

H. K. HITCHCOCK.
METHOD OF AND APPARATUS FOR APPLYING FINELY DIVIDED MATERIAL TO GRINDING AND
SMOOTHING MECHANISM.
APPLICATION FILED AUG. 9, 1915.

1,311,518.

Patented July 29, 1919.

2 SHEETS—SHEET 1.

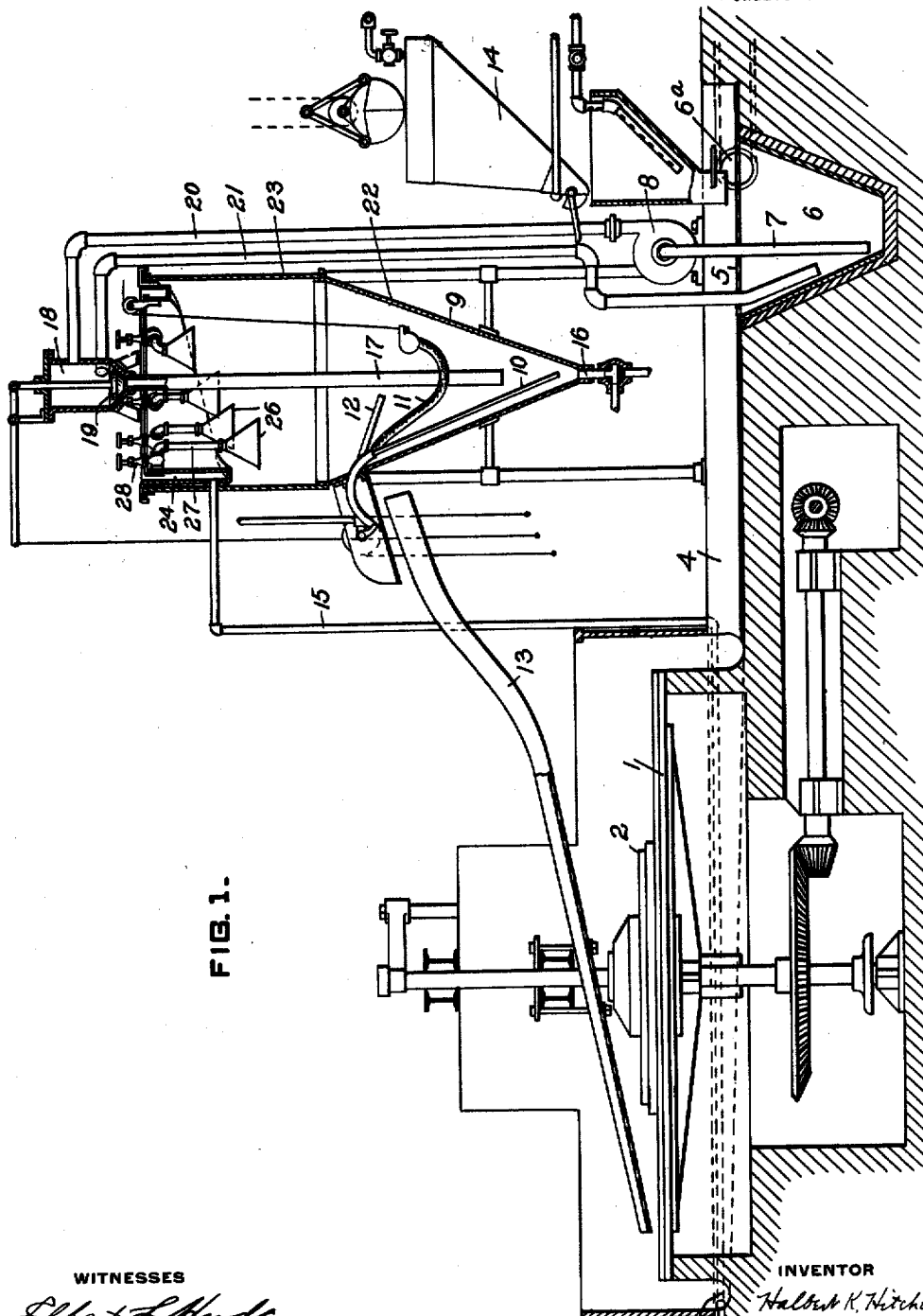


FIG. 1.

