No. 765,013. PATENTED JULY 12, 1904.

F. J. KING.

MAGNETIC ORE SEPARATOR.

APPLICATION FILED MAR. 31, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

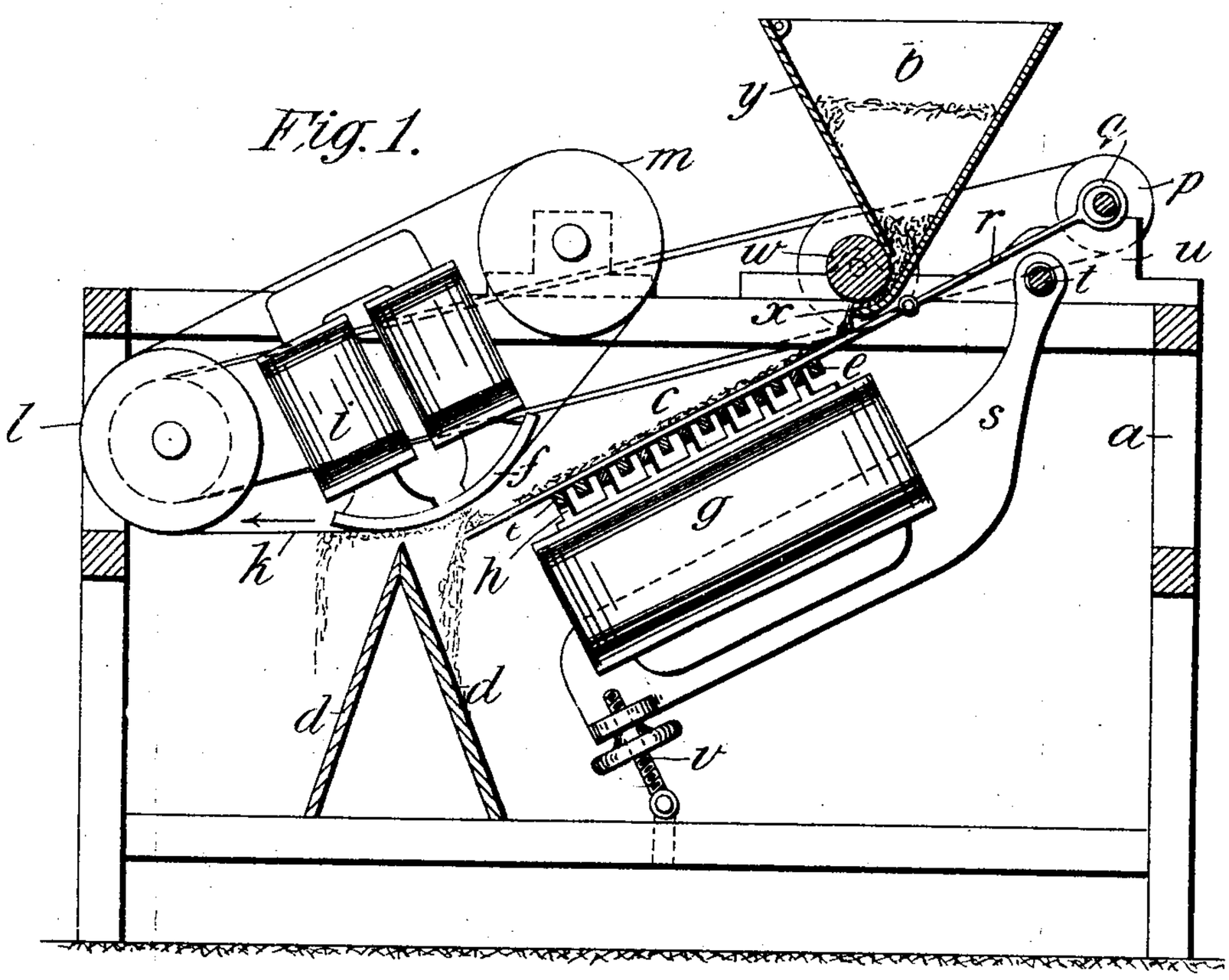
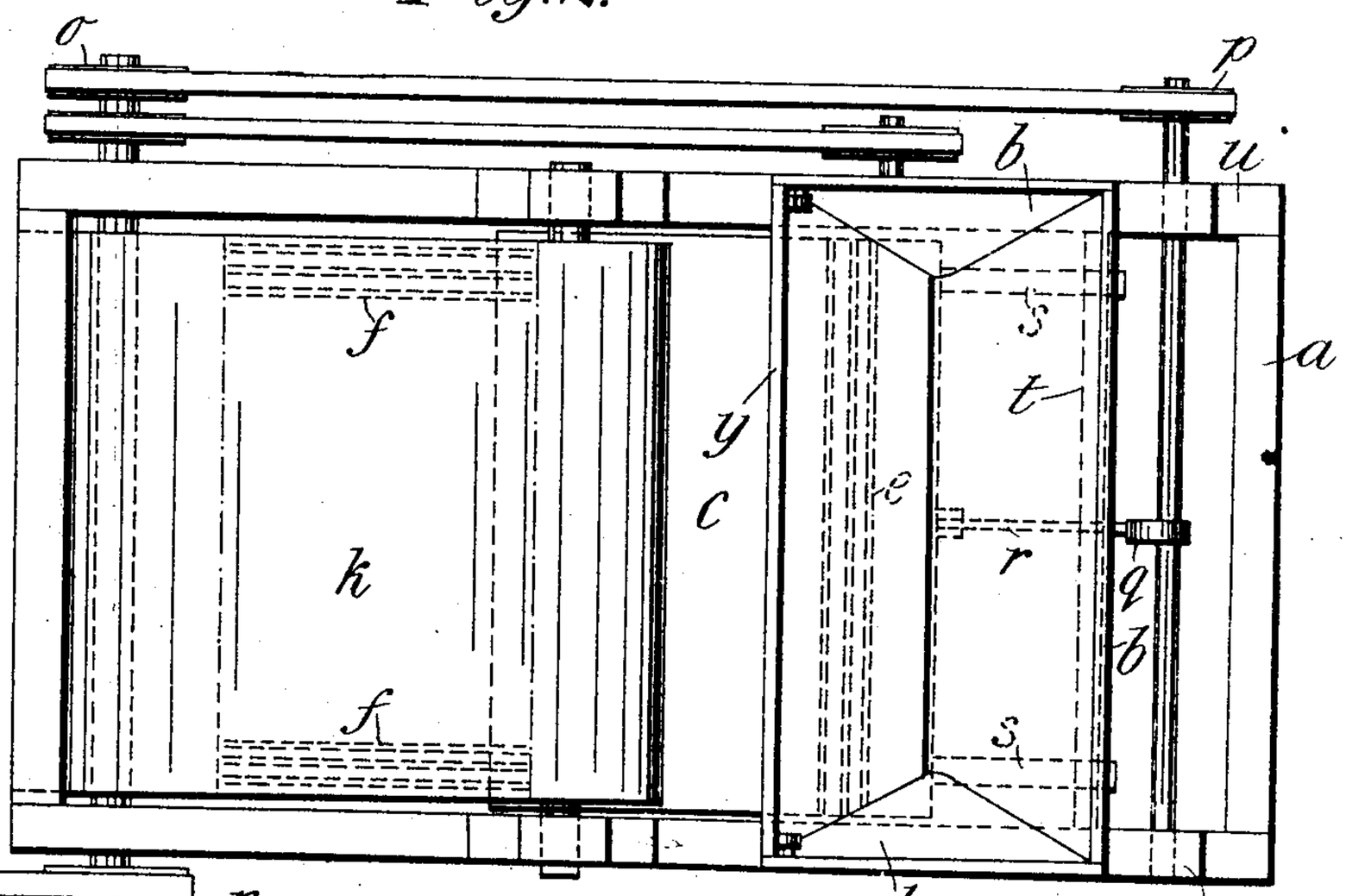


