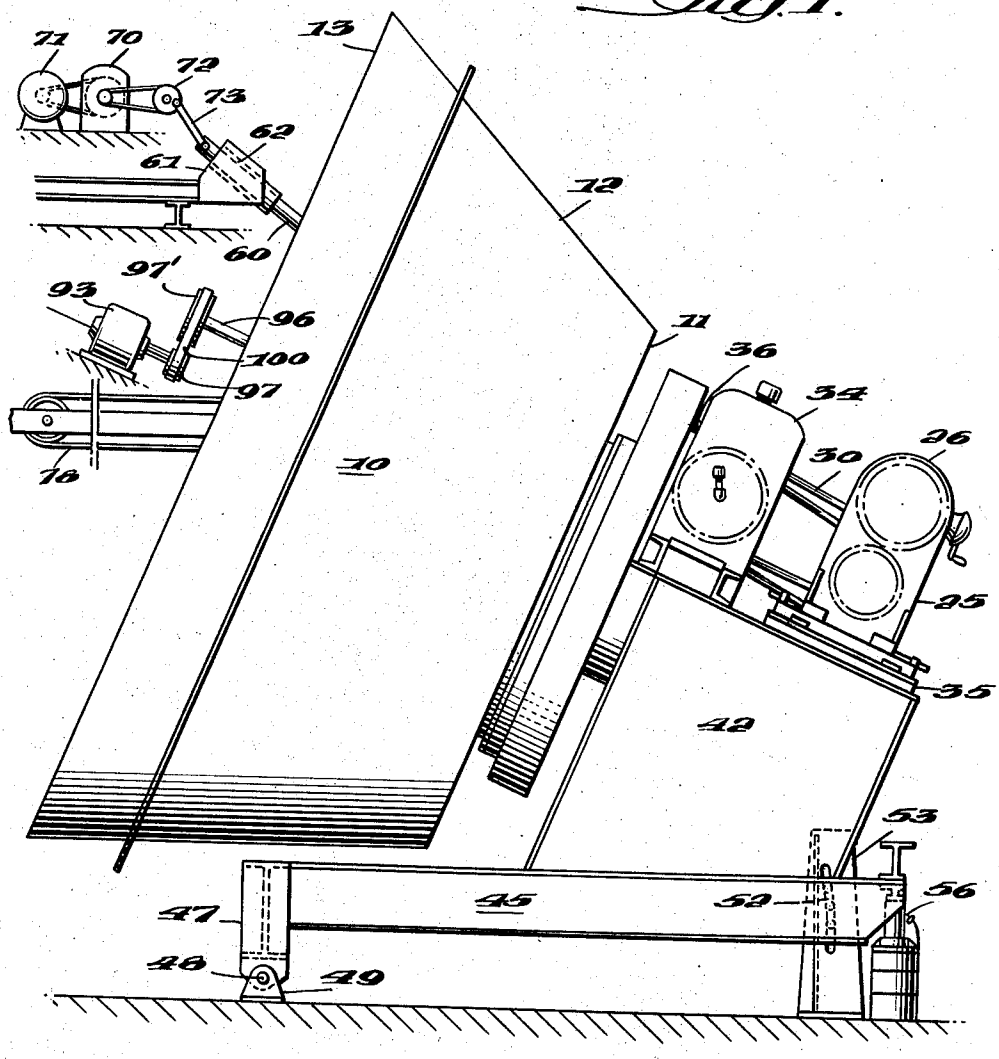
Aug. 2, 1960 F. D. DE VANEY 2,947,026

TREATING ORE CONCENTRATES

Filed March 23, 1956

5 Sheets-Sheet 1

Fig. 1.



