L. N. MORSCHER.

GRADER.

APPLICATION FILED OCT. 23, 1908.

990,157. Patented Apr. 18, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

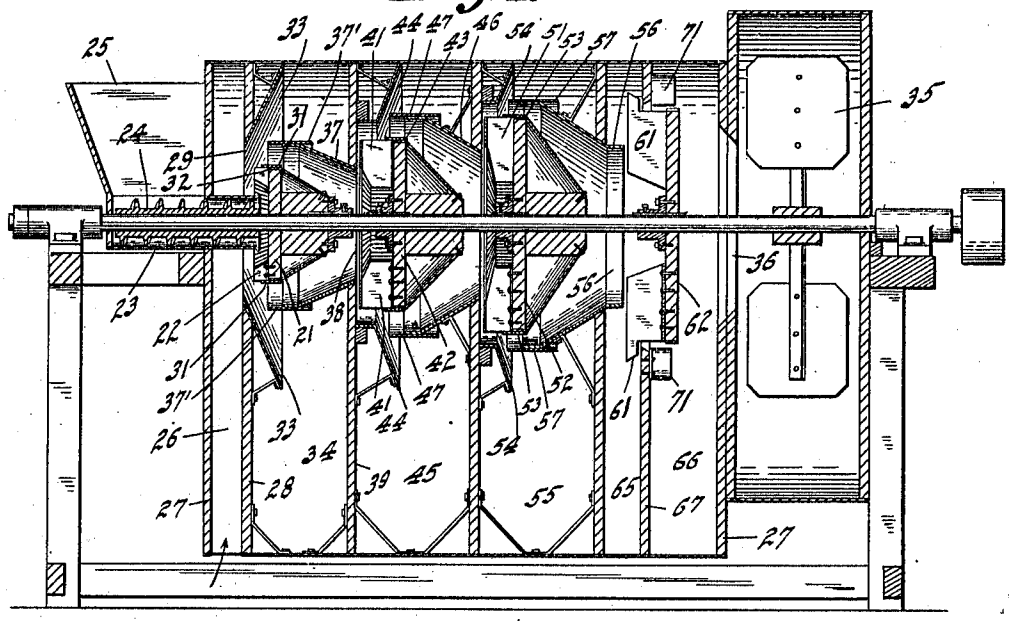


Fig. 2.

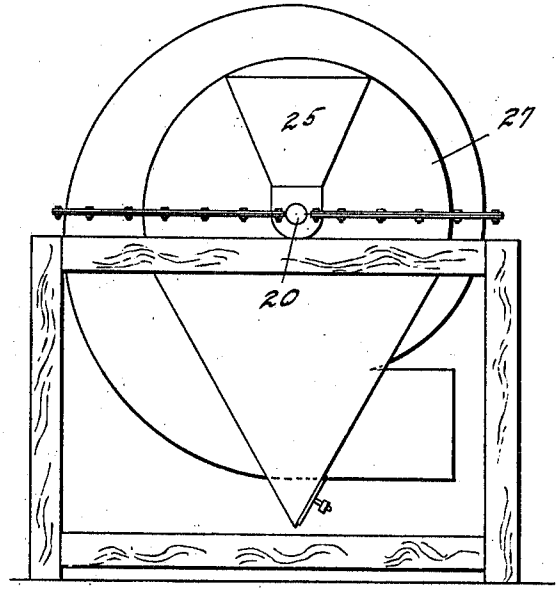


Fig. 3.

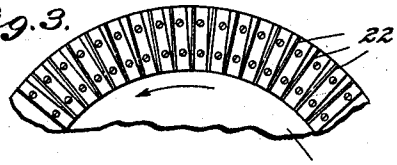


Fig. 4.

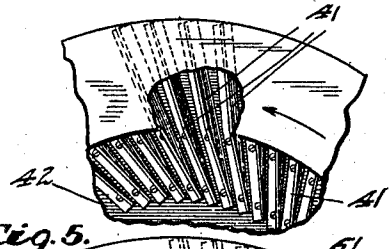
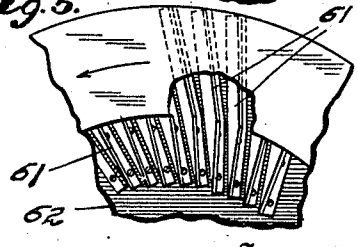


Fig. 5.



