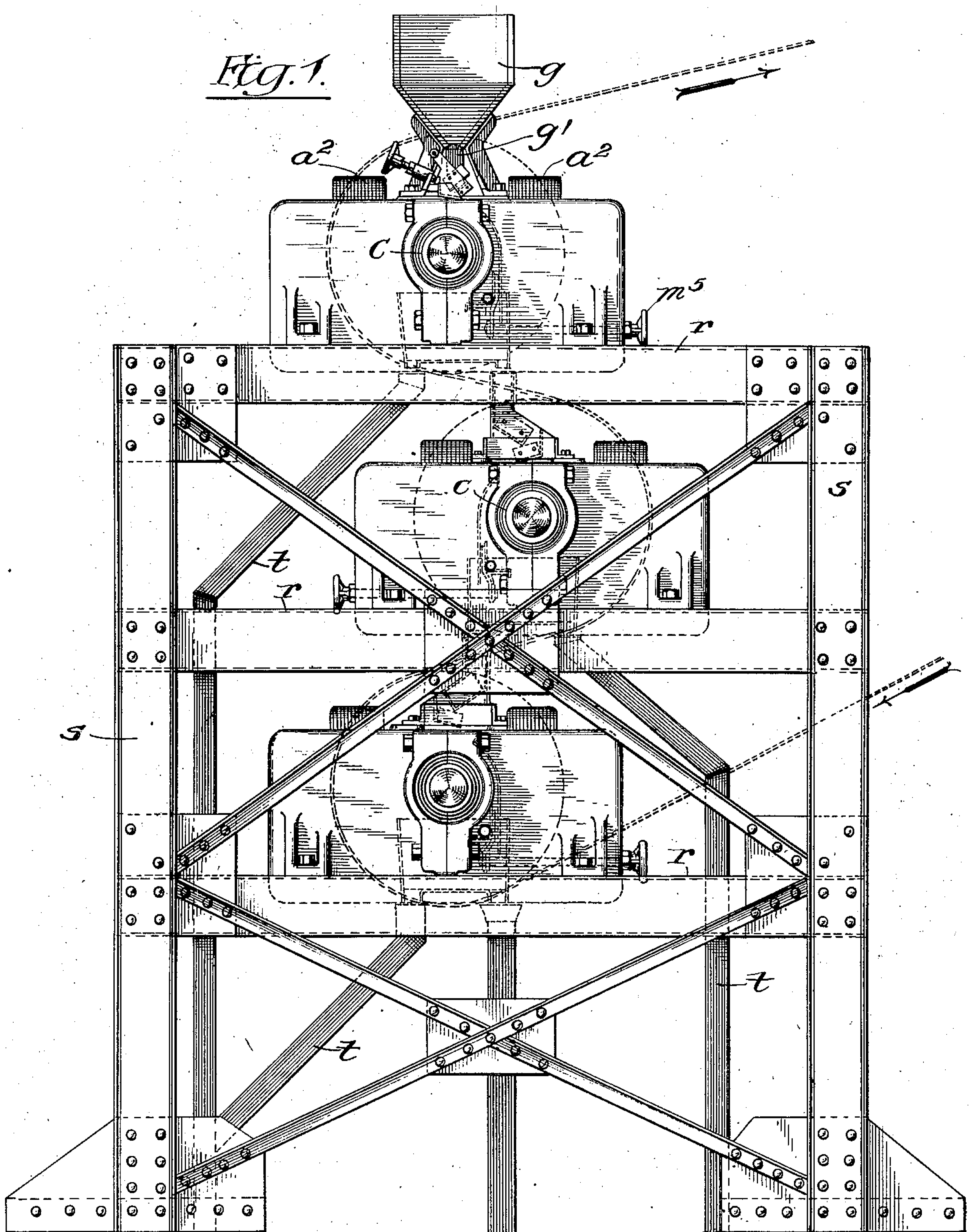
F. T. SNYDER.
ORE SEPARATOR.
APPLICATION FILED APR. 4, 1904.