INVENTOR

Fred D. De Vaney,

BY Pierce, Scheffler & Parker

his ATTORNEYS

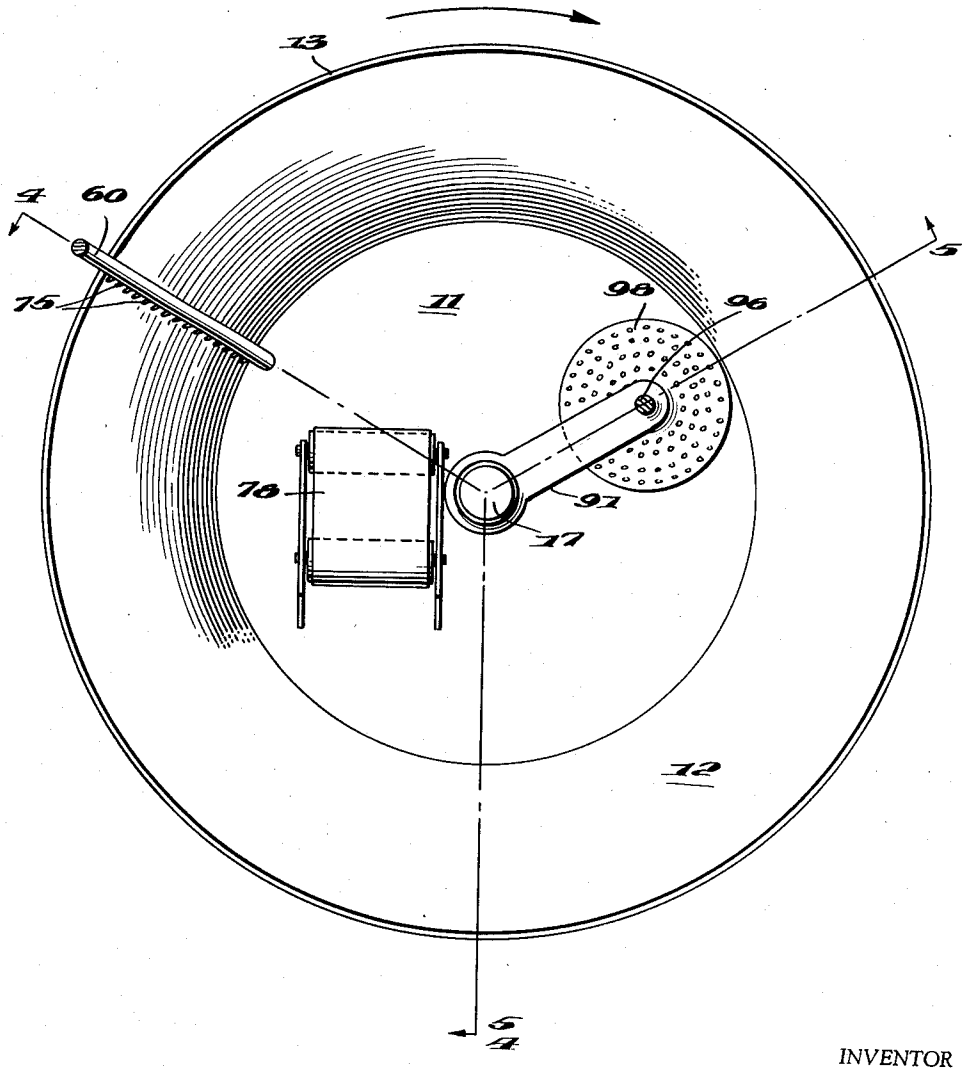
Aug. 2, 1960 F. D. DE VANEY 2,947,026

TREATING ORE CONCENTRATES

Filed March 23, 1956

5 Sheets-Sheet 2

Fig. 2.



INVENTOR
Fred D. De Vaney,

BY Pierce, Scheffler & Parker

his ATTORNEYS

Aug. 2, 1960 F. D. DE VANEY 2,947,026

TREATING ORE CONCENTRATES

Filed March 23, 1956

5 Sheets-Sheet 3

Fig. 3.

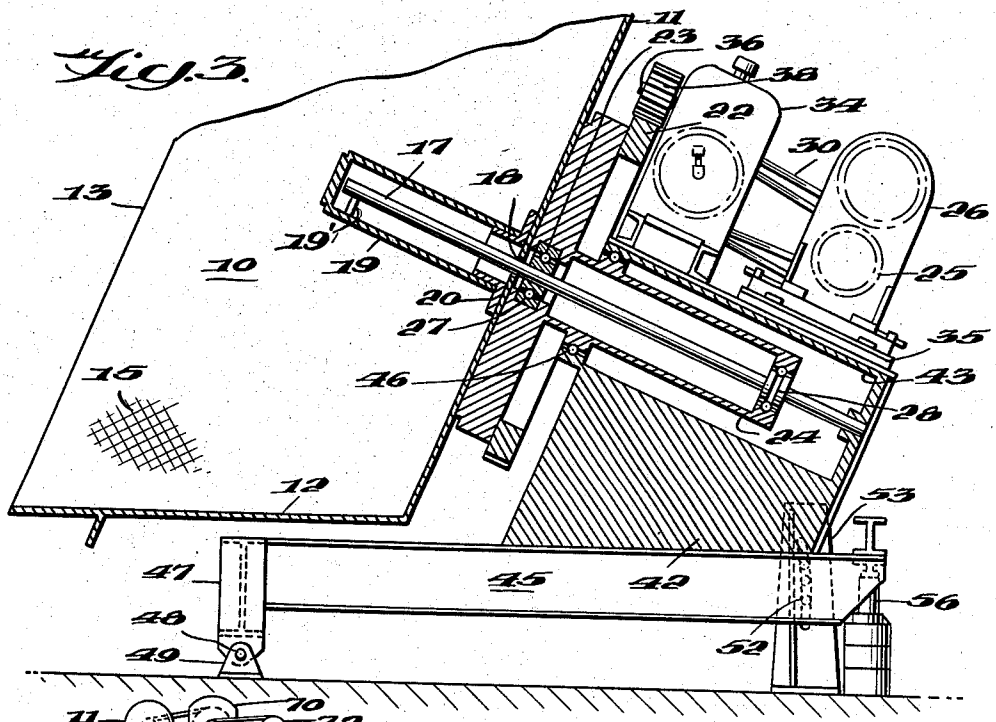
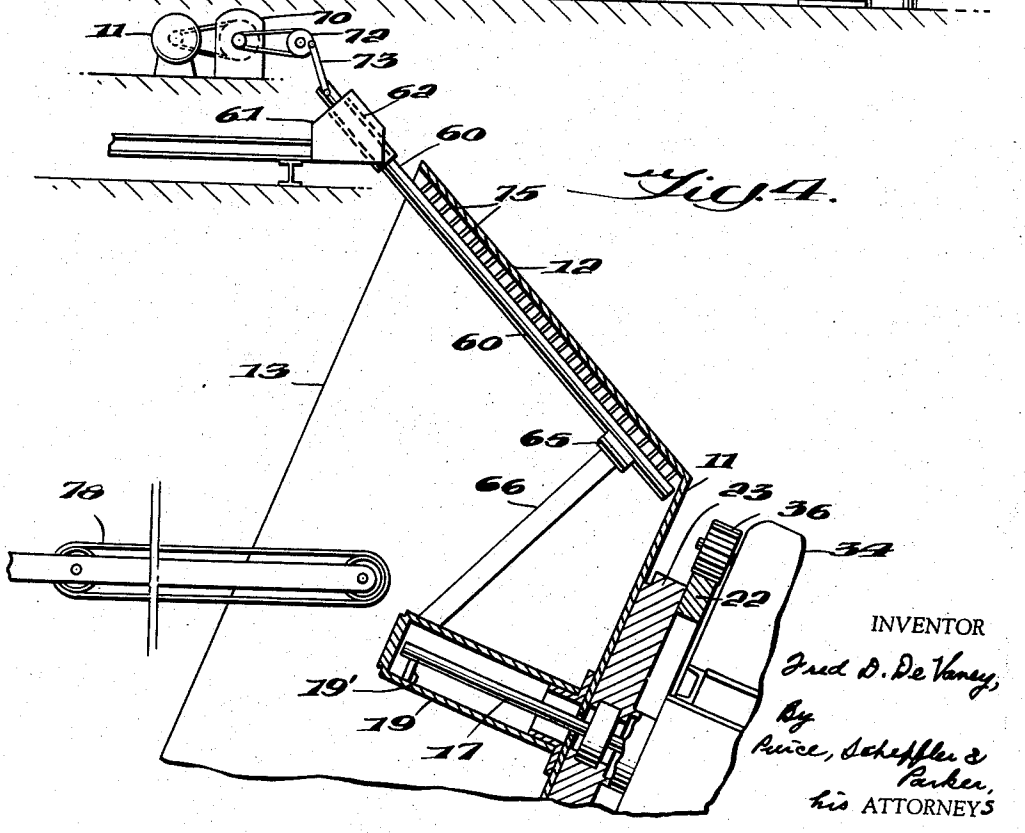


Fig. 4.



INVENTOR
Fred D. De Vaney,
By
Price, Scheffler & Parker,
his ATTORNEYS

Aug. 2, 1960 F. D. DE VANEY 2,947,026

TREATING ORE CONCENTRATES

Filed March 23, 1956 5 Sheets-Sheet 4

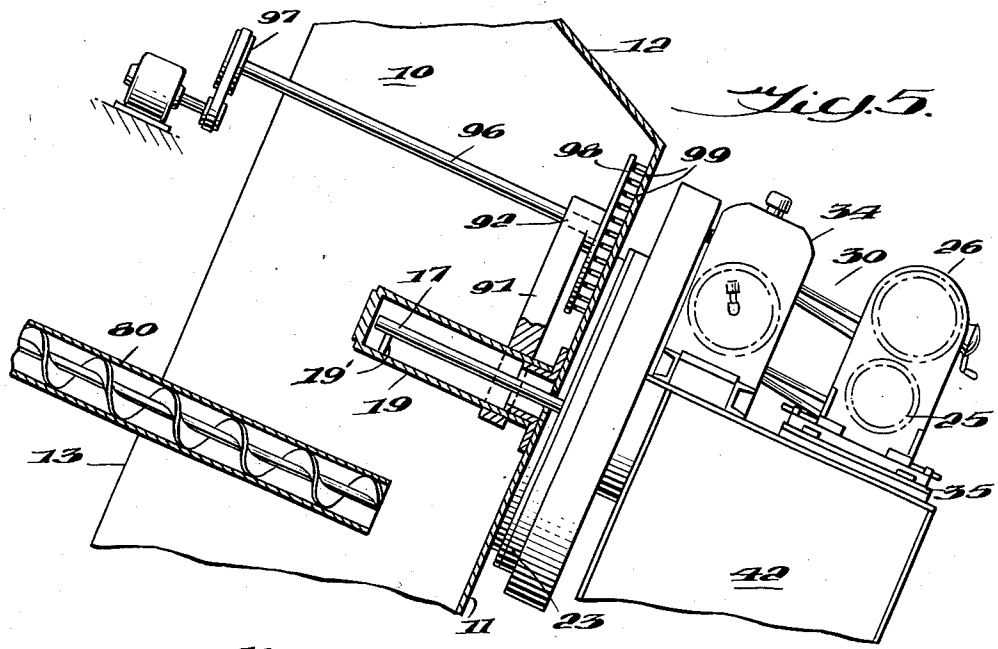


Fig. 5.

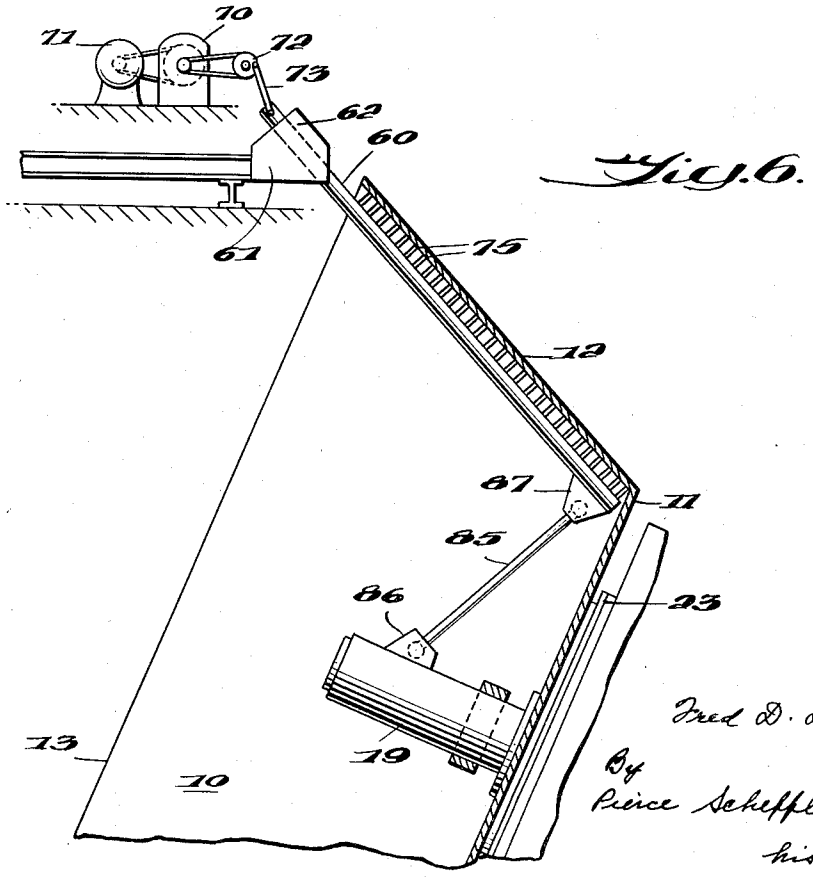


Fig. 6.