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2 SHEETS—SHEET 2.

Fig. 6

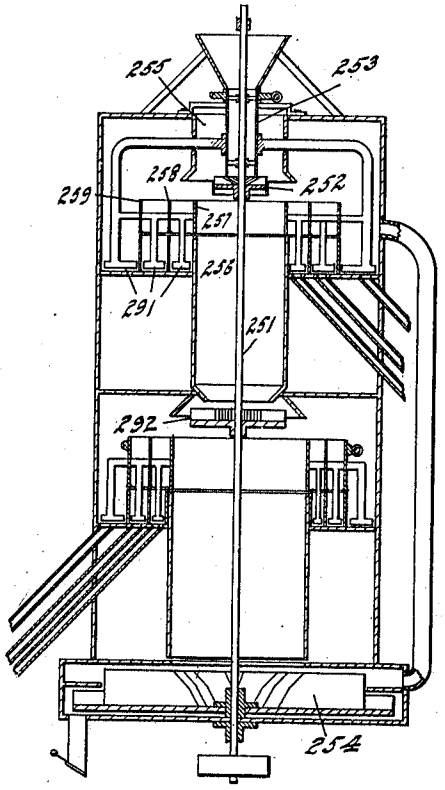
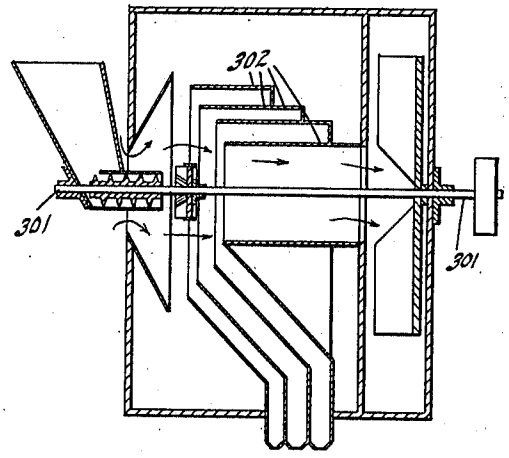


Fig. 7



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GRADER.

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Application filed October 23, 1908. Serial No. 459,155.

To all whom it may concern:

Be it known that I, LAWRENCE N. MORSCHER, a citizen of the United States, residing at Lawrence, in the county of Douglas and State of Kansas, have invented certain new and useful Improvements in Graders, of which the following is a specification.

My invention relates to an improvement in the art of grading granular particles of like or similar material but of different sizes, or for separating the granular particles of approximately equal size but differing in specific gravity this separation being accomplished by the deflecting action of fluid currents upon the particles after said particles have been hurled at high velocity into the fluid stream, said velocity being so great that the effect of gravity upon the particles is entirely negligible, the free falling velocity of the particles due to gravity having no effect in the separation.

An object of my invention is to produce an apparatus by means of which a quantity of particles may be separated into grades by mechanism which may be operated continuously and in which there will be no accumulation of any particular grade or grades to interfere with the continuation of grading. To that end I propose to give to the solid particles an initial velocity which shall be considerably in excess of the velocity which might be attained by a free falling, (so that the operation of the apparatus shall be practically independent of gravity), and subject the projected particles to a deflecting fluid current or successive deflecting fluid currents, the force, or forces, of which shall be so proportioned as to deflect the desired particles from their normal trajectories to a sufficient extent to propel them to differentiating collectors. In the operation of such a mechanism it is essential, in order to attain uniformity of deflection from the normal trajectory, that the deflecting fluid current shall at all times maintain a given ratio of force relative to the force of projection of the solid particle, as otherwise a variation of this ratio will result in a variation of deflection and a consequent variation of grade. I have also found that, in practice, an attempt to produce the initial impulsion of the particles, by the force of a fluid current carrying the particles, results in a considerable loss of power, owing to the slippage of the impelling current upon the particles, and that also there is a lack of uniformity of impulsion due to variation in conformation of the particles themselves. In addition to this an impulsion by fluid currents necessarily involves a provision of a defining channel which will consequently result in a frictional engagement of a considerable proportion of the projected particles along the walls of the defining channel and this friction varies with the difference in conformation of the particles. It is therefore desirable that the initial projection of the particles, in order to produce a normal trajectory from which there shall be a greater or lesser departure due to the deflecting fluid currents, shall be produced by an impeller capable of mechanically engaging the particle and imparting to it a definite and positive impelling force. An apparatus capable of producing the desired grading, in the manner described, needs to comprise, therefore, an impeller, or impellers, of such character as to engage successive oncoming particles and impel the same through a predetermined trajectory; a fluid-current-producer capable of producing a fluid current having a force at all times directly proportional to the particle-impelling force; means for so directing the fluid current that it shall transversely traverse the normal trajectory of the particles, and means for receiving the graded projectiles. Where more than one grade is desired it is also probably desirable that the mechanism already described should be duplicated at a point capable of receiving and again treating one of the grades.