944,699. **Patented Dec. 28, 1909.**

4 SHEETS—SHEET 1.



Witnesses:
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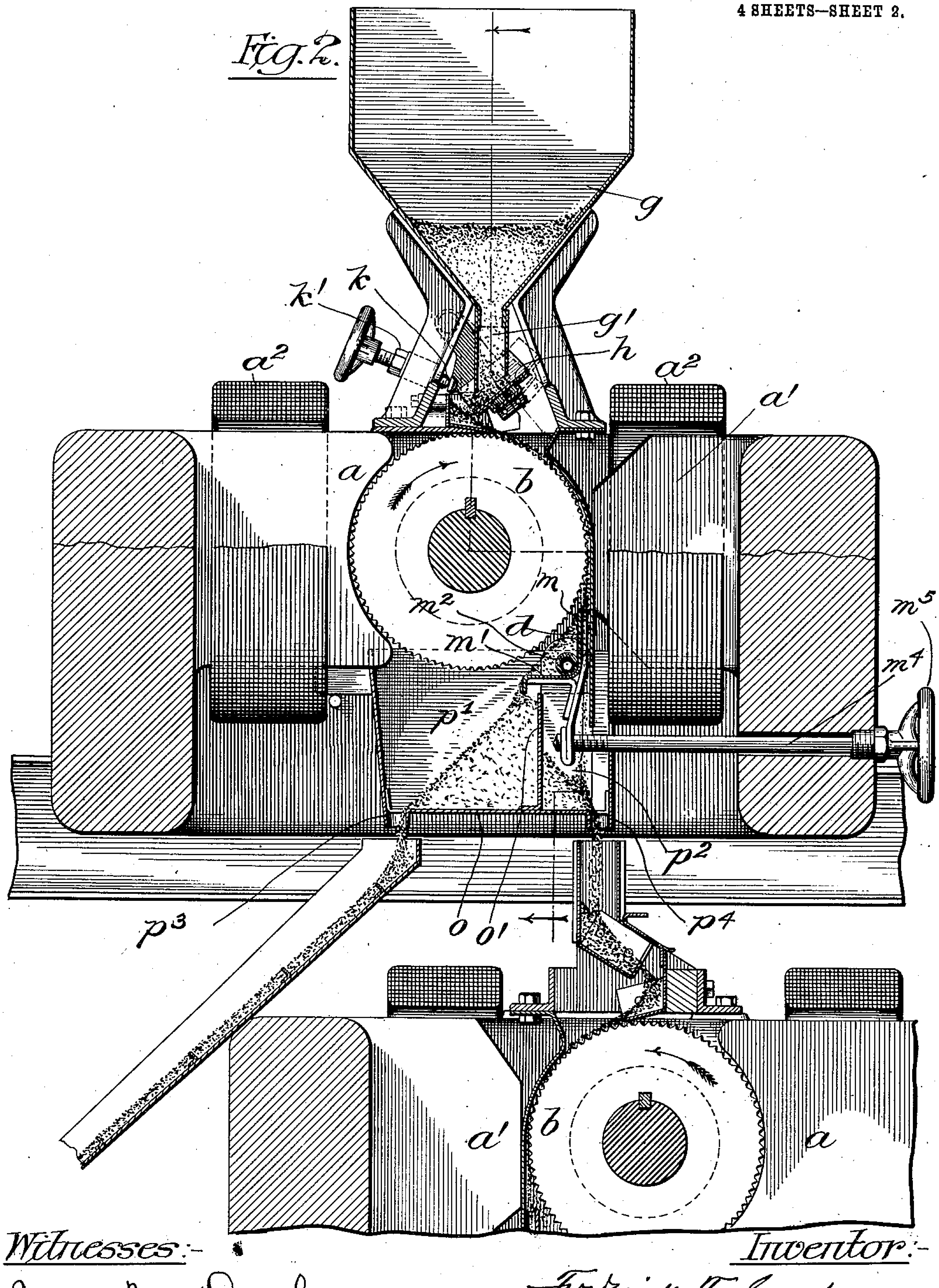
4 SHEETS—SHEET 2.

Fig. 2.