INVENTOR
Fred D. De Vaney,
By
Peirce Scheffler & Parker
his ATTORNEYS

Aug. 2, 1960 F. D. DE VANEY 2,947,026

TREATING ORE CONCENTRATES

Filed March 23, 1956 5 Sheets-Sheet 5

Fig. 7.

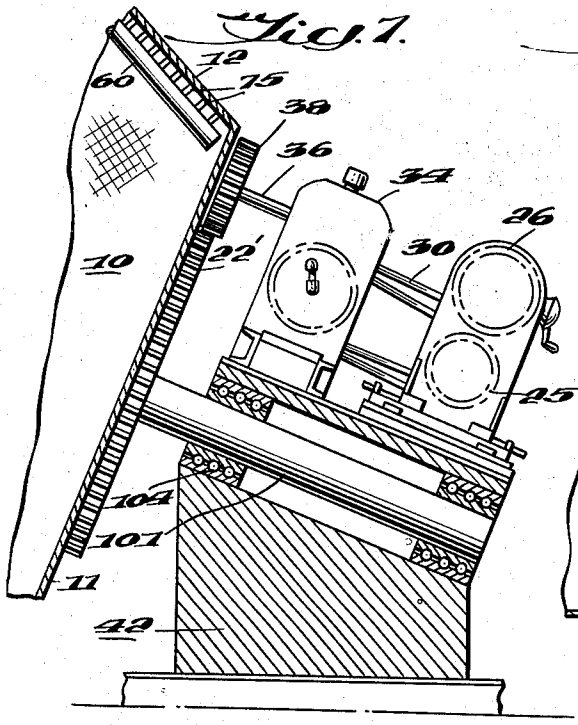
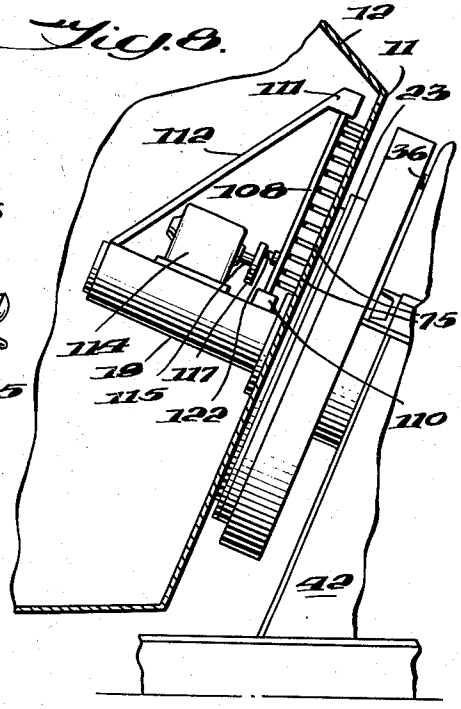


Fig. 8.



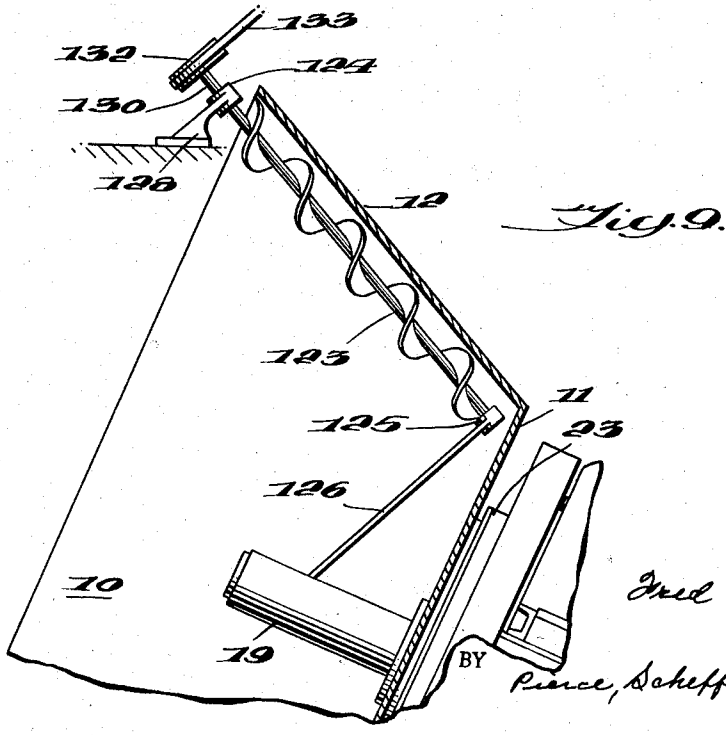


Fig. 9.

INVENTOR

Fred D. De Vaney,

BY Pierce, Scheffler & Parker

his ATTORNEYS

United States Patent Office 2,947,026
Patented Aug. 2, 1960

2,947,026

TREATING ORE CONCENTRATES

Fred D. De Vaney, Hibbing, Minn., assignor to Erie Mining Company, Hibbing, Minn., a corporation of Minnesota

Filed Mar. 23, 1956, Ser. No. 573,419

2 Claims. (Cl. 18—1)

This invention relates to the art of pelletizing moist, finely divided, mineral solids, e.g., ore fines, and is concerned with the provision of an improved pelletizing procedure and of improved pelletizing apparatus. By the expression "pelletizing" is here meant the operation of forming moist finely divided mineral solids into small balls or pellets by a rolling procedure—as distinguished from briquetting and from nodulizing. In the following specific description the present invention will be described with particular reference to pelletizing moist oxidic iron ore concentrates.

In balling moist particles of mineral solids it heretofore had been proposed to roll the same on an inclined surface, e.g., the inner peripheral surface of a revolving conically shaped vessel—called herein a "balling cone" but sometimes colloquially referred to as a "flying saucer"— and to prevent build-up of the moist particles of mineral solids on such inner peripheral surface by continuously scraping off any adhering particles therefrom. However, the clean metallic inner surface promoted sliding rather than rolling, and hence it became apparent that a rolling surface should be provided which would promote positive rolling of the material being treated.