Fig. 2.



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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.

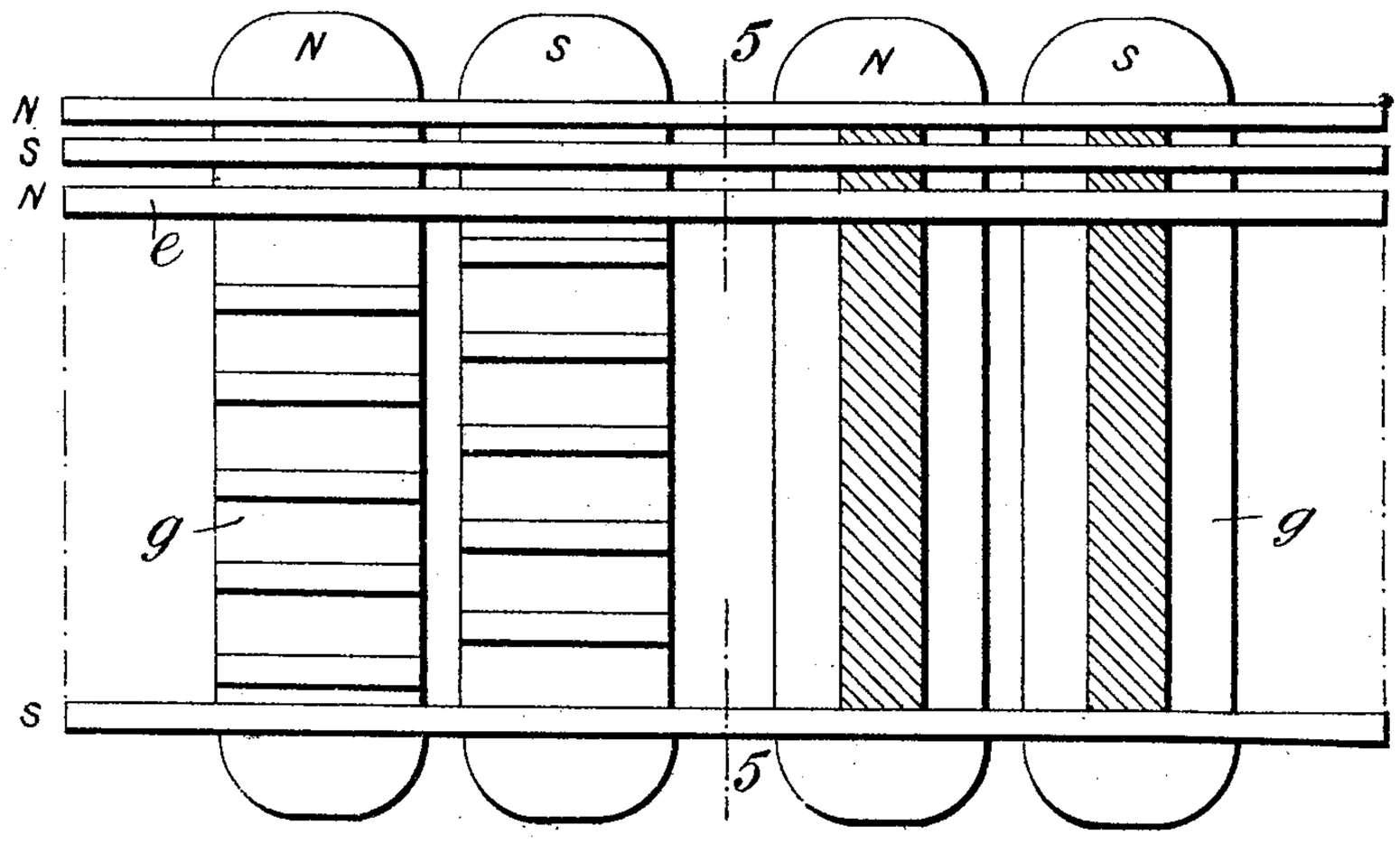


Fig. 4.

