H. M. SUTTON & W. L. & E. G. STEELE.

PROCESS OF AND APPARATUS FOR SIZING OR CLASSIFYING COMMINUTED MATERIALS.

APPLICATION FILED JULY 21, 1913.

1,141,852.

Patented June 1, 1915.

7 SHEETS—SHEET 1.

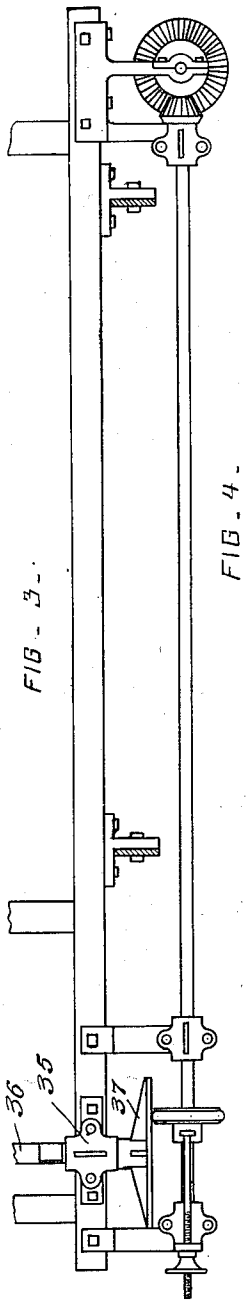


FIG. 3.

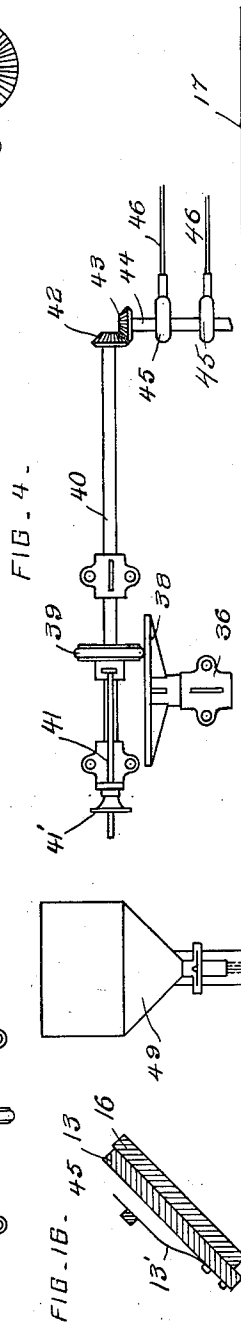


FIG. 4.

FIG. 1.

FIG. 1B.

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7 SHEETS—SHEET 2.

FIG. 17.

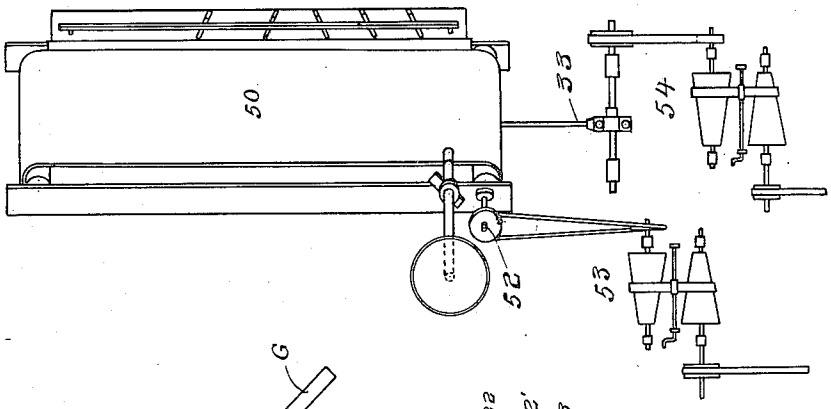


FIG. 5.

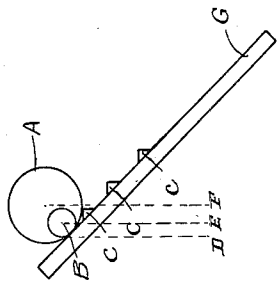


FIG. 2.

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7 SHEETS—SHEET 3.

FIG. 7.

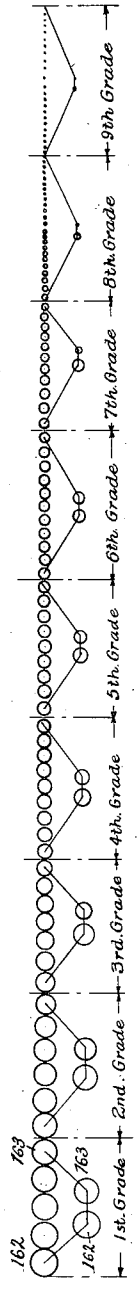
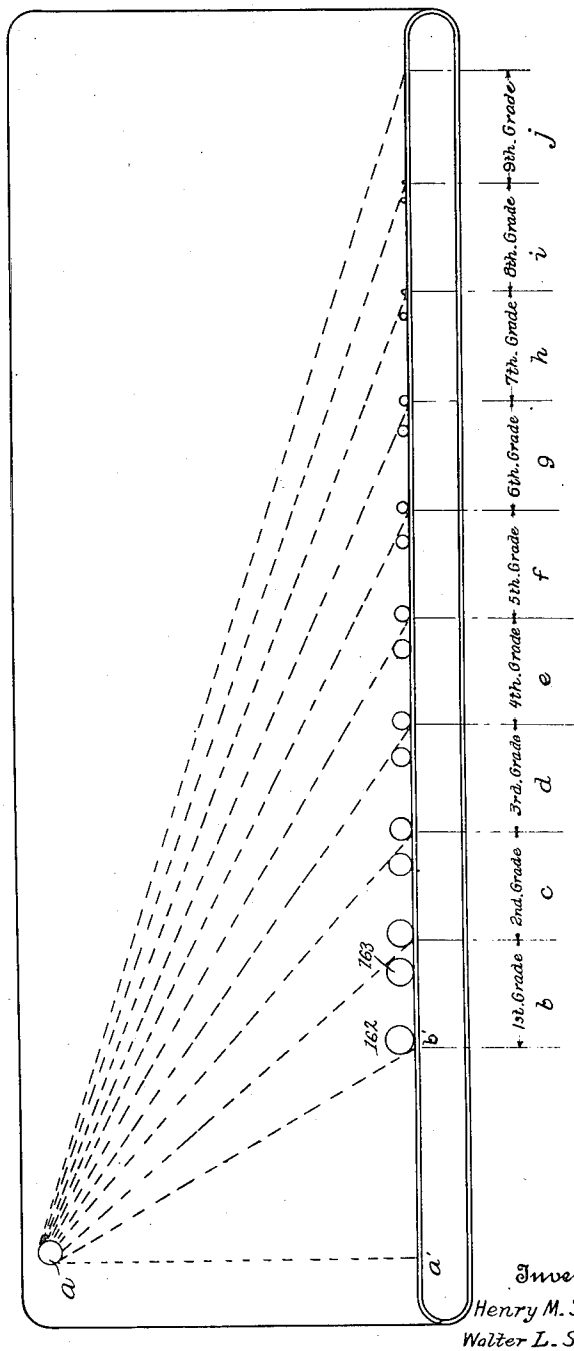


FIG. 8.