Accordingly, the conventional method of operating balling cones is to provide a stationary scraper on the sloping sides of the cone at either the 10 or 12 o'clock position. It is also rather common to position a stationary scraper at the closed end of the cone at, say, the 12 o'clock position. These scrapers maintain a coating or adherent layer of the moist, finely divided mineral solids, said coating having a desired thickness, but tend to give the same a slick, smooth surface on which the balls tend to slide rather than roll. A still greater objection to the use of stationary scrapers is that the drum cake becomes, with continuous scraping, very hard causing excessive power consumption and chattering of the scrapers. This chattering causes the drum to roll unevenly and the balls to bounce; this latter, in turn, causes undesirable ball breakage. Chattering may become so severe as to tear the drum loose from its supporting spider and supporting bearings.

According to the present invention, the formation of the moist particles into small balls or pellets is effected on a specifically prepared rolling surface—as distinguished from a clean metal surface—by a procedure which is characterized in that moist particles of mineral solids are permitted to adhere to the inner peripheral surface of the balling cone, to the formation thereover of a compacted bed or layer thereof, and the thickness of such compacted layer is limited to a predetermined arbitrary value and simultaneously its upper (outer) surface is prepared by continuously doctoring (i.e., scraping) the same at a plurality of relatively very narrow, separate areas therealong and progressively shifting the zone of doctoring longitudinally of the balling vessel so as to effect eventual doctoring of the entire area of the compacted

layer adhering to the sloping walls of the balling cone thereby maintaining over said surface a condition of controlled roughness promoting positive rolling of the moist material thereover.

Apparatus for use in carrying out this procedure comprises, in combination with the rotatable balling cone and its supporting and driving mechanisms—which balling cone is per se old and not herein claimed as such—a doctoring means which is stationary with respect to the rotation of the balling cone and which doctors the exposed surface of the aforesaid compacted layer at a plurality of spaced apart, relatively very narrow paths extending circumferentially of said surface, said doctoring means including means for progressively shifting said paths laterally whereby to effect eventual doctoring of the entire area of the exposed surface of said compacted layer.

Preferably, said doctoring means comprises (1) a rotationally stationary, reciprocatable shaft or "cutter bar" mounted largely within, and in parallelism to the sloping side wall of, the balling cone and carrying affixed thereto an array of spaced-apart, relatively very narrow, scraping elements projecting from said cutter bar, after the manner of teeth on a comb, into engagement with the exposed surface of said compacted layer but having their free or outer ends spaced from the sloping side wall of the balling cone by a distance equal to the arbitrarily chosen thickness to which said compacted layer is to be limited, and (2) means—preferably exteriorly of the balling cone—associated with the outer end of said cutter bar and adapted to longitudinally reciprocate the cutter bar in such manner that said scraping elements scrape a plurality of spaced, relatively very narrow, paths in said surface which paths are parallel to each other and, by reason of the reciprocation of the cutter bar, are helical with respect to the compacted layer. Through continued rotation of the balling cone and continued reciprocation of the cutter bar these narrow helical paths eventually extend across the entire exposed surface of the compacted layer limiting the thickness of the latter to a predetermined value while leaving the surface in a state of controlled roughness effecting the positive rolling—rather than mere sliding—of the loose moist particles thereon.

By the expression "relatively very narrow paths" as used herein I mean paths of such slight width that nuclei of appreciable size cannot readily fall thereinto and hence slide on the rather "slick" bottom surface of the freshly scraped groove, such width being of the order of 0.25 inch.

In lieu of the above described doctoring means I can substitute a helical screw positioned with its long axis in parallelism with, and substantially coextensive with, the side wall of the conical balling vessel, together with means for rotating the screw. In this case, the outer edges of the screw are spaced from the inner surface of the side wall a distance equal to the preferred thickness of the adherent layer of moist particulate material to be allowed to remain on the side wall. Preferably, the pitch of the flights of the screw is so selected as to cause the screw—during rotation of the same on its axis—to cut or doctor a plurality of spaced apart, relatively very narrow paths in the exposed surface of said layer.

It has been found desirable also to permit an adherent layer of moist fines to build upon the inner surface of the bottom of the balling cone, and to continuously limit its thickness. Accordingly, I may and preferably do associate with the aforesaid means for doctoring the compacted layer of moist particles adhering to the sloping wall of the balling cone a second doctoring means adapted to continuously limit the thickness of a layer

of the moist particles adhering to the sloping bottom of the balling cone and to provide the aforesaid condition of controlled roughness thereon. Said second doctoring means preferably functions in the upper right hand gradient as seen from the open end of the balling cone. This latter doctoring means may be similar to either of the above discussed two alternative means for doctoring the layer adhering to the side wall of the cone.

The invention will now be described in greater particularity and with reference to the accompanying drawings, in which:

Fig. 1 is a side elevational view with certain non-essential parts removed, of one form of apparatus exemplifying the principles of this invention;

Fig. 2 is a front elevational view of the apparatus shown in Fig. 1, showing relative disposition of doctoring means and of feeding means;

Fig. 3 is a diagrammatic side sectional view, with part of the balling cone cut away, showing details of the means for supporting the balling cone in inclined position and for rotating the same;

Fig. 4 is a fragmentary side sectional view, on line 4—4 of Fig. 2, with bearing means and driving means omitted, showing details of an operable form of reciprocatory cutter bar in combination with a balling cone;

Fig. 5 is a fragmentary side sectional view, on line 5—5 of Fig. 2, with bearing means and driving means and reciprocatory cutter bar omitted, showing details of an operable form of means for doctoring a layer of material adhering to the closed end of the balling cone;

Fig. 6 is a fragmentary sectional view similar to Fig. 4, but showing alternative means for supporting the inner end of a reciprocatory cutter bar;

Fig. 7 is a diagrammatic view of a modified form of the apparatus according to the present invention;

Fig. 8 is a fragmentary side sectional view, generally similar to Fig. 5, showing an alternative form of means for operating a rotary doctor for the bottom of the balling cone; and

Fig. 9 is a fragmentary side sectional view, generally similar to Fig. 4, showing an alternative means for doctoring a layer of moist material adhering to the side wall of the balling cone.

In Figs. 1 and 3, the balling cone per se is represented at **10** as being an inclined vessel in the form of a truncated cone, comprising a sloping bottom member **11** and a conical side wall **12**, and having an open mouth **13**. In one actual embodiment the included angle of the conical side wall was about 48°, the diameter of the mouth was approximately 14 feet, the horizontal length of side of the cone was approximately 6 feet and the diameter of the closed end of the cone was approximately 9 feet. In this actual embodiment the inner surface of the conical side wall was covered with expanded metal "lath," as indicated at **15**, spot-welded to the side wall. The purpose of this expanded metal was to provide a medium for the building up and the retention of a compacted layer of moist particles lining the inner surface of the side wall of the device.

A capped sleeve member **19**, of larger internal diameter than the diameter of supporting shaft **17**, is disposed concentrically about that part of supporting shaft **17** which extends within cone **10** and is secured to said shaft as by pin **19'** and hence is stationary.

To the outer side of bottom member **11** there is affixed (as by welding, bolting or the like) the enlarged annular band end **23** of a spider member **23, 24**, the elongated sleeve-like extension **24** of which surrounds, is concentric with, and spaced from, that part of stationary supporting shaft **17** which is disposed outside of balling cone **10**.

A bull gear **22** is secured to the annular band end **23** of the spider member, with its axis concentric with the axis of shaft **17**. The spider member is rotatable about stationary supporting shaft **17** by means of a first bearing member **27** interposed between the shaft and the annular band end **23** and by means of a second bearing member **28** interposed between the shaft and the sleeve-like extension of the spider member.

Power for rotating balling cone **10** is provided by an electric motor **26** feeding into a variable speed transmission **25** the output of which can be continuously varied over a range of from about 1170 to about 585 r.p.m.

The output of the variable speed transmission device is connected by suitable belt drive **30** to the input side of a cone gear (speed reduction) unit generally represented at **34**. The motor-transmission unit may, as is indicated at **35** in Fig. 1, be slidably mounted for adjustment of the distance between the same and speed reduction unit **34**. To the outer end of output shaft **36** of said speed reduction unit there is keyed a pinion gear **38** which meshes with bull gear **22**.

The relative sizes of the gears and the capacity of the speed reduction unit are so selected that the balling cone can be rotated at any desired speed within the range 15–5 r.p.m. Preferably, the rotational speed is adjusted to give a rim travel (at mouth **13**) of from about 460 feet to about 220 feet per minute.

Stationary supporting shaft **17** is mounted on a box girder support member **42** which is secured to a girder framework **45**. The spider member is rotatably mounted, intermediate its ends, on box girder support member **42** by means of a third bearing member **46** interposed between the latter and said extension **24**, on the one hand, and, on the other hand, between said extension **24** and a bridging support member **43** which is mounted on member **42** and in turn supports the above described drive mechanism.

At its front end (beneath balling cone **10**), framework **45** is provided with two downwardly disposed supporting legs **47, 47'** which, adjacent their lower ends, are pivoted as at points **48, 48'** to pivot members **49, 49'**. At its rear end, framework **45** is adjustably secured, as at securing means **52, 52'**, to fixed support plates **53, 53'**. As shown in Fig. 1, framework **45** is so disposed that the side wall of the balling cone at its lowermost flight is horizontal, at which disposition the angle of inclination of shaft **17** and of the axis of balling cone **10** is approximately 24° from the horizontal. However, the framework **45** can be given an inclined disposition by suitably pivoting the same, at pivot points **48, 48'**, by means of a suitable jack **56**, so as to giv a limited range of inclination thereto and hence to balling cone **10**. In this actual installation, the range of variation was 28–20° from horizontal.

The construction above described is, in general, old and for that reason no further detailed description thereof is necessary.

As shown in Fig. 4, the thickness of the compacted layer of moist particles adhering to wall **12** of the balling cone is continuously limited by the doctoring means about to be described. In this embodiment, a cutter bar shaft **60** is disposed mainly within balling cone **10**, and adjacent its outer end is supported by a horizontally adjustable, inclined support member **61** and slidable within bushing **62** mounted in support member **61**. At its inner end, shaft **60** is slidably supported, parallel to side wall **12** of the balling cone, on yoke member **65** adjustably secured to the outer end of arm **66** radially extending from stationary shaft **17**. At its outer end, shaft **60** is provided with a suitable mechanism for reciprocating it in bushing **62** and upon yoke member **65**, said reciprocating mechanism comprising a speed reducer **70**, belt driven by an electric motor **71**, and in turn driving an eccentric device **72** whose linking member **73** is attached to the end of, and functions to reciprocate, shaft **60**. As will be well understood, the length of reciprocatory stroke may be adjusted by radially varying the location of the pin of linking member **73**; in the

actual installation being described shaft **60** was given a stroke of slightly in excess of 4 inches. The rate of reciprocation was made 1 minute (for a complete stroke) but this rate could be modified, as desired, by suitable adjustment of the speed reducer **70**.

A plurality of individual scraper members **75, 75** are secured to the shaft **60** so as to project toward wall **12**, their outer ends being spaced from the latter by an interval corresponding to the desired thickness of the compacted layer of moist particles. Scraper members **75, 75** may be and preferably are spaced about 4 inches apart along that portion of shaft **60** which lies within cone **10**. Each scraper member presents a chisel-like scraping end having a scraping width of about 0.25 inch.

