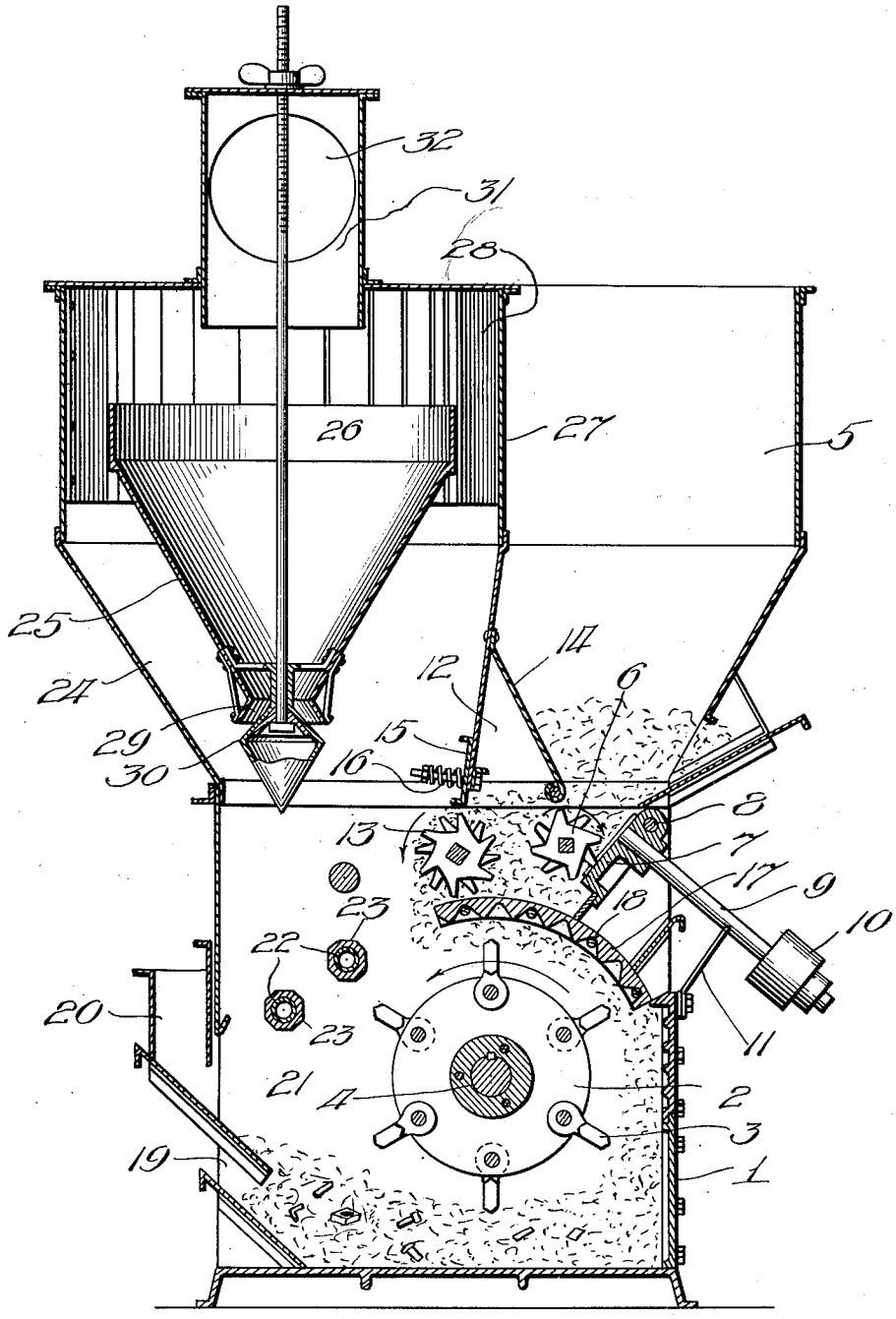
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REDUCING MILL

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REDUCING MILL

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The present invention relates to means for and methods of reducing materials, such as coal.

Grinding or pulverizing of friable material is usually effected by mechanical crushing or shear actions. In the present invention the material is reduced by attrition in moving masses of particles acting upon each other under the stresses effecting a whirling or cyclonic action of the mass and the medium of conveyance, such as air.