Witnesses
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7 SHEETS—SHEET 4.

FIG. 11.

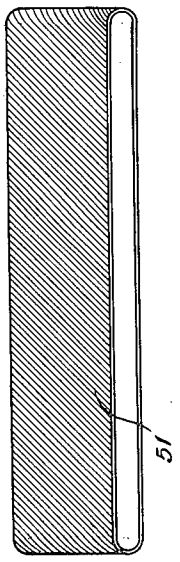


FIG. 12.

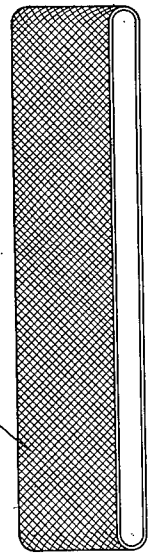


FIG. 14.



FIG. 13.



FIG. 15.

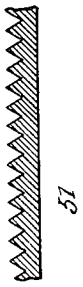


FIG. 8.

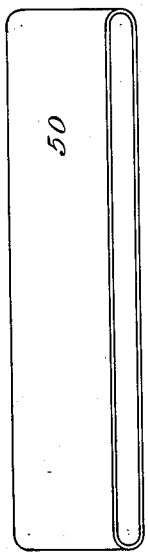


FIG. 9.

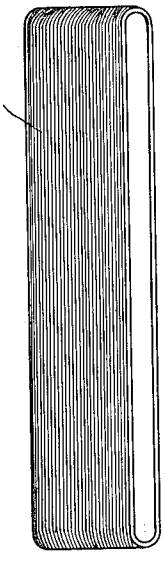
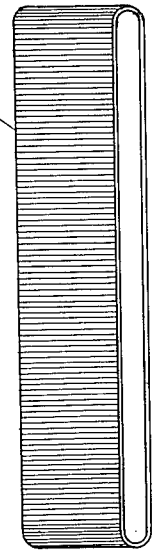


FIG. 10.



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7 SHEETS—SHEET 5.

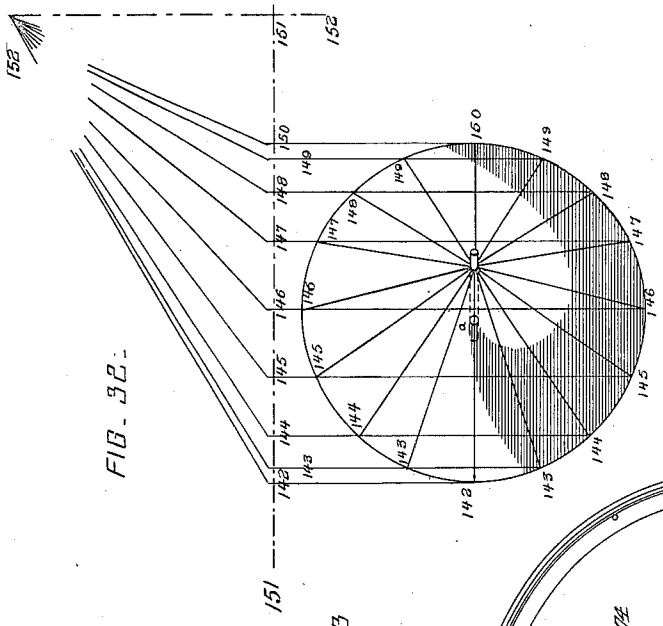


FIG. 32.

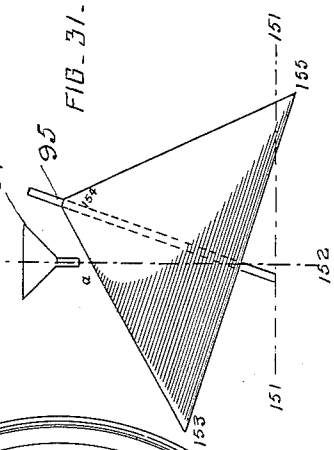


FIG. 31.

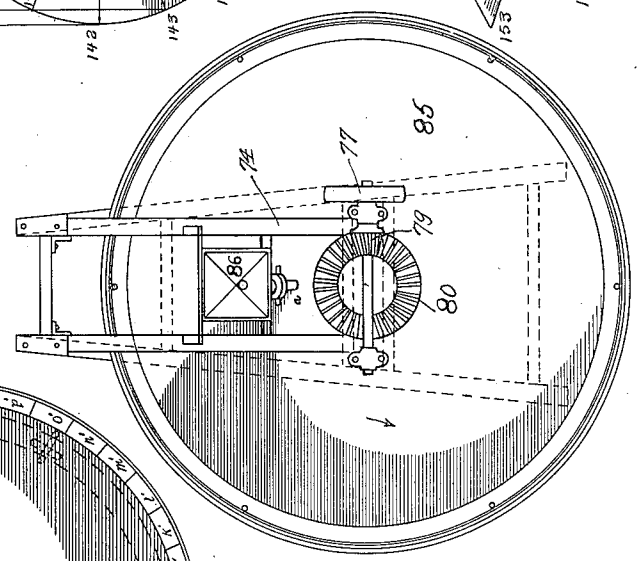


FIG. 23

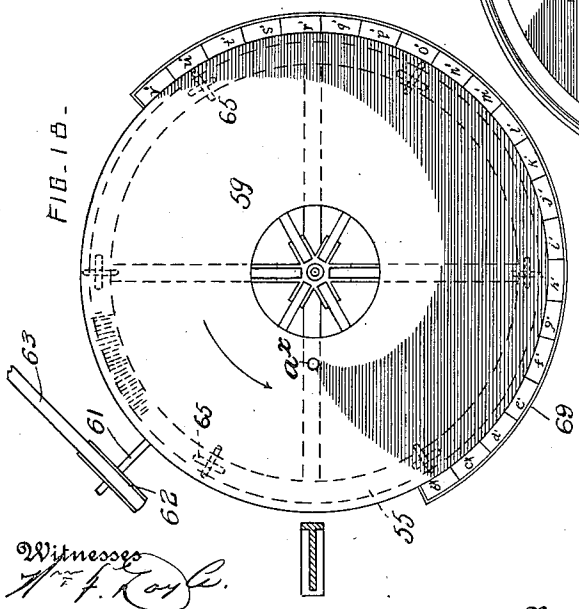


FIG. 18.