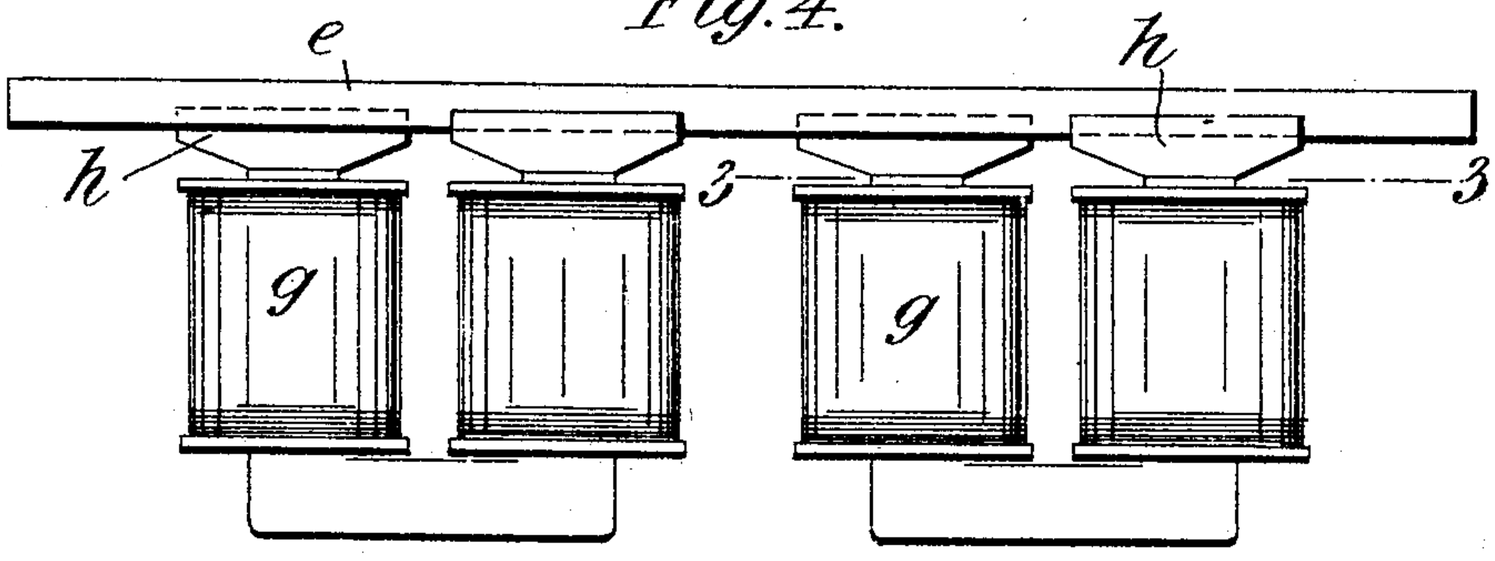
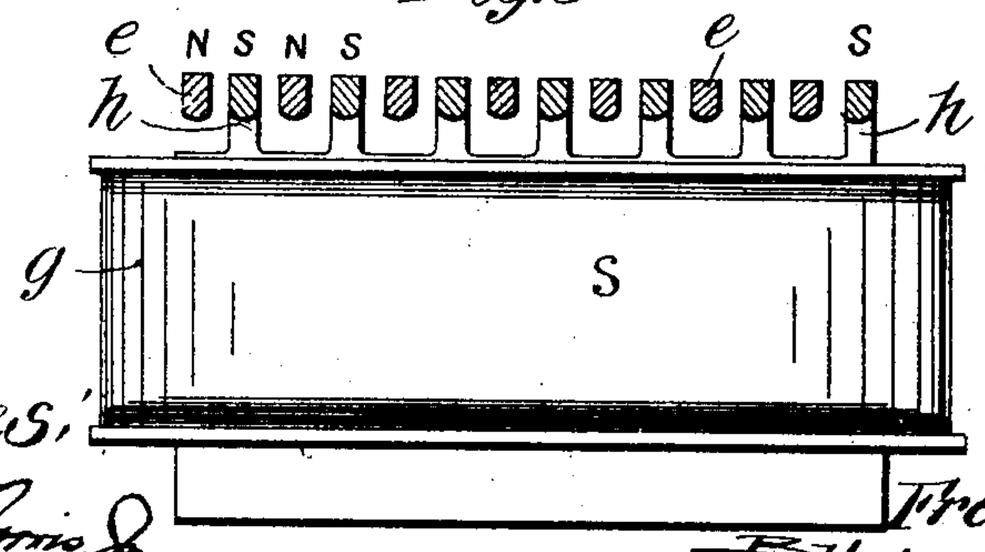


Fig. 5



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MAGNETIC ORE SEPARATOR.

APPLICATION FILED MAR. 31, 1902.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 6.