Among the objects of the invention is to provide a novel reducing means with a rapidly rotating or revolving member or rotor, capable of causing an entraining of air around the same and the conveying of suspended particles of material therein, so that the particles, by reason of rubbing upon each other under the stresses imparted by the rotor or the reaction of the walls of a stationary chamber in which the rotor operates, or both, will be reduced and in condition for selective separation of the fines.

The rotor creates a cyclonic or whirling action in the chamber, and the latter is relatively large so as to provide a clearance or zone of action between the periphery of the rotor and the walls of the chamber. The high speed of rotation of the rotor will cause an entraining of the mass in such zone with the layers or strata nearer the rotor moving at a greater rate than the layers or strata more remote therefrom, the layers near or at the walls of the chamber moving either very slowly or being stationary. The inner wall of the chamber may be formed, as with corrugations, for acting as an anchor means or a retard for the outer layers so that reaction may be effected between the layers to the end of causing the particles of one layer or stratum to rub against and reduce those in the adjacent layers or strata. The rapid rotation of the rotor will also maintain the mass exteriorly of the periphery of the rotor and also effect a radial stress through the mass in the zone so that the impact of the particles upon each other will be sufficient to effect the reducing action mentioned.

The invention also comprehends the idea of continuously feeding off or supplying the reduced material in a stream from the zone of action, whereby the fines may be readily separated. The separation of the fines is preferably provided for by a means causing a flow of air or any other desired fluid through the stream of reduced material so as to separate therefrom the finer or lighter particles from the heavier or coarser particles, the latter returning for continued reduction. For the purpose of aiding in effecting this separation, the invention may also comprehend the idea of dispersing the projected reduced material, which may be accomplished by the interposition of a number of cross-bars at different points in the path of projection of the reduced material as it proceeds from the zone of action, so that the projected material may be dispersed in all directions and be spread for the passage therethrough of the air stream for separation. The separated particles and the air may then proceed to an enlargement or chamber adjacent the reducing chamber where the mass may expand for further separation of the fines to the desired degree.

Other objects, advantages and capabilities are comprehended by the invention as will later appear and are inherently possessed by the invention.

Referring to the drawing illustrating an embodiment of the invention, the figure is a vertical transverse view through a reducing mill construction in accordance with the invention and employing the methods herein disclosed.

Referring now more in detail to the drawing, the embodiment selected to illustrate the invention is shown as comprising a reducing chamber 1 in which is rotatably mounted a rotor 2 carrying arms 3 and secured to a shaft 4, in any suitable manner, the shaft extending to the exterior of the chamber for operation in a suitable manner.

Above the chamber is located a hopper 5 in which may be placed the material to be crushed and later fed to the reducing chamber. The crushed material will be fed in the hopper to the lower part thereof to a crushing roll 6 acting upon the material and in association with a plate 7 connected to

the machine by way of a pivot 8 and carrying a weighted arm 9 to which is adjustably secured the weight 10. The roll 6 and the plate 7 are so located as to gauge the size of the material to be fed to the reducing mechanism. Should non-crushable objects be engaged between the roller and the plate, the latter will yield and open a passage from the hopper to permit the non-crushable material to be ejected to the exterior. Normally the plate is held in a position shown by the arm 9 resting upon a support 11 secured to the chamber 1, as shown upon the drawing.

After the material passes from the crushing roller, it is fed into an intermediate chamber 12 at a greater rate than it can be taken from this chamber and fed by a feeding roll 13 rotatably mounted above the reducing chamber. As the material piles up in the chamber 12, it may return to the hopper chamber through a door 14 which will open automatically for that purpose. Should pieces of non-crushable material pass by the roll 6, and be caught in the feeding roll, a release member or gate 15 normally held in place by a spring 16 but yieldable to permit the gate to open when the crushable material passes through, is provided as shown.