It will be seen from what has been said that my invention involves fundamentally the impulsion, at high velocities, of particles of different masses tending toward a normal trajectory, and the impulsion of a fluid current under such conditions that, at a predetermined point, said fluid current will traverse transversely the normal trajectory of the particles and deflect the particles to a greater or less extent varying inversely as their masses so that a separator may be introduced between the limits of trajectory deflection. Specifically, the particle current and fluid current may proceed together, or substantially together, for a desired time, the particle current serving as an envelop, or partial envelop, of the

fluid current, and the fluid current deflected through the normal trajectories of the particles. The propulsion of the two currents, either or both of them, may be accomplished by mechanical impulse or otherwise upon the particles or components of the currents, and more specifically the process involves the mechanical impulsion of the particles toward a normal trajectory, and a deflection thereof, varying inversely with the mass, due to a fluid current which may be originated independently of, and projected along a path wholly dissimilar from, but intersecting, the normal path of travel of the projectile.

The improvement may be used in the sizing, grading or separating of seeds, gravels, sands, placer ores and the like as well as finely comminuted material such as middlings, powdered rock in cement manufacture, comminuted ores, etc. Where the particles to be graded are heavy the fluid currents may be water or other liquid but where the particles are comparatively light, such as flour, cement, etc., the fluid currents are preferably air or some other gas.

Apparatus having these characteristics and capable of performing the operations mentioned may assume a very considerable number of forms and the accompanying drawings illustrate somewhat diagrammatically several of such forms.

Figure 1 is an axial section, practically on a working scale, of an apparatus embodying my invention and capable of producing four grades; Fig. 2 an end elevation of said apparatus; Fig. 3 an end elevation of the initial impeller and its separator; Fig. 4 a similar view of one of the subsequent impellers and adjacent parts; Fig. 5 a similar view of the final impeller; Fig. 6 a modification, provision being made for several separations resulting from the propulsion produced with one impeller; Fig. 7 a vertical shaft modification having provision for a plurality of grades from one impeller.

I have shown in the drawings a plurality of forms of graders embodying the same principle in order that it may be seen that the invention may be properly broadly defined as stated at the beginning of the specification, and the various forms illustrated, as well as others, will form the subject-matter of divisional applications which will be filed in due course.