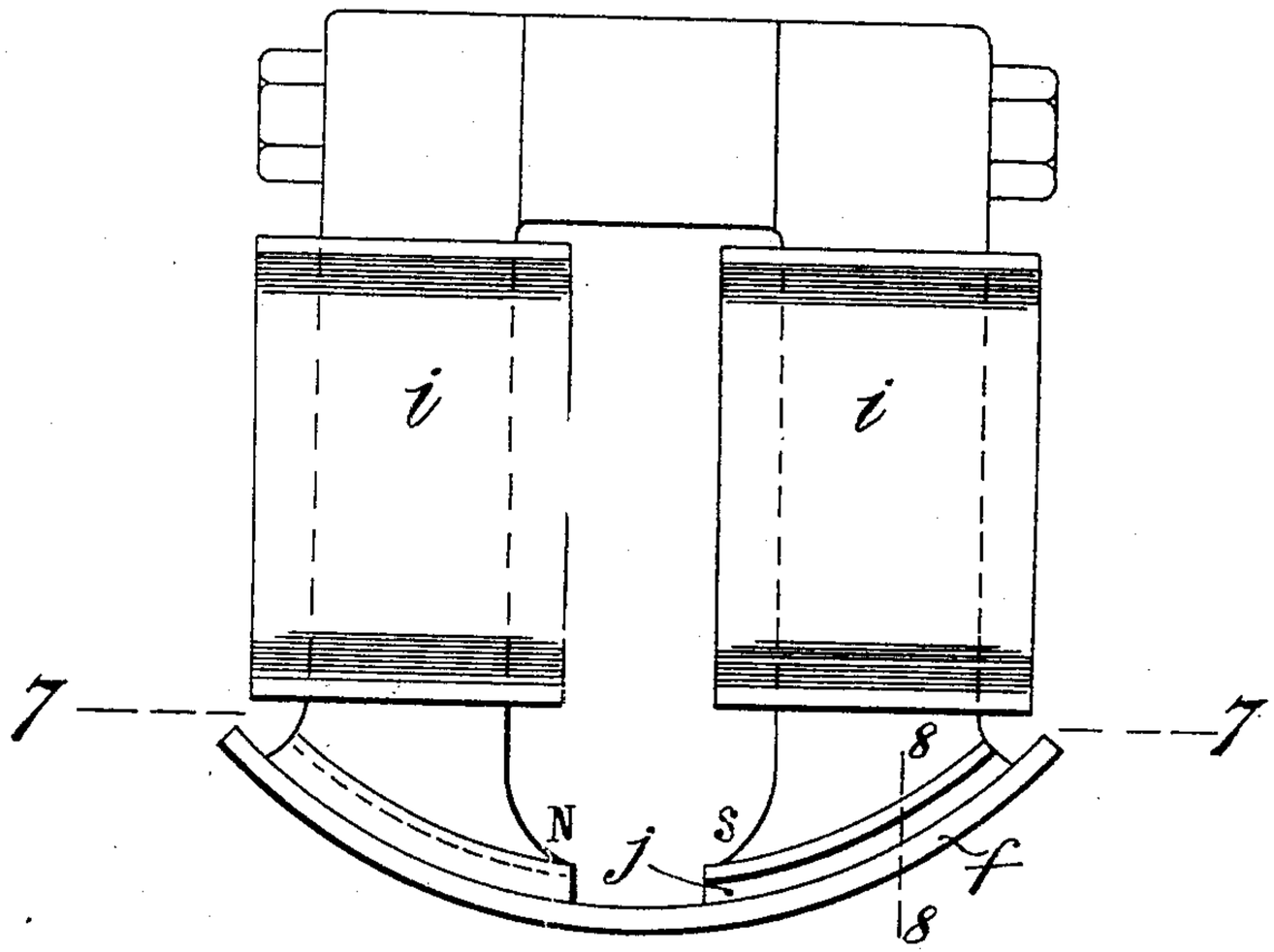


Fig. 7.