In the reducing chamber and above the rotor is located a retard or anchor plate 17 which is preferably formed with an irregular face or corrugated as shown, the plate being held in place by cross-bars 18 secured at their ends in the side walls of the reducing chamber. It will be observed that this plate is located at a distance from the outer ends of the arms 3 so as to provide a clearance or operating zone therebetween. In the lower part of the chamber 1 is provided a pocket in which the material may accumulate and also into which non-reducible objects, such as pieces of iron or the like, may be cast initially when fed into the reducing chamber. This is effected by the objects being fed by the feeding roller to the discharge side of the rotor, and being impacted suddenly by the arms 3 will be cast tangentially into the material found in the lower part or pocket of the chamber 1. The projection of these objects will be with such force that they will be embedded or buried in such material. For the purpose of facilitating the removal of these objects after they have accumulated in the pocket in the lower part of the chamber 1, the latter may be provided with an opening or passage 19, and above this passage is another passage 20 into which may pass a stream of air or the like into the interior space 21 of the chamber 1. Above the space 21 are located transverse bars 22 upon which may be supported cast iron or similar pieces 23 having irregular surfaces as shown. These are located at different points on the discharge side of the rotor so that the material being continuously fed in a stream from the discharge side of the rotor may impact against these impact members and be dispersed and spread in all directions so that the air proceeding in through the passage 20 and upwardly to the space 21 may readily extract the fine particles of the material to be carried upwardly into an expansion chamber later described.

Above the chamber 1 and at the forward side thereof, is located an expansion chamber 24 in which is located a cone shaped inner chamber 25 having the upper and larger end 26 of the cone open as shown. Between the upper and open end of the cone and the side wall 27 of the chamber 24, are provided a series of vertically disposed vanes 28 arranged tangentially with reference to the cone so that the upward passage of air and suspended particles between the vanes 28 may be directed inwardly toward the open upper end of the cone. The lower end of the cone has also a passage 29 through which heavier and coarser particles of material may pass or return into the space of the chamber 24. Beneath the passage 29 is a spreader 30 having its faces so inclined as to cause an aspiration at the lower end of the opening 29 as the upwardly moving mass of air and suspended particles pass toward the blades 28, so as to cause a re-aspiration of the particles being discharged through the passage 29, and for carrying, for recirculation, any of the fine particles that may have been thrown down in the cone 25.

The discharge of the mass into the cone by the vanes 28 will cause a whirling or cyclonic action in the cone such that the centrifugal action of the whirl will effect the movement of the heavier and coarser particles to the side walls of the cone and the finer particles will be carried up centrally into a discharge pipe 31 and an outlet 32 connected to a suitable fan or the like for creating a draft of the air through the apparatus and to supply the mixture of air and fine particles to a place of use, such as a combustion chamber of a furnace or the like.

In the operation of the device the material is first placed in the hopper 5 and operated upon by the crushing roller to reduce it to the proper size for feeding to the reducing chamber. The feeding roller will then feed it at a given rate to the rotor 2. The latter is rotated at a very high speed so that the material, instead of falling in between the arms 3, will be carried by an entraining action around the periphery of the rotor. The high speed of rotation of the rotor will carry with it a cyclone or whirl of air and will by either a suction or aspirating action cause an entraining exterior of the periphery of rotation of the arms 3 of a stream of particles of material in the chamber 1 and will cause a moving zone around the rotor and in the space between the hammers 3 and the side wall of

the rotor and the plate 17. This action will be felt radially through the zone of material toward the side walls of the chamber where the material is either held stationary or moving very slowly in layers or strata. The inner layers, that is to say the layers more nearly located to the periphery of the rotor, will move with a greater speed and by reason of the radial stress in the moving material, and the relative movement of the particles in the various layers, there will be a frictional engagement or attrition of the particles one upon the other with the result of reducing them in size. This action will go on continually with a certain portion of the same being projected or cast in a continuous stream from the projecting side of the rotor and against the impact members 23 whereby the same may be dispersed in various directions as in clouds and the like.

At the same time the fan which feeds the material to the place of use, will create a suction or draft through the apparatus and draw in a stream of air through the passage 20 which will proceed upwardly through the space 21 and in the spaces between the impact members 23 and through the material projected from the rotor. This stream of air will carry upwardly the fine particles in suspension and proceed into the spaces between the vanes 28 and into the separating cone 25 where the final fine particles are separated and carried to the feeding fan and the point of use; the heavier particles containing moisture and the coarser particles coasting downwardly and on the side walls of the cone 25 into and to the discharge 29 for either re-aspiration at the end of the discharge 29 or return of the coarser particles into the reducing chamber for further reducing in size.

While I have herein described and upon the drawings shown an embodiment of the invention and disclosed a method of carrying out the same, it is to be understood that the invention is not limited thereto but that other constructions, methods, arrangements of parts and details are comprehended thereby without departing from the spirit thereof.

Having now disclosed my invention, I claim:

1. A reducing mill of the character described comprising a normally fixed pulverizing chamber, a rotor located within said chamber and having means for creating a unidirectional rotating air zone around the rotor, and means for depositing material directly into said zone, so that particles of said material entrained thereby will be subjected to a reducing attrition upon each other during their travel.

2. A reducing mill of the character described comprising a normally fixed pulverizing chamber, a rotor located within said chamber and having means for creating a unidirectional rotating air zone around the rotor, and means located above said rotor for depositing material directly into said zone, so that the particles of material entrained thereby will be subjected to a reducing attrition upon each other during their travel.

3. A reducing mill of the character described comprising a normally fixed pulverizing chamber, a rotor located within said chamber, said rotor being provided with a plurality of radially disposed peripheral arms for creating a unidirectional rotating air zone around the rotor, and means for depositing material directly into said zone, so that the particles of material entrained thereby will be subjected to a reducing attrition upon each other during their travel.

4. A reducing mill of the character described comprising a normally stationary pulverizing chamber, means for creating an attrition zone consisting of a unidirectionally travelling stream of air moving in a normally uninterrupted circular path at high velocity within said chamber, means for depositing friable material directly into said attrition zone, so as to provide a stratum of mixed air and friable material of substantial depth moving in a common direction, and to cause attrition of the particles of material upon each other, and means for maintaining the cross section of said stratum in an approximate uninterrupted circle.

5. A reducing mill of the character described comprising a normally stationary pulverizing chamber, means for creating an attrition zone of unidirectionally travelling air moving in a normally uninterrupted circular path at high velocity, means for depositing friable material directly into said zone so as to create a plurality of moving strata of mixed air and material, said stream-producing means including means for moving one of said strata continuously in an approximately circular path, so that the particles of moving material will impinge against each other.

6. A reducing mill of the character described comprising a normally fixed chamber, means within said chamber for providing a rotating air zone, mechanical means other than the air-zone-producing means arranged to deposit friable material into said zone so as to form strata of air and friable material within the zone, and means for moving said strata in unidirectional circular paths through said zone and at different speeds, so that the material of each stratum will contact with material of other strata.

7. A reducing mill of the character described comprising a normally fixed pulverizing chamber, a rotor located within said chamber and having means for creating a unidirectional air current so as to provide a rotating air zone around the rotor, mechanical

means other than said rotor arranged to deposit material into said zone so as to form a plurality of approximately concentric strata of material particles entrained by the air current, whereby the particles of the various strata will be subjected to a reducing attrition upon each other, and means for retarding the travel of some of said strata.

8. A reducing mill of the character described comprising a normally fixed pulverizing chamber, a rotor located within said chamber, means within said chamber having a material entraining and reducing space adjacent to the periphery of the rotor, said rotor having means for creating a unidirectional air current through said space, the periphery of said rotor being spaced from the wall of the chamber a substantial distance, so as to provide a rotating air zone around and within said reducing space, and means for depositing material directly into said air zone so that particles of said material entrained by said current will be subjected to a reducing attrition upon each other during their travel.

9. A reducing mill comprising a rotor, a fixed chamber enclosing said rotor, the periphery of said rotor being spaced from the wall of the chamber a substantial distance, said rotor having means for providing a unidirectionally moving rotating material-entraining and reducing-air-zone around the rotor and between the periphery of the rotor and the walls of the chamber, wherein the particles of entrained material act upon each other to effect reduction thereof, and means adjacent the periphery of said zone for depositing material directly thereinto.

10. A grinding mill of the character described comprising a rotor, a normally stationary pulverizing chamber enclosing said rotor, the periphery of the rotor being spaced a substantial distance from the walls of the chamber, to provide a material-entraining and reducing-space, said rotor having means for creating a unidirectionally moving rotating air zone in said space so that the particles of entrained material will be subjected to reducing attrition upon each other during their travel through said zone, and means positioned above said zone for depositing material directly thereinto.

