d^2 will be very complete.

In the operation of the mill it will be understood that the material in the space in which the grinding balls roll is carried around with them, the centrifugal action tending to hold it against the outer ring, until it is reduced to such a degree of fineness that it is carried upward by the air current as described.

The loading blocks f and the sections c forming the inner guide ring carried by them can move only radially with respect to the holder disks and as these loading blocks are all of the same size and weight they will exert a substantially equal pressure at all points against the grinding balls so that there will be no tendency of the balls to wear unevenly and get out of spherical form. The action of the inner ring formed of the sections c rolls them on the inner face of the outer ring the friction thus being rolling friction only except as regards the contact with the balls of the arms i of the spider h where there will be sliding friction. But as the spider h is mounted to rotate freely and the arms i follow the balls without exerting any pressure against them, the slight amount of sliding friction is of little importance. The movement of the grinding balls is thus due to the rotation of the inner ring and the rapidity of their rotation is dependent on the speed of rotation of the operating shaft and the centrifugal action of the loading blocks due to their rotation with the shaft. By reason of their rotation being thus dependent on the speed of rotation of the operating shaft and the fact that their crushing and grinding action is dependent on the speed of rotation and the centrifugal force developed rather than on the size or weight of the balls it is found possible to use effectively much smaller grinding bodies than can usually be employed in mills of this type and it is found possible to regulate the mill to produce any pressure desirable in crushing and grinding particular material or in reducing the material treated to any particular degree of fineness by merely varying the speed of rotation of the operating shaft.

It will of course be understood that I do not desire to be limited to the particular construction and arrangement shown and

described as it is obvious that many changes in the construction and arrangement of parts may be made without departing from the spirit of the invention.

Having thus described my invention what I claim is—

1. In a grinding mill the combination with an outer guide and a series of grinding bodies adapted to roll in contact with the inner face of said outer guide, of an inner guide comprising radially movable sections having its periphery in contact with the grinding bodies, means for rotating the inner guide and for moving the sections outward against the grinding bodies, said sections being each provided on its forward end with a portion adapted to yield inwardly relatively to the rear portion of the section.

2. In a grinding mill the combination with an outer guide and a series of grinding bodies adapted to roll in contact with the inner face of said outer guide, of an inner guide comprising sections carried by radially movable loading blocks and having their outer faces in contact with the grinding bodies, means for rotating the loading blocks to cause them to move outward by centrifugal force to press the sections against the grinding bodies, said sections being each provided on its forward end with a portion adapted to yield inwardly relative to the rear portion of the section.

3. In a grinding mill the combination with an outer guide and a series of grinding bodies adapted to roll in contact with the inner face of the outer guide, of a rotary shaft, upper and lower holder disks carried on and rotating with the shaft, loading blocks between and rotating with the holder disks each carrying a section of an inner guide having its outer face in contact with the grinding bodies, said sections being each provided on its forward end with a portion adapted to yield inwardly relative to the rear portion of the section.

4. In a grinding mill the combination with an outer guide and a series of grinding bodies adapted to roll in contact with the inner face of the outer guide, of a rotary shaft, upper and lower holder disks carried on and rotating with the shaft, loading blocks between and rotating with the holder disks each carrying a section of an inner guide having its outer face in contact with the grinding bodies, the upper edge of the outer guide being above the level of the upper face of the upper holder disk, and means for leading the material to be treated onto the upper face of the upper holder disk.

5. In a grinding mill the combination with an outer guide and a series of grinding bodies adapted to roll in contact with the inner face of the outer guide, of an inner guide comprising sections carried by radially movable loading blocks and having their outer faces in contact with the grinding bodies, means for rotating the loading blocks to cause them to move outward by centrifugal force to press the sections against the grinding bodies, a disk arranged to rotate below the grinding bodies and to receive material ground by them, and means for forcing a current of air upward at the edge of the disk.

6. In a grinding mill the combination with an outer guide and a series of grinding bodies adapted to roll in contact with the inner face of said outer guide, of an inner guide comprising radially movable sections having its periphery in contact with the grinding bodies, means for rotating the inner guide and for moving the sections outward against the grinding bodies, a disk arranged to rotate below the grinding bodies and to receive material ground by them provided with wings to create a current of air and force it upward at the edge of the disk.

7. In a grinding mill the combination with an inclosing casing having an air inlet in its bottom and an air outlet in its top of an outer guide secured within the casing and so spaced therefrom as to leave passages between its outer face and the casing, a series of grinding bodies adapted to roll in contact with the inner face of said outer guide, an inner guide comprising radially movable sections having its periphery in contact with the grinding bodies, means for rotating the inner guide and for moving the sections outward against the grinding bodies, a disk below the grinding bodies having its edge so arranged as to leave a narrow passage between it and the casing in line with the passages between the outer guide and the casing and means for causing a current of air upward through the passage at the edge of the disk, through the passages between the outer guide and the casing and out through the outlet in the top of the casing.

This specification signed and witnessed this 12 day of April, A. D. 1919.

KRISTIAN MIDDELBOE.

Signed in the presence of—

A. TORSTENSPAN,

E. W. MISKON.