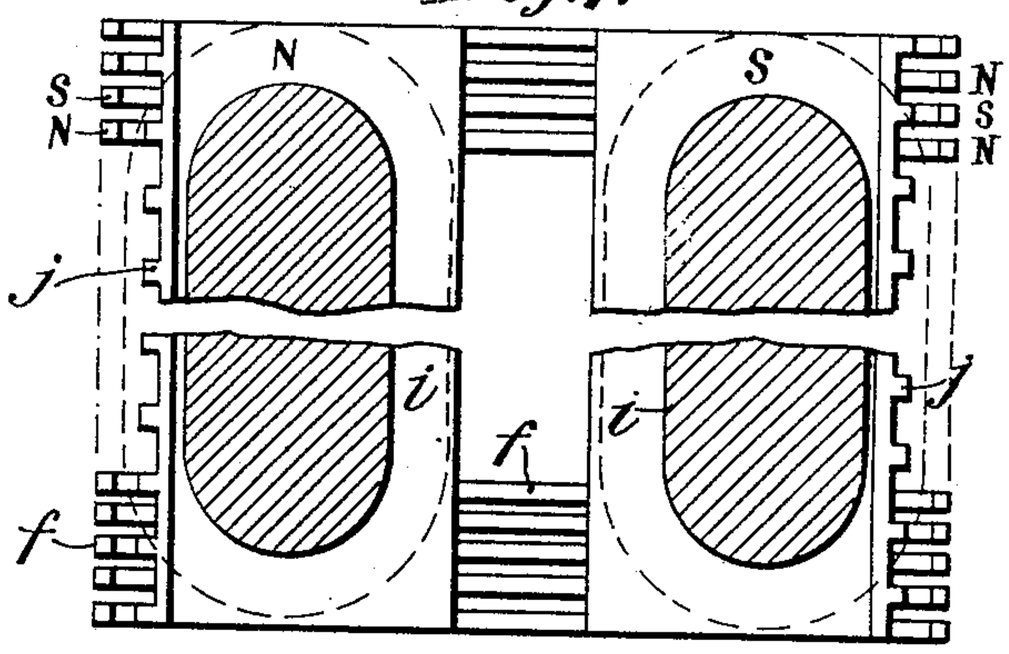
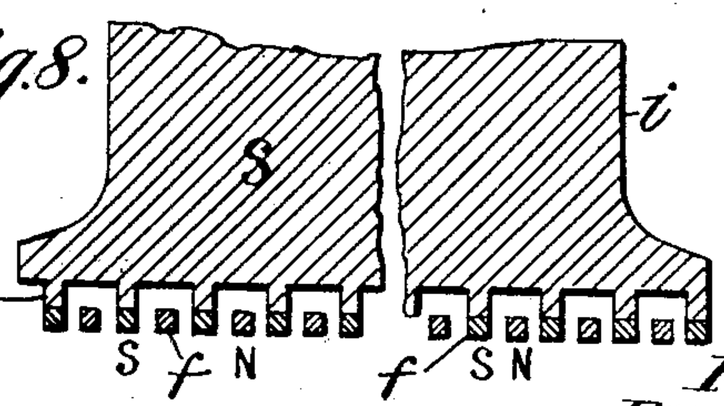


Fig. 8.



Witnesses:
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Frederick J. King
By James L. Norris.
Atty.

No. 765,013. Patented July 12, 1904.

UNITED STATES PATENT OFFICE.

FREDERICK JOHN KING, OF CROYDON, ENGLAND.

MAGNETIC ORE-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 765,013, dated July 12, 1904.

Application filed March 31, 1902. Serial No. 100,825. (No model.)

To all whom it may concern:

Be it known that I, FREDERICK JOHN KING, mining engineer, a subject of the King of Great Britain, residing at 17 South Park Hill road, Croydon, in the county of Surrey, England, have invented certain new and useful Improvements in and Relating to Magnetic Ore-Separators, of which the following is a specification.

This invention has reference to magnetic ore-separators, and is designed to overcome the difficulties which are found in separators of the kind or class in which powerful electromagnets are employed. In separators of this kind if the ore be brought directly under the influence of the separating-magnets considerable loss arises owing to the non-magnetic portion of the material being caught and carried away by the magnetic particles which are attracted to the magnets, and only an imperfect separation is attained. Moreover, if the magnetic fields are not kept quite uniform, or practically so, then the degree of separation varies according to the strength of each particular part of the field or fields.

Now according to this invention I first treat the ore in a preliminary manner by passing it over a magnetic table or plane consisting of a series of more or less tranverse magnetic bars or poles arranged very closely together and energized uniformly, or practically so, throughout their length by being connected alternately to the opposite poles of a series of very powerful electromagnets. The transverse bars thus serve to split up the fields of these electromagnets into a considerable number of subsidiary uