No. 824,893. PATENTED JULY 3, 1906.

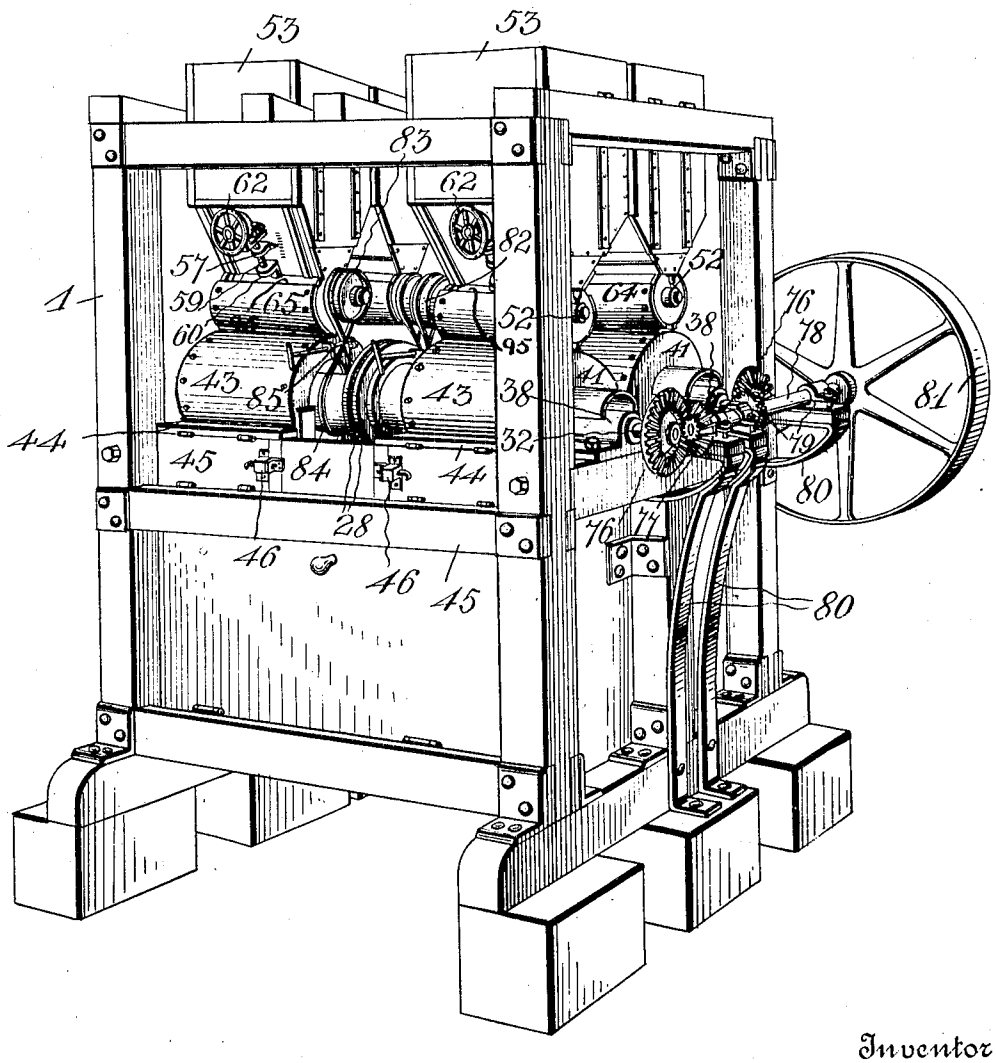
J. WEATHERBY, JR.

MAGNETIC ORE SEPARATOR.

APPLICATION FILED AUG. 3, 1905.

6 SHEETS—SHEET 1.

FIG. 1



Witnesses

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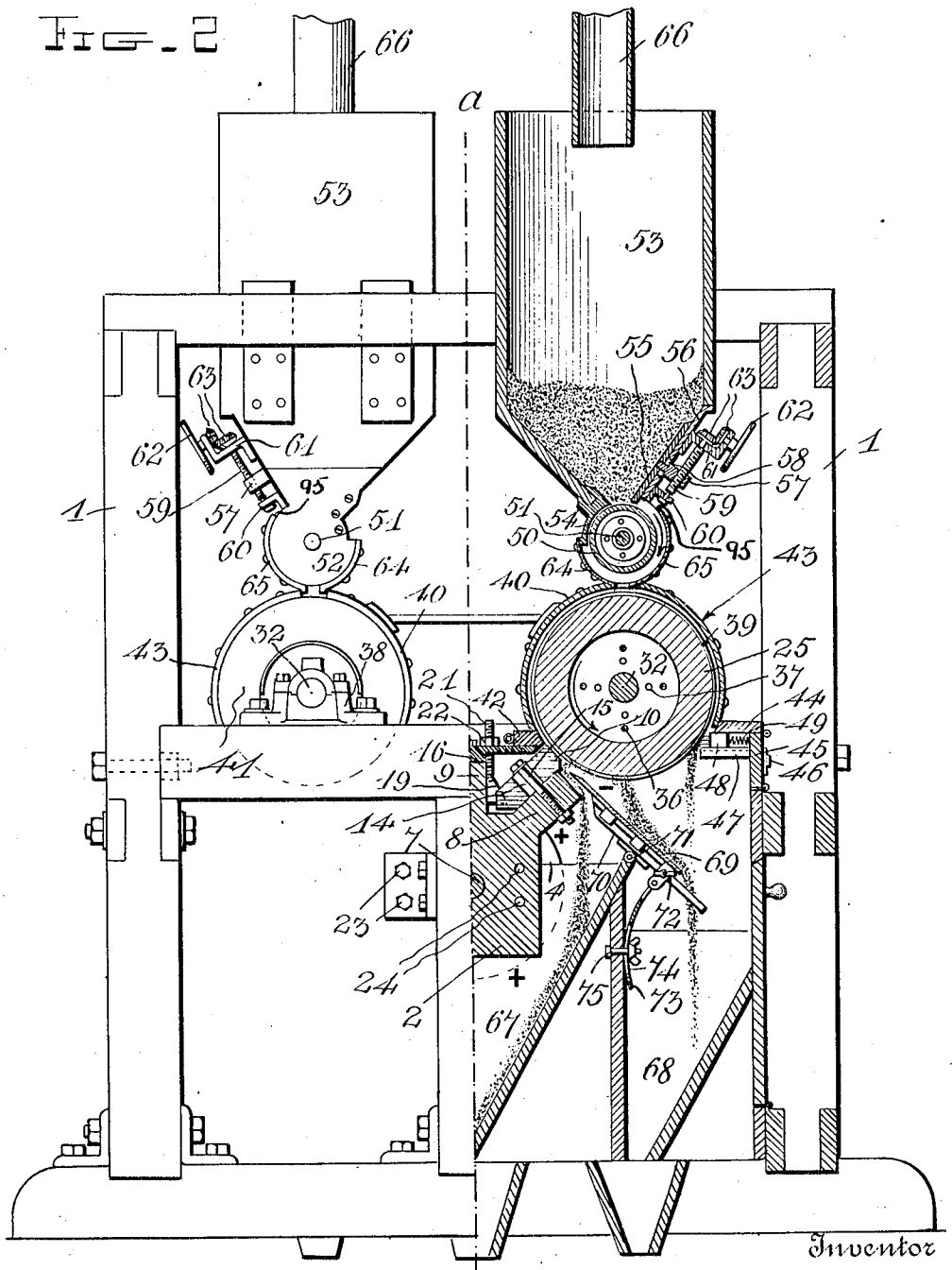
6 SHEETS—SHEET 2.

FIG. 2



Witnesses

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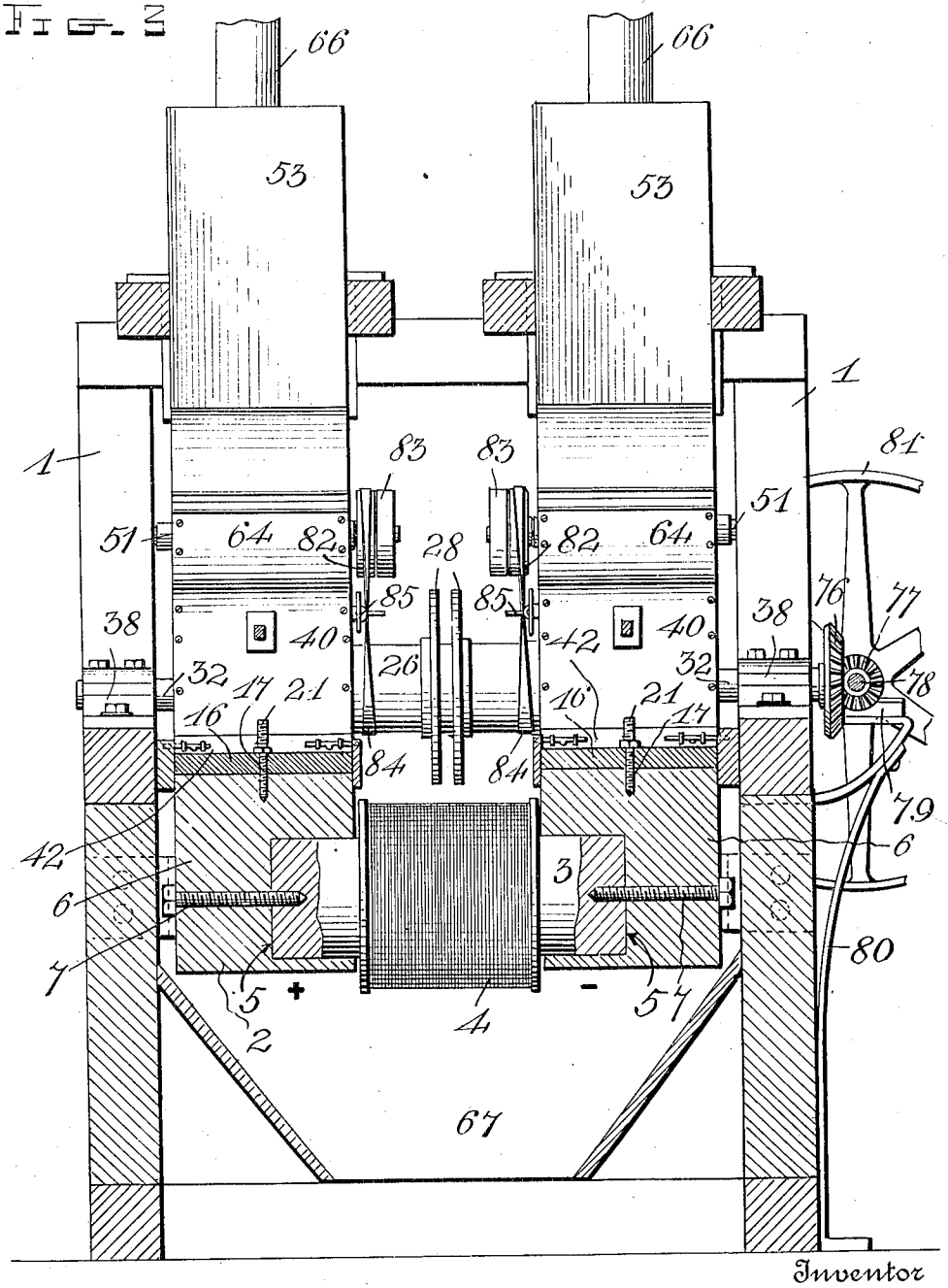
6 SHEETS—SHEET 3.

FIG. 2



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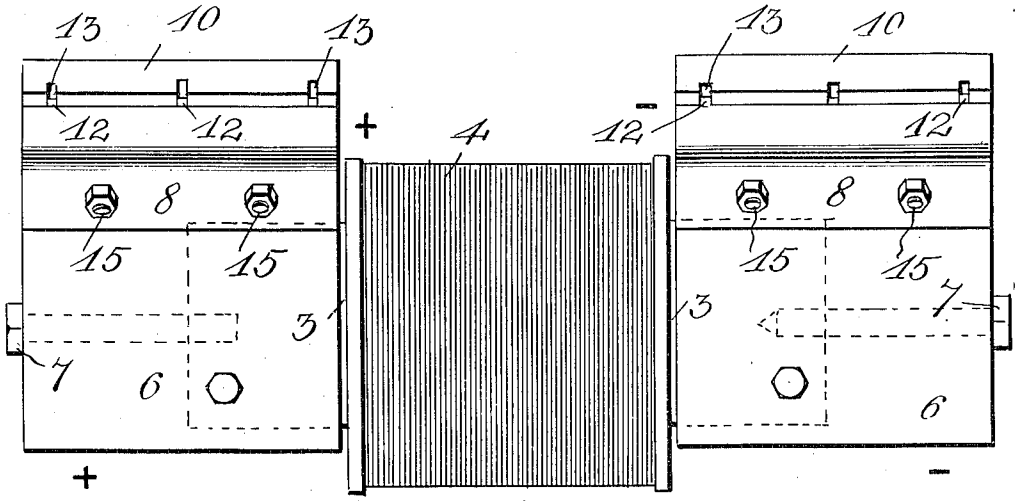
6 SHEETS—SHEET 4.

FIG. 4



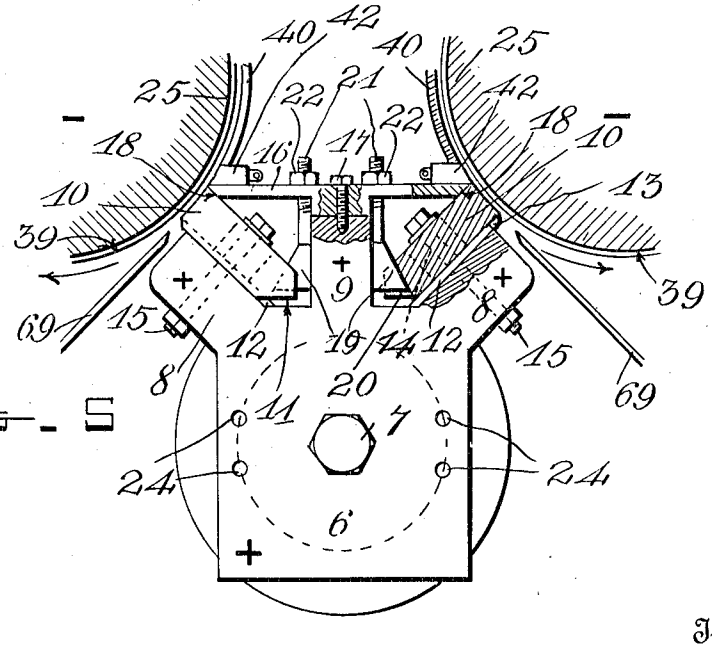


FIG. 5

Witnesses

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6 SHEETS—SHEET 5.

FIG. 5

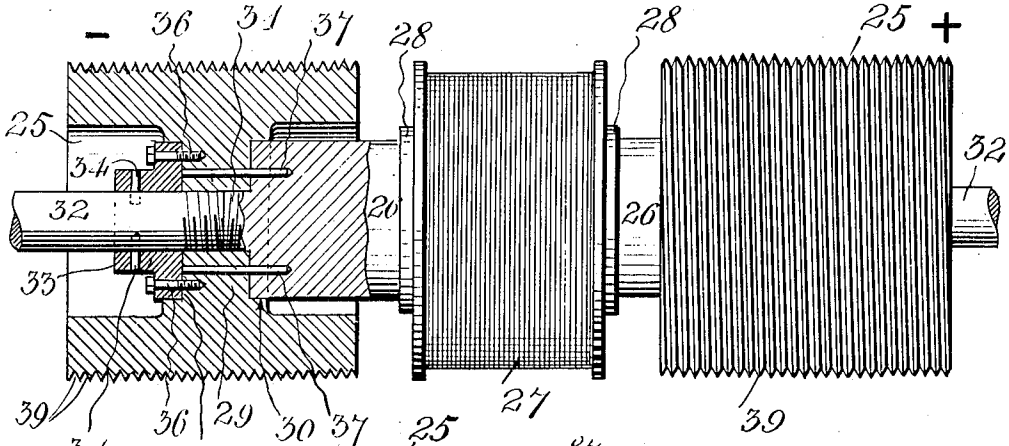


FIG. 8

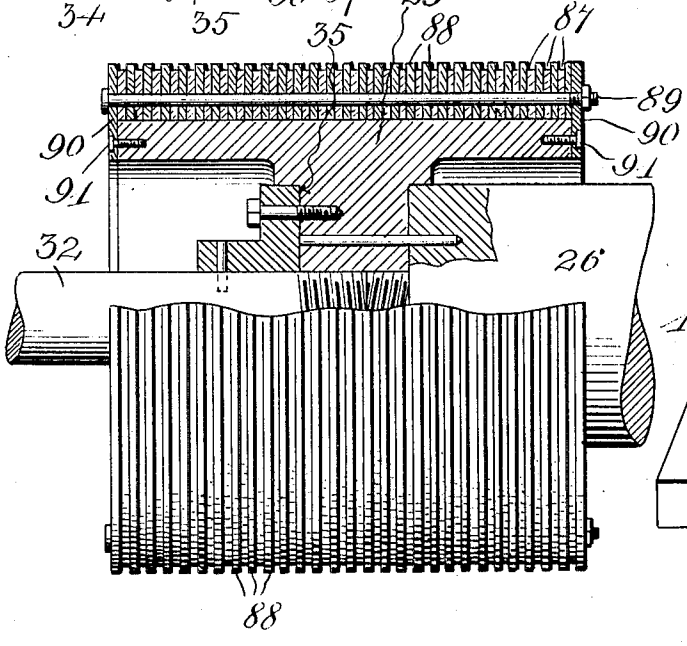
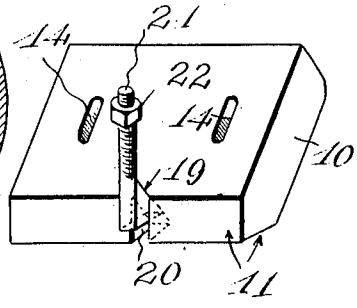


FIG. 7



Witnesses

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6 SHEETS—SHEET 6.

Fig. 9

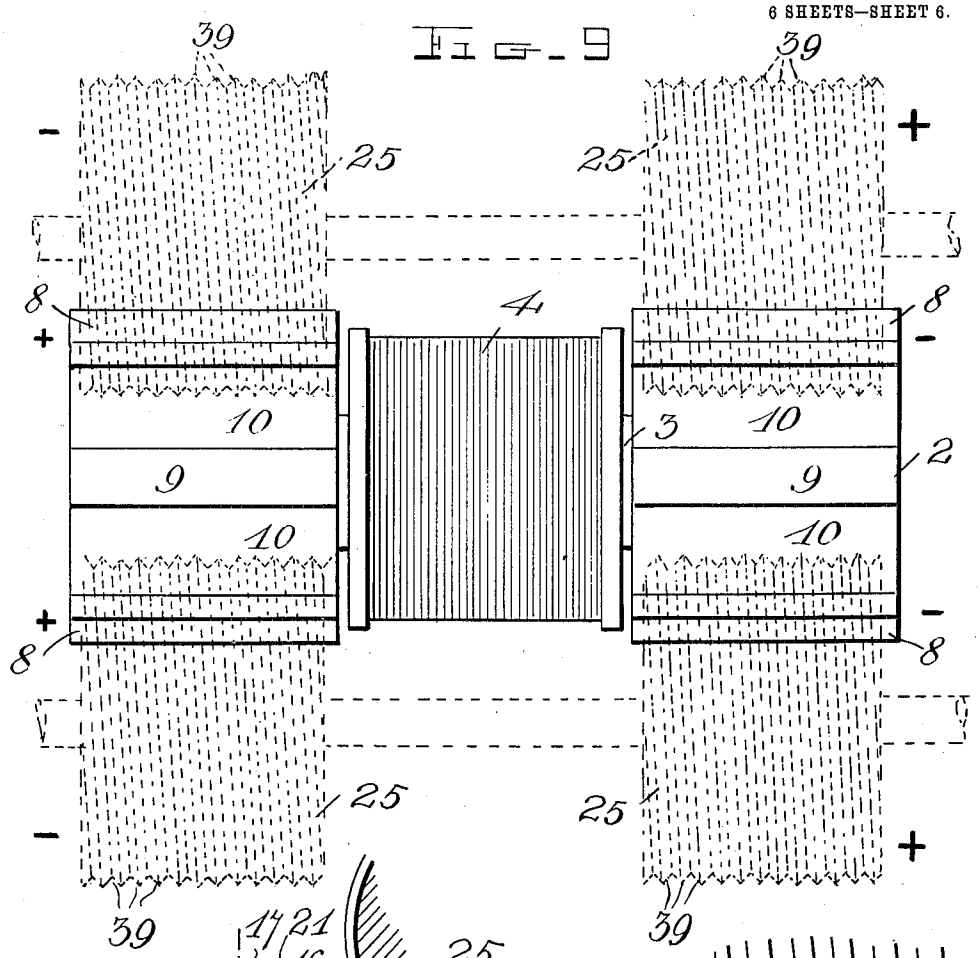


Fig. 10

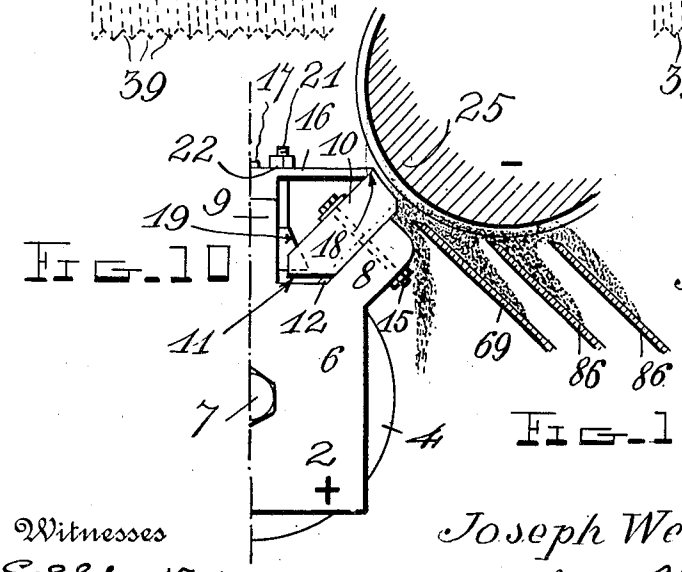
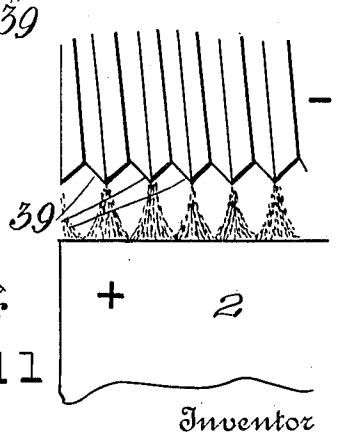


Fig. 11



Witnesses

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UNITED STATES PATENT OFFICE.

JOSEPH WEATHERBY, JR., OF NEW CUMBERLAND, PENNSYLVANIA.

MAGNETIC ORE-SEPARATOR.

No. 824,893. Specification of Letters Patent. Patented July 3, 1906.

Application filed August 3, 1905. Serial No. 272,537.

To all whom it may concern:

Be it known that I, JOSEPH WEATHERBY, Jr., a citizen of the United States, residing at New Cumberland, in the county of Cumberland and State of Pennsylvania, have invented certain new and useful Improvements in Magnetic Ore-Separators; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention is an improved magnetic ore-separator adapted to separate ore particles possessing magnetic permeability from gangue particles of no magnetic permeability and to effect a separation of the magnetic particles in accordance with the degree of magnetic permeability thereof.

One object of my invention is to effect improvements in the construction and arrangement of the magnet and movable armature elements, whereby a single magnet may be employed with a plurality of such movable armature elements to increase the capacity of the machine and to effect an economy in the operation thereof.

A further object is to effect improvements in the construction of the movable armature elements, whereby the same comprise revoluble armature-rolls which act centrifugally to impart mechanical motion to the ore particles before they are treated magnetically to facilitate the magnetic separation of the permeable particles from the gangue particles having no magnetic permeability.

A further object of my invention is to combine with a magnet and a movable armature element a movable member of a pole-piece of the magnet which is adjustable toward and from the movable armature element to vary the width of the space or air-gap between them.

A further object is to provide improved means to adjust such adjustable pole-piece member.

A further object is to effect such improvements in the construction and arrangement of the magnet pole-piece and movable armature as to provide a downwardly-opening inclined air-gap between them to facilitate the discharge by gravity of the gangue particles, and, further, to combine with such pole-piece and movable armature a partition which is interposed in the air-gap and in the magnetic field between the pole-piece and the movable armature to effect the separation of particles of minimum magnetic permeability from the gangue particles, and hence recover such particles of minimum magnetic permeability.

A further object is to combine with the pole-piece of a magnet a movable armature provided on its opposing surface with localized areas of greater magnetic efficiency than corresponding areas of the magnet pole-piece to cause loose magnetic particles in the magnetic field to adhere to such localized areas and be carried by the movement of the armature out of the magnetic field, thus enabling me to dispense with the use of a screen in connection with and between the magnet pole-piece and the armature.

A further object of my invention is to provide in connection with the magnet pole-piece and the movable armature means to mechanically move the particles between them in a plane at an angle to that of their movement in the lines of force in the magnetic field in addition to the movement of such particles with the movable armature when being carried thereby through and out of the magnetic field.

A further object is to effect improvements in the construction of the armature-rolls, whereby the same are provided with spirally-disposed localized areas of greater magnetic efficiency than corresponding areas of the opposing pole-pieces of the magnet, which spirally-disposed localized areas serve both to cause the ore particles to be mechanically moved at an angle to the plane of their movement in the lines of force in the magnetic field to effect a maximum disturbance of such particles and finally cause the ore particles possessing magnetic permeability to adhere to such armature-rolls and be carried out of the magnetic fields by the rotation of such rolls.

A further object is to effect improvements in the construction of the armature-rolls, whereby the same may be caused to become the pole-pieces of a magnet.

A further object is to provide improved means for adjusting the partition-plates interposed in the magnetic fields between the pole-pieces and the armature-rolls, so that such partition-plates may be moved into such magnetic fields to any desired extent and may be disposed at any desired inclination.

A further object is to combine with a magnet pole-piece and a movable armature element means to cause material to lie in a thin

layer on the working face of such movable armature element while being conveyed to the air-gap between such element and the pole-piece.

A further object is to provide improved means for feeding material to the armature-rolls.

In the accompanying drawings, Figure 1 is a perspective view of a magnetic ore-separating machine embodying my invention. Fig. 2 is partly a side elevation and partly a vertical section view of the same. Fig. 3 is a vertical sectional view of the same, taken on the plane indicated by the line *a a* of Fig. 2. Fig. 4 is a detail side elevation of the magnet. Fig. 5 is a detail transverse sectional view showing the magnet and the revoluble armature-rolls arranged in operative relation thereto and also indicating the position of the diamagnetic partition-plates with their upper ends interposed in the magnetic fields between the divided pole-pieces of the magnet and armature-rolls. Fig. 6 is a detail view, partly in elevation and partly in section, showing an armature having a pair of rolls which comprise its pole-pieces. Fig. 7 is a detail perspective view of one of the adjustable members of the magnet pole-pieces, also showing the adjusting-screw which operates the same. Fig. 8 is partly an elevation and partly a sectional view illustrating a modification in the construction of the armature-rolls. Fig. 9 is a top plan view showing the relative arrangement of the armature-rolls and the magnet with which they coact. Fig. 10 is a diagrammatic elevation showing the relative arrangement of the magnet, the armature-rolls, and a plurality of partition-plates for effecting a permanent separation of the ore particles in accordance with the respective magnetic permeability of such particles. Fig. 11 is a diagram illustrating the magnetic relation between the armature and field-magnet, showing the dense magnetic flux concentrated on the serrations of the armature.

In a suitable framework 1 is secured a horizontally-disposed electromagnet 2, which comprises the core 3 and the coil 4. The ends of the core, which is of cylindrical form, project beyond the ends of the coil and are forced into, completely fill, and are firmly secured in correspondingly-shaped sockets 5 in pole-pieces 6. Bolts 7 are here shown to secure the pole-pieces on the ends of the core. Each pole-piece is here shown as rectangular in form, provided on its upper side with a pair of upwardly-diverging inclined divisions 8, which at each end of the core are of one polarity—that is to say, the division 8 of one of the pole-pieces 6 will be of positive polarity, while those of the other pole-piece 6 will be of negative polarity. Lugs 9 are also formed on the upper sides of the pole-pieces 6. The divisions 8 and the lugs 9 extend lengthwise of the respective pole-pieces from end to end thereof. On the upper side of each pole-piece division 8 is an adjustable pole-piece member 10, which is of oblong rectangular form, and the inner edge of which is beveled, as at 11. Guide-bars 12, which are preferably made of steel, are secured on the upper sides of the pole-piece divisions 8, and the adjustable members 10 are provided on their under sides with guide-grooves 13, which are engaged by said guide-bars, and the said members 10 are hence mounted for longitudinal movement on the pole-piece divisions 8, so that they may be extended outwardly therefrom to any necessary extent. The said members 10 form prolongations of the pole-pieces, as will be understood. By the provision of the guide-bars and guide-grooves friction between the divisions 8 and the members 10 is diminished to facilitate the adjustment of the said members 10. The said adjustable members 10 are provided with slots 14. Bolts 15, which secure the said members to the pole-piece divisions 8, pass through the said slots, the latter, as will be understood, serving to permit the adjustment of the said members 10.

On the lug 9 of each pole-piece is secured a plate or supporting member 16 of suitable length and width and which is made of brass or other suitable diamagnetic material. Such plates 16 are secured on the said lugs 9 by means of screws 17, and their outer edges are beveled on their under sides, as at 18, and bear against the adjustable pole-piece members 10. To adjust the said members 10, I provide vertically-movable wedge-cams 19, which bear against and are guided by the sides of the lugs 9 and the inclined cam-wedges of which engage similarly-shaped cam-recesses 20 in the adjustable pole-piece members 10. The said wedge-cams are provided with screws 21 and adjusting-nuts 22, which bear on the said plates. By turning the nuts to raise the screws and cam-wedges the movable pole-piece members 10 may be moved outwardly to project beyond the pole-piece division 8, assuming that the bolts 15 have been first loosened. By lowering the cam-wedges 19 to release the adjustable pole members 10 the latter will by their own gravity move downward and inwardly on the pole-piece divisions 8. The electromagnet is here shown as secured to and supported in the frame by means of screws 23, which enter openings 24 in the pole-pieces 6.

Above and on opposite sides of the magnet are pairs of rolls 25, which form the pole-pieces of armatures, as hereinafter described. The members of each pair of rolls 25 are secured on the ends of a core 26, which is here shown as the core-piece of an electromagnet, the coil being shown at 27 at a point between the pair of roller pole-pieces and commutator rings or disks being indicated at 28. Hence

by sending current through the coil 27 the rolls 25 will become pole-pieces of revoluble electromagnets, but the relation of said rolls to the pole-pieces of the magnet 2 is that of armature-pole pieces. It is only when recovering ore of exceedingly low magnetic permeability that it ever becomes desirable to supply current to the coil 27, and hence I prefer to employ the term "armature-rolls" as most appropriately designating the function and relation of the said rolls 25, since they act as armature pole-pieces with reference to the magnetic pole-pieces and also act as rollers to impart mechanical motion to the ore particles. It will be observed by reference to Fig. 6 that the rolls 25 have their ends hollowed and have their intermediate solid portions 29 counterbored, as at 30, to receive the ends of the cores 26. The ends of the cores 26 are provided with short screw-threaded extensions 31, which are screwed into correspondingly-threaded openings in the centers of the armature-rolls. Journal members 32 for the cores 26 and the armature-rolls have their inner ends screw-threaded reversely to the threads on the core extensions 31 and screwed into the said threaded openings in the center of the armature-rolls, the inner ends of the said journal members abutting against the extensions of the cores 26. Collars 33 are secured on the journal members, as by means of dowel-pins 34, and fit counterbores 35 in the solid intermediate portions of the armature-rolls. Said collars are secured to the armature-rolls by screws 36 and engage the outer ends of the dowel-pins 37, which extend through openings in the intermediate portions of the armature-rolls and enter corresponding openings in the ends of the cores 26. The said journal members 32 of the shafts and armature-rolls are mounted in bearings 38, with which the frame 1 is provided.

From the foregoing description and by reference to the drawings, particularly Figs. 2, 4, and 5 thereof, it will be understood that in the construction of my improved ore-separator I provide a magnet having a divided pole-piece of one polarity at each end in combination with a plurality of revoluble armature-rolls, one opposed to each division of each pole-piece of the magnet, so that I may be enabled to employ only a single magnet in operative relation to a plurality of armature-rolls, thus greatly increasing the capacity of the machine and effecting a material economy in the cost of the operation thereof. It will be understood that in those cases in which current is supplied to the coils 27 and the armature-rolls become pole-pieces of revoluble magnets the polarity of each roll will be the opposite of that of the magnet pole-piece to which it is opposed. The peripheries of the armature-rolls are screw-threaded, as at 39, to provide serrations which form wedge-shaped localized areas, which effect a great accumulation of the lines of force thereon and produce great differences of magnetic density as between such serrations and the opposing field pole-pieces, with the result that such localized areas of the armatures are of greater magnetic efficiency than the opposing localized areas of the flattened surfaces of the field pole-pieces, so that the loose magnetic particles in the magnetic fields or air-gaps between the pole-pieces and the armature-rolls will be caused to leave the pole-pieces and adhere to the serrations of the armature-rolls and by the rotation of the armature pole-piece rolls be carried out of the said magnetic fields.

Substantially mounted on the frame 1 and at both ends of the armature pole-pieces 25 are the end guards 41, preferably made of wood or other diamagnetic substance. These end guards fit close to the ends of the pole-pieces and are of a greater diameter, thus allowing space between the pole-faces and the shields 40. On the inner side of each armature is a semicylindrical shield-plate 40, substantially secured to the end guards 41 by screws. At the base of each of said shield-plates is an opening in which is placed a removable guard 42, preferably made of wood, and so disposed as to tightly close the opening thus formed between the shield-plates and the supporting member 16. The said removable guards when removed from the said openings enable the outer edges of the adjustable pole-piece members 10 to be sighted, thus greatly facilitating the adjusting of the adjustable pole-piece members and enabling them to be set at the required distance from the armature-poles. On the outer side of each armature-pole is a substantially semicylindrical shield-plate 43, secured to end guards 41, the base of which forms a jamb for the hinged board 44, which is in turn hinged to a door 45, that is normally secured in a closed position by means of a bolt or other suitable locking device 46. On the inner side of each door and fastened to the frame 1 are horizontally-disposed supporting guide-bars 47, on which are laterally-movable brushes 48, which bear against the peripheries of the armature pole-pieces and the bristles of which are held in contact with the armature-poles by the action of springs 49, here shown as coil-springs, which are fastened at one end to the heads of the brushes and at the other end bear against the doors 45. The hinged boards 44 also act as guides for the brushes. When the doors 45 and the hinged boards 44 are opened, the brushes 48 are exposed and can be readily removed or replaced.

Above each armature-roll is a feed-roll 50. Each of said feed-rolls has its shaft 51 journaled in bearings 52, which depend from secondary hoppers 53, that are supported by the

framework 1, as shown. The inner inclined lower side of each secondary hopper is provided with a concave guard-brace 54, disposed at a slight distance to one side of the upper portion of the feed-roll of such hopper. The opposite inclined lower side of each secondary hopper is provided with a vertically-movable feed-regulating gate 55, here shown as supported on an inclined side plate 56, provided with a lug 57, that projects out through and operates in a slot 58 in said plate, said lug forming a traveling nut engaged by a screw 59, which has its bearings 60 61 secured on said plate. Said screw is geared to a hand-wheel 62 by means of miter-gears 63, the shafts of said hand-wheels being journaled in the said bearings 61. Each feed-roll is inclosed in a casing comprising a substantially semicircular inner member 64, secured to the concave guard-base and to the journal end plates 52, and a substantially semicylindrical outer member 65, also secured to the journal end plate 52. Sight-openings 95 are formed at the upper sides of the said outer members. The secondary hoppers, each of which supplies material to the feed-roll above one of the armature-rolls, are supplied with material from a master-hopper, bin, or other compartment (not shown) which is located above the secondary hoppers and is provided with feed-pipes 66, which extend downwardly into the upper ends of the secondary hoppers. Material flows from the master-hopper to the secondary hoppers through the said feed-pipes 66 until the lower ends of the said feed-pipes become closed by the accumulation of material in the said secondary hoppers, and the supply to the said secondary hoppers ceases until enough material has been discharged therefrom onto the feed-rolls to cause the lower ends of the feed-pipes to be uncovered. Hence the secondary hoppers are kept automatically supplied with material so long as there is such material in the master-hopper, and the secondary hoppers are prevented from overflowing.

Under the pole-pieces of the magnet 2 are hoppers 67 for the reception of the gangue. On the outer sides of the said hoppers 67 are hoppers 68, of which there may be any suitable number, for the reception of the concentrates or ore particles separated from the gangue by the action of the magnet and the armature-rolls, as hereinafter stated. Under each armature-roll is an inclined diamagnetic partition plate or chute 69, which is longitudinally slidably mounted on the pivotally-supported member 70. One of said supporting members 70 is here shown as pivotally mounted on one side of the hopper 67, as at 71. Each partition-plate has a set-screw 72 to secure it to the supporting member 70 at any suitable adjustment, and each supporting member 70 has a supporting-link 73, pivotally connected thereto and provided with an adjusting-slot 74, through which passes a set-screw 75, employed to secure the lower portion of the link to one wall of one of the hoppers 68. The slots 74 and screws 75 permit such adjustment of the links as is required to secure any desired angular adjustment of the supports 70 and partition-plates 69, so that the latter may be disposed at any required inclination. It will be observed by reference to the drawings, particularly Figs. 2 and 5, that the upper ends of the partition-plates 69 are interposed directly in the magnetic fields between the divisions 8 of the pole-pieces and the armature-rolls and that the said plates 69 may be adjusted so as to dispose their upper ends to within a very short distance of the adjustable pole-piece members 10 or to adjust them somewhat more remotely from said adjustable pole-piece members, as may be required by the character of the material treated.

The shafts of the armature-rolls are here shown as provided each at one end with a bevel-gear 76, which bevel-gears are engaged by similar gears 77 on the power-shaft 78, which has its bearings 79 secured on suitable supports 80 at one end of the frame 1. Said power-shaft is here shown as provided with a pulley 81, whereby it may be rotated by a belt in order to drive the armatures. The latter revolve in the direction indicated by the arrows in Figs. 2 and 5. The shaft 51 of each feed-roll is provided on its inner end with a loose pulley 82 and a fast pulley 83. Crossed belts 84 are driven by the cores 26 of the armature-rolls and may be shifted to either the fast pulleys or the loose pulleys to cause the feed-rolls to rotate reversely with reference to their respective companion armature-rolls or to be thrown out of gear. Belt-shifters 85 are here shown to thus shift the said belts. In practice in a machine having armatures sixteen inches in diameter said armature-rolls have been driven at a rate of from one hundred and fifty to about two hundred revolutions per minute, according to the material treated.

The operation of my invention is as follows: The ore to be treated by my improved magnetic ore-separator must be first ground, but need not be roasted. The ore in each hopper 53 rests upon the feed-roll 50. When its gate is appropriately opened, the rotation of the roll causes the ore to be delivered in a thin sheet or film onto the upper side of the revoluble armature-roll below the feed-roll. The armature pole-piece roll as it revolves carries the material to the magnetic field or air-gap between the pole-piece 8 and adjustable pole-piece member 10 and the portion of the armature-roll which is opposed thereto. The motion and centrifugal force of the armature-roll cause mechanical motion to be set up in the ore between the pole-piece and

its adjustable member and the armature-roll, which mechanical motion of the ore particles facilitates the separation of the gangue, which has not magnetic permeability, from those particles which have magnetic permeability and which are capable of magnetic saturation to a greater or less degree. Owing to the provision of the spirally-arranged serrations on the periphery of the armature-roll, the ore in the magnetic field is also moved mechanically and angularly with respect to the plane of magnetic movement thereof in the lines of force in the magnetic field, which angular motion of the ore particles further facilitates the separation of the gangue particles from those possessing magnetic permeability. That portion of the magnetic field is stronger between the carrier armature-roll and the magnetic pole extension 10 than that portion which is between said roll and the opposing face of the pole-piece 8. The magnetic action of the roll and extension 10 causes the material to lag somewhat as it passes between them, so that some slip occurs at this point between the material and the roll which increases the mechanical action of the spirally-disposed serrations on the roll and sets up such a scouring action between the particles of the material as to cause a much larger percentage thereof to finally adhere to the roll and be carried out of the magnetic field thereby than would otherwise be the case. It will be observed that the pole-piece presents an inclined surface under the armature-roll and coacts with the latter to form an inclined downwardly-opening air-gap between them, which permits the particles of gangue to drop from the adjustable pole-piece member 10 onto the inclined face of the pole-division 8 opposite to the armature while still in the magnetic field and from said inclined face into the hopper 67. Those ore particles which have magnetic permeability in any degree, owing to the provision of the localized areas of greater magnetic efficiency formed by the serrations on the periphery of the armature-roll and on the wedge terminations of which the lines of force accumulate, leave the gangue particles and are caused to adhere to the armature-roll and are carried by the rotation of the armature-roll beyond the upper edge of the partition-plate 69. Such ore particles as possess only very slight magnetic permeability drop from the armature-roll while yet in the magnetic field and are directed by gravity from the plate 69 into the hopper 68 and are saved and separated from the gangue. Such particles hence are saved because of the disposition of the upper portion of the partition-plate in the magnetic field. Such particles as possess a greater magnetic permeability adhere to the armature-roll for a greater length of time and are carried by the said roll farther before they drop therefrom by the conjoint actions of gravity and the centrifugal force of the armature-roll. It will be understood that the magnetic field of the armature-roll diminishes in force as it recedes from the pole-piece and that thus particles which possess magnetic permeability are carried by the armature-roll from the air-gap to an extent conditioned upon the degree of their magnetic permeability, those particles which possess a high degree of magnetic permeability being carried by the armature-roll farther from the air-gap than those which possess a lower degree of magnetic permeability, so that the constituent elements of the material are divided and separately discharged by the action of the armature-roll in accordance with the respective magnetic permeability of such particles. By the provision and employment of a plurality of suitably-spaced partition-plates under the armature-rolls the particles thus separated by the armature-rolls in accordance with the extent of their magnetic permeability may be kept permanently separated. I have shown such a plurality of partition-plates in Fig. 10, the primary plate being indicated at 69 and the others at 86. The brushes 48, which bear against the armature-rolls, prevent any magnetic particles of high magnetic permeability from being carried round and round by such rolls. The function of the shields which cover the feed-rolls and the armature-rolls is to prevent material from being thrown centrifugally from said rolls, an additional function being to dispose the material on the working sides of said rolls in a thin layer and to also prevent dust from escaping.

In Fig. 8 I show a modification in the construction of an armature-roll in which the peripheral face of the same is composed of a plurality of annular disks 87 88 of unequal diameter, the disks 88 being the larger and disposed alternately on the periphery of the roll secured together by bolts 89, which pass therethrough and also pass through heads 90, which are secured on the ends of the roll by screws 91.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a magnetic ore-separator, a relatively fixed magnet having a divided pole-piece of one polarity, in combination with a plurality of movable armatures each in operative relation to one of the divisions of the said pole-piece.

2. In a magnetic ore-separator, a relatively fixed magnet having a divided pole-piece of one polarity, in combination with a plurality of revoluble armatures, each in operative relation to one of the divisions of the said pole-piece.

3. In a magnetic ore-separator, the combination of a magnet having a pole-piece presenting an inclined surface, and an extension

of said pole-piece also presenting an inclined surface and forming a shoulder, a moving magnetic carrier element presenting a surface above said pole-piece and extension and forming an inclined air-gap between them, and a partition interposed directly in the broadened portion of the air-gap between the pole-piece and the carrier element and behind the shoulder formed by the pole extension.

4. In a magnetic ore-separator, the combination of a magnet having a pole-piece presenting an inclined surface, and an extension of said pole-piece also presenting an inclined surface and forming a shoulder, a moving magnetic carrier element presenting a surface above said pole-piece and extension and forming an inclined air-gap between them, and a plurality of partitions to catch the magnetic particles dropped by the carrier, one of said partitions being interposed directly in the broadened portion of the air-gap between the pole-piece and the carrier element and behind the shoulder formed by the pole extension.

5. In a magnetic ore-separator, the combination of a magnet having a pole-piece presenting an inclined surface and an extension of said pole-piece also presenting an inclined surface and forming a shoulder, a cylindrical revolving magnetic carrier element presenting a surface above and moving past said pole-piece and extension and forming an inclined air-gap between them, and a partition interposed directly in the broadened portion of the air-gap between the pole-piece and the carrier element and behind the shoulder formed by the pole extension.

6. In a magnetic ore-separator, the combination of a magnet having a pole-piece presenting an inclined surface and an extension of said pole-piece also presenting an inclined surface and forming a shoulder, a cylindrical revolving magnetic carrier element presenting a surface above and moving past said pole-piece and extension and forming an air-gap between them, means to feed material in a thin layer to the air-gap, and means to subject such material, while its movement through the air-gap is magnetically retarded, to force exerted in a direction at an angle to the lines of magnetic force in the air-gap and also at an angle to the plane of movement of such material with the carrier.

7. In a magnetic ore-separator, the combination of a magnet having a pole-piece presenting an inclined surface and an extension of said pole-piece also presenting an inclined surface and forming a shoulder, a cylindrical, revolving magnetic carrier presenting a surface above and moving past said pole-piece and extension, said surface being made up of spirally-arranged serrations, substantially as described.

8. In a magnetic ore-separator, the combination of a magnet having a plurality of pole divisions at each end and a plurality of revoluble armatures having cylindrical poles each disposed opposite one of the magnet-pole divisions and having peripheral serrations, for the purpose set forth.

9. In a magnetic ore-separator, the combination of a fixed magnet comprising a core, a coil on the intermediate portion and laterally-extending pole-pieces on the ends thereof, with a revoluble armature comprising a core and cylindrical pole-pieces on the ends thereof, and opposed to the pole-pieces of the magnet, substantially as described.

10. In a magnetic ore-separator, the combination of a magnet having a plurality of radially-disposed, fixed pole-pieces, one between the others, a plate of non-magnetic material on the intermediate pole-piece and extending in opposite directions therefrom, adjustable pole extensions on the outer fixed pole-pieces, armatures presenting moving surfaces opposed to and spaced from the outer fixed pole-pieces and the adjustable pole extensions, and means carried by the said plate to adjust said pole extensions, substantially as described.

11. In a magnetic ore-separator, the combination of a magnet having a plurality of radially-disposed, fixed pole-pieces, one between the others, a plate of non-magnetic material on the intermediate pole-pieces and extending in opposite directions therefrom, adjustable pole extensions on the outer fixed pole-pieces, armatures presenting moving surfaces opposed to and spaced from the outer fixed pole-pieces and the adjustable pole extensions, and means to adjust said pole extensions, substantially as described.

12. In a magnetic ore-separator, the combination of a magnet having a plurality of radially-disposed, fixed pole-pieces, one between the others, a plate of non-magnetic material on the intermediate pole-pieces and extending in opposite directions therefrom, adjustable pole extensions on the outer fixed pole-pieces, armatures presenting moving surfaces opposed to and spaced from the outer fixed pole-pieces and the adjustable pole extensions, and wedge-cams carried by said plate and bearing against the intermediate pole-pieces to adjust said pole extensions, substantially as described.

13. In a magnetic ore-separator, the combination of a magnet, an adjustable pole-piece for such magnet, an armature presenting a moving surface opposed to and spaced from said adjustable pole-piece, a supporting member, a shield disposed in proximity to and spaced from said armature and also spaced from said supporting member to form an opening through which the end of the pole-piece presented to the armature may be observed, and a removable guard to close such opening, substantially as described.

14. In a magnetic ore-separator, the combination of a magnet having a plurality of

pole divisions at each end and a plurality of revoluble armatures having cylindrical poles, each disposed opposite one of the magnet-pole divisions, substantially as described.

15. In a magnetic ore-separator, the combination of a magnet, an armature having a revoluble cylindrical pole-piece, a shield for said pole-piece, a hinged door, guides, a brush movable on the guides, a spring to press the brush against the armature pole-piece, and a board hinged to the door and covering the brush when closed against the shield, substantially as described.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

JOSEPH WEATHERBY, JR.

Witnesses:
DONALD HOYER,
J. C. DELANEY.