The interval between the outer ends of scraper members **75, 75** and wall **12**—and hence the thickness of the layer permitted to adhere to wall **12**—may be modified by suitable horizontal adjustment of support member **61** and suitable radial adjustment of yoke member **65** on arm **66**. Preferably a layer thickness of about three-fourths of an inch to one inch is maintained.

Any appropriate means for introducing loose moist particles into balling cone **10** may be employed, e.g., an endless belt conveyor **78**. A screw conveyor type of feeding device, as indicated at **80** (Fig. 5) might be substituted for endless belt conveyor **78**.

In this embodiment of the invention, shaft **60** preferably is disposed in the upper left quadrant. That is to say, viewed from the front the balling cone is revolved in clockwise fashion and shaft **60** is disposed in the 9–12 o'clock quadrant—more particularly at the 10 o'clock position, in order to assure that removed material shall fall onto the material being carried (by rotation) part-way up the "rising" side of the cone and then rolling back on itself.

In use of the apparatus above described, balling cone **10** is caused to rotate at about 7.5 r.p.m. (i.e., a rim speed of about 335 feet per minute), and the loose moist particles to be pelletized are fed into the cone at the rate of approximately 1000 pounds per minute. Assuming that a layer of desired thickness previously had been built up over the inner surface of wall **12**, the freshly introduced loose moist particles for the most part roll upon the surface of said layer; a small fractional part of the fresh feed tends to adhere to said layer and hence to increase the thickness of the latter. Such freshly adhering material, by rotation of the balling cone, is brought into contact with scraper members **75, 75**, and the latter scrape a plurality of parallel, relatively very narrow (0.25 inch) grooves, spaced 4 inches apart, therein down to the desired permanent thickness of said layer. With continuous, relatively slow, reciprocation of the cutter bar, the grooves "cut" by scraper members **75, 75**, are made helical and overlap each other whereby in the course of each complete reciprocation substantially the entire exposed surface of said layer has been "doctored" to predetermined extent. The resulting doctored surface is desirably rough thereby insuring against slippage between loose particles and layer. Continued rolling of the particles results in the formation of initially tiny nuclei which nuclei gradually "grow"—by adherence of particles thereto—into small balls or pellets. The "growth" is gradual, since constant rubbing between adjacent nuclei effects constant attrition as well as adherence of particles to nuclei and compaction of the particles constituting such nuclei. Such gradual growth promotes the formation of dense, mechanically "rugged" pellets, which characteristics are generally critically required from the standpoint of further handling and processing of the pelletized product.

As the pellets accumulate they spill over the rim of mouth **13** and onto a conveyor (not shown) by which they are transported to a point of further processing or use.

In the embodiment so far described, no provision is made for doctoring the surface of a layer of moist particles which may adhere to the sloping surface of bottom member **11**. While it appears to be the fact that doctoring of this latter surface is somewhat less critical—to acceptable operation of the balling cone—than is doctoring the layer on side wall **12**, a definite improvement in performance may be realized by providing means for limiting the thickness of such bottom layer. This may be effected by the use of a rotatable bottom-doctoring device—about to be described—or, in lieu thereof, by the use of a fixed doctor blade secured to that side of arm **66** which is adjacent bottom member **11**, the scraping edge of such fixed doctor blade being spaced from bottom member **11** by an interval equal to the thickness of build-up desired (or tolerable). It is to be understood that such doctor blade functions less desirably than, and preferably is substituted by, a preferred doctoring means now to be described.

A supporting arm **91** is mounted on stationary sleeve **19** and projects therefrom into the upper right quadrant—preferably in the 2 o'clock position. At that end thereof which is remote from sleeve **19** arm **91** is provided with a bushing. Exteriorly of the balling cone there is provided an inclined support member **94** for a bushing **95**. A shaft **96**, passing through bushings **95** and **92**, extends from without the balling cone into the latter, in a direction transverse to the plane of bottom member **11**, and supports on its inner end a rotary cutter disk **98**, which is parallel to and spaced from bottom member **11**. A drive pulley **97** is fixed to the outer end of shaft **96**, for rotation of the shaft and said disk by any suitable means such as a belt drive (not shown). On that face of disk **98** which is opposed to bottom member **11** there are fixed a plurality of relatively very narrow scraping elements **99, 99**, the free ends of which latter being spaced from bottom member **11** a predetermined short distance, of the order of 1 inch. Scraping elements **99, 99** are disposed in "random" array over the face of disk **98** in such manner that upon rotation of the disk said scraping elements will scrape circular paths which overlap each other to affect substantially all of the space coextensive with the area of the disc. Preferably disc **98** is rotated at a speed within the range 5 to 100 r.p.m. Simultaneous rotation of the balling drum brings substantially all of the area of bottom member **11** into the zone of influence of scraping elements **99, 99**.

In the modification shown in Fig. 6, the "inner" end of cutter bar shaft **60** is supported by a supporting rod or "reed" **85** which is secured at one end thereof to stationary sleeve **19** by means of a resilient, rubber, anchoring socket **86**: at its other end, supporting rod **85** terminates in a resilient, rubber, bearing socket **87** upon which cutter bar shaft **60** is yieldingly supported. These rubber connections, which provide firm support for shaft **60** while permitting reciprocatory motion of the latter, tend to reduce vibration of shaft **60**.

The apparatus shown in Figs. 1 to 6 can be modified as indicated in Fig. 7. According to this latter embodiment, the bottom member **11** of the balling cone is imperforate, and shaft **17** (of Figs. 1–6) is substituted by an inclined rotatable supporting shaft **101** which is fixed at its upper end to bottom member **11** and which is maintained in inclined attitude in suitable bearings **104, 105**, in box girder support member **42** (Fig. 7). A bull gear **22'** is secured to the bottom member **11**, concentric with the latter, for rotation by means of the pinion gear **38**. In this circumstance, the "inner" end of shaft **60** is not directly supported, said shaft being cantilevered from outside the balling cone at bushed support **61**, said support and its bushing **62** being made sufficiently elongated to support shaft **60** and to maintain same in desired position. Similarly, the shaft **96** can be supported in desired position simply by bushed support **94**, the same, and its bushing **95**, being suitably elongated for this purpose.