In Figs. 1 to 5 inclusive of the drawings, 20 indicates a horizontal rotatable shaft mounted in suitable bearings upon a supporting framework and driven at a high speed from any suitable source. Mounted upon shaft 20 is an impeller head 21 which is preferably in the form of a smooth cone or conical frustum having its base presented toward the inlet of the apparatus and preferably provided with a plurality of impeller blades 22 which may be either arranged radially or inclined from the radial, as may be deemed advisable to procure a proper trajectory of particles in a manner to be hereafter more fully described. The blades 22 may be in any desired number depending very largely upon the size of the largest particles to be graded but, as the apparatus is more especially designed for grading comparatively small particles, the impeller blades should be comparatively close together. In practice I find that, in an apparatus capable of grading the product of a cement or gypsum mill, where the major portion of the particles would pass through a 90 mesh, it is desirable that the blades 22 be placed, on a 14 inch impeller about 6 degrees apart. Leading to the receiving face or base of the impeller 21 is a feed tube 23 through which the particles to be graded are continuously fed. I find it desirable not to overload the machine with oncoming material and therefore provide means for positively and uniformly feeding the material through the feed tube 23. Conveniently this may be an ordinary feed worm 24 having a pitch sufficient to produce the desired proportion of feeding, and a hopper 25 leads to the feed worm, the said feed worm being attached to shaft 20. Surrounding the feed tube 23 is an inlet 26 for the deflecting fluid stream. In the present machine this deflecting fluid stream is an air current and for convenience in the further description I shall refer to the air current it being understood, however, that the term "air", as used herein, is fully equivalent to the broader term "fluid", so far as the theory and practical application of the invention is concerned, it being in many cases at least, possible to use any convenient fluid, either gases or liquid. The passage 26 is formed within the main casing 27 by means of a partition 28 and formed through this partition 28, around the feed tube 23 and adjacent the impeller blades of the impeller 21, is an air opening 29, the size of which is designed to admit that quantity of air which, by proper calculation, is found to be desirable to produce the initial separation desired. In order to reduce, as far as possible, the effect of differences in friction between successive particles and the receiving face of the impeller, and in order, as far as possible, to bring the particles to a uniform radial velocity, so as to obtain a trajectory of each particle approximating as nearly as possible, a tangent to the path of movement of the outer ends of the impeller blades, I have found it desirable to provide a ring 31 which surrounds the impeller 21, at its base, and projects over the receiving face of the impeller so that a ring of the particles may be gathered in the corner 32 and thus form, upon the face of the impeller, a continually

renewing working surface of particles over which succeeding particles must pass radially between the impeller blades to reach the outer ends of said blades, thus arriving substantially uniformly at the points of departure from the impeller. In the present form of apparatus the impeller 21 may be of comparatively small diameter and the impeller blades may be practically placed radially on the impelling surface.

It will be seen, from what has been said, that a rotation of shaft 20 will cause a feeding of the particles to the receiving face of the impeller and, if the speed of rotation be sufficiently high, the oncoming particles will be ejected from the feeder in a substantially horizontal stream which will strike the impeller and be distributed uniformly in all directions radially of the shaft, by the impeller blades, substantially independent of gravity and, when each particle reaches the circumference of the impeller the particles will be discharged in such manner as to follow a trajectory substantially tangential to the path of travel of the ends of the impeller blades. In order to gather and properly deflect the materials thus thrown from the impeller, I provide an inclined deflecting ring 33 which leads into the first collecting pocket 34, which, in the present form, is a dead air space. The particles thrown from the impeller 21 will therefore move, at least for a short distance from the circumference of the impeller, in a substantially flat annular plane which is substantially at right angles to the axis of the shaft 20, and all of the particles would reach the ring 33 unless some means is provided for deflecting and separating a portion thereof. It is at this point that the function of the air current introduced from the passage 26 appears. This air current may be produced either by suction through the opening 29, or by a blast, but, in order to avoid back pressure upon the incoming material, I prefer to produce this air current by means of suction, such suction also preventing loss by reason of leakage in the main casing of the machine. For this purpose, and in order that the air current may at all times have a force directly in proportion to the force of projection from the impeller, I mount upon shaft 20 a suction fan 35 through the eye 36 of which is drawn the current of air originating in the passage 26. The current of air produced by the suction fan 35 is directed to the fan by means of a ring 37 which surrounds the propeller 21 and leads to an opening 38 formed in a partition 39 which forms the wall of pocket 34 opposite wall 28. As the air current passes through opening 29 toward opening 38 it traverses transversely the trajectory plane of the particles projected by the impeller 21 and therefore tends to deflect all of the particles from their normal trajectory plane. The velocities of all of the particles, as they leave the impeller, are the same irrespective of size or specific gravity, the gravity effect on the movement of the particles through the dead air being a negligible quantity for the short spaces through which the operation takes place, but the energy of projection varies as the mass of the particle, the mass varying as the cube of the diameter, while the deflecting force of the air current varies as the area, and the area varies as the square of the diameters, so that the smaller particles, presenting a surface which is greater in proportion to their mass than the larger particles the particles of less mass will be deflected from the normal trajectory plane to a greater degree than the particles of greater mass so that the actual trajectory of the particles will be, instead of a plane, an annular solid having inner and outer bounding surfaces approximating logarithmic curves. It will be readily seen, therefore, that a separation or grading may be obtained by introducing a separator annulus 37′ the working edge of which shall lie between the bounding surfaces of the trajectory volume, the grade of separation depending upon the position which the working edge occupies relative to both of said bounding surfaces. I therefore deem it advisable to make the separator 37′ axially adjustable relative to the shaft so that the position of its working edge may be adjusted to attain the proper degree of separation. The particles having a mass exceeding the mass of differentiation will pass beyond the working edge of the separator and into the collecting pocket 34 while the particles having a mass less than the mass of differentiation will be drawn forward by the air currents through the ring 37 and opening 38 and discharged between the impeller blades 41 of an impeller 42, like impeller 21 but preferably of an increased radius so that the velocity of trajectory will be greater than the velocity of trajectory from the impeller 21, this being necessary for the reason that the velocity of air current, in the form of apparatus shown, remains substantially constant throughout the apparatus.

The impeller 42 is provided with a controller ring 43 like the controller ring 31 and surrounding said impeller is a flared ring 44 like ring 33 said ring 44 leading into the collecting pocket 45. The impeller 42 is also surrounded by an air-current-defining ring 46 and by a separator ring 47. In order that the length of trajectory from the impeller 42 shall be substantially the same as the length of trajectory from the impeller 21, the radial distance between the circumference of the impeller 42 and separator 47 is less than the radial distance between the impeller 21 and separator 39. This is done principally in order to maintain a uni-

formity of area through which the air current is to pass but it is not at all essential for satisfactory grading as a quite material variation of area may be had without in any manner affecting materially the degree of separation, for, if the trajectory be increased in length the area for the passage of air will be also increased and the decreased air velocity will be compensated by the increased time during which the air may act upon the projectile due to the increase in length of trajectory.

The impeller blades 41 are required to have a width, (axially of the shaft 20), considerably exceeding the same dimension of the impeller blades 22 in view of the fact that the air current must pass through between these blades and there must be an opportunity for the projectiles to reach the face of the impeller so that they may all leave the impeller at the working edge of the controller 43. Neglecting the air current for a moment, the projectiles will be projected from the impeller at the working edge of the controller 43 in a substantially flat annular trajectory plane but the air current, being drawn into the interior of the collector 47, will transversely traverse this normal trajectory plane in exactly the manner already described, and will deflect the projectiles to a greater or lesser extent into an annular trajectory volume which may be separated into grades, in the manner already described, by the separator 47 the grade of greater mass passing into the pocket 45 and the remainder passing through ring 46 to the blades 51 of the impeller 52 having a controller 53 and surroundied by a ring 54, a ring 56 and a separator 57 similar to parts already described, the ring 54 delivering to the collector pocket 55.

It will be readily understood that as many of the impellers and associated parts may be strung upon the shaft 20 as may be desired to attain as many separations as necessary.

In order to insure the movement of all of the projectiles from the impellers 42 and 52, the blades 41 and 51 are pitched forwardly at their receiving edges so as to mechanically draw the projectiles or particles forward to the face of the impeller and the blades are also pitched forwardly at their outer ends, *i. e.:* the ends most distant from the axis of the shaft, in order to retard the radial or outward movement of the particles, thus insuring the movement of practically every particle by the impeller in such way that it will of necessity leave the impeller at the working edge of the controller with practically no radial component.

In the structure thus far described there is, at each separation, a remainder carried forward with the air current as it advances toward the suction fan but it is of course desirable that this air current issue from the apparatus with as small a freight of projectiles as possible and I have therefore provided a final impeller of a form differing slightly from those already described so that it may serve to mechanically withdraw from the current all of the projectile freight. The projectiles remaining in the air current after the action of the impeller 52 pass through the ring 56 and are delivered to the vanes 61 of an impeller 62 carried by the shaft 20. The blades 61, instead of being pitched forwardly at their receiving edges are pitched backwardly but are also pitched forwardly at their outer ends so that when the projectiles are engaged by these blades the centrifugal force serves to drive them radially from the shaft and the angular force of the impellers serves to reverse their movement axially of the shaft and thus permit the air current to continue in its onward journey while the projectiles are arrested relatively to the air current and carried transversely into the receiving pocket 65. Between the two pockets 65 and 66 is an intermediate partition 67 which closely hugs the circumference of the impeller 62 in order to prevent any currents of such character as would serve to pick up the projectiles which are discharged reversely from the propeller blade 61.

The separation by means of the impeller 62 is produced, it will be seen, not by having the air current traverse the trajectory of the projectiles but by having the air current leave the trajectory, the trajectory being inverted. The air current as it leaves the final impeller 62 would, of course have a cyclonic movement which would tend to decrease the efficiency of the fan as the direction of revolution of the air current would be the same as the direction of the rotation of the fan. It may therefore be desirable, in some instances, to arrange, within the pocket 66, retarder blades 71 which will serve to interrupt and practically prevent any cyclonic movement of the air current so that it would be delivered substantially axially to the suction fan, thus increasing the speed of delivery to the fan.

The form which I have described up to this time has shown only a single grading *i. e.* a separation into two quantities, as a result of the action of a single impeller. It will be readily understood, however, that, without especial difficulty, a plurality of grades may be obtained from a single impeller by inserting into the trajectory volume a plurality of separators which will be arranged in differing relations to the trajectory volume. As an illustration of the possibilities along the lines mentioned, attention is called to the Fig. 6 where the vertical shaft 251 carries an impeller 252 arranged beneath a feed tube 253, which impeller has the general characteristics of the im-

peller 21 illustrated in Fig. 1. The lower end of shaft 251 carries a suction fan 254 so that a current of air will be drawn downward through the eye 255 so as to traverse transversely the normal trajectory plane of the impeller and pass downward through the passage 256. The particles will be deflected to a greater or lesser extent from the trajectory plane into an annular trajectory body, and several grades may be obtained by arranging a plurality of concentric separators 257, 258 and 259 the upper edges of which project into the trajectory at different distances from the axis of shaft 251 and therefore in position to intercept different portions of the volume and divide the same into as many grades as there are collectors plus 1, the material of greatest mass passing beyond the outermost collector. It is desirable that, in a form of this type, some means should be provided to remove the material from the bottoms of the collecting chambers, yet it is also desirable that the upper or working edges of the collectors be at all times unobstructed. It is, therefore, convenient to form the collectors into upper and lower rings, the upper ring being rotatable and carrying a scraper 291 adapted to traverse the bottom of the collector chamber, such scraper mechanism being driven at any desired speed by a suitable driving member. In the diagram of Fig. 6, I have illustrated the possibility of subjecting the material passing through passage 256 to a second impeller 292, with which may be associated a plurality of collectors in the manner already described.

In Fig. 7 the structure is substantially the same as in Fig. 6 except the impeller shaft 301 is horizontal instead of vertical, and the collector rings 302 have their working edges arranged in different planes instead of in the same plane, as shown in Fig. 6, the different arrangement being shown merely to illustrate the fact that the difference in grade does not necessarily result from any particular relation between the several collectors themselves, but results from the arrangement of the working edge of the collector relative to the trajectory volume.

Diagrammatic illustrations of variations all involving the fundamental ideas of my invention might readily be multiplied to a very considerable extent, but sufficient illustration has been given to show the comparatively wide applicability of the fundamentals of the invention.

Actual experiments with operable devices illustrated to a greater or less degree of accuracy by the various drawings has developed the fact that such devices will successfully grade into a plurality of grades even such impalpable powders as Portland cement, plaster of Paris, gypsum, etc., and will also grade materials differing not only in size but in specific gravity such for instance as corn, wheat and other grains.

I claim as my invention:

1. The combination, with a mechanical impeller for receiving separable particles of varying masses and mechanically engaging and impelling the same through a normal and uniform trajectory at velocities largely in excess of the velocity producible upon such particles by gravity through said trajectory, whereby the gravity effect becomes negligible, a fluid current impeller, guides for causing said fluid current to traverse transversely the normal trajectories of the particles, a receiving chamber into which the impelled particles would normally be delivered, and a separator adjustably projectable into the trajectory volume to prevent flow of the impelled particles from a predetermined portion of the trajectory volume into the receiving chamber.

2. The combination, with a mechanical impeller for receiving separable particles of varying masses and mechanically engaging and impelling the same through a normal and uniform trajectory at velocities largely in excess of the velocities producible upon such particles by gravity through said trajectory, whereby the gravity effect becomes negligible, a fluid current impeller, guides for causing said fluid current to traverse transversely the normal trajectories of the particles, a receiving chamber into which the impelled particles would normally be delivered, a separator adjustably projectable into the trajectory volume to prevent flow of the impelled particles from a predetermined portion of the trajectory volume into the receiving chamber, and means for delivering a succession of separable particles to the mechanical impeller.