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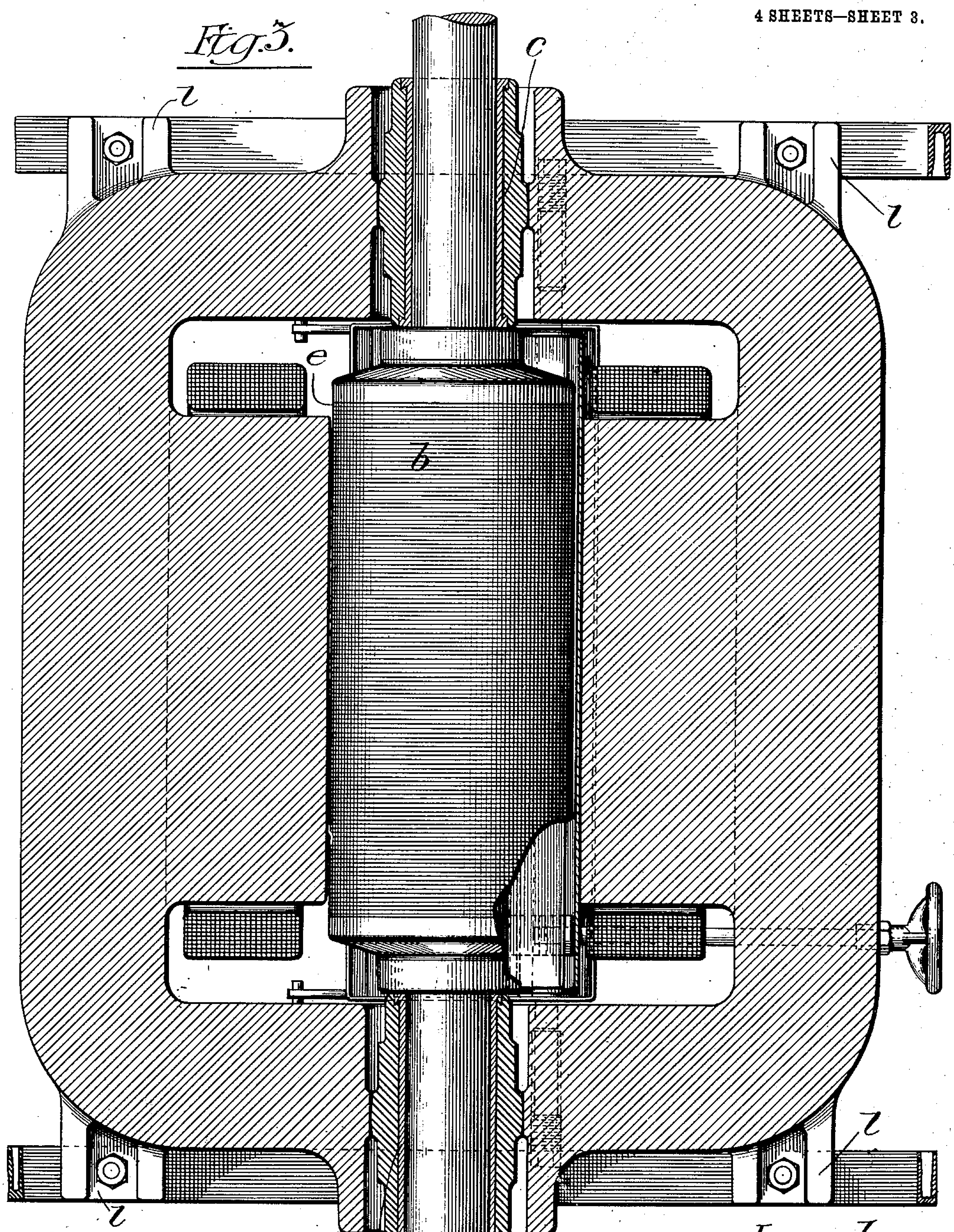
4 SHEETS—SHEET 3.

Fig. 3.