WITNESSES

Albert L. Hyde,
J. Herbert Bradley.

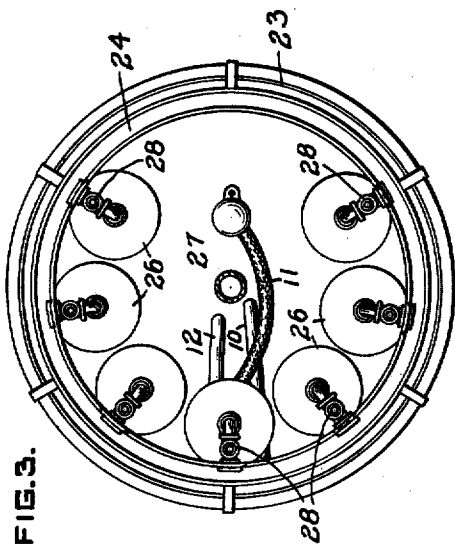
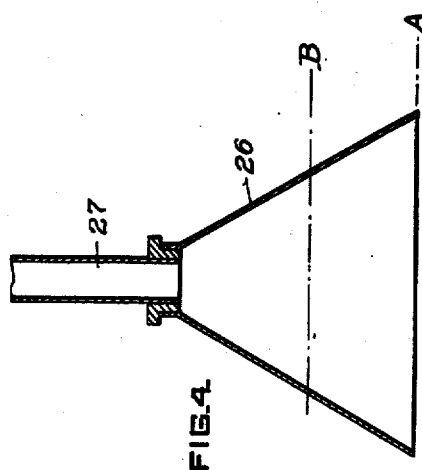
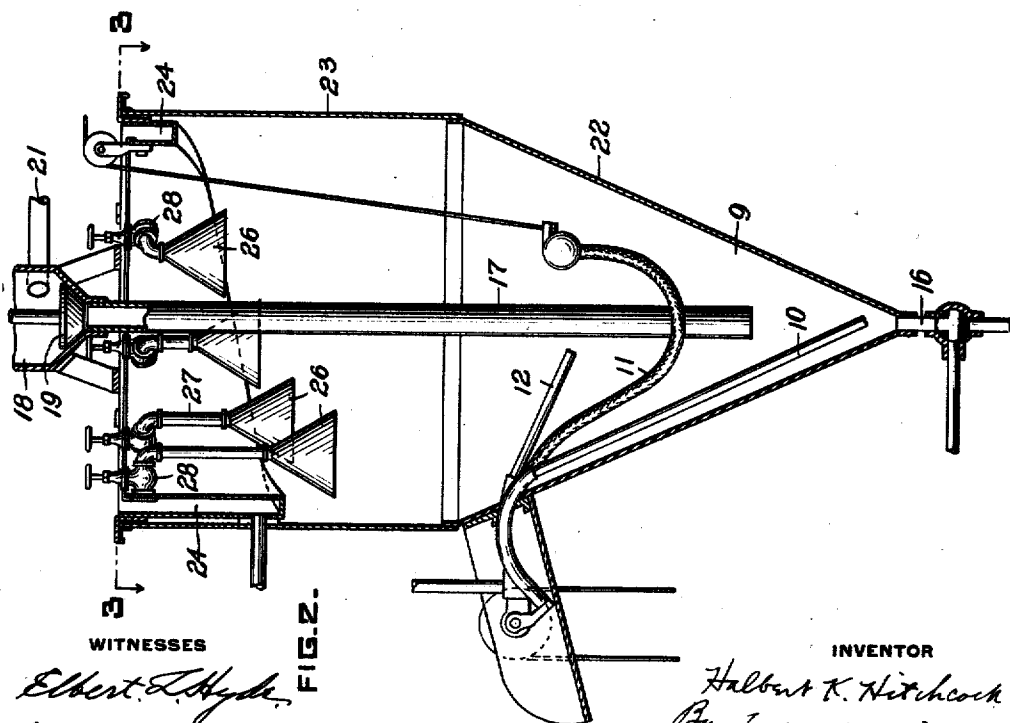
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2 SHEETS—SHEET 2.



