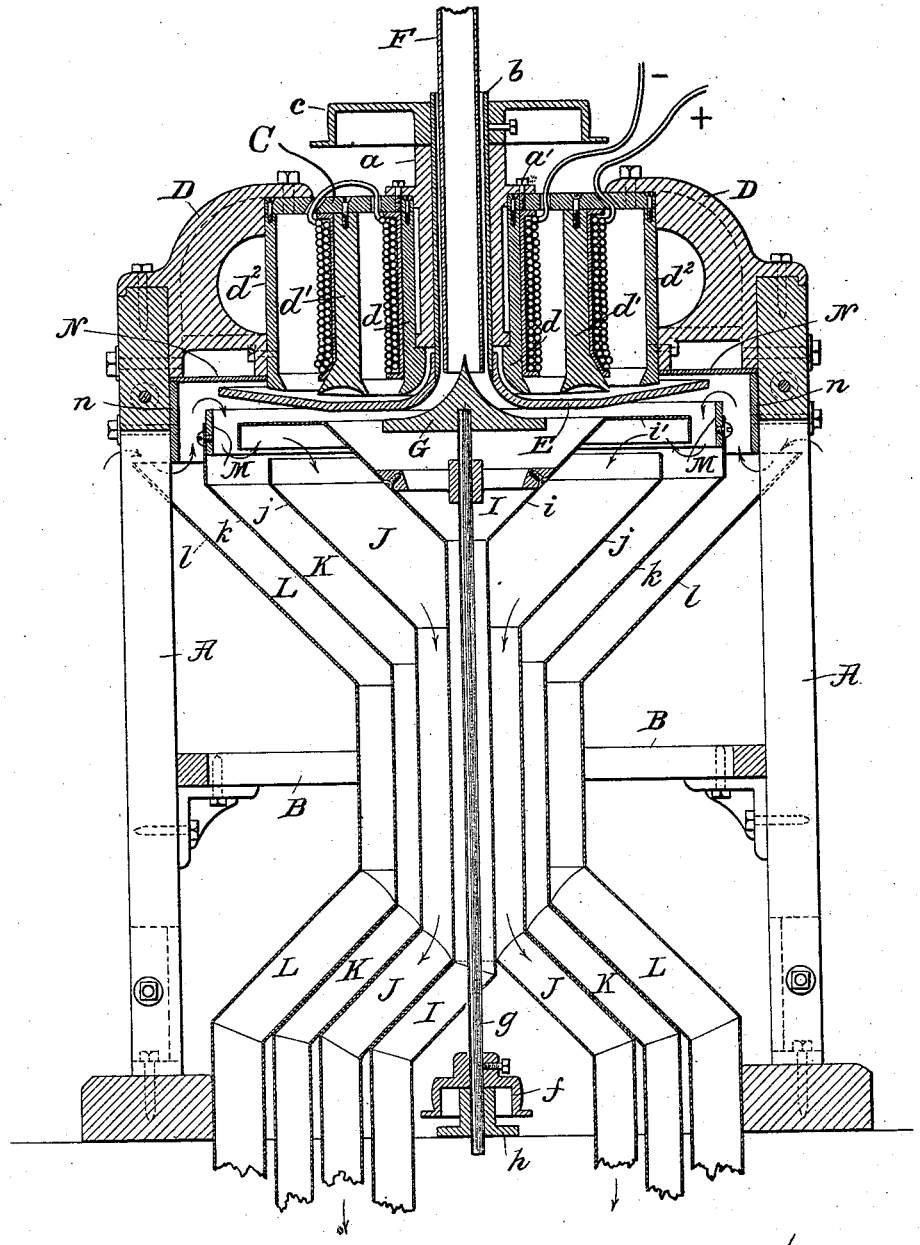
(No Model.) 4 Sheets—Sheet 1.

H. G. FISKE.

MAGNETIC SEPARATOR.

No. 455,984. Patented July 14, 1891.

FIG. 1.



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(No Model.) 4 Sheets—Sheet 2.

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MAGNETIC SEPARATOR.