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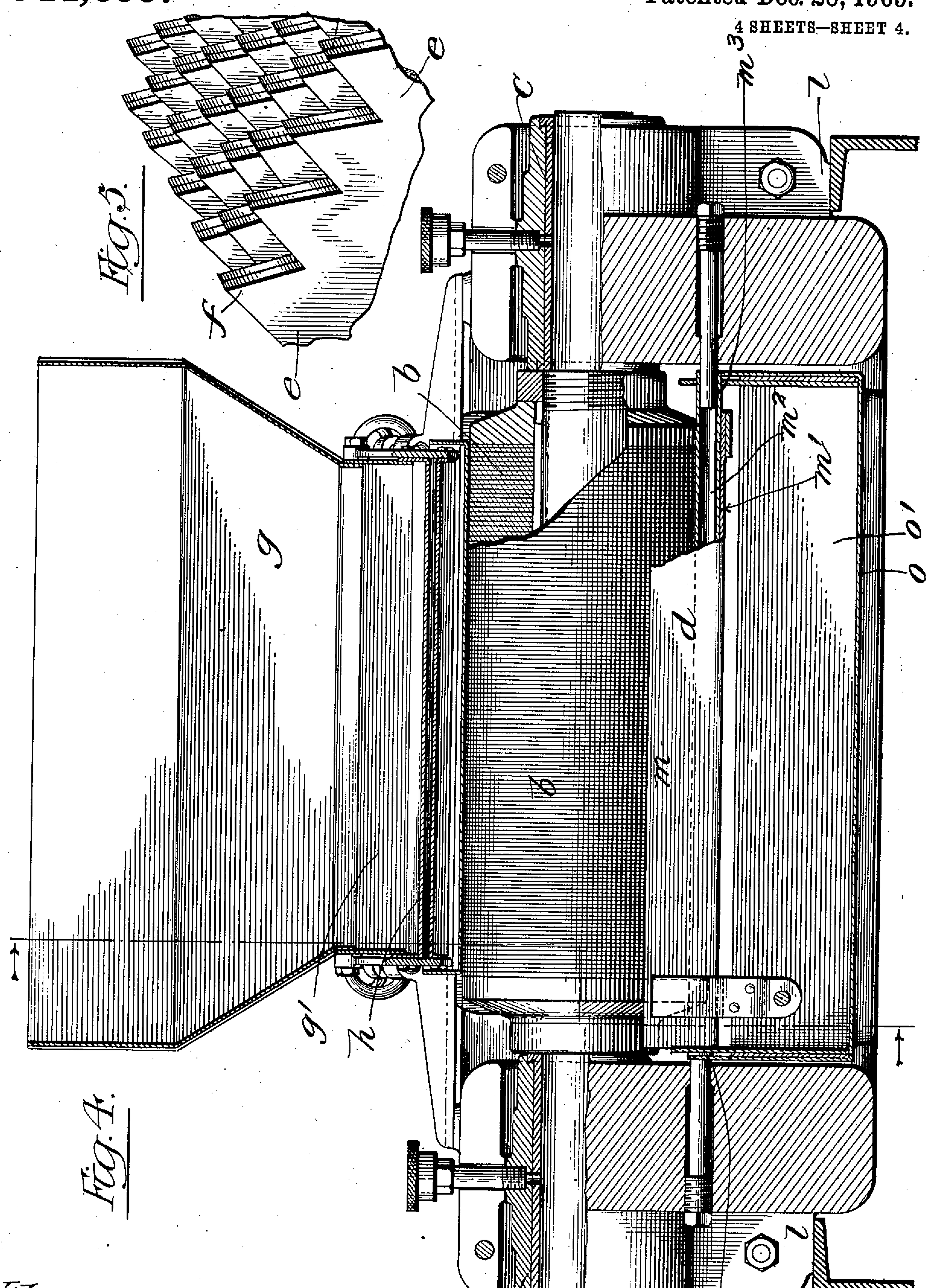

Fig. 3.

Fig. 4.

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UNITED STATES PATENT OFFICE.

FREDERICK T. SNYDER, OF CHICAGO, ILLINOIS, ASSIGNOR TO INTERNATIONAL SEPARATOR COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF NEW JERSEY.

ORE-SEPARATOR.

944,699. Specification of Letters Patent. Patented Dec. 28, 1909.

Application filed April 4, 1904. Serial No. 201,381.

To all whom it may concern:

Be it known that I, FREDERICK T. SNYDER, citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Ore-Separators, (for which I have made applications for patents in foreign countries as follows: in New South Wales November 27, 1903, in Great Britain December 24, 1903, and in Sweden January 2, 1904,) of which the following is a full, clear, concise, and exact description.

My invention relates to a magnetic ore separator, and its object is to produce a machine which will be especially effective for the separation of ores of very low permeability, and which may be run without undue waste of energy.

Generally speaking, my invention contemplates a structure in which an iron armature cylinder provided with teeth or other permeable projections upon its periphery, is arranged to rotate between two magnet poles of opposite polarity which are external to the cylinder, and facing the same, the material to be separated being fed into contact with the cylinder and carried around in the rotation thereof, so as to pass between the cylinder and one of said poles. The more permeable material will be attracted along converging lines of force to the surface of the cylinder, while the less permeable material will fall down, so that a separation of the two classes of material is effected, the separated materials being further directed in different paths by a suitable divider or partition. The two magnet poles of opposite polarity, being external to the cylinder, tend to establish a neutral point upon the surface of the cylinder, where the polarity of the flux is reversed. At this point the most strongly attracted material will be released, no matter how dense the flux may be at the place of separation. Preferably the two magnet poles are applied on diametrically opposite sides of the cylinder, which gives rise to the advantage that the magnetic traction of each pole upon the cylinder is opposed by the traction of the other pole, to reduce the friction upon the bearings. The armature cylinder is preferably built up of iron disks or laminæ having teeth or serrations upon their edges, and the best results are obtained if the laminæ are assembled in such a way as to present the teeth in staggered or off-set relations, so that the falling material cannot escape the magnetic fluxes diverging from the points and edges of the teeth. The magnet poles are preferably constructed to embrace unequal areas of the armature, and the material to be separated is fed between the cylinder and the pole piece of restricted area. The face of this pole piece, below the axis of the cylinder, is preferably formed to lie beyond a vertical plane tangent to the cylinder, to permit a free fall of the unattracted material and a concentration of the magnetic lines of force where the surfaces of the cylinder and pole piece most closely approach.

Other features of my invention consist in a novel form of divider, an improved form of magnet frame which will be strong and rigid, but which will permit easy removal of the armature, and an improved construction of the magnet framework and mounting whereby several individual machines may be readily assembled in a compact train, so that the ore may be passed directly from one machine to the next and so on through the series without stopping and without the requirement of separate conveying mechanism.

Further details of my invention will hereafter be described by reference to the accompanying drawings, and pointed out in the claims.

Figure 1 is a view in elevation of an ore separating mill or train comprising three individual separating machines stacked up according to my plan to take the material through them in series; Fig. 2 is a sectional elevation of the top machine, showing also a portion of the machine next below; Fig. 3 is a sectional plan view; Fig. 4 is a vertical sectional view on line 4—4 of Fig. 2; and Fig. 5 is a detail view of a portion of the surface of the armature, showing how it is built up.

The same letters of reference are used to designate the same parts wherever shown.

Each machine consists in its elements of a hollow box-form magnet frame, open at the top and bottom, and having pole pieces *a a′* projecting inwardly from the sides of said frame, between which pole pieces the cylindrical armature *b* is mounted to rotate on its axis, said armature being journaled in bearings c c in the sides of the magnet frame. Said frame is made in two parts bolted together at the bearings as shown.

The pole pieces a a' are preferably both provided with magnet windings or helices a^2 a^2 and are magnetized thereby to opposite polarities. The magnet windings may be energized by any suitable source of current.

The material to be separated is fed upon the upper surface of the rotating armature, and is carried around past the pole piece a', the face whereof is preferably of restricted area. In passing the pole piece, the more permeable particles of ore are attracted to the armature by virtue of a construction thereof which I shall presently describe, and are carried to one side of the divider d, and so separated from the less permeable particles which fall directly down.

A considerable advantage is obtained by providing magnet windings on both pole pieces, instead of upon only one, because there is less tendency for the magnetic lines of force set up by one pole to avoid the armature and leak back through the air.

The armature is located between the two pole pieces, which face each other on diametrically opposite sides of said armature, so that the magnetic traction of one pole upon the armature is opposed or counteracted by the traction of the other pole. The friction on the bearings will therefore be comparatively slight, and only a small amount of energy will be required to rotate the armature.

The armature or rotating cylinder is built up of a number of flat punched sheet iron disks or laminations e e. The edges of said disks are serrated into teeth as shown at f f. The disks are preferably assembled side by side upon a shaft in such relative positions as to present the teeth in staggered relations upon the surface of the cylinder, as shown most clearly in Fig. 5. A series of permeable projections or points of magnetic concentration is thus provided upon the surface of the cylinder, which will have the effect of attracting permeable particles of ore to the cylinder, instead of to the magnet pole piece.