WITNESSES

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UNITED STATES PATENT OFFICE.

HALBERT K. HITCHCOCK, OF PITTSBURGH, PENNSYLVANIA.

METHOD OF AND APPARATUS FOR APPLYING FINELY-DIVIDED MATERIAL TO GRINDING AND SMOOTHING MECHANISM.

1,311,518.

Specification of Letters Patent.

Patented July 29, 1919.

Original application filed August 9, 1915, Serial No. 44,622. Divided and this application filed August 9, 1915. Serial No. 44,623.

To all whom it may concern:

Be it known that I, HALBERT K. HITCHCOCK, a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Methods of and Apparatus for Applying Finely-Divided Material to Grinding and Smoothing Mechanism, of which the following is a specification.

This invention relates to method and apparatus for grading abrasives and supplying the same to grinding machines, and particularly for grading sand or other abrading material and supplying the same to apparatus for grinding or finishing plate glass.

One object of the invention is to improve the grinding and finishing operations by more accurate classification or grading of the abrasive material and the production of cleaner grades each uncontaminated by material from any other grade, and a denser mixture of the abrading material with the liquid, so that the grinding and finishing operations can be carried out more economically, with less liquid and less handling of the material, and with a reduction in the total time required for grinding and finishing. A further object of the invention is to provide a method and apparatus enabling the grading operation to be carried on under uniform conditions with the production of sharply differentiated grades of material which are collected, condensed and maintained at various levels in the grading vessel, so that the operator can depend upon the accuracy of each grade of abrading material and the supply thereof at the various levels in the grading vessel. A further object of the invention is to provide a method and apparatus in which the abrading material is supplied to the grading vessel in suspension in a liquid at a level intermediate its bottom and the upper level of liquid therein, and preferably under a uniform head or pressure of liquid in a downwardly moving stream of mixture independent of the body of mixture in the grading vessel, so that the supply of material to said vessel is regulated by minute variations in the density of the body of mixture in said vessel and maintains substantially uniform grading conditions in said vessel and avoids contamination of one grade by material from any other grade. A further

object of the invention is to secure a dense mixture, especially of the finer grades, by eliminating from the various levels in the grading vessel the superfluous liquid, so as to collect and condense a sufficient supply of the finer grades in suspension without the necessity of conducting the finer grades of abrading material to a separate vessel, and thereby securing a more rapid and efficient operation of the apparatus during finishing. A further object of the invention is to provide an improved method and apparatus wherein the rough grinding is carried on in a continuous cycle of circulation with the material constantly in suspension in a liquid, the finer grades being collected in the same grading vessel and condensed by elimination of the surplus liquid and subsequently conducted to the grinding apparatus for the finishing operation. Further objects of the invention are in part obvious and in part will appear more in detail hereinafter.

In the drawings, which represent one embodiment of the invention, Figure 1 is a diagrammatic sectional elevation; Fig. 2 is a detail sectional elevation on a larger scale, through the grading vessel; Fig. 3 is a sectional plan view on the line 3-3, Fig. 2; and Fig. 4 is a detail sectional view, on a larger scale, through one of the inverted cones.

Referring to the drawings, 1 indicates a grinding table equipped with a pair of runners 2 of the usual form. Said table is surrounded by a gutter 3 communicating with a conduit 4 which conveys the liquid and used abrading material over a screen 5 to the sump or pit 6, having the usual overflow 6* for elimination of the excess liquid, the slimes and the material too fine for further use. From the sump the mixture is withdrawn through a pipe 7 by the centrifugal pump 8 and delivered to the grading vessel 9. The grading vessel is arranged to grade the new material, regrade the used material and separate the various grades and maintain them at various levels therein, from which levels the several grades may be withdrawn independently and in any desired sequence to several withdrawal pipes 10, 11 and 12 to a trough 13 for conducting the abrading material in suspension in the liquid by gravity to the grinding table 1.

One of said pipes, such as the pipe 11, may be a flexible tube long enough to reach to the bottom or top of the grading vessel and having its free end weighted and connected to suitable devices on the outside of the grading vessel for moving it to any level therein, so that mixture can be withdrawn through said pipe from any level in the grading vessel. One suitable arrangement for this purpose is shown in my prior application Serial No. 806,594, filed December 13, 1913, and therefore requires no further description. The fresh abrading material or sand can be added to the system at any point, but preferably is supplied directly to the sump or pit 6 from a hopper 14 fed by a clam shell bucket or other suitable device and in measured batches, one before or during the first part of each grinding operation. The grading vessel is provided with the usual overflow pipe 15, for carrying away the scum, superfluous liquid, and abrading material too fine for further use, said pipe leading to the gutter 3 so that the liquid is utilized for washing out the gutter and ditches around the table. So far as described to this point the apparatus may be of the same kind shown, for example, in Fig. 1 of my prior Patent No. 1,089,705, dated March 10, 1914, or as more fully described in my copending application, of even date herewith, for method and apparatus for applying abrading material to grinding and smoothing mechanism, Serial No. 44622, of which this application is a division.

According to the present invention the grading operation in the vessel 9 is carried out in a manner to utilize the general principles set forth in my prior Patent 1,100,302, dated June 16, 1914, and grades or classifies the material while in suspension in a liquid in the grading vessel by the action of a current of liquid having an upward flow or travel relative to a downward movement of the material, which separates and distributes the several grades in different strata in said vessel, the finer grades near the top and the coarser grades near the bottom.

The material to be graded has heretofore been introduced into the grading vessel either at its bottom, as in my Patent 1,100,302, or at the upper level of liquid in said vessel. When introduced at the bottom the finer grades are carried upwardly by the upward flow of liquid relative to the material and pass in turn the several outlets through which the coarser grades are withdrawn. Some of the fine material therefore unavoidably passes out through these openings when the apparatus is run continuously. On the other hand, when the abrading material is introduced at the upper level of liquid in the grading vessel the coarse material falls past the outlets for the several finer grades, so that said grades are contaminated

by some of the coarser material, or, a considerable time must be allowed for the coarse material to reach equilibrium at its proper levels before the fine material can be withdrawn to the grinding apparatus during finishing.

In the present invention the material to be graded is introduced into the grading vessel at a level intermediate its bottom and the upper level of liquid therein, thereby enabling the coarser material to travel downwardly against the rising current of liquid and the finer grades to travel upwardly with said current, so that all grades of material find their proper levels without contaminating one grade with material from another.

The bottom of the grading vessel shown is provided with an inlet 16 for a clear liquid supply to produce a definite upward flow in the apex of the cone and to augment the upward flow or travel of the liquid relative to the material in the upper part and produce the grading action. This clear liquid supply is preferably under a sufficiently high pressure so that it produces the effective upward flow or travel of the liquid for the grading operation. The material to be graded is delivered to the grading vessel in suspension in a liquid through a depending pipe or conduit 17 whose bottom opening is immersed in the liquid in said vessel at a suitable level intermediate its bottom and the upper level of liquid therein, for example, at a level intermediate the levels of the openings to the outlet pipes 10 and 11, and consequently above the level at which the clear liquid supply through the pipe 16 is introduced to the grading vessel. As the material to be graded passes out of the pipe 17 the coarse particles fall downwardly against the rising current from the inlet 16, but the velocity of said current is sufficient to carry the finer particles of material upwardly, and prevents them from dropping to the outlet or outlets for the coarser grades. Consequently a very clean coarse grade or grades of material may be withdrawn through the pipe 10. The finer grades rise to the levels of the outlets for the finer grades, but no coarse material is carried up with the fine so that the several finer grades withdrawn from the upper strata are clean and free of contamination by the coarser grades.

The material to be graded is supplied to the pipe 17 from a supply box or vessel 18, located at the upper end of the pipe 17 and provided with a suitable hand operated valve 19 for controlling the flow of material from the vessel 18 to the pipe 17. The material is supplied to the vessel 18 by the pump 8 through a pipe 20. Vessel 18 is also supplied with an overflow pipe 21 delivering to the sump and connected to said vessel 18 at a level above the valve 19, so that when said valve is open a constant head or level of

liquid is maintained in the supply vessel 18 at the level of the overflow pipe 21.

In operation of this system, during rough grinding, the valve 19 is open and the material delivered by the pump to the vessel 18 passes downwardly into the grading vessel through the pipe 17, the excess flowing back to the sump through the overflow 21. The grading operation is carried on continuously so that a sufficient supply of graded abrading material is always collected at the proper levels in the grading vessel. During the rough grinding operation the coarse material in suspension in the liquid is withdrawn through pipe 10 and conducted by trough 13 to the grinding table and is thrown into the gutter 3 and flows through ditch 4 to the sump 6, where the excess water and slimes are eliminated through the overflow 6^a and from which the mixture is returned to the grading vessel to be regraded therein. The grading and regrading with the material constantly in suspension in the liquid, and the cycle of circulation from the grading vessel to and from the grinding apparatus go on continuously until the rough grinding or facing operation is finished. During this operation the finer grades in the grading vessel are collected for use during the finishing operation, but without contamination by the coarser grades, which are supplied to the grading vessel at a level below the finer grades and therefore do not contaminate the same. When the rough grinding or facing is concluded the supply of coarse material through the pipe 10 is shut off, and the finishing is effected by withdrawing the several finer grades through the pipes 10 and 11 in succession or in any desired sequence and conducting them to the table. During such finishing these finer grades may be circulated to the grinding apparatus and back to the grader, or not, as desired. At the conclusion of the rough grinding or facing operation the supply of material to the grading vessel from the vessel 18 may be discontinued by closing the valve 19 after a sufficient time has elapsed to collect the proper quantity of finer grades in the grading vessel, in which case the pump 8 continues to run and the material delivered thereby is circulated between the sump and vessel 18 and by-passed around the grading vessel. This is only done when there is a large supply of abrading material in the system. The accurate classification or grading of the abrading material, however, so largely reduces the total quantity of abrading material required that it is usually necessary to collect and hold in the grading vessel as much material as possible, so as to be sure of having a sufficient supply for various stages of grinding and finishing. The supply of material to the grading vessel from the source of supply 18 is therefore

usually allowed to continue without interruption during both grinding and finishing.

The finishing operation is most efficiently effected with a more dense mixture of the finer grades than occurs in any single grader grading apparatus heretofore used. Suitable means is therefore provided for eliminating and regulating the flow of the surplus liquid from the various levels in the grading vessel, but preferably without withdrawing any useful abrading material therefrom, so as to secure the desired density and distribution of the mixture. Preferably, the apparatus is so arranged as to dehydrate and condense the mixture in the grading vessel, and particularly the finer grades, during the operation of rough grinding as well as during finishing, so as to avoid delaying the finishing operation after rough grinding is finished to collect a sufficient supply of the finer grades. In the apparatus shown the grading vessel 9 has a conical lower portion 22 which produces a decreasing upward velocity of flow or travel of the liquid relative to the material at the various levels therein to collect or classify the coarse grades, and a cylindrical upper portion 23 which serves as a supplemental grader for the finer grades superposed upon the lower or conical portion of the vessel, and which traps various finer grades at different levels therein. Within the cylindrical upper portion 23 of the grading vessel is located an annular gutter or trough 24 to receive over its inner wall an overflow of the liquid in the grading vessel. The bottom of the gutter is inclined downwardly in opposite directions circumferentially of the grading vessel from one side to the other, and at its lowest point said gutter communicates through an opening in its side wall and through the side wall of the tank with the overflow pipe 15. Within the cylindrical portion of the grading vessel and at different levels therein are located a series of small hollow dehydrating cones 26 communicating with upwardly extending pipes 27 discharging into the gutter 24, said pipes being provided with suitable regulating valves 28.

When the valves 28 are fully closed no liquid or abrading material can flow upwardly or into the cones 26, but if said valves are opened the liquid flows out through the cones 26 and pipes 27 into the gutter 24, the velocity of flow increasing with the size of the opening through said valves. When liquid is flowing upwardly through the cones 26 and pipes 27 the velocity of flow increases from the bottom of the cones upwardly and reaches a maximum at the pipe 27. Each valve 28 is adjusted so that the velocity of flow in its cone at a level between its top and bottom, say at the line B, Fig. 4, is equal to the velocity of flow of the mixture in the grading vessel at the level A

at the bottom of the cone. The velocity of flow of the liquid between levels A and B is therefore something less than at said levels, and is insufficient to lift any abrading material lying in equilibrium at the level A into the cone 26. Consequently each cone abstracts or removes from the grading vessel at its particular level some of the liquid of the mixture, but without removing any abrading material normally belonging in that cone.

The discharge of liquid at each of the cones 26 progressively reduces the upward velocity in the cylindrical portion 23 of the grading vessel by a series of steps, so that the finer grades are separated into groups distributed at various levels in the grading vessel. At each level a certain grade or size of material between definite limits gradually accumulates, each grade becoming more and more dense as the dehydrating operation proceeds. The grades become gradually finer and finer upwardly between the different levels in the vessel as the interstitial velocity of the liquid decreases. The several zones between the bottoms of the inverted cones 26 therefore form a series of traps, each accumulating during the rough grinding operation its own particular grade of fine material, and the cones condense it by abstracting the superfluous liquid therefrom, so that these finer grades are collected and stored during the several cycles of the rough grinding operation for later use during finishing. The character and position of these grades can be regulated by means of the valves 36.

The apparatus described also serves to regulate the supply of abrading material to the grading vessel by variations in the density of the mixture in said vessel, so as to maintain said density substantially uniform and prevent variation in the grading conditions in the vessel. This insures the maintenance of accurate grades of material at the different levels in the grading vessel throughout the entire operation, as more fully described in my application for method and apparatus for grading finely divided material, of even date herewith, Serial No. 44624. The density of the mixture in the grading vessel varies from time to time as the total quantity of material therein to be graded increases or diminishes, and the total quantity of material in the grading vessel varies with the supply thereto and the amounts of the various grades withdrawn at the different outlets. While the downwardly moving stream of mixture introduced into the grading vessel through the pipe 17 is independent of or separated from the body of mixture therein, the density of the body of mixture in the vessel nevertheless affects the velocity of flow in the stream of mixture being supplied to said vessel. This is due

to the fact that the column of liquid in the conduit or pipe 17, which is under constant head or pressure, is balanced against a similar column of liquid in the body of mixture in the grading vessel, but at a lower head or pressure. If the weight or pressure produced by the body of liquid in the grader is less than that of the column of liquid in the pipe or conduit 17 the preponderating weight of the mixture in the latter produces a more rapid downward flow thereof, while on the other hand, if the weight or pressure produced by the mixture in the grading vessel is greater than that in the pipe or conduit 17 through which the mixture is introduced, then the preponderating effect of the body of liquid in the grading vessel tends to produce an upward flow of the mixture in the pipe 17. This effect partially or completely counteracts the normal downward flow of the mixture in the delivery pipe 17 to replace the mixture being withdrawn from the grading vessel and causes more or less of the mixture being supplied to the grader to pass out through the overflow 21 and back to the sump, thus shunting the superfluous material around the grader. Consequently, the downward flow or travel of the mixture through the delivery pipe or conduit varies inversely with the density of the body of the mixture in the grading vessel, increasing as the density decreases and decreasing as the density increases, and automatically governs or regulates the mixture being graded in the vessel so that it is maintained at a practically uniform or fixed density.