Witnesses

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APPLICATION FILED JULY 21, 1913.

1,141,852.

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7 SHEETS—SHEET 6.

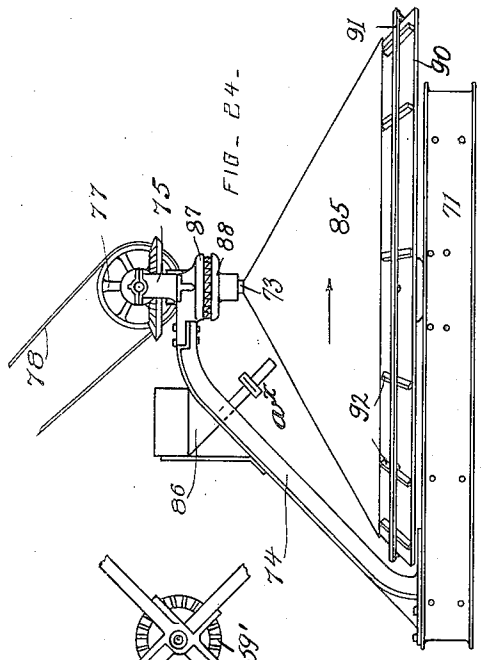


FIG. 24.

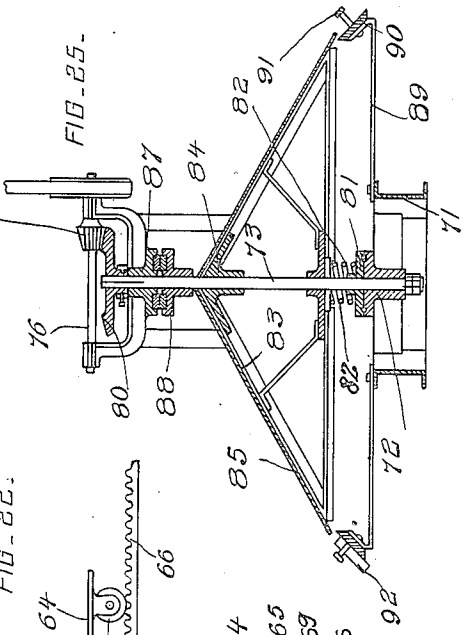


FIG. 25.

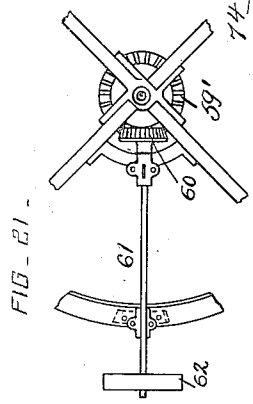


FIG. 21.

FIG. 22.

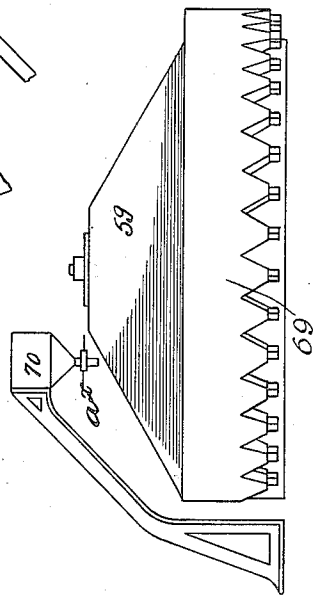


FIG. 20.

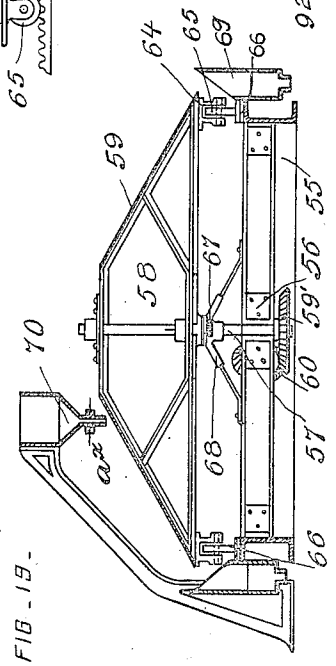


FIG. 19.

Witnesses

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PROCESS OF AND APPARATUS FOR SIZING OR CLASSIFYING COMMINUTED MATERIALS.

APPLICATION FILED JULY 21, 1913.

1,141,852. Patented June 1, 1915.

7 SHEETS—SHEET 7.

FIG. 28

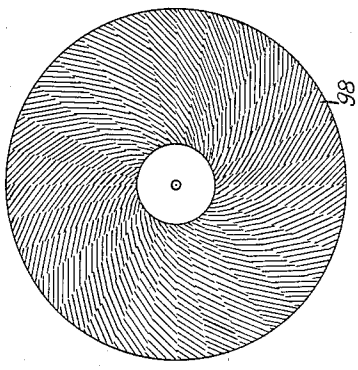


FIG. 30.

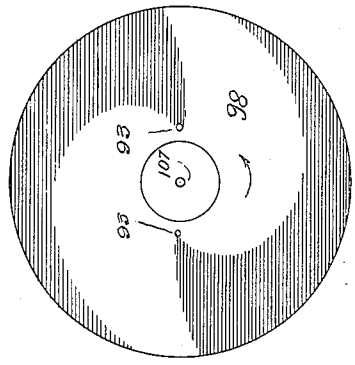


FIG. 27.

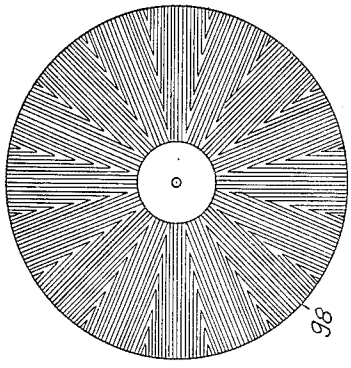


FIG. 29.