3. The combination, with a mechanical impeller for receiving separable particles of varying masses and mechanically impelling the same through a normal and uniform trajectory at velocities greatly in excess of the velocities producible in said particles by gravity through such trajectory, an impeller for producing a fluid current bearing a fixed ratio of deflecting effect relative to the projective effect of the impeller, means for causing said fluid current to traverse transversely the normal trajectories of the particles, and means for differentially receiving the differentially deflected particles.

4. The combination, with a mechanical impeller for receiving a succession of separable particles of varying masses and mechanically impelling the same through a normal and uniform trajectory at velocities greatly in excess of the velocities producible in said particles by gravity through such trajectory, an impeller for producing a fluid current bearing a fixed ratio of deflecting effect relative to the projective effect of the impeller,

means for causing said fluid current to traverse transversely the normal trajectories of the particles, and means for differentially receiving the differentially deflected particles.

5. The combination of a rotary impeller adapted to receive a stream of particles and project the same centrifugally through a uniform trajectory at a velocity greatly in excess of the possible free falling velocity attainable by said particles through the trajectory, a fluid-current producer for producing a fluid current having a velocity of a maintained ratio relative to the velocity of projection of the particles, means for delivering particles to the impeller, guides for causing the fluid current to traverse transversely the uniform and unobstructed trajectory of the particles, a separator arranged between the limits of deflection for separating differently deflected particles, a second rotary impeller arranged to receive the particle-laden-fluid stream carrying the deflected particles separated by said separator, and adapted to project the particles therein centrifugally through uniform trajectories at a velocity greatly in excess of the possible free falling velocity attainable by said particles through said trajectories, guides for causing the fluid current to traverse transversely the trajectories of particles from said second impeller, and a separator for separating the differently deflected particles projected by said second impeller.

6. The combination of a rotary impeller adapted to receive a stream of particles and project the same centrifugally through a uniform trajectory at a velocity greatly in excess of the possible free falling velocity attainable by said particles through the trajectory, a fluid-current producer for producing a fluid current, means for delivering particles to the impeller, guides for causing the fluid current to traverse transversely the uniform and unobstructed trajectory of the particles, a separator arranged between the limits of deflection for separating differently deflected particles, a second rotary impeller arranged to receive the particle-laden-fluid stream carrying the deflected particles separated by said separator, and adapted to project the particles therein centrifugally through uniform trajectories at a velocity greatly in excess of the possible free falling velocity attainable by said particles through said trajectories, guides for causing the fluid current to traverse transversely the trajectories of particles from said second impeller, and a separator for separating the differently deflected particles projected by said second impeller.

7. In a grader a rotatable impeller, means for delivering a plurality of particles of differing masses to said impeller whereby said impeller will serve to normally project said particles through desired unobstructed trajectories at velocities greatly in excess of the velocities producible in said particles by gravity through such trajectory, means for producing a fluid current transversely traversing the trajectories to deflect the projectiles from their normal trajectories, said deflecting fluid current having a velocity at all times bearing a maintained ratio relative to the projection of the projectiles, and a separator arranged within the deflected trajectory volume.

8. The combination of a rotary impeller adapted to receive a stream of particles and project the same centrifugally at a velocity greatly in excess of the possible free falling velocity attainable by said particles through the paths of projection, means for producing a fluid current having a velocity of a maintained ratio relative to the velocity of centrifugal projection of the particles, means for delivering particles to the impeller, means for causing the fluid current to traverse transversely the normal unobstructed trajectories of the particles, and means arranged between the limits of deflection for separating differently deflected particles.

9. In a grader a rotary impeller adapted to receive particles and centrifugally project the same through a uniform trajectory, means for delivering a particle-laden fluid stream to said impeller, means for deflecting the fluid stream to cause the same to traverse transversely the trajectories of the particles after leaving the impeller, and a cylindrical separator axially adjustable to bring its forward edge to various positions within the boundaries of the trajectory.