11. A grinding mill of the character described comprising a rotor, a normally stationary chamber enclosing said rotor, the periphery of the rotor being spaced a substantial distance from the walls of the chamber to provide a material-entraining and reducing-space, said rotor having means for creating a unidirectional rotating air zone in said space so that the particles of entrained material will be subjected to reducing attrition upon each other during their travel through said zone, and means adjacent the periphery of said zone for depositing material directly thereinto.

12. On grinding mill of the character described comprising a rotor, a normally fixed pulverizing chamber enclosing the rotor, the periphery of said rotor being spaced a substantial distance from the walls of the chamber to provide a material entraining space, said rotor having means for creating a unidirectionally moving rotating air zone in said space, so that the particles of entrained material will be subjected to reducing attrition upon each other during their travel through said zone, means located adjacent to the periphery of said zone for retarding and accumulating a layer of friable material, said means being so positioned that it will become covered by said layer during the operation of said rotor, and means for depositing material directly to said air zone.

13. The method of pulverizing friable material comprising creating an approximately annular attrition zone consisting of a unidirectionally moving stream of air travelling at high velocity, and depositing friable material directly into said stream of air, so as to effect attrition of the particles of said material upon each other.

14. The method of reducing materials comprising causing a rapidly revolving body to create an attrition zone consisting of a plurality of unidirectionally moving currents of air within a fixed chamber, causing said currents to travel in a normal circular path with the inner currents of air adjacent said revolving body travelling at a higher speed than the outer currents which are nearer to the walls of the chamber so as to effect a repeated contact of the particles of material of the inner layers with the particles of the outer layers, and introducing material directly into said zone from a position adjacent the periphery thereof, so that the particles of material will conform to the respective layers of air and will also act upon each other by attrition.

15. The method of reducing materials comprising rapidly revolving a body to create an attrition zone consisting of a plurality of unidirectionally moving currents of air within a fixed chamber, causing said currents to travel in a normal circular path with the inner currents of air near the surface of said revolving body travelling at a higher speed than the outer currents which are nearer to the walls of the chamber so as to effect repeated contact of the patricles of said material, depositing material directly into said zone from a position adjacent the periphery thereof and causing the particles of said material to conform to the layers of air and also causing them to act upon each other by attrition, and continuously projecting a stream of reduced material and air from the said zone.

16. The method of pulverizing friable material comprising creating an approximately

annular attrition zone consisting of a stream of air moving unidirectionally in a normally uninterrupted circular path at high velocity, introducing material directly into said zone from a position adjacent the periphery thereof, causing said material and air to form moving strata of mixed air and material travelling in normally uninterrupted annular paths but at different velocities, and causing the material in one stratum to be reduced by frictional contact with the material in adjacent strata.

17. The method of pulverizing friable material comprising creating an approximately annular attrition zone consisting of a stream of air moving unidirectionally at high velocity, depositing material directly into said zone from a position adjacent the periphery thereof, forming moving strata of mixed air and material in continuously moving uninterrupted paths, causing said strata to travel at unequal velocities so that material in one stratum is reduced by friction with material in adjacent strata, and continuously projecting a stream of reduced material and air from the said zone.

18. The method of pulverizing friable material comprising creating an approximately annular attrition zone consisting of a stream of air moving unidirectionally at high velocity, depositing material directly into said zone from a position adjacent the periphery thereof, forming moving strata of mixed air and material in continuously moving uninterrupted paths, causing said strata to travel at unequal velocities so that material in one stratum is reduced by friction with material in adjacent strata, and causing a stream of air to pass in proximity to the periphery of said zone so as to carry away the finely pulverized material.

19. The method of reducing material comprising creating an approximately annular attrition zone consisting of a stream of air moving unidirectionally at high velocity, depositing friable material directly into said zone adjacent the periphery thereof, causing said friable material and air to form a layer of material mixed with air, forming adjacent to the first layer a second layer of friable material and air, causing the first layer to travel in a continuous approximately circular path, and forcing the particles of the first layer into contact with the particles in the second layer so as to reduce all of said particles by attrition.

In witness whereof, I hereunto subscribe my name to this specification.

HENRY G. LYKKEN.