In any magnetic separator the attraction of the particle is in the direction of the convergence of the lines of force and is proportionate both to the degree of convergence and to the number of lines of force threading through the particle. Lines of force leaving the face of the pole piece a' in fairly uniform distribution are severally converged upon the teeth or points of concentration upon the surface of the armature, and this convergence of the lines of force to different points is materially assisted by the laminated construction of the armature. When the surface of the armature is formed as above described, the falling particles of ore are sure to strike or roll onto the points of teeth, and are not liable to miss the teeth and glide through between them.

It is not necessary that the teeth should have any particular shape, but it is desirable that the points of the teeth should be sharp, and that they should project radially from the armature. If the teeth were square at the points, for example, there would be a convergence of the lines of force to the edges or corners of the teeth on each side, and there would also be a flux of substantially uniform density from the central portion of the tooth, which last mentioned flux would be of less service in attracting permeable particles of ore. If the teeth of the armature be formed by serrations or V-shaped notches in the edges of the disks, such as shown in Fig. 5, the ideal condition is obtained.

In the claims I use the expression "permeable projections" as a generic term, referring not only to the particular teeth shown, but also to any construction whereby the magnetic lines of force are converged or concentrated upon or diverged from magnetically-projecting points, lines or narrow areas at the periphery of the cylinder, whether the physical surface of the cylinder is roughened or not.

The laminated construction of the armature is of great importance in producing the desired convergence of the lines of force, not only by reason of the facility with which it lends itself to the production of the toothed formation already spoken of, but also because the lines of force naturally tend to converge upon the individual disks. Such a construction, furthermore, permits the armature to be turned in the intense magnetic field with a comparatively slight expenditure of energy, which is not possible with a solid armature.

The location of the rotating armature between diametrically opposite pole pieces serves not only to balance the magnetic traction and so to reduce the friction upon the armature, but also insures the establishment of a neutral point at some place on the armature between the two pole pieces. This neutral point is highly desirable, since at this point even the most permeable particles of ore which have stuck to the cylinder in its rotation must be totally released and disengaged from the armature before it carried them clear around.

The face of the pole piece a' is preferably of restricted area, as shown, to produce a more intense concentration of the lines of force, but the other pole a is preferably formed with a curved face to closely embrace the armature. This gives rise to a slight inequality of the pull upon the armature, but is nevertheless desirable, because it greatly reduces the reluctance of the magnetic circuit, and so reduces the ampere turns and the size of the magnetic frame required to establish a magnetic field of the required strength.

I will now describe my improved form of feeding mechanism by which the ore is directed into contact with the surface of the armature. The hopper *g* may be of the usual form, with a discharge spout *g'*. A gate *h* is hung to swing to and fro underneath the discharge spout of the hopper, and is balanced so that it tends to swing to a closed position, and to return to this position after having been thrown open. An adjustable screw stop *k* is arranged to limit the closure of the gate, whereby the gate may be initially adjusted to a given feeding position. This construction is very desirable in case the feeding opening should be clogged, in which case the gate may be opened for the moment to allow the material which is caught to pass on through, after which the gate will automatically return to its proper feeding position without experimental adjustment. I further preferably provide an adjustable stop nut *k'* for the screw *k*, said nut being adapted to limit the advance of the screw to determine the feeding position of the gate. This structure is useful where the machine is temporarily shut down, since on starting up again, the gate may be returned to the previous feeding position without experimental adjustment, it being necessary merely to screw up the stop *k* until its advance is checked by the stop nut *k'*.

The divider below the armature is constructed of angularly disposed plates *m m'*, which are adapted to retain a portion of the falling material in the corner thereof to provide a self-renewing inclined deflecting surface. The divider may be formed of a single sheet of metal bent at a right angle to form the vertical and horizonal portions *m m'*. It may be mounted upon a hollow shaft m^2, which is pivoted at m^3 m^3 in the sides of the magnet frame, and may be adjusted by a worm screw m^4 having an operating hand wheel m^5.

Each machine is provided with a collecting box *o* having a partition *o'* therein under the divider, forming two compartments p' p^2, into one of which, p', the more permeable material will be deflected, while the less permeable material falls directly down into the other compartment p^2. The discharge spouts or openings p^3 p^4 of the compartments p' p^2 respectively are preferably so located that the material will pile up between the floor and the side of the collecting box, to form a self-renewing inclined surface for the falling material, as shown in Fig. 2. By this construction, the metal parts of the collecting box are less liable to be quickly worn out by the attrition of the falling material.