10. The combination, of a rotary impeller having outwardly extending vanes thereon advanced in the direction of rotation at their receiving edges, means for delivering a particle-laden fluid stream to said vanes, means for causing the fluid stream to traverse transversely the trajectories of the particles beyond the vanes, and a cylindrical collector axially adjustable to bring its forward edge to various positions between the limits of the trajectory.

11. The combination, of a rotary impeller having outwardly extending vanes thereon advanced in the direction of rotation at their receiving edges, and also advanced at their outer ends, means for delivering a particle-laden fluid stream to said vanes, means for causing the fluid stream to traverse transversely the trajectories of the particles beyond the vanes, and a collector arranged between the limits of the trajectory.

12. The combination of a rotary impeller, vanes carried by the face of said impeller and extending outwardly from the axis of rotation with their receiving edges inclined away from the direction of rotation, means

for delivering a particle-laden fluid stream to said vanes, a surrounding air chamber within which the receiving edges of the vanes travel, and a fluid-stream outlet conduit communicating with that portion of the vanes beyond the surrounding air chamber.

13. The combination, of a rotary impeller, vanes carried by the face of said impeller and extending outwardly from the axis of rotation with their receiving edges inclined away from the direction of rotation and their outer ends advanced in the direction of rotation, means for delivering a particle-laden fluid stream to said vanes, a surrounding air chamber within which the receiving edges of the vanes travel, and a fluid-stream outlet communicating with that portion of the vanes beyond the surrounding air chamber.

14. The combination, with a suitable inclosing casing, of a rotary impeller mounted therein and adapted to project particles centrifugally therefrom through a uniform trajectory, means for feeding particles to said impeller, a suction fan arranged in advance of the impeller, means for causing the air current produced by said fan to traverse transversely the trajectory of particles subsequent to their projection from the impeller, and a cylindrical separator axially adjustable to bring its forward edge to various positions within the limits of the deflected trajectories of the particles.

15. The combination, with a suitable inclosing casing, of a rotary impeller mounted therein and adapted to project particles centrifugally therefrom through a uniform trajectory, means for feeding particles to said impeller, a suction fan arranged in advance of the impeller, and rotating synchronously therewith, means for causing the air current produced by said fan to traverse transversely the trajectory of particles subsequent to their projection from the impeller, and a separator arranged within the limits of the deflected trajectories of the particles.

16. The combination, with a suitable inclosing casing, of a rotary impeller mounted therein and adapted to project particles centrifugally therefrom, means for feeding particles to said impeller, a suction fan arranged in advance of the impeller and rotating synchronously therewith, means for causing the air current produced by said fan to traverse transversely the trajectory of particles subsequent to their projection from the impeller, a separator arranged within the limits of the deflected trajectories of the particles, a second rotary impeller arranged to receive the deflected fluid current and particles carried thereby and deflect said particles centrifugally from said impeller, means for causing the fluid current to traverse transversely the trajectories of said particles after leaving the impeller, and a separator arranged within the boundaries of the trajectories of particles from the second impeller.

17. The combination, with a suitable inclosing casing, of a rotary impeller mounted therein and adapted to project particles centrifugally therefrom, means for feeding particles to said impeller, a suction fan arranged in advance of the impeller, means for causing the air current produced by said fan to traverse transversely the trajectory of particles subsequent to their projection from the impeller, and a cylindrical separator axially adjustable to bring its forward edge to various positions within the limits of the deflected trajectories of the particles, a second rotary impeller arranged to receive the deflected fluid current and particles carried thereby and deflect said particles centrifugally from said impeller, means for causing the fluid current to traverse transversely the trajectories of said particles after leaving the impeller, and a separator arranged within the boundaries of the trajectories of particles from the second impeller.

18. In an apparatus of the class described, a rotary impeller having a receiving surface lying at an angle to the axis of rotation, vanes arranged upon said surface and extending outwardly from the axis of rotation, and a retarding collar arranged around the circumference of said impeller and projecting from the receiving face at the ends of the vanes.

In witness whereof, I have hereunto set my hand and seal at Indianapolis, Indiana, this sixth day of October, A. D. one thousand nine hundred and eight.

LAWRENCE N. MORSCHER. [L. S.]

Witnesses:

ARTHUR M. HOOD,

THOMAS W. MCMEANS.