What I claim is:—

1. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades in any desired sequence and conducting the same to grinding mechanism, and returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom.

2. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades in any desired sequence and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom, and simultaneously introducing liquid into said vessel below the level from which the coarse material is withdrawn.

3. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades in any desired sequence

and conducting the same to grinding mechanism, and returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom, said grading, regrading and circulation being carried on in an uninterrupted cycle with the material constantly mixed with the liquid.

4. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades separately and independently and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same in suspension in a liquid into said vessel at a level intermediate the coarsest and finest grades withdrawn therefrom and simultaneously controlling the supply of material to said vessel by variations in the density in the body of mixture therein.

5. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades separately and independently and conducting the same to grinding mechanism, and returning the same to the grading vessel and introducing the same into said vessel in suspension in a liquid by a downwardly moving stream of mixture independent of the upward flow or travel of the body of liquid in said vessel, to thereby control the flow of said stream by the density of the mixture in said vessel.

6. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades separately and independently and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same into said vessel in suspension in a liquid by a downwardly moving stream of mixture independent of the upward flow or travel of the body of liquid in said vessel, to thereby control the flow of said stream by the density of the mixture in said vessel, and withdrawing coarse material from a level below and fine material from a level above the level at which the material is introduced into said vessel.

7. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same into said vessel by a downwardly moving stream independent of the main body of liquid in said vessel, and simultaneously introducing liquid into said vessel at a level below the level from which the coarse material is withdrawn.

8. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades in any desired sequence and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom, and simultaneously eliminating superfluous liquid from various levels in said vessel and thereby collecting and condensing the grades at said levels.

9. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades in any desired sequence and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom, eliminating superfluous liquid from various levels in said vessel and thereby collecting and condensing the grades at said levels, and simultaneously introducing liquid into said vessel below the level from which the coarse material is withdrawn.

10. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing the coarser grades in any desired sequence and conducting the same to grinding mechanism during the rough grinding operation, and returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom, said grading, regrading and circulation being carried on in an uninterrupted cycle with the material constantly mixed with a liquid, and during the rough grinding operation eliminating superfluous liquid at various levels in said vessel and thereby collecting and condensing the finer grades at various levels therein, and conducting the finer grades from said vessel to the grinding mechanism for finishing.

11. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing the coarser grades in any desired sequence and conducting the same to grinding mechanism during the rough grinding operation, and returning the same to the grading vessel and introducing the same into said vessel in a downwardly moving stream of mixture at a level intermediate the coarsest and finest grades withdrawn therefrom, said grading, regrading and circulation being carried on in an uninterrupted cycle with the material constantly mixed with a

liquid, and during the rough grinding operation eliminating superfluous liquid at various levels in said vessel and thereby collecting and condensing the finer grades at various levels therein, conducting the finer grades from said vessel to the grinding mechanism for finishing, and during both the rough grinding and finishing operations introducing liquid into said vessel below the level at which the material to be graded is supplied thereto.

12. The method described, consisting in separating abrading material mixed with a liquid in a vessel into different grades, withdrawing said grades separately and independently and conducting the same to grinding mechanism, returning the same to the grading vessel and introducing the same into said vessel in suspension in a liquid by a downwardly moving stream of mixture independent of the upward flow or travel of the body of liquid in said vessel to thereby control the flow of said stream by the density of the mixture in said vessel, and simultaneously eliminating superfluous liquid from various levels in said vessel to condense and collect the finer grades at various levels therein.

13. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material, means for withdrawing different grades from said vessel and conducting the same to the grinding mechanism, and means for returning said material in suspension in a liquid from the grinding mechanism to said vessel and including a downwardly extending conduit opening into said vessel at a level below the upper level of liquid therein, whereby the supply of material to said vessel is regulated by variations in the density in the body of mixture therein.

14. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material, means for withdrawing different grades from said vessel and conducting the same to the grinding mechanism, means for returning said material in suspension in a liquid from the grinding mechanism to said vessel and including a downwardly extending conduit opening into said vessel at a level below the upper level of liquid therein, whereby the supply of material to said vessel is regulated by variations in the density in the body of mixture therein, and means for maintaining a constant head or pressure of the liquid in the supply to said vessel.

15. Apparatus of the character described, comprising in combination, grinding mechanism,

a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material to separate the material into grades, means for eliminating superfluous liquid from various levels in said vessel while retaining the abrading material therein, to thereby collect and condense the grades at said levels, means for conducting the different grades independently from said vessel to the grinding mechanism, and means for returning the used material from the grinding mechanism to said vessel and introducing the same therein by a downwardly moving stream of mixture in said grading vessel at a level intermediate its bottom and the upper level of liquid therein.

16. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material to thereby separate the material into grades, means for conducting said grades independently to the grinding mechanism, means for returning said material in suspension in a liquid from the grinding mechanism to said vessel and including a downwardly extending conduit opening into said vessel at a level below the upper level of liquid therein, whereby the supply of material to said vessel is regulated by variations in the density of the body of mixture in said vessel, and means for eliminating superfluous liquid from various levels in said vessel while the grading operation is going on, to thereby collect and condense the finer grades in said vessel.

17. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material to thereby separate the material into grades, means for conducting said grades independently to the grinding mechanism, means for returning said material in suspension in a liquid from the grinding mechanism to said vessel and including a downwardly extending conduit opening into said vessel at a level below the upper level of liquid therein, whereby the supply of material to said vessel is regulated by variations in the density of the body of mixture in said vessel, means for eliminating superfluous liquid from various levels in said vessel while the grading operation is going on, to thereby collect and condense the finer grades in said vessel, and means for maintaining a constant head or pressure of the liquid in the supply to said vessel.

18. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of

the liquid relative to the material to separate the material into grades, a source of supply of the material at a level above the upper level of liquid in said vessel, means for maintaining a constant head or pressure of liquid in the supply to said vessel, means for conducting the several grades independently from said vessel to the grinding mechanism, and means for returning the used material in suspension in a liquid and introducing the same into said source of supply.

19. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material to separate the material into grades, a plurality of cones located at various levels in said vessel and arranged to withdraw superfluous liquid from various levels in said vessel, while retaining, collecting and condensing the grades therein, means for conducting said grades independently to the grinding mechanism, and means for returning the used material from the grinding mechanism and introducing the same into said vessel by a downwardly moving stream of mixture at a level

intermediate its bottom and the upper level of liquid therein.

20. Apparatus of the character described, comprising in combination, grinding mechanism, a grading vessel, means for producing in said vessel an upward flow or travel of the liquid relative to the material to separate the material into grades, a plurality of cones located at various levels in said vessel and arranged to withdraw superfluous liquid from various levels in said vessel, while retaining, collecting and condensing the grades therein, means for conducting said grades independently to the grinding mechanism, means for returning the used material from the grinding mechanism and introducing the same into said vessel by a downwardly moving stream of mixture at a level intermediate its bottom and the upper level of liquid therein, and means for regulating the velocity of flow of the superfluous liquid through said cones.

In testimony whereof, I have hereunto set my hand.

HALBERT K. HITCHCOCK.

Witnesses:

ELBERT L. HYDE,
GLENN H. LERESCHE.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."