E. NEWTON.

APPARATUS FOR SEPARATING MAGNETIC MATERIAL.

APPLICATION FILED JULY 20, 1916.

1,340,457. **Patented May 18, 1920.**

5 SHEETS—SHEET 1.

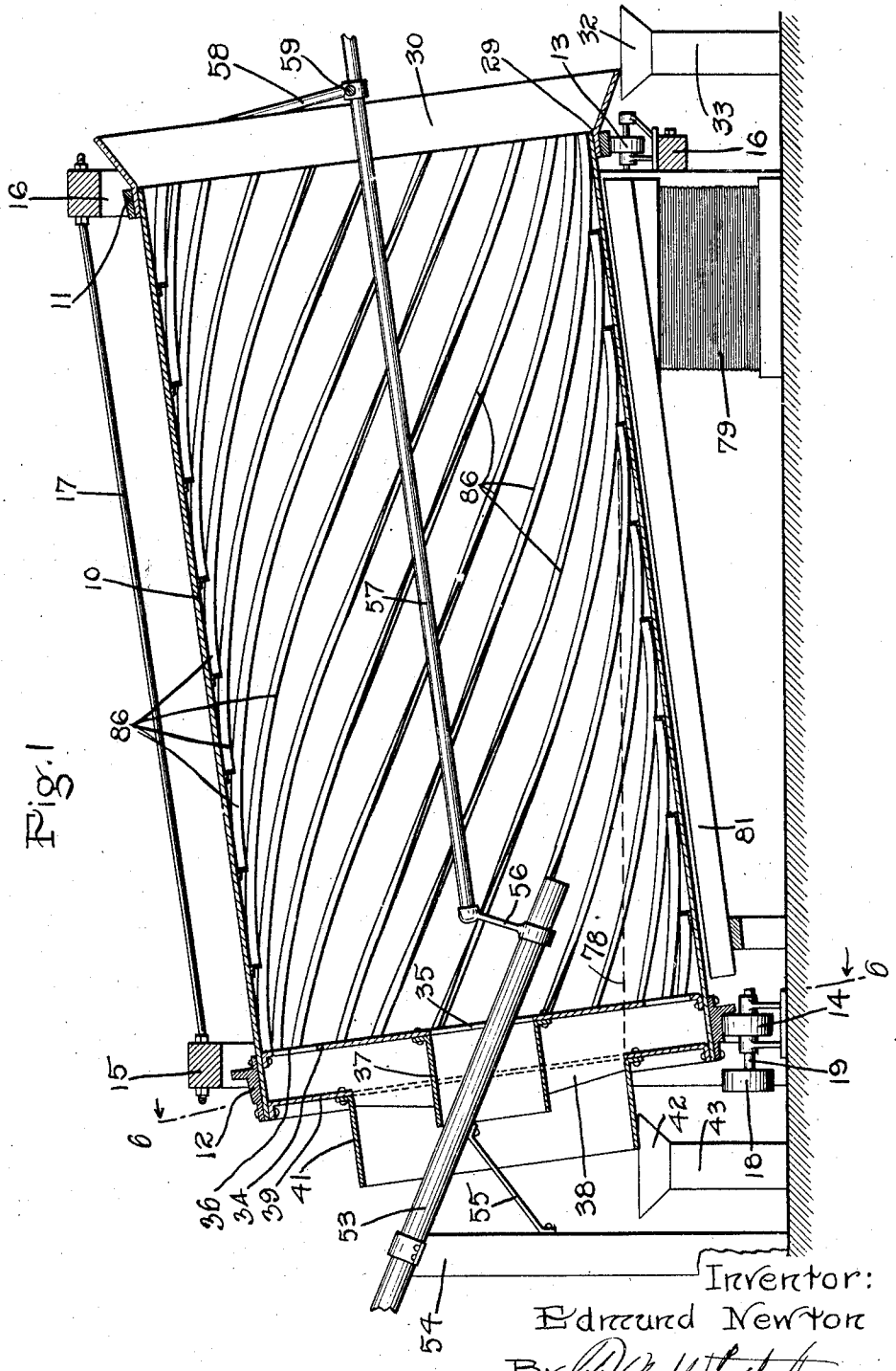


Fig. 1.

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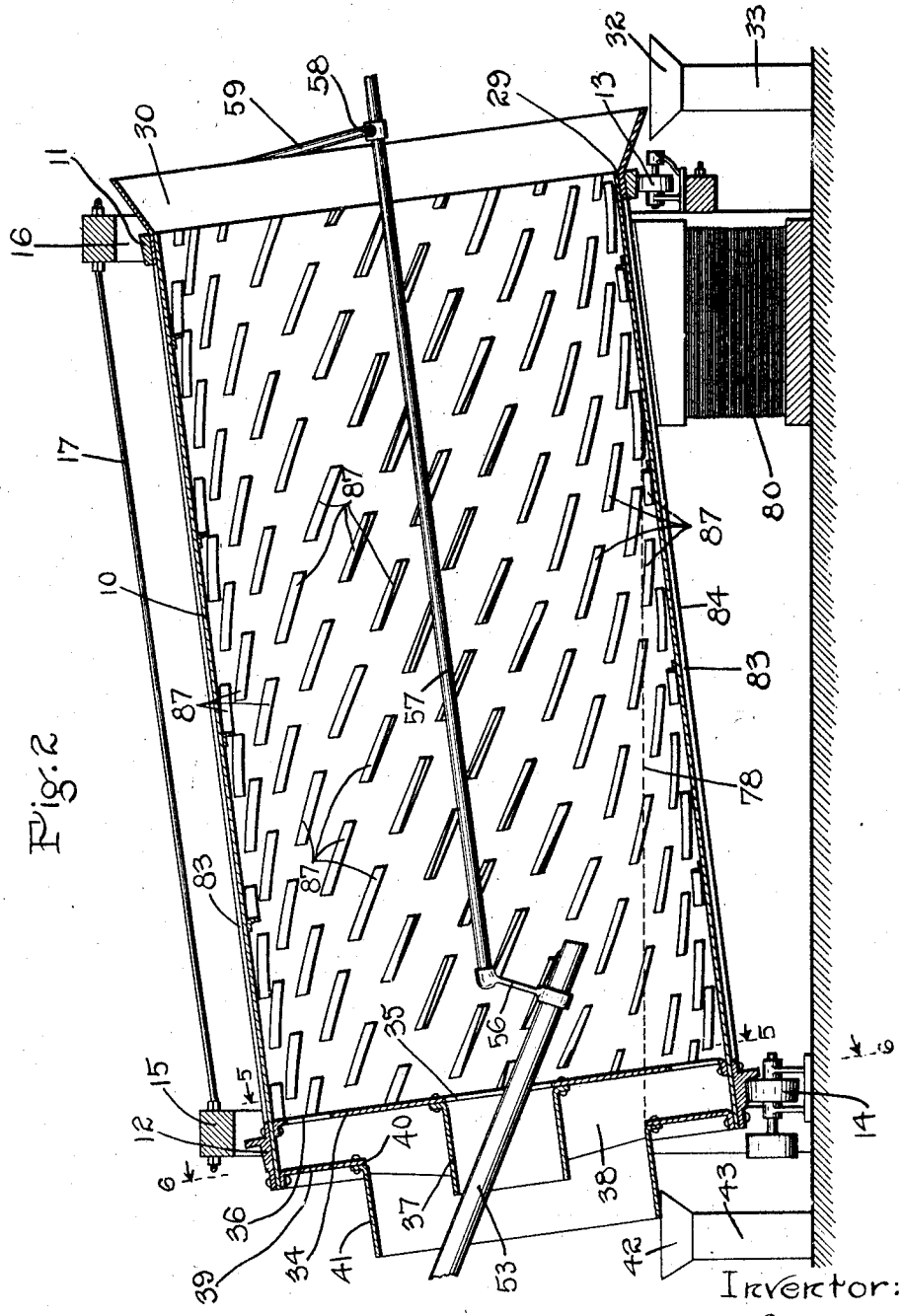


Fig. 2.

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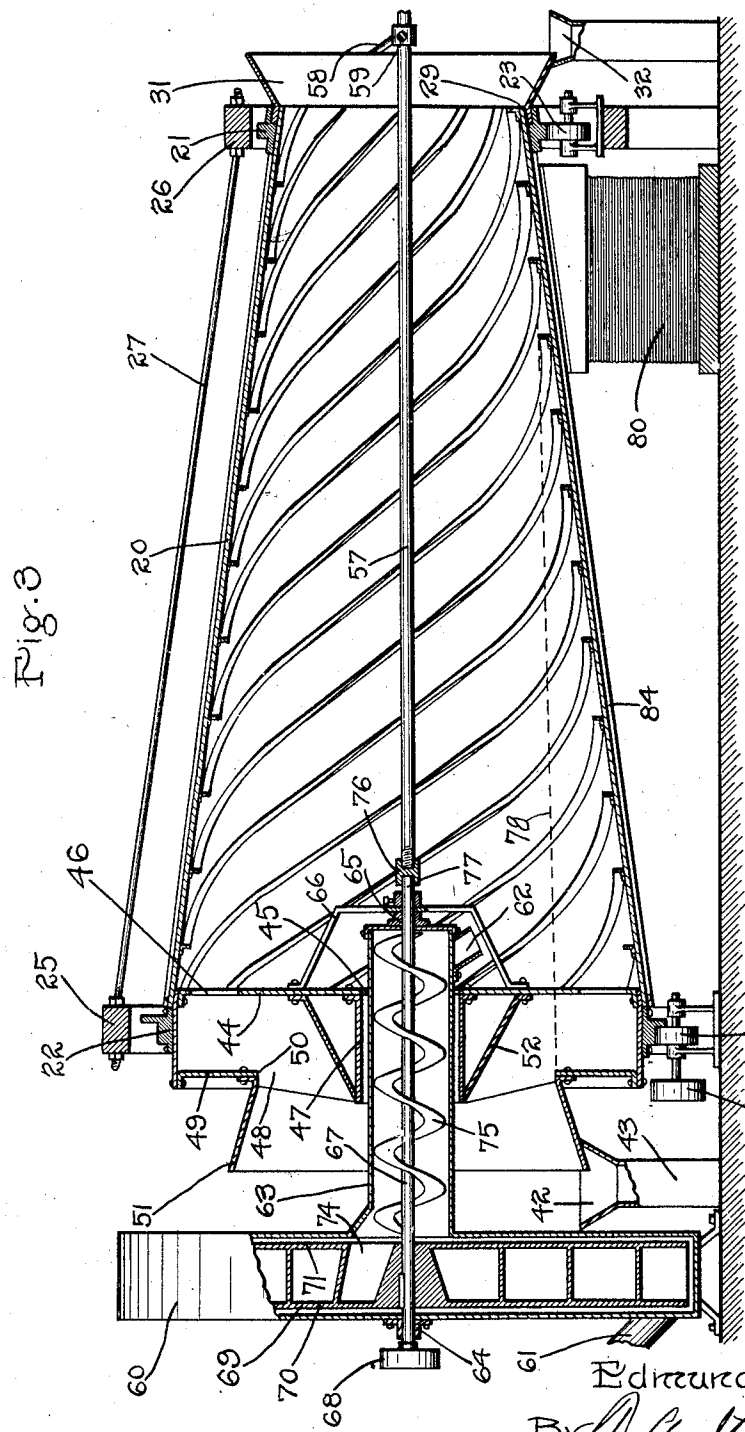


Fig. 3

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5 SHEETS—SHEET 4.

Fig. 5

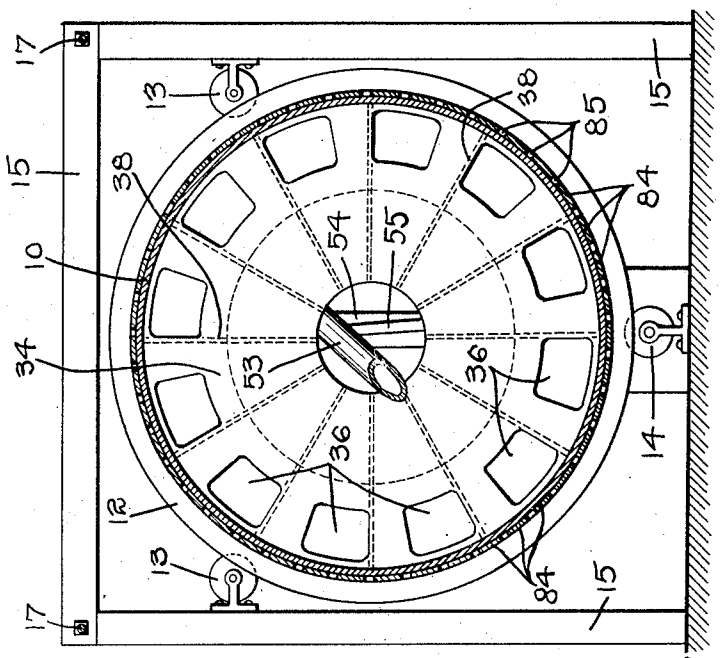
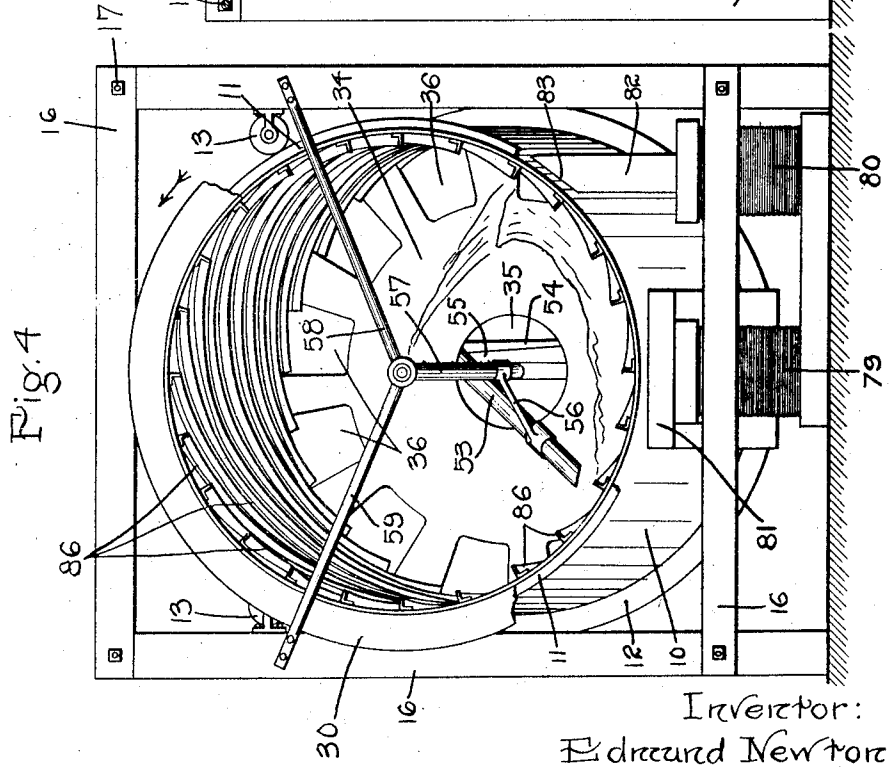


Fig. 4



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5 SHEETS—SHEET 5.

Fig. 6

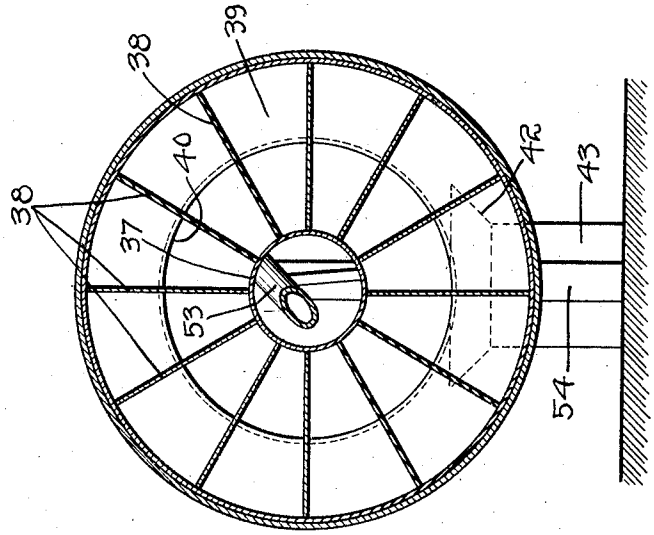
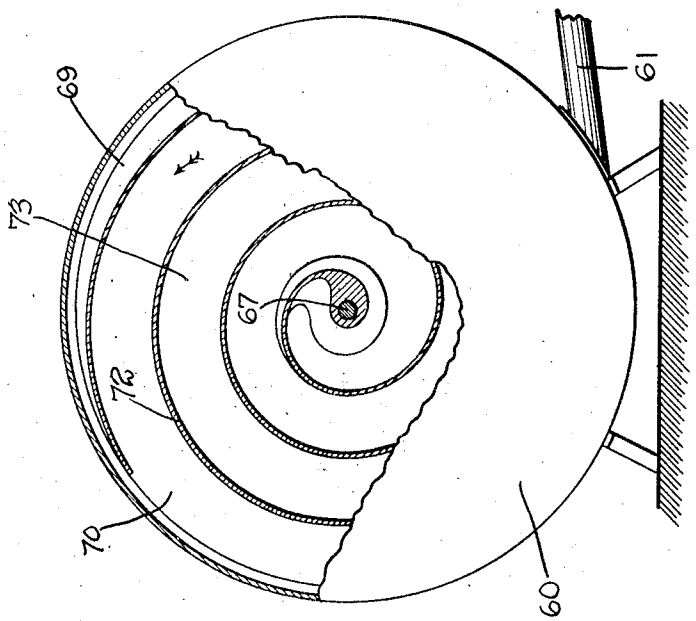


Fig. 7



Inventor:
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UNITED STATES PATENT OFFICE.

EDMUND NEWTON, OF MINNEAPOLIS, MINNESOTA.

APPARATUS FOR SEPARATING MAGNETIC MATERIAL.

1,340,457. Specification of Letters Patent. Patented May 18, 1920.

Application filed July 20, 1916. Serial No. 110,314.

To all whom it may concern:

Be it known that I, EDMUND NEWTON, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Apparatus for Separating Magnetic Material, of which the following is a specification.

My invention relates to apparatus for separating magnetic material from a gangue of non-magnetic material, and has for its object to provide a device embodying a rotating member into which the gangue is fed and also into which water may be fed, said rotating member being a receptacle for holding a mixture of pulverized ore and water. Magnetic means are provided tending to hold the magnetic particles at the bottom of the rotating receptacle and means are formed upon and movable with the receptacle for causing said magnetic material to move toward one end of the receptacle in opposition to the direction of movement under gravity of the water and gangue, the magnetic material discharging at one end of the receptacle and the water and gangue at the opposite end.

It is the object of my invention to provide simplified and efficient means for effecting the above indicated results, together with improved means for controlling the feed of the crushed material containing magnetic matter, the watering of the mixture in the receptacle and the discharge of the magnetic matter at one end and the gangue at the other end.

The full objects and advantages of my invention will appear in connection with the detailed description thereof, and are particularly pointed out in the claims.

In the drawings illustrating an application of my invention in one form,—

Figure 1 is a sectional elevation of one form of apparatus of carrying out my invention. Fig. 2 is a view similar to Fig. 1 of a modified form of the invention. Fig. 3 is a view similar to Fig. 1 of another form of the invention, showing a special form of feeding means which may be employed. Fig. 4 is an end elevation of the parts shown in Fig. 1. Fig. 5 is an elevational sectional view taken on line 5—5 of Fig. 2. Fig. 6 is a sectional elevation on line 6—6 of Figs. 1 and 2. Fig. 7 is an end partly sectional view of the feeding mechanism as shown in Fig. 3.

As illustrated in Figs. 1 and 2 a cylindrical receptacle 10 is provided with rings 11 and 12 by which it is supported and guided by a multiplicity of rollers 13 and a friction drive roller 14 all journaled upon a frame work comprising a rectangular front frame portion 15 and a rear frame portion 16 which are connected together by tie-rods 17. The friction roller 14 is driven from any desired source of power by a pulley 18 fast on a shaft 19 of said roller. It is obvious, in place of the friction drive above described, a gear pinion drive or other form of drive mechanism may be substituted. The form of the invention shown in Fig. 3 similarly comprises a receptacle 20 which is in the form of the frustum of a cone instead of cylindrical, and it is provided with rings 21, 22 supported by rollers 23 and 24 on frame members 25, 26 held together by tie-rods 27, the roller 24 being a friction member driven by pulley 28.

The cylindrical receptacles of Figs. 1 and 2 are supported upon rollers 13 and 14 with the axis of the cylinder obliquely disposed, whereas the conical receptacle 3 is supported with its axis horizontal. In each case, this results in positioning the lower wall of the receptacle so that it extends obliquely, rising from its lowest point adjacent the front end thereof to the high point 29 where the cylindrical member runs into a flaring flanged construction 30 and the conical member into a similarly flaring construction 31. In each case the edge of the flange 30 or 31 extends over a hopper 32 of elongated shape, which hopper is connected with a discharge chute 33 by which the separated magnetic material may be conveyed to any desired point. It is to be noted that the rear end of either cylinder 10 or cone 20 is entirely open throughout its whole circumference, being bounded by and adapted to discharge across the flaring flanged member 30 or 31.

Referring to Figs. 1, 2, 4, and 5, near the front end of cylinder 10 is positioned a partition or diaphragm 34 having formed therein a central circular aperture 35 and a multiplicity of apertures 36 positioned adjacent the outer periphery of disk 34. Surrounding aperture 35 is a cylindrical extension member 37 from which extend radially a multiplicity of partitions 38. The partitions 38 extend to the periphery of cylinder 10 and are covered at the front end of

said drum by a second disk 39 having therein a circular aperture 40 concentric in respect to aperture 35. A cylindrical extension 41 is carried from disk 39 surrounding aperture 40 and concentric with respect to extension 37. It will thus be apparent, and having reference to Fig. 5, that the apertures 36 each discharge into a separate chamber bounded by radial partitions 38 and plate 39, and that said chambers all discharge through separate openings between said radial partitions into the cylindrical extension 41, which extension overlies hopper 42 of elongated form, as shown in dotted lines in Fig. 6 (said hopper being similar in character to hopper 32), and which hopper discharges through a spout 43 to any desired point. The apertures 36, as clearly shown in Fig. 5, are preferably of a width less than the distance between the two partitions 38, and are placed adjacent that partition which is on the side toward the direction of movement of the cylinder, thus leaving a shovel-like portion adjacent the other partition 38 and between disks 34 and 39 which is adapted to receive and lift material where the same may slide, under the influence of gravity, off of partitions 38 and tubular extension 37 and through tubular extension 41 to hopper 42.

The corresponding construction shown in Fig. 3 applied to the conical receptacle is in the main similar to that heretofore described for the cylindrical members. A diaphragm or partition 44 is provided with a central circular aperture 45 and side apertures 46, a tubular extension 47 surrounding aperture 45 and partitions 48 extending radially from said extension 47 and between diaphragm 44 and a partition 49 having a central circular opening 50, all similar in position and operation to corresponding parts described in reference to cylinder 10. An extension member 51 surrounds the aperture 50 in plate 49 and is in the form of the frustum of a cone flaring outwardly from said aperture; and a separate conical member 52 is applied between extension 47 and plate 44 to give an inclined surface for the discharge of material into the extension 51 which overlies hopper 42 and discharge chute 43. In all other respects the discharge mechanism shown for the conical form of the invention of Fig. 3 is identical with that heretofore described in reference to Fig. 2.

As illustrated in Figs. 1 and 2, the mixture of crushed rock, including the mineral matter to be separated, is fed into the receptacle 10 through a pipe 53 which is supported upon a standard 54 and braced by a member 55, so that said pipe is adapted to support by a bracket 56 a water sprinkler pipe 57, which is supported at its other end by a pair of brace rods 58, 59 connected with rear frame portions 16. As clearly shown in Figs. 4 and 5, the pipe 53 passes through the cylindrical extensions 37 and 41 and the aperture 35 in a direction transversely oblique to the axis of the cylinder. This results in discharging the material at one side of the central line of the receptacle and against movement thereof, as shown by the arrows in Fig. 4. This form of feed through pipe 53 is of course a gravity feed and ordinarily will be found satisfactory, as the crushed rock is mixed with water forming a pulp which under usual conditions will flow with sufficient speed and certainty merely under the impulse of gravity.

The feeding mechanisms shown in Figs. 6 and 7 may, however, be substituted for a strictly gravity feed where it is desired to force the feeding more rapidly than can be effected by gravity alone, or where, for certain reasons, a strictly gravity feed may prove uncertain. This mechanism comprises a casing 60 of cylindrical form everywhere inclosed excepting for the entrance of an admission pipe 61 and a discharge pipe 62, said discharge pipe being from a cylindrical extension 63 from casing 60, which is concentrically positioned at the center of said casing and extends through members 47 and 51 to the interior of receptacle 20 (corresponding to members 41 and 37 of receptacle 10), from which point the discharge spout 62 extends in substantially the same position within the receptacle as spout 53 heretofore described. Journaled upon the bearing 64 at the center of a side of casing 60 and a second bearing 65 carried by a cradle 66 secured to partition 44 is a shaft 67 adapted to be driven from any desired source of power by a pulley 68. Upon the shaft 67 is secured a member 69 adapted to be rotated by said shaft, which member comprises side walls 70, 71, and a spiral partition 72 forming an extended spiral passageway 73 adapted to open at its outside upon the bottom of casing 60, and having a discharge opening 74 into the interior of extension 63 in which a screw 75 on shaft 67 operates to forward the material to discharge spout 62 through which it is forced into the receptacle. When this form of feeder is used the spray pipe 57 may conveniently be supported by a socket 76 carried upon the protruding end 77 of shaft 67.

From the above description of the apparatus it will be apparent that water and crushed material may be fed into receptacles 10 or 20 in which normally they may accumulate to a height indicated by dotted lines 78, after which discharge of water at least must take place from the front or receiving end of the receptacle since the discharge point is in each case lower than the highest discharge point 29 of the other end of the receptacle. All material discharged therefore must go out of the receiving end of the

receptacle, except as means are provided for conveying material in opposition to gravity from the other end of the receptacle and into the hopper 32 and discharge spout 33. Means are provided for accomplishing this result, as regards the magnetic material in the pulp, and in this manner the separation of such magnetic material is effected. To accomplish this magnets are provided for holding the magnetic material at the bottom of the receptacle, and means are provided in and upon the receptacle for operating upon this held material and causing it to move in opposition to gravity along the upwardly sloping lower portion of the receptacle to and over the discharge point 29.

In carrying out this feature of my invention, all parts of the cylinder 10 or receptacle 20 primarily are formed of non-magnetic material. In the preferred form of magnetic construction shown in Figs. 1 and 4, a powerful electric magnet 79, 80 is provided having one pole piece 81 in the form of a flat bar extended directly beneath and tangential to the bottom element 10. A second pole piece 82, as best shown in Fig. 4, comprises a similar bar at the side of the cylinder away from the direction of movement, which pole piece is vertically extended and is provided with an oblique face 83, also close to and tangential to the cylinder 10. It will be apparent that the magnetic force in taking the line of least resistance from the respective pole pieces will pass through magnetic material in the bottom of the receptacle, thereby drawing such material toward the bottom and tending to hold it at all times in the lower part of said receptacle against both the action of gravity and the frictional action of the cylinder itself and any members within the cylinder. In the form of the device shown in Figs. 2, 3 and 5, instead of having pole pieces directly attached to the armatures of magnet portions 79, 80, the receptacle itself is provided with a multiplicity of magnetic metal bars 84 separated by spaces 85, as best shown in Fig. 5. As these bars are successively carried around into the magnetic field above the armatures they become magnetized and the flow of magnetism is bridged across through the magnetic material at the bottom of the receptacle acting to hold the same against the force of gravity and the frictional forces of the rotating receptacle in a manner analogous to the action of the fixed pole pieces 81, 82.

From the above it will be seen that the magnetic material held upon the bottom of the rotating receptacle in effect is constantly caused to slide upon said surface as the receptacle moves, because the magnetic force always pulls the magnetic material toward the pole pieces and resists the tendency to carry the material up and away from such position by the frictional contact therewith of the rotating cylinder or receptacle. This fact makes the form of application of magnetism shown in Figs. 1 and 4 peculiarly effective, since the magnetic force is applied from the lower center of the rotating member along the side thereof and is therefore to some extent aided by gravity in resisting the friction of the rotating member. The material must, however, at all times slide upon the surface of the rotating drum, and I have discovered that this sliding may be effected longitudinally of the drum at the same time that it occurs circumferentially by applying to the interior of the drum (cylinder cone or other receptacle having an upwardly sloping lower wall) members movable with the drum and obliquely positioned, so that as they rotate with the drum and pass through the held magnetic material they will exercise a wedging action, and as they themselves slide through the material, will, in turn, push or slide the held material longitudinally along the bottom of the drum and up the sloping lower floor to the discharge point 29, where said material is released from the magnetic action and passes into hopper 32 and discharge chute 33.

As shown in Figs. 1, 3 and 4, the members employed comprise a multiplicity of ribs 86 of non-magnetic material, preferably angle pieces of some of the forms of non-magnetic steel, the ribs being continuous and spirally positioned, as shown. In place of continuous ribs a series of separated short bars 87 in relatively staggered relation, as shown in Fig. 2, may be employed. Other forms of movable members secured to and movable with the drum and operative upon the magnetic material to move it longitudinally in the manner herein described, may be employed, and I do not wish to limit myself to any particular form of rotating receptacle or of material-moving member carried thereon and movable therewith.

The operation of my device will be understood generally from the description already given. Assuming the use of the form of the device shown in Figs. 1 and 4, the material to be operated upon is conveyed through pipe 53. This comprises more or less finely crushed rock mixed with water in the form of a pulp. This material is directed against a moving side of cylinder 10 and the ribs 86 thereon and above the water line 78 at a point some distance in advance of the discharge plate 34. This results in spreading and disintegrating the material so that the magnetic particles are freed from the gangue and readily pass through the same into the magnetic field where they are held upon the bottom of the rotating receptacle. At the same time through pipe 57 a spray of water is directed downwardly and toward

the side of the cylinder and throughout most of the length thereof, as best indicated in Fig. 4. As the cylinder revolves the ribs 86 at the forward end of the cylinder perform the double function of agitating and stirring the entire mass of material and of engaging the held magnetic material, and sliding the same toward the rear of the receptacle. At the rear of the receptacle after this material has passed out above the water line, the ribs continue to slide the held material rearwardly until it finally pushed over the point 29 and discharged. In the meantime, as the unheld gangue is continually raised by the moving ribs it is subject to the spray of water, as also is the magnetic material at the rear end of the cylinder. The heavier rock portions of the gangue will quickly gravitate to the lower front portion of the cylinder and passing through apertures 36 will be engaged by radial partitions 38 and carried upwardly and discharged through extension member 41. The lighter portions of the gangue will similarly pass out with the water in which such portions are suspended. The result of the operation will not only be an effective and complete separation of the magnetic materials in which said magnetic materials will have been thoroughly cleansed and purified and rendered commercially available in their most useful form, but the operation is such as to involve a very high capacity of separation in proportion to the size of the apparatus employed and the amount of power required to operate it. Furthermore, the parts are not subjected to violent wear or shocks which might cause breakage, as would be the case if relatively fixed and movable members were employed. In the practice of the present invention, as regards the separating mechanism within the cylinder, except for the relatively fixed and movable members outside of the inlet feed pipe and water pipe which of course are far removed from the active separating mechanism, all parts are continuously driven together, and the only fixed element or element that is held relatively fixed is the magnetic material itself held by the magnetic forces, from which it will be apparent that no violent shock or strain or wear upon the operating parts could result.

I claim:

1. A separator of magnetic material comprising a rotating receptacle, means for mounting said receptacle so that the bottom continually slopes upwardly, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle, magnetic means for holding the magnetic material upon the lower portion of the receptacle, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally up the receptacle to a point of discharge therefrom, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

2. A separator of magnetic material comprising a rotating receptacle, means for mounting said receptacle so that the bottom continuously slopes upwardly, means for for feeding a mixture of magnetic and non-magnetic materials into the receptacle, means for providing for discharge of materials fed into the receptacle, magnetic means for holding the magnetic material within the receptacle and preventing its discharge with the other materials, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally up the receptacle to a point of discharge separate from the first named discharge means, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

3. A separator of magnetic material comprising a rotating receptacle, means for mounting said receptacle so that the bottom continually slopes upwardly, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle, means for subjecting the material in the receptacle to a spray of water, means for permitting the discharge of water and materials from the receptacle, magnetic means for holding the magnetic material within the receptacle and preventing its discharge with the other materials, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally up the receptacle to a point of discharge therefrom, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

4. A separator of magnetic material comprising a rotating receptacle, means for mounting said receptacle so that the bottom continually slopes upwardly, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle, magnetic means for holding the magnetic material upon the lower portion of the receptacle, a multiplicity of obliquely disposed members projecting inwardly from and movable with said receptacle for engaging the held material and forwarding it longitudinally up the receptacle to a point of discharge therefrom, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

5. A separator of magnetic material comprising an elongated receptacle, means for mounting said receptacle so that the bottom continually slopes upwardly, means for rotating the receptacle in a given direction, a feed pipe discharging at one end of the receptacle and positioned to feed a mixture of

magnetic and non-magnetic materials along and against a moving wall of the receptacle as the same is rotated, magnetic means for holding the magnetic material upon a portion of the receptacle below and at one side of the line of feed of said material, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally up the receptacle to a point of discharge therefrom, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

6. A separator of magnetic material comprising an elongated receptacle, means for rotating the receptacle, said receptacle being mounted so that during its rotation the bottom thereof shall continually slope upwardly toward one end, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle at a point toward the lower portion of said sloping bottom, magnetic means for holding the magnetic material upon said sloping bottom, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally of the receptacle up said inclined bottom to a point of discharge from the receptacle, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

7. A separator of magnetic material comprising a rotating receptacle, said receptacle being open at one end and partially open at the other end and being mounted so that during its rotation the bottom thereof shall continually slope upwardly toward the open end, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle through the partially closed end, magnetic means for holding the magnetic material upon the lower portion of the receptacle, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally of the receptacle up said inclined bottom and out of the open end thereof, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

8. A separator of magnetic material comprising an elongated receptacle, said receptacle being mounted so that during its rotation the bottom thereof shall continually slope upwardly to a point of discharge at one end, means for providing a point of discharge for material at the other end which is lower than the first named point of discharge, means for rotating the receptacle, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle near the lower portion of said sloping bottom, magnetic means for holding the magnetic material upon the sloping bottom of the receptacle, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally of the receptacle up said inclined bottom to the first named point of discharge, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

9. A separator of magnetic material comprising a rotating receptacle, said receptacle being open at one end and partially open at the other end and being mounted so that during its rotation the bottom thereof shall continually slope upwardly to a point of discharge at the open end, said partially closed end also providing a point of discharge for material which is lower than the point of discharge at the open end, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle through the partially closed end, magnetic means for holding the magnetic material upon the inclined bottom of the receptacle, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally of the receptacle up said inclined bottom to the first-named point of discharge, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

10. A separator of magnetic material comprising an elongated receptacle, said receptacle being open at one end and being mounted so that during its rotation the bottom thereof shall continually slope upward toward the open end, a receiving hopper, a flaring flanged member secured to the open end of the receptacle and extending above said hopper, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle at a point near the lower portion of said sloping floor, magnetic means for holding the magnetic material upon the inclined bottom, means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally of the receptacle up said inclined bottom and upon said flanged member for discharge therefrom into the hopper, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

11. A separator of magnetic material comprising an elongated receptacle open at one end and mounted so that during its rotation the bottom thereof shall continually slope upward toward the open end, a closure for the other end provided with a central aperture and a series of apertures adjacent the periphery of said closure, a second closure having an enlarged discharge aperture with the point of discharge above the upper edges of said peripheral apertures when in their lowermost positions, pockets

formed between said closures each communicating with one of said apertures and with the discharge opening of the second closure, means for introducing a mixture of magnetic and non-magnetic materials through the central apertures of said closures, means for rotating the receptacle, means including a magnet and members on and movable with the receptacle for separating the magnetic material from the non-magnetic material and discharging it through the open end of the receptacle, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

12. A separator of magnetic material comprising a rotating receptacle formed and mounted so that during rotation the bottom thereof will continually slope upwardly toward one end of the receptacle, means for introducing a mixture of magnetic and non-magnetic material into the receptacle at a point near the other end, magnetic means for continuously holding the magnetic material upon the sloping portion of the receptacle, a multiplicity of spirally-arranged ribs projecting inwardly from and movable with said receptacle for engaging the held material and forwarding it longitudinally along the receptacle to a point of discharge at the open end thereof, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

13. A separator of magnetic material comprising a rotating receptacle, means for mounting said receptacle so that the bottom continually slopes upwardly, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle, magnetic means for holding the magnetic material upon the lower portion of the receptacle while the non-magnetic materials are discharged therefrom at one end, a multiplicity of extended ribs on and movable with the receptacle for engaging the held material and forwarding it longitudinally up the receptacle to a point of discharge therefrom at the other end of the receptacle, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said receptacle.

14. A separator of magnetic material comprising an elongated cylinder, means for mounting said cylinder so that the bottom continually slopes upwardly, means for rotating said cylinder, means for feeding a mixture of magnetic and non-magnetic materials into the cylinder, magnetic means for holding the magnetic material upon the lower portion of the cylinder, a multiplicity of spirally-arranged ribs projecting inwardly from and movable with said cylinder for engaging the held material and forwarding it longitudinally up the cylinder to a point of discharge therefrom, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said cylinder.

15. A separator of magnetic material comprising a rotating receptacle mounted and formed so that during its rotation the bottom thereof shall continually slope upwardly toward one end, means for feeding a mixture of magnetic and non-magnetic materials into the receptacle, a horse-shoe magnet having a flat pole piece extending longitudinally beneath the center of said sloping bottom, and a second pole piece with a face extending tangentially along a portion of said receptacle at one side and removed from the first-named pole piece, the magnetic force from said pole piece acting through the magnetic material in the receptacle to hold said magnetic material upon the sloping bottom, and means within said receptacle and movable therewith for engaging said held material and forwarding it longitudinally of the receptacle up said inclined bottom to a point of discharge from the receptacle.

16. A separator for magnetic material comprising an elongated cylinder mounted for rotation about an obliquely disposed axis, means for rotating said cylinder, means for feeding a mixture of magnetic and non-magnetic materials into the cylinder, magnetic means for holding the magnetic material upon a lower portion of the cylinder, a multiplicity of spirally-arranged ribs formed with spaces between the ends of adjacent alining ribs projected inwardly from and movable with said cylinder for engaging the held material and forwarding it longitudinally up the cylinder at a point of discharge therefrom, and means for permitting the discharge of heavy non-magnetic particles from the lower end of said cylinder.

In testimony whereof I affix my signature in presence of two witnesses.

EDMUND NEWTON.

Witnesses:
F. A. WHITELEY,
H. A. BOWMAN.