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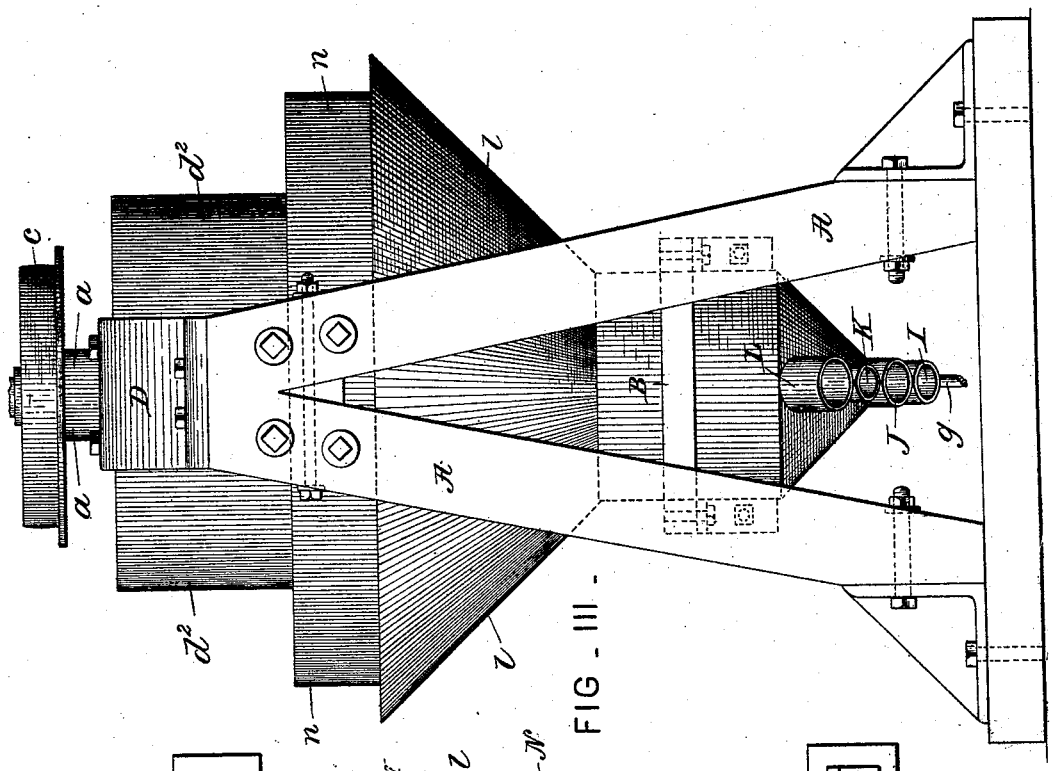

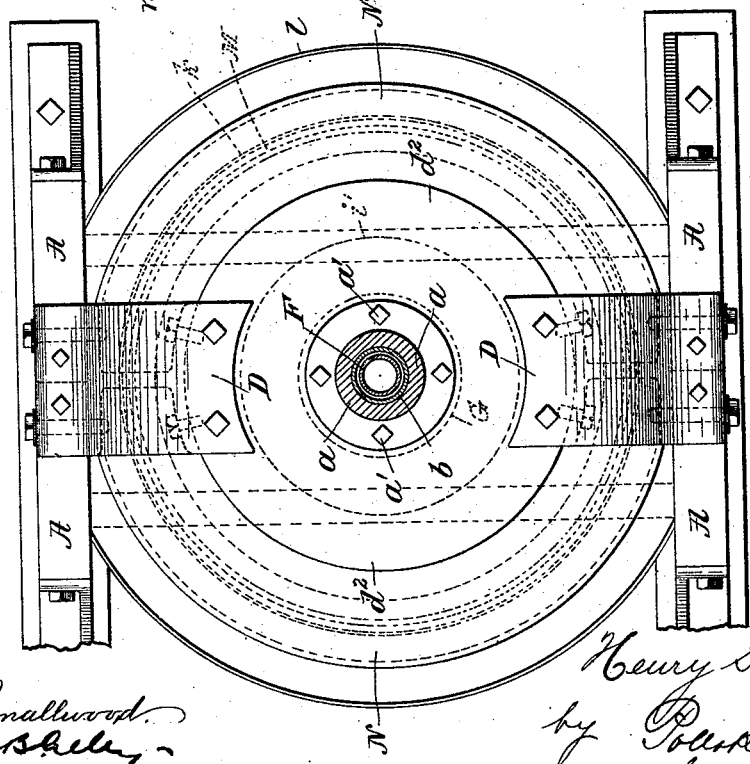

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(No Model.) 4 Sheets—Sheet 3.

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MAGNETIC SEPARATOR.

No. 455,984. Patented July 14, 1891.

FIG. IV.

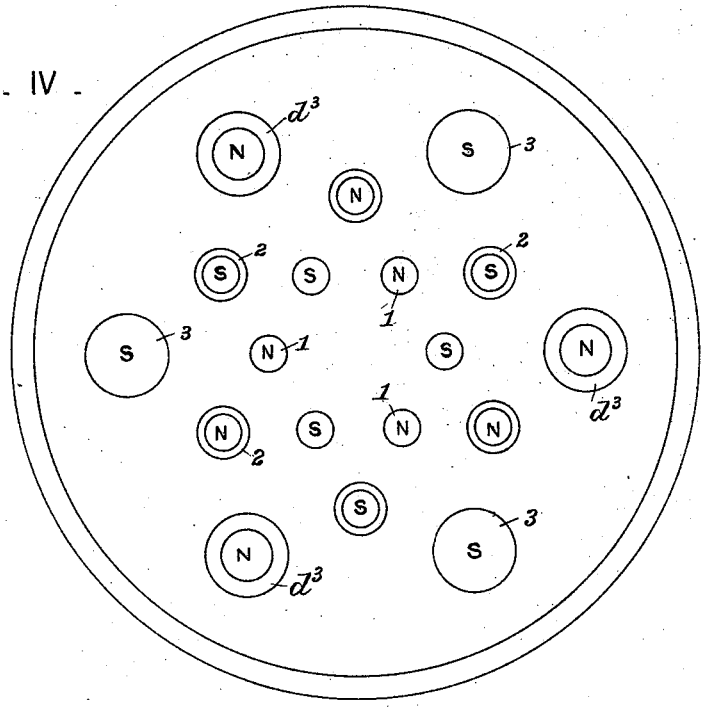


FIG. V.

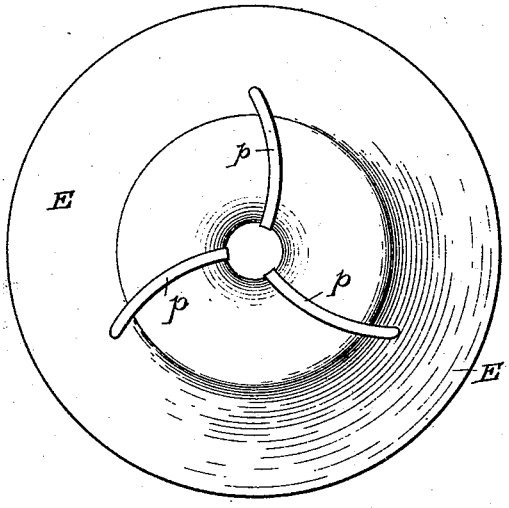
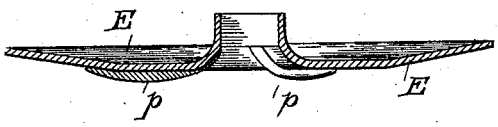


FIG. VI.



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(No Model.) 4 Sheets—Sheet 4.

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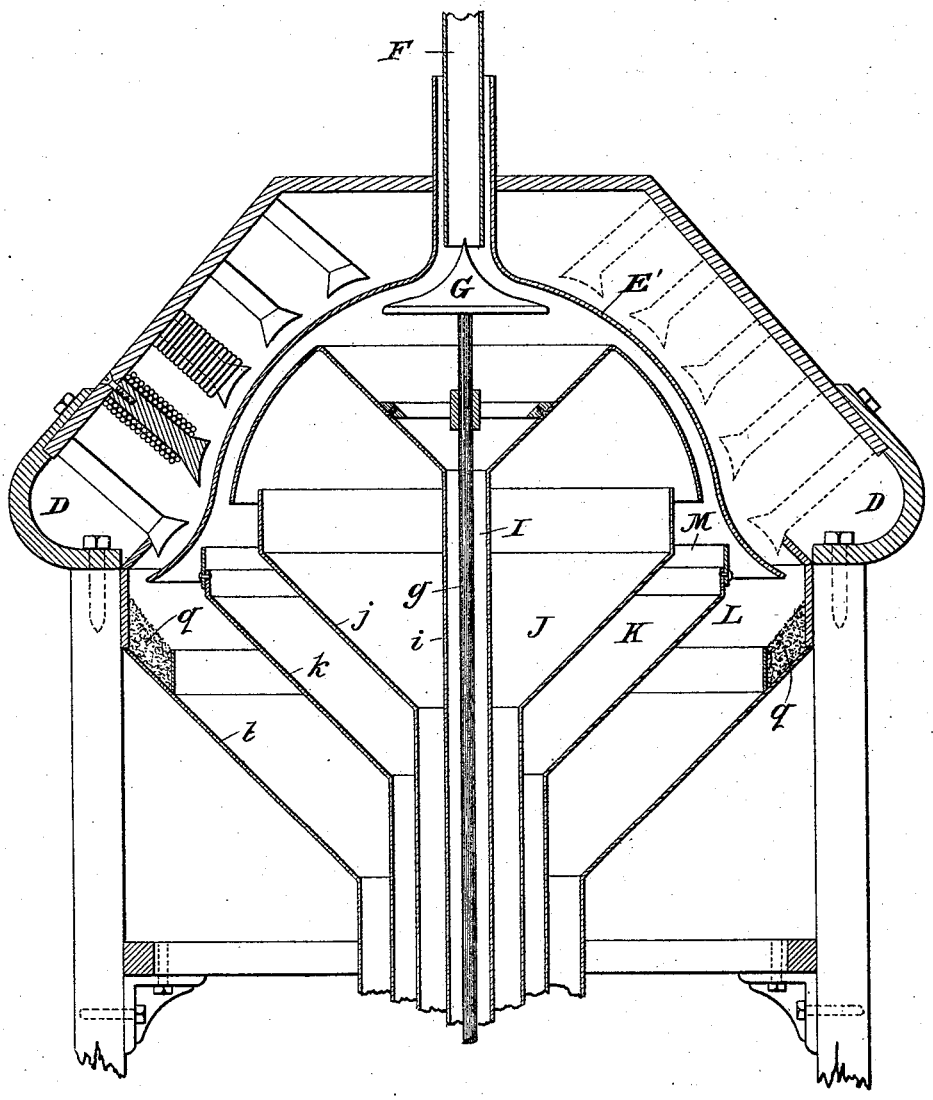
MAGNETIC SEPARATOR.

No. 455,984. Patented July 14, 1891.

FIG . VII .



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UNITED STATES PATENT OFFICE.

HENRY G. FISKE, OF NEW YORK, N. Y., ASSIGNOR TO JOHN D. CHEEVER, OF SAME PLACE.

MAGNETIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 455,984, dated July 14, 1891.

Application filed March 26, 1891. Serial No. 386,527. (No model.)

To all whom it may concern:

Be it known that I, HENRY G. FISKE, a resident of New York city, county and State of New York, have invented a new and useful Improvement in Magnetic Separators, which improvement is fully set forth in the following specification.

This invention has reference to the construction of magnetic separators; and its general objects are to produce an apparatus of simple and economical form operating in such manner as to utilize the force of the magnetic field to the best advantage and to obtain from the gangue a maximum quantity of concentrates.

The invention contemplates the feeding of the gangue through or across the magnetic field in a film or stream of regulated thickness, so that the best conditions are presented for separating all the magnetic particles from the tailings. It contemplates, further, the utilization of the entire surface of the magnet by feeding the mass of ore from the center toward the circumference thereof, which arrangement has the additional advantage that the layer or film of ore decreases in thickness toward the extremity of the magnetic field, so that the magnets have a better opportunity to sort out the magnetic particles and produce a high grade of concentrates. The mass is fed across the magnetic field by means which leave it practically unsupported, so that the disengaged tailings are free to drop at once into the receptacle provided for them.

In the apparatus herein described the mass of ore or other materials to be graded is delivered by a feed-pipe through the center of the magnetic field and then spread out laterally by centrifugal force. Thus a comparatively small portion of the mass traverses the entire field, whereas in most of the separators now in general use the entire body of gangue crosses the field, and the presence of the large quantity of non-magnetic particles, which constitutes the bulk of the mass, makes it difficult to obtain such a large proportion of concentrates as to render the operation commercially profitable. By means of the present invention it is possible to operate successfully with very low grade ores.

For feeding the gangue across the magnetic field I employ a disk, shield, or septum rotating at high speed, this device being arranged close to the poles of the magnet and having little thickness, so that the particles of the mass can approach very close to the poles. The shield is made of non-magnetic material and extends entirely across and beyond the edge of the magnets. In conjunction with this shield I employ a deflector for spreading the mass uniformly in every direction. The deflector may be stationary. It is preferred, however, to rotate it at a lower speed than the shield or septum. Adjusting means are provided, so that the thickness of the space between the shield and deflector can be regulated.

The invention includes a peculiar arrangement of air-passages, whereby a current of air is caused to pass through the concentrates in a direction opposite to their motion, carrying off the dust eliminated therefrom through a separate duct. When the air-current passes through the entire mass of gangue its energy is largely wasted, there being no object in separating the fine dust from the tailings. When the exhaust-fan is connected with the duct which carries the tailings, the fan is quickly damaged or destroyed by the hard particles which are drawn through it. Both these difficulties are avoided by the arrangement herein described.

The invention further includes improvements in the magnets designed to adapt them to act more efficiently. The ore in passing across the field adheres together in small lumps, in which non-magnetic particles are carried along with the iron. In order to disintegrate these lumps, I make the poles of the magnets hollow or concave at the ends, thus forming in the center a practically neutral point or line, and increasing proportionally the density of the field at the edges of the poles. Consequently when the small knots or lumps reach the neutral point they break up and the particles forming them scatter in different directions, thereby releasing the non-magnetic pieces, which fall into their proper receptacle.

The invention includes, in addition to the

leading features indicated above, other details, special arrangements, and combinations of parts, as will be fully described in connection with the accompanying drawings, which illustrate an apparatus embodying the principle of the invention.

Figure I is a vertical central section; Fig. II, a top plan view; Fig. III, a side elevation; Fig. IV, a diagram showing a special arrangement of the magnets. Figs. V and VI are details illustrating a shield provided with wipers or clearers, and Fig. VII is a view in vertical section illustrating a particular arrangement of the shield and magnets.

The frame-work of the machine consists of the uprights A, strengthened by a cross-piece B, and supports the circular field-magnets C, which are clamped to uprights A by means of the brackets D.

As shown in Fig. I, the magnets are in the form of concentric cylinders or tubes d d' d^2, so wound that their lower ends form poles alternating in polarity. Within the inner cylinder d is a sleeve a, preferably of brass, which is fastened by screws a' to the top plate of the magnet. This sleeve forms a bearing for the tubular shaft b, to which is attached at the upper end a band-pulley c, and carries at its lower end the shield or septum E. The latter extends across the entire face of the magnet and in close proximity to the poles. Within the shaft b is the feed-pipe F, suitably supported from above, and which delivers the mass to be treated through a central opening in shield F upon the top of the conical deflector G, which is carried by the upright spindle g. Pulley c is detachably secured to its shaft, as by a set-screw, so that the septum E can be adjusted vertically. The driving-pulley is similarly attached to spindle g, and rests upon a bushing h, so that the deflector G can also be adjusted vertically. By these adjustments the thickness of the stream of material may be regulated as desired.

The several discharge passages or ducts for carrying away the materials of different grades are formed by a series of concentric casings, which may be made of sheet metal. The inner passage I is for the tailings or materials of lowest grade. The passage K is for the intermediates or lean ores and passage L for the concentrates. The inner casing i flares outwardly at its upper end and has a horizontal annular portion i', terminating in a downwardly-projecting flange, which overhangs the chute K. The air-duct J is formed between the casings i and j. Casing k, which separates the concentrates from the intermediates, has at its upper edge a vertical adjustable rung M. The object of this adjustment is to enable the partition separating these two grades to be varied according to the results desired and the materials treated, and also to compensate for wear caused by the abrasion of the hard particles upon the edge of this partition.

The space above the ducts between the magnets and frame is closed by a top piece N. The outer casing l extends beyond this top piece, so that air can freely enter the passage L and pass under the ring n, upon which the piece N is supported. The several casings are contracted downwardly, so as to occupy less space, and at their lower ends are connected with pipes, which are lettered to correspond with the several channels. The channels L, K, and J branch to two pipes, while the channel I terminates in a single one.

In operation the shield E rotates at a high velocity—say five hundred revolutions per minute, more or less. The conical deflector G is rotated in the same direction, but at a much lower speed. As the mass of ore strikes the deflector it is spread out laterally into a sheet and urged by centrifugal force across the magnetic field. When this stream reaches the edge of the deflector, a great portion of the non-magnetic particles at once drops out of the mass into channel I and a comparatively small part of the entire mass continues across the field. This separation at the very point of entrance into the magnetic field is an important feature of the invention. The magnetic particles, being attracted by the magnetism of the field, cling to shield E and are constantly urged toward the edge thereof by centrifugal action. As the pole d' is of opposite polarity to pole d, the magnetic particles tend to turn over, and thus free themselves to some extent from the non-magnetic particles clinging thereto, the latter falling on the horizontal plate i. As shown, the pole d' is made concave for the purpose of increasing the intensity of the magnetism at the edges and weakening it at the center, as already set forth. This construction is preferably adopted for all the poles. When the sheet of ore, which increases in richness and decreases in thickness as it leaves the center of the field, approaches the edge of the shield, it encounters the air-current coming in the opposite direction and is freed thereby from much of the fine dust carried with it. The current passes down the duct J, to the end of which the exhaust-fan is connected. It will thus be seen that the action of the air is confined to the richer parts of the mass, so that its energy is not wasted in sifting dust out of the tailings, and, further, that the fan draws through it only the comparatively small quantity of dust which is eliminated from the concentrates. The intermediates or second grade products will fall into the chute or channel K, while the concentrates will be thrown with more or less violence against the ring n and then drop into the chute or channel L. If it is desired to increase the action of the air-current, it may be taken into channel L at a lower point than that shown.

For the sake of simplifying the explanation, I have shown but three cores or rings com-

prising the field-magnets; but obviously the number may be increased. When the poles of the field-magnets are formed, as in Fig. I, of continuous rings, there are presented lines of great resistance to the feed of the ore, tending to arrest the outward motion thereof. For this reason I prefer to break the continuity of the poles, thus providing, as it were, openings or passages of little resistance through the field. This may be accomplished, as represented in the diagram Fig. IV, by substituting a series of small cylindrical cores for each ring or tubular core, these small cores being disposed at suitable distances apart in concentric rings 1, 2, and 3. The cores of the several series are made of different sizes, the outer series being of the largest size. In this arrangement adjacent poles of the same series are of opposite polarity, as indicated by the letters N S, so that the magnetic particles shift or turn over as the septum carries them past successive poles. For the purpose of making a neutral point at the center of each pole, from which the particles of a lump will tend to scatter in radial lines, the cores of these magnets may be made hollow. Those marked d^3 are so shown in the drawings. It is preferred to surround the magnetic field by a continuous magnetic ring, as indicated.

When the septum is shaped as shown in Fig. I, there is a great increment of velocity as the particles pass toward the outer limit of the field. On this account I prefer the conoidal or bell shaped septum E′, (shown in Fig. VII,) whose angular velocity increases toward the outer edge at a much smaller ratio than is the case with a practically flat shield. Another advantage of this arrangement is that it increases the area of the magnetic field, which is measured along the outer surface of the septum, instead of in a practically horizontal line across it from edge to edge. Fig. VII also shows the arrangement of a pocket *q* at the point where the ore is thrown off the shield. The accumulation of ore in this pocket protects the casing from wear, and similar pockets may be located at other exposed points.

It is desirable to provide means for preventing the clogging of the passage between septum E and deflector G. Such means are shown in Figs. V and VI, and consist of a series of ribs or clearers *p*, extending from the edge of the central opening in the shield toward its outer edge. As the shield and deflector move at different speeds, these ribs prevent the clogging of the space between the two without impeding the motion of the stream of ore across the field.

It will be obvious to persons skilled in the art to which the invention relates that modifications other than those described herein could be made without departing from the spirit of the invention, and that some of the improvements herein set forth could, if desired, be used without the others.

Having now fully described the principle of my invention, as well as what is deemed the best embodiment thereof, what I claim, and desire to secure by Letters Patent, is—

1. A magnetic separator provided with a centrifugal acting feeding device for feeding the mixed mass of magnetic and non-magnetic particles across the field on the under side of the magnets, substantially as described.

2. In a magnetic separator, the combination, with the stationary field-magnets, of a pipe for delivering the materials to be treated at about the center of the field, and a rotatory septum or shield covering the poles of the magnets and adapted to spread and feed the materials across the field by centrifugal force, substantially as described.

3. The combination, with the field-magnets, of a delivery-pipe passing through the same, a rotatory septum covering the poles on the under side of the magnets and having an orifice for the passage of the ores or other materials, and a series of ducts or channels beneath the septum for receiving the graded products, substantially as described.

4. The combination, with field-magnets having downwardly-projecting poles, of a rotatory septum in close proximity to said poles, a deflector beneath said septum, means for delivering ores or other materials between the septum and deflector, and ducts or channels for receiving the graded products, substantially as described.

5. The combination of the field-magnets and means for feeding a stream of ore or other materials across the magnetic field, air-inlets for taking air near the extremity of the magnetic field and passing the same through the concentrates, air-forcing means communicating with said inlets, and a separate duct for diverting the air-current from the gangue or mass of mixed materials, as set forth.

6. The combination of the stationary magnets, the rotatory septum beneath the same, the feed-pipe, the conical deflector beneath the septum and opposite the discharge-orifice of the feed-pipe, and means for rotating the deflector, substantially as described.

7. The combination of the magnets, the rotatory septum beneath the same, means for adjusting the septum with reference to the poles of the magnets, and the deflector beneath the septum, substantially as described.

8. The combination, with the magnets, the feed-pipe, and the rotatory septum, of the deflector supported on a shaft and adjustable toward and away from said septum, substantially as described.

9. The combination of the magnets, the rotatory septum, and the deflector beneath said septum, the latter being provided with ribs or clearers, substantially as and for the purposes described.

10. The combination of the magnets with downwardly-projecting poles, the septum

adapted to rotate in proximity to said poles, the feed-pipe for delivering the gangue at the center of the field, and a series of concentric casings beneath the septum forming channels or ducts for receiving the graded products, substantially as described.

11. The combination of the stationary magnets having poles arranged in series around the center of the field, a feed-pipe for delivering the gangue within the inner series, and a rotatory septum for urging the mass across the field by centrifugal force, adjacent poles which successively act on the particles of the mass being of opposite polarity, substantially as described.

12. The combination of the magnets having cores and poles arranged in concentric series, the rotatory septum, and means for delivering gangue within the inner series of poles to be spread by centrifugal action across the magnetic field, the poles of each series being separated or discontinuous, so as to form paths of low magnetic intensity through the field, substantially as described.

13. In a magnetic separator, a field-magnet composed of cores arranged in rows or series with suitable spaces between adjacent cores of each series, such adjacent cores being of opposite polarity, in combination with means for feeding a stream of ore across the field, substantially as described.

14. A field-magnet composed of cores and poles arranged in concentric rows, adjacent poles of the same row being separated by a suitable space and being of opposite polarity, in combination with a rotatory septum and with a pipe for delivering gangue against said septum within the inner row of poles, substantially as described.

15. A field-magnet composed of cores and poles arranged in a concentric series, the mass of the outer series of cores being greater than those within, in combination with a rotatory septum and a feed-pipe discharging within the inner ring or row, substantially as described.

16. In a magnetic separator, a field-magnet having its polar extremities hollowed out or recessed to form a point or line of minimum strength for the purpose specified, in combination with means for feeding a stream of materials across the face of the pole, substantially as described.

17. The combination of the flaring or bell-shaped septum, the feed-pipe for delivering ore inside the same, the field-magnets having their poles arranged in close proximity to said septum, and means for rotating the latter, substantially as described.

18. The combination, with the rotatory septum and magnets above the same, of a series of channels formed by casings, one within the other, for receiving the graded products, the partition between two adjacent channels which receive the concentrates and intermediates, respectively, being provided with an adjustable ring, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

HENRY G. FISKE.

Witnesses:
PHILIP MAURO,
JONA. B. CILLEY.