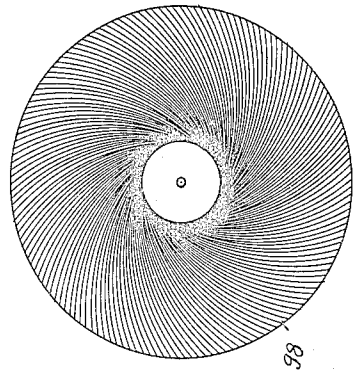


FIG. 26

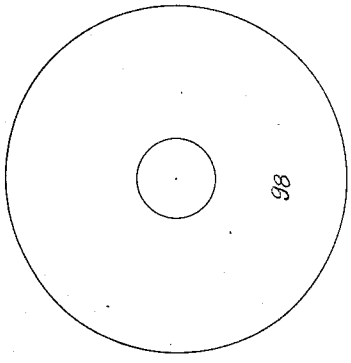
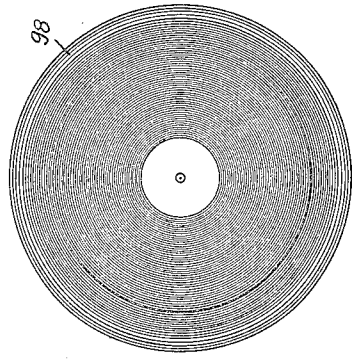


FIG. 25.



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UNITED STATES PATENT OFFICE.

HENRY M. SUTTON, WALTER L. STEELE, AND EDWIN G. STEELE, OF DALLAS, TEXAS.

PROCESS OF AND APPARATUS FOR SIZING OR CLASSIFYING COMMINUTED MATERIALS.

1,141,852. Specification of Letters Patent. Patented June 1, 1915.

Application filed July 21, 1913. Serial No. 780,360.

To all whom it may concern:

Be it known that we, HENRY M. SUTTON, WALTER L. STEELE, and EDWIN G. STEELE, citizens of the United States, residing at Dallas, in the county of Dallas and State of Texas, have invented certain new and useful Improvements in Processes of and Apparatus for Sizing or Classifying Comminuted Materials, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to certain new and useful improvements in process of and apparatus for sizing or classifying comminuted material according to the size of the particles of the material, regardless of any difference in specific gravity of the particles constituting the comminuted material, whereby the particles can be classified according to size and discharged from the apparatus in different receptacles; the particles in each of the receptacles being substantially all of the same size regardless of their difference in specific gravity.

Another object of the invention is to provide a continuously moving roughened sizing surface or deck, upon which the comminuted material is delivered and from which the particles of the comminuted material are discharged according to their size; means being provided for agitating the sizing surface so as to cause the particles thereon to be agitated, whereby the particles will gravitate at different rates of speed according to their size transversely of the sizing surface from which they can be discharged into receptacles.

Another and further object of the invention is to provide an apparatus in which the comminuted material will be prevented from accumulating at the point of delivery upon the sizing surface, thereby overcoming the difficulties now existing with separators of this character, as the agitation of pulverulent material upon a table which is not continually in motion, causes the finer particles thereof to become more thoroughly packed and prevents the more granular particles from moving in order to properly size the material.

Another and further object of the invention is to provide a process and apparatus by means of which, a greater amount of material can be sized in a given time than with other classes of sizing machines, and the cost of sizing per ton, is greatly reduced.

Another and further object of the invention is to provide a process and apparatus by means of which, comminuted material having particles differing in size to a great extent, can be classified. That is, large particles as well as pulverulent material from the crusher can be delivered upon the continuously moving sizing surface and when discharged therefrom into the respective receptacles, the particles in one receptacle will be substantially of the same size; that is, particles of material of low specific gravity of a certain size will be deposited with particles of high specific gravity of the same size, and so on throughout the classification. The pulverulent material adhering to the continuously moving surface is discharged at the end of the same into a separate receptacle which can be separated if the same contains minerals of value.

A further object of the invention is to provide a process and apparatus for sizing or classifying material in which screens of all kinds are dispensed with, thereby overcoming the difficulties now existing with screen sizers and at the same time, a classifying surface is produced which is not subjected to the sliding action of the material being sized, thereby reducing the frictional wear on the surface, which is the main difficulty with a screen classifier used for screening pulverulent material, as the life of the screen when operating upon certain classes of material is very short and as the cost of the screen has to be considered in connection with the cost of classifying ore, it will be seen that by providing a classifying surface which is not subjected to wear to any great extent, the cost of classifying comminuted material is greatly reduced.

We are aware that we are not the first in the art to provide a sizer or classifier in which the particles are classified according to their size by the movement of the particle upon a classifying surface but in apparatuses of this character previously constructed, a classifying surface was given a projecting pulsation in order to cause the par-

ticles to be advanced thereon by a sliding action, while with our apparatus, the agitation of the classifying surface does not effect the movement of the particles longitudinally upon the surface but causes the same by being agitated, to roll by gravity transversely of the classifying surface and as the classifying surface is moved continuously, the particles are carried by the moving surface or deck longitudinally, when they are in the act of rolling transversely and by timing the speed of movement of the classifying surface and regulating the pitch of the surface so as to cause the particles to travel by gravity at a certain rate of speed, a classifier can be produced which will thoroughly classify the comminuted material delivered thereon at a high rate of speed at a small cost, which is the main object to be accomplished in all classifiers now in use.

A further object of the invention is to provide a roughened or corrugated classifying surface in order to form a resistance on the material without actually obstructing the flow of the particles by gravity transversely across the surface, as it is a well-known fact that the larger particles when placed upon an inclined surface will travel at a higher rate of speed than the smaller particles, and our improved process and apparatus is carried out upon this fundamental principle.

Other and further objects and advantages of the invention will be hereinafter set forth and the novel features thereof defined by the appended claims.

In the drawings Figure 1, is a side elevation of one form of apparatus for carrying out our improved process of sizing or classifying comminuted material; Fig. 2, is a transverse vertical section through the same showing the inclination of the classifying surface with the means for adjusting the same; Fig. 3, is a top plan view of one form of driving mechanism for the continuously moving classifying surface; Fig. 4, is a plan view of the agitating mechanism showing the means for regulating the speed thereof, the eccentric being so constructed that no differential movement is imparted to the classifying surface as it is essential that the agitation will not impart a longitudinal projecting movement to the material on the surface while we have shown a reciprocatory movement, it is of course understood that a vertical movement could be employed to accomplish the same result; Figs. 5, 6 and 7, are diagrams illustrating the fundamental principles of our improved process and apparatus for sizing or classifying comminuted material; Fig. 8, is a perspective of one form of belt; the same being provided with a roughened or unpolished surface; Fig. 9, is a similar view showing a belt provided with a longitudinally corrugated surface; Fig. 10, is a similar view showing a belt provided with a transverse corrugated surface; Fig. 11, is a similar view showing a belt provided with an obliquely or diagonally arranged corrugated surface, the corrugations running in a reverse direction in the movement of the belt; Fig. 12, is a similar view showing a belt having diagonal grooves running in both directions; Fig. 13, is a detail section through a belt showing the corrugations formed of acute angled grooves; Fig. 14, is a detail section showing the corrugations formed upon curved lines; Fig. 15, is a detail section showing the corrugations formed upon straight lines. These figures, *i. e.*, nine to fifteen, show various forms of corrugated belts in order to increase or decrease the resistance without obstructing the flow of the material by gravity transversely of the belt. Fig. 16, is a detail section through the apron showing the construction of the deflecting fingers; Fig. 17, is a plan view of another form of apparatus showing the application of a belt drive instead of the gear drive; Fig. 18, is a top plan view of another form of apparatus for carrying out our improved process of sizing or classifying comminuted material in which a conical classifying surface is employed. Fig. 19, is a vertical transverse section through the same; Fig. 20, is a side elevation; Fig. 21, is a detail plan of the driving mechanism; Fig. 22, is a detail elevation of the agitating means; Fig. 23, is a top plan view of another form of apparatus for carrying out the process of sizing or classifying comminuted material; Fig. 24, is another form of apparatus for carrying out the process of sizing or classifying comminuted material, showing a top drive; Fig. 25, is a transverse vertical section through a form of apparatus shown in Figs. 23 and 24; Figs. 25× to 29, are plan views of conical classifying surfaces showing various forms of corrugations in order to carry out the process of sizing or classifying the comminuted material; Fig. 30, is a top plan of a conical classifying surface showing the movement of the material from a two-point feed; the shading thereon indicating the direction of the material in its movement over the surface when the same is in continuous movement; and Figs. 31 and 32, are diagrams of a conical classifier showing the same arranged on an oblique axis in order to arrange the conical classifying surface upon an inclination for the purpose of increasing the pitch of the surface from the point of feed; the diagrammatic lines showing the ratio of the pitch to the size of the material being delivered upon the conical surface.

Like numerals of reference refer to like parts in the several figures of the drawings.

In the form of apparatus shown in Figs.

1, 2, 3 and 4, 1 indicates a suitable base frame upon which are arranged spring supports 2 carried by brackets 3 and having their upper ends fixed to couplings 4 which are pivotally mounted loosely in bearings 5 carried by a frame 6, one of these springs being arranged substantially at each corner of the frame 6 so as to support the frame 6 in a horizontal position in such a manner that the same can be reciprocated so as to agitate the same, as will be later described, and while we have shown this particular construction of mounting the frame 6 to accomplish this result, it is of course understood that various other forms of supporting means can be employed without departing from the spirit of our invention.

Mounted upon the frame 6 is a deck or belt frame 7 which is connected thereto along one of its longitudinal edges by hinges 8 in order to allow the frame to be thrown at any inclination desired. For supporting the opposite edge of the belt frame, we provide the same with depending curved slotted arms 9 which work over threaded studs 10 carried by the frame 6 upon which are mounted hand wheels 11 for locking said arms in their adjusted position, so as to hold the belt frame at any inclination desired, as will be later described.

The belt frame 7 is provided with suitable bearings 12 at each end in which are mounted shafts 13 and 14 carrying rollers 15 and 16 over which is arranged an endless belt or deck 17 preferably formed of rubber and as herein shown, is provided with diagonally arranged corrugations running in the direction of the movement of the belt in order to form a deflecting resistance to the comminuted material without absolutely obstructing the flow of the particles by gravity transversely of the belt and this form of belt is the preferred form used in carrying out our improved process of sizing or classifying comminuted material.

Arranged longitudinally along the belt frame at one edge thereof, is an inclined apron 18 adapted to receive the particles sized or classified by the endless belt or deck, and said apron is provided with a longitudinally centrally arranged bar 19 spaced therefrom and under which are arranged deflecting or spacing fingers 20 which are provided with springs which bear against the under side of the bar 19 to hold the fingers in adjusted position in such a manner that they can be shifted longitudinally under the bar or thrown at any angle desired in order to adjust the sizing of the material as it is discharged from the belt and by arranging suitable receptacles under the apron, the sized or classified particles can be deposited into suitable receptacles from which they can be removed by any suitable means such as a conveyer.

In order to provide means for driving the belt continuously at any speed desired when the table is adjusted to the desired inclination, we provide the shaft 14 carrying the roller 16 with a beveled gear 21 which meshes with a beveled gear 22 carried by a shaft 22′ mounted in a suitable bearing carried by the frame 7; said shaft having a universal connection with the intermediate shaft 23 which is universally connected to a shaft 24 mounted in a suitable vertical bearing 25 formed in the arm of a bracket 26 extending laterally from the base frame 1. Feathered upon this shaft 24 is a beveled gear 27 which meshes with a beveled gear 28 fixed on one end of a shaft 29 mounted in an arm 26′ of the bracket 26 whereby the rotation of the shaft 29 will cause the roller 16 to be revolved through the medium of the beveled gears and connection so as to rotate the belt continuously in one direction.

The shaft 29 is mounted at its opposite end in suitable bearings 30 and 30′ carried by the extension of the frame 1 and is provided with a feather upon which is mounted a friction disk 32 having a hub upon which is loosely mounted a collar 32′ to which is connected one end of a screw 33 which extends through a bearing 33′ and is provided with a hand nut 34 by means of which the friction disk 32 can be adjusted longitudinally upon the driven shaft 29 for the purpose later described.

Mounted in suitable bearings 35 arranged on the frame 1, is a driven shaft 36 which is provided with a friction disk 37 at one end contacting with the friction disk 32 by means of which the driving shaft 29 is rotated and it will be seen that by shifting the position of the friction disk 32 in respect to the face of the friction disk 37, the speed of the driving shaft can be regulated in order to regulate the speed of travel of the classifying belt or deck.

In order to provide means for agitating the belt or deck through the medium of the supporting frames, we provide the driven shaft 36 with a frictional disk 38 at its opposite end which contacts with a disk 39 feathered upon a shaft 40 which is adjusted thereon by a screw 41 and hand nut 41′ constructed substantially the same as disclosed in the speed-changing mechanism of the belt driving means.

The shaft 40 is provided at its inner end with a beveled gear 42 which meshes with a beveled gear 43 carried by a transversely arranged shaft 44 which is provided with spaced eccentrics 45 over which are arranged eccentric straps of rods 46 which extend under the frame 6 and are adjustably secured in eyes formed in brackets 47 secured to the longitudinal bars of the frame 6 by lock nuts 46′ in order to allow the rod to be adjusted to take up any wear and it will be

seen by this construction, that the frame 6 is reciprocated through the medium of the spaced eccentrics in such a manner that the movement in both directions is the same, as no differential movement occurs in the operation of the eccentrics so as to prevent the material from being propelled lengthwise of the belt or deck and while we have shown agitating means operated by this construction, it is of course understood that the main object of agitating the belt or deck, is to cause the particles of the comminuted material to be agitated so as to allow the same to roll transversely of the belt or deck by gravity and a vertical agitation would accomplish the same result and we do not wish to limit ourselves to any exact construction of agitation but wish to differentiate a non-propelling agitation that does not propel the material longitudinally from a projecting agitation that propels the material upon the surface, as such an agitation would defeat the fundamental principle of this invention.

The driven shaft 36 is provided with a drive pulley 48 over which is adapted to pass a drive belt from the power shaft, not shown, and it will be seen that when the shaft 36 is being driven, the belt will be driven continuously and at the same time agitated and by adjusting the position of the friction wheels 32 and 39 in respect to the coöperating friction wheels, the speed of the belt and the speed of the agitation can be regulated to suit the material being operated upon.

A gate-controlled hopper 49 is carried by a support and is so arranged that the comminuted material is delivered upon the upper edge of the belt or deck at the receiving end, and the sizing at once takes place; the belt carrying the pulverulent material which is too fine to roll by gravity, along with the run of the belt until it has passed over the roller 16 where it is discharged into a suitable receptacle.

The other particles of the comminuted material start to roll by gravity according to their size over the inclined classifying surface of the belt or deck; the same being deflected by the resistance of the corrugations without actually obstructing the flow of the particles by gravity transversely of the belt.

In the diagram shown in Fig. 5, an inclined surface G is shown upon which we illustrate two particles A and B; A being we will suppose, twice the size of B. The surface G is provided with obstructions *c*, *c*, *c*. The inclination of the surface under normal conditions is such that the particle B will be maintained in the position shown with its center of gravity bearing different ratios to the obstructions *c*, *c*, *c* as will be noted by the lines drawn from the centers D, E, F. The line E from the center of the smaller particle passes over the center of the obstruction C. This particle would consequently remain at rest upon the surface and would not roll by gravity thereon unless the surface G was vibrated and the particles thereby dislodged. The particle A, however, by referring to the line F upon the center of this particle, passes in front of the obstruction C, in other words, its center of gravity is over the point of rest against the obstruction *c* and this particle would of course roll down the inclined surface G of its own volition, and while this diagram is carried out upon an enlarged scale in order to illustrate the fundamental principle of this invention, upon inspecting the same it will be readily seen that the particles of different sizes will roll at different rates of speed down a roughened inclined surface and in order to carry out our improved process in connection with a roughened surface as hereinbefore referred to, it is only necessary to continuously move said surface away from the point of feed of the material, and at the same time constantly vibrate said surface, whereby the particles will be classified into separately sized products.

In the diagrams shown in Figs. 6 and 7, the point of feed designated by *a*, from which the lines radiate, shows the line of travel of the different sized particles upon a moving agitated belt and the line *a*—*a'* indicates the line of travel of the particles upon a stationary agitated belt and the line *a*—*b'* indicates the line of travel on a moving belt showing the difference in time that such particles would take to travel across the belt.

In order to clearly illustrate the travel of the particle, supposing that the particle 162 will travel the width of the belt which we will assume in this instance to be four feet in one second, it is evident that a particle seven-eighths of its size represented by 163, would lag behind or require a much proportionately longer time to travel thus causing it to report above one-eighth of the width of the belt in advance of the particle 162 where it woud be delivered from the edge of the belt into its proper compartment and so on with the remainder of the particles.

The first grade or larger particles roll more freely and are delivered at a point transversely across the deck closest to the point of feed and so on down, the pulverulent material adhering to the belt when it becomes so small that it will not roll upon the inclined surface and by the movement of the belt, is carried over the end thereof and deposited into a suitable receptacle, and from the above description, it will be seen that we have a ratio of separation of the particles from each other depending upon the speed of travel of the belt and the dif-

ference in the speed of travel of the particles across the same with a given number of agitations of the belt as the faster the belt is agitated, the faster the particles will travel across the same at any inclination, and by arranging the separating fingers upon the apron in the desired positions, a large number of sizes can be made from a single apparatus. If the belt had a speed of one foot per second, and the particle is rolling across the same at the same rate of speed, it is evident that it would reach the point of discharge about one foot distant from a line drawn transversely across the belt from the point of feed, and on the other hand, supposing that the particle is traveling one-fourth as fast as the belt, the particle would be carried four feet by the belt by the time it had traveled one foot across the same, and therefore, it would be carried a greater distance before being discharged therefrom.

The agitation of the belt does not in any way propel the particles of the comminuted material lengthwise thereof, but performs the function of causing the particles to be dislodged from the roughened surface so that they will roll transversely of the belt by gravity as the belt or deck is moving.

In the form of belt shown in Fig. 8, a surface 50 is shown which is only roughened, that is, the same is not polished and is especially adapted to be used for sizing or classifying fine pulverulent material.

In Figs. 9, 10, 11, 12, 13, 14 and 15, various forms of corrugated surfaces are illustrated for the belt which is preferably formed of rubber and these forms of corrugations 51 have simply a bearing upon the difference in friction value of the particles and only perform the function of causing a resistance upon the particles without actually obstructing the flow of the particles by gravity transversely across the belt.

The size and depth of the corrugations have no material bearing on the sizing, except within very wide limits. For instance, corrugations one-sixteenth of an inch wide and one-thirty-second of an inch deep would size a mass of particles ranging from one-fourth of an inch to one-thousandth of an inch in diameter, and where it is necessary to size large particles ranging from one-eighth of an inch in size to several inches in size, a larger corrugation having depth of about one-eighth of an inch and a width of about one-fourth of an inch can be employed, the corrugations bearing that relation to the rolling particle as will offer a certain amount of resistance to the rolling movement of said particles in order to deflect the same without being sufficient to stop the particles from moving by gravity and being agitated upon the surface, and we have found by experimenting, that it is not absolutely necessary that corrugations be used, as by employing a roughened surface similar to that of a double-cut file as illustrated in Fig. 12, the process of sizing or classifying comminuted material is carried out, and in the normal operation of the process, the inclination of the belt is such that the largest particles will just remain at rest when the belt is at rest but will start to move as soon as the belt or deck is agitated.

In the form of apparatus shown in Fig. 17, the endless belt or deck forming the roughened sizing surface is constructed substantially in the same manner as previously disclosed and instead of providing a gear drive, belt drives are employed and the shaft 52 is driven through a change-speed mechanism 53 of the ordinary construction now in use and the agitating rod and eccentric 53′ are driven through a similar change-speed mechanism 54, and this view is illustrated in order to show that various drives for the endless belt can be employed; the essential feature being that change-speed mechanism be employed in order to regulate the speed of the belt and the speed of agitation separately, so as to adjust the apparatus to accommodate different grades of comminuted material.

In Figs. 18 to 32, we show conical forms of apparatuses for carrying out our process of sizing comminuted material which are provided with various forms of roughened surfaces upon which the material is fed when the cone is rotated continuously and at the same time agitated.

In the form shown in Figs. 18, 19, 20 and 21, 55 indicates a circular base provided with a central bearing 56 in which is mounted a vertical shaft 57 upon which is loosely feathered a conical frame 58 having a sizing surface 59; said frame being capable of vibrating upon the shaft as will be later described.

In order to drive the conical separator, the shaft 57 is provided with a beveled gear 59′ which meshes with a beveled gear 60 carried by a shaft 61 having a drive pulley 62 over which a power belt 63 passes and it will be seen that as the shaft 61 is rotated, the frame 58 will be revolved through the medium of the gears.

In order to cause the classifying surface or deck carried by the frame to be vibrated as the same is rotated, we provide the frame 58 with bearings 64 carrying rollers 65 which travel upon a circular rack 66 mounted upon the base frame 55.

The frame 58 is mounted upon the shaft 57 in such a manner by the feather as to permit the same to move up and down thereon, as the rollers travel over the rack so as to produce a vibration upon the classifying surface. The frame 58 is provided with a central hub mounted upon a hub 67 carried

by arms 68 of the base frame 55. Arranged around the lower peripheral edge of the cone is a series of pockets 69 which are in the form of hoppers having discharge spouts from which the sized particles can be delivered to suitable receptacles arranged thereunder.

A support is arranged to one side of the separator having a gate-controlled hopper 70 which is adapted to deliver comminuted material upon the cone at the point designated by a^x and it will be seen that as the conical surface is rotated and agitated, the coarser particles of the mass will be deposited in the pocket b^x, the next finer in the pocket c^x, and so on down, until the final pocket designated by the reference character v' is reached; the pulverulent material which is delivered into any of these pockets being carried off the edge of the cone beyond the last pocket v' where it can be caught by a suitable receptacle.

In the top plan view of this form of cone the shaded lines designate the travel of the material upon the cone from the point a^x where the material is delivered to the cone.

In the form of apparatus shown in Figs. 23, 24 and 25, 71 indicates the base having a central bearing 72 in which is mounted a shaft 73 supported at its upper end by an arm 74 extending from the base 71 which is provided with bracket arms 75 in which is mounted a driven shaft 76 provided with a pulley 77 over which the power belt 78 passes. The shaft 76 is provided with a beveled pinion 79 which meshes with a beveled gear 80 feathered upon the upper end of the shaft 73 as clearly shown in Fig. 25. Surrounding the shaft 73 and resting upon the bearing 72 is a collar 81 upon which is mounted a coil spring 82 for supporting a conical deck frame 83 provided with a bearing 84 at its upper end to receive the shaft and said conical frame is provided with a classifying surface or deck 85 upon which the comminuted material is adapted to be delivered from the gate-controlled feed hopper 86 carried by the arm 74 as clearly shown in Fig. 24.

In order to cause the conical frame carrying the classifying surface to vibrate when the same is rotated through the medium of the beveled gears and drive pulley, we provide the arm 74 and with a ratchet member 87 which co-acts with the companion ratchet member 88 carried by the shaft 73; the teeth of which are so arranged that when the cone is rotated in the direction of the arrow, the same will be pushed downwardly against the tension of the spring as the teeth ride over one another, and the vibration will be exerted upon the classifying surface of the cone.

While we have shown and described in connection with this upper drive conical apparatus for classifying comminuted material, a vibrating mechanism in the form of coöperating ratchets, it is of course understood that the form of vibrator shown in Figs. 18 to 21 could be employed in connection with this form of drive or the form of ratchet agitating mechanism can be employed in connection with the form shown in Figs. 18 to 29, and we do not wish to limit ourselves to any exact construction of driving mechanism to be used in connection with a conical form of apparatus for carrying out the process, as various means can be employed for causing a conical surface to be rotated continuously at a given rate of speed together with means for agitating the conical surface and while we have failed to show any particular change-speed mechanism used in connection with these forms of apparatus, it is of course understood that they are to be employed in order that the speed of the conical surface can be regulated independently of the speed of vibration, and for instance, by interchanging the ratchets and racks, the vibration exerted upon the surface can be changed. In this form of apparatus instead of providing the peripheral edge of the cone with pockets to receive the sized material, the base 71 is provided with radial arms 89 carrying a circular apron 90 above which is arranged a circular bar 91 for holding the spacing or separating fingers 92 in their adjusted positions in order to size the material into various sizes as the same is discharged from the conical separator. The form of finger illustrated in this view is substantially the same as shown in the belt type of apparatus and is provided with the usual spring for retaining the same in its adjusted position.

In Figs. 25^x to 29, we show various forms of classifying surfaces 98 for the conical separators in which the corrugations or roughened surfaces are arranged so as to accommodate different grades of material and while we have shown these forms as preferred types of surfaces, we do not wish to limit ourselves as other forms of corrugations running in different directions can be used without departing from the spirit of our invention.

In the form of conical classifier illustrated in Fig. 30, the shaded lines indicate the travel of the material from a two-point feed upon a comparatively smooth surface, that is a roughened surface, but not polished and without corrugations, and especially adapted to be used for sizing fine pulverulent material, the points designated by the numerals 93 indicating the points at which the material is fed upon the surface and when the surface is rotated in the direction as indicated by the arrow, the com-

minuted material will travel as indicated by the shading, the larger particles passing off of the conical surface in substantially a radial line, while the smaller particles which travel at a lower rate of speed are discharged at substantially an opposite point from the point of feed.

In the form shown in Figs. 31 and 32, a conical separating apparatus is illustrated diagrammatically in which the cone is inclined for the purpose of increasing the pitch or inclination of its surface away from the point of feed of the comminuted material and in these figures, 94 indicates the feed hopper and 95 the supporting shaft of the cone, a vertical line being indicated by 152. The diagrammatic lines show the ratio of this pitch to the size of the material on the cone and taking line 151 as an example in connection with the vertical line 152, the line 142 shows the degree of slope of the cone at the feed. As the material gets finer, the slope of the cone by its inclination gets deeper until we reach the line 150 which represents the point when the finer particles of the material are delivered from the surface. This increases the pitch of the cone and facilitates the delivery of the finer comminuted material and as in all other cases, the shading upon these figures shows the travel of the material upon the cone when the cone is revolving and being agitated.

While we have shown and described a number of forms of apparatus for carrying out the process of sizing or classifying comminuted material according to the size of the particles regardless of the specific gravity thereof, we wish it to be clearly understood that various other forms of apparatus can be used for carrying out our improved process without departing from the spirit of our invention as the fundamental principles of this invention are a continuously moving inclined roughened surface upon which comminuted material is delivered and carried by the moving surface away from the point of feed; the surface being agitated so as to cause the particles to travel transversely of the moving surface by gravity upon the inclined surface according to their size, whereby all of the particles of the comminuted material will be sized and classified which are of any size and are affected by gravity, the pulverulent material being discharged from the surface separately from the particles of any size.