Each machine is provided with lugs *l l* upon the frame thereof, which are adapted to rest upon supporting rails *r r*. The two halves of the machine, being separable at the journals, may readily be slid apart upon the supporting rails *r r*, and permit the insertion or removal of the armature.

As shown in Fig. 1, I preferably provide a number of individual separating machines arranged in a train or mill, one above the other, so that the ore may be passed directly from one machine to the next, and so on through the series without requiring separate conveying mechanism. The framework *s* is provided with a series of cross rails *r r* at different heights, each pair of cross rails being adapted to support an individual separating machine, such as I have described. The several machines, being slidably supported upon said cross rails, may not only be readily taken apart, but may be easily adjusted to bring the receiving hopper or feeder of a lower machine under either one of the discharge spouts of the machine above it, as may be desired. In the arrangement of Fig. 1, each of the lower machines is arranged to receive the less permeable material discharged from the machine above it, the more permeable material separated by each machine being discharged into corresponding receiving troughs or spouts *t t*. It will be observed, however, that by sliding the machines on their cross rails, this arrangement can be varied so that a lower machine will take the more permeable material which has been separated from the rest by the machine above, if such an arrangement should be desirable. The three machines may, if desired, be arranged to be driven by a single belt, as shown.

I am aware that prior to my invention, Clarence Q. Payne had invented, constructed and used a magnetic ore separator comprising a hollow separating cylinder and opposing magnet poles located one outside and one inside of said cylinder, and that in such machine the hollow cylinder was transversely laminated, being built up of sheet iron plates having teeth on their outer edges which constituted the surface of the cylinder, the plates being assembled in such relations that the teeth were out of alinement or staggered. I therefore disclaim the broad invention of such a laminated toothed separating cylinder, and limit myself to the combinations set forth in the appended claims.

Where the term disks is used in the claims, it should be understood to include any flat plates of general circular outline, no matter how large the hole through the center may be. In other words, I understand that the term would include flat rings, which, when assembled, would make a hollow cylinder.

I claim:

1. In an ore separator the combination

with a rotating cylinder adapted to carry the material to be separated, and means for magnetizing said cylinder, of a divider mounted below said cylinder having a substantially vertical plate in a plane near the edge of said cylinder and a substantially horizontal ledge extending underneath the cylinder from the lower portion of said vertical plate, whereby a portion of the falling material is retained in the corner between said plate and ledge to provide a self-renewing inclined deflecting surface.

2. The combination with an ore separator having a rotating cylindrical carrier, of a divider mounted below said carrier comprising a shaft and a sheet metal plate bent at a right angle to form vertical and horizontal portions, said plate being mounted upon said shaft, and means for rotating said shaft to adjust the vertical portion of said plate with relation to said carrier.

3. The combination with the horizontal supporting rails, of a magnetic separator frame constructed in hollow box-form, open at the top and bottom, and having inwardly-projecting pole-pieces and a cylindrical armature mounted horizontally to rotate upon its axis in bearings in the sides of said frame, said frame being separable, the two members of said frame being supported upon said rails and adapted to slide apart horizontally thereon to permit the insertion or removal of the armature.

4. An ore-separating mill, comprising a frame-work having a series of cross rails adapted to support a corresponding series of individual separating machines, each machine comprising a hollow box-form magnet frame having inwardly projecting pole-pieces and an armature journaled horizontally in bearings in the sides of the magnet frame, each machine having a receiving feeder at the top and separate discharge spouts at the bottom for the materials which have passed through, the several machines being slidably supported on said cross-rails to permit adjustment thereof to bring the receiving hopper of a lower machine under one of the discharge spouts of a machine above it, and means for collecting the separated materials.

5. In a magnetic separator, the combination with a magnet, of a stationary pole on said magnet, said pole having a vertical face, a cylindrical armature rotatably mounted before said pole, a divider between said pole and said armature, the edge of said divider lying substantially in the vertical plane tangent to the periphery of said armature, and means for feeding material to be separated into the space between said stationary pole and said armature.

In witness whereof, I hereunto subscribe my name this 1st day of April A. D., 1904.

FREDERICK T. SNYDER.

Witnesses:

DE WITT C. TANNER,

W. W. LEACH.