In this embodiment of the invention, as in the em-

bodiment shown in Figs. 1–6, the balling cone **10** preferably is so disposed that its axis is inclined from the horizon at an angle equal to, or a few (2 or 3) degrees greater, or less than, one-half the included angle of the conical side wall **12**, so as to insure the retention of a suitable "bed" of the particulate material—and nuclei—within the balling cone long enough to permit the "growth" of nuclei into balls of the optimum size.

In the modification shown in Fig. 8, the hereinbefore described rotating cutter disc is substituted by a reciprocatory cutter bar **108** and associated mechanism as follows:

Cutter bar **108** is slidably supported, parallel to and spaced from, the inner surface of bottom member **11**, adjacent either end thereof, by means of sliding supporting bearings **110** and **111**. Of these latter, bearing **110** is mounted on stationary sleeve **19**, while bearing **111** is mounted at the upper end of an inclined supporting shaft **112** whose lower end is mounted on sleeve **19**. An electric motor **114** likewise is mounted on sleeve **19**, and to its output shaft **115** there is secured a disc **117** having an eccentric groove **118** in that face thereof which is opposite bottom member **11**. A pin **120**, attached to cutter bar **108**, extends into eccentric groove **118** and, upon rotation of said disc, follows said eccentric groove imparting reciprocatory motion to cutter bar **108**.

In lieu of the reciprocatory cutter bar, previously described, for doctoring a layer of adhering material on the inner surface of side wall **12**, there may be substituted a rotating helical screw, as illustrated in Fig. 9. In this embodiment, a helical screw **123** is disposed largely within balling cone **10** with its major axis parallel to side wall **12** and disposed substantially in the 10 o'clock position, being supported by an outer bearing **124** and an inner bearing **125**. Bearing **125** is mounted at one end of a supporting shaft **126** whose other end is fixed to sleeve **19**. The outer bearing **124** is mounted on a suitable external support member **128**. Bearings **124** and **125** are so disposed that the outer edge of helical screw **123** is spaced from wall **12** by a distance—of the order of 0.75–1.0 inch—equal to the desired thickness of the layer of material to be permitted to remain adhering to wall **12**. At its outer end, helical screw **123** terminates in a shaft **130** to which is affixed a drive pulley **132** adapted to be rotated by a drive belt **133** imparting rotary motion from a source not shown.

Upon rotation of the balling cone **10** and of helical screw **123** the surface of built-up layer of material adhering to wall **12** is progressively, continuously "doctored" to the predetermined thickness while retaining a condition of controlled roughness over the surface so doctored.

I claim:

1. Apparatus for forming moist finely divided loose mineral solid particles such as ore fines into balls, said apparatus comprising an inclined hollow conically shaped vessel provided with a bottom member having a centrally located aperture, said vessel having, during use, at least the greater part of the inner surface of its conical side wall lined with a compacted layer of the moist particles constituting a rolling surface for the loose moist particles, inclined stationary supporting shaft means projecting through said aperture and into said vessel, means for feeding loose moist particles to the interior of the vessel, means for rotating the vessel about said supporting shaft means, doctoring means for continuously limiting the thickness of said compacted layer and simultaneously providing on the latter a rolling surface of controlled roughness, said doctoring means being stationary with respect to the rotation of said vessel, said doctoring means comprising a reciprocatable elongated member extending within said vessel for a distance substantially equal to the height of said side wall and provided along that part thereof which extends within said vessel with a plurality of spaced scraping members fixed to and extending radially in a row from said elongated member, the free ends of said scraping members being spaced from said side wall and presenting relatively narrow scraping edges, means exteriorly of said vessel for supporting said elongated member in a position parallel to said side wall, a supporting member interiorly of said vessel and bearing on said shaft means for slidably supporting the inner end of said elongated member, and means exteriorly of said vessel for imparting reciprocatory motion to said elongated member longitudinally thereof the stroke of such reciprocatory motion being at least equal to the space between adjacent scraping members.

2. Apparatus for forming moist finely divided loose mineral solid particles such as ore fines into balls, said apparatus comprising an inclined hollow conically shaped vessel in the form of a right frustrum of a cone the smaller end of which is closed by a generally plane bottom member having, during use, at least the greater part of the inner surface of its conical side wall and of its bottom member lined with a compacted layer of moist particles constituting a rolling surface for the loose moist particles, means for feeding loose moist particles to the interior of the vessel, means for rotating the vessel about its inclined axis, first doctoring means for continuously limiting the thickness of the compacted layer on the bottom wall of said vessel comprising a rotatable disc disposed with one face substantially parallel to said bottom member and provided over said face with a plurality of spaced relatively narrow scraping elements the free ends of which are equally spaced from said bottom member, means for rotating said disc, and second doctoring means for continuously limiting the thickness of the compacted layer on the side wall of said vessel comprising an elongated member extending within said vessel for a distance substantially equal to the height of said side wall and parallel thereto, said elongated member being coplanar with the axis of rotation of said vessel, fixed bearing means exteriorly of said vessel for slidably supporting said elongated member, said elongated member having a plurality of spaced scraping members extending radially in a row therefrom, the free ends of said scraping members being equally spaced from said side wall and presenting relatively narrow scraping edges, and means exteriorly of said vessel for reciprocating said elongated member in said bearings independently of the rotation of said first doctoring means, the stroke of reciprocation of said elongated member being at least equal to the space between adjacent scraping members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,357,941	Eirich et al.	Sept. 12, 1944
2,422,989	Skoog	June 24, 1947
2,709,833	Wiklund	June 7, 1955
2,728,940	Yessberger	Jan. 3, 1956

FOREIGN PATENTS

181,807	Australia	Sept. 15, 1954