In the drawings, we have shown the eccentrics placed upon a counter-shaft 44 for agitating the belt in order that the speed of the agitation can be regulated, but it is of course understood that the driven shaft 36 can be provided with eccentrics on which the rods are mounted for agitating the belt without departing from the spirit of our invention, as in some cases it is not necessary to have a change-speed mechanism in connection with the agitation of the belt.

We claim:

1. The process of sizing a mass of comminuted material, consisting in subjecting a mass of material containing particles of different sizes in dry condition, to a continuous movement in one direction upon a moving support, causing the particles to gravitally deviate from the line of normal movement, retarding said gravital deviation and so proportioning the forces, that the deviation shall be proportional to the size of the respective particles, and separately collecting the thus sized particles.

2. The process of sizing a mass of comminuted material, consisting in subjecting a mass of material containing particles of different sizes in dry condition, to a continuous movement in one direction upon a continuously moving support, causing the particles to gravitally deviate from the line of normal movement of the material, retarding said gravital deviation to cause the particles to travel contiguously and so proportioning the forces, that the deviation shall be proportional to the size of the respective particles, and separately collecting the thus sized particles.

3. The process of sizing a mass of material, consisting in supporting said material upon an inclined roughened surface, continuously moving said surface in one direction, agitating said material upon said surface to cause the material to move at an angle to the movement of the surface proportioned solely to the sizes of the grains of the mass, and separately collecting the thus sized particles.

4. The process of separating comminuted material, containing particles of different sizes, consisting in continuously moving and agitating said material when in a dry condition, subjecting said material to the force of gravity to cause said material to move in lines deviating from the continuous movement of said material at angles proportioned to their sizes, exerting a resistance on said material against the force of gravity, and separately collecting the thus sized particles.

5. The process of sizing a mass of pulverulent material, consisting in feeding the material dry, upon a continuously moving inclined roughened supporting surface, agitating the mass, causing the components of the mass to deviate from the line of normal movement at angles proportionate to their sizes, and separately collecting the so sized particles.

6. The process of sizing a mass of pulverulent material, consisting in feeding the material dry, upon a continuously moving inclined roughened supporting surface, agi-

tating said supporting surface and causing the components of the mass to deviate from the line of normal movement at angles proportionate to their sizes, and separately collecting the so sized particles.

7. The process of sizing a mass of material, consisting in feeding and continuously moving the material dry, in one direction, subjecting said material to the force of gravity and exerting a resistance to said material against the force of gravity and causing the components of said material to travel in lines deviating from the continuous movement of said material at angles proportionate to their sizes, and separately collecting the thus sized particles.

8. The process of sizing a mass of material, consisting in feeding and continuously moving the material dry away from the point of feed in one direction, exerting a resistance to said material in a direction at an angle to the continuous movement thereof, subjecting said material to the force of gravity to cause the components of said material, to travel at angles to the continuous movement against the resistance, the resistance and components of motion due to gravity, being proportioned to cause the angles of movement to be proportioned to the sizes of the particles, and separately collecting the thus sized particles.

9. The process of sizing a mass of material, consisting in feeding said material on to a continuously moving supporting surface, subjecting said material to the force of gravity when on said surface, agitating said material upon said surface, exerting a deflecting resistance to said material on said support against the force of gravity, to cause the components of said material to travel at angles to the continuous movement against the resistance, the resistance and components of motion due to gravity being proportioned to the size of the particles, and separately collecting the thus sized particles.

10. The process of sizing a mass of material having particles of different sizes, consisting in feeding and continuously moving said material away from the point of feed in one direction, permitting the components of said material to respond to gravity sufficiently to cause the granular particles thereof to travel according to the size thereof, at different rates of speed in lines at angles to the continuous movement of said material proportioned to the sizes of said components, agitating said material continuously, and separately collecting the thus sized particles.

11. The process of sizing a mass of material, consisting in moving said material in dry condition, upon a continuously moving transversely inclined supporting surface, agitating said material and causing the particles of said material, to travel by the force of gravity upon the inclined surface at different rates of speed according to the sizes of the particles thereof, in lines deviating proportionately to their sizes from the lines of travel of the mass upon the support, and separately collecting the different sized particles of the pulverulent material.

12. The process of sizing a mass of material, consisting in feeding said material dry, upon an inclined continuously moving roughened flexible surface, agitating said material upon said surface to aid the movement of said material by gravity, and causing the granular particles thereof to move in lines deviating proportionate to their sizes from the line of movement of the material, and separately collecting the thus sized particles and the pulverulent material.

13. In a sizing apparatus, the combination with a continuously moving transversely inclined flexible sizing surface, of means for feeding material on said surface at one end thereof adjacent its upper edge, means for exerting a resistance to said material in its movement by gravity adapted to retard the material without stopping the same in its movement by gravity, means for vibrating said supporting surface to modify said resistance, and means for collecting the sized particles.

14. An apparatus for sizing comminuted material, comprising an endless flexible deck having a supporting surface provided with resistance means arranged at an angle to the inclination thereof adapted to retard without stopping, the movement of the dry pulverulent material by gravity, means for vibrating said deck, and means for collecting the particles delivered from said deck.

15. An apparatus for sizing comminuted material, consisting of particles of different sizes, comprising an endless flexible belt having a transversely inclined roughened sizing surface for exerting a resistance to the dry material adapted to retard without stopping, the movement of the material in its movement by gravity, means for vibrating said flexible belt for modifying the resistance, and independent means for driving and vibrating said belt.

16. In a machine for sizing solid materials, a laterally inclined and longitudinally progressing separating surface, mechanism for imparting agitative movement thereto, means to feed unsized material to said surface, and means to collect the different grades of sized material discharged from said surface.

17. In a machine for sizing solid materials, means for supporting the material, comprising a laterally inclined endless belt, means to actuate the same, means to feed unsized material to the belt, means to agitate

the material on the belt and means to collect the different grades of sized material discharged from said belt.

18. In a machine for sizing solid materials, a laterally inclined and longitudinally progressing separating surface, mechanism for imparting agitative movement thereto, means to vary the lateral inclination of said surface, means to feed unsized material to said surface, and means to collect the different grades of sized material discharged from said surface.

In testimony whereof we affix our signatures in presence of two witnesses.

HENRY M. SUTTON.
WALTER L. STEELE.
EDWIN G. STEELE.

Witnesses for Henry M. Sutton and Walter L. Steele:

J. H. McElwain,
Jay S. Myers.

Witnesses for Edwin G. Steele:

J. V. Haynes,
B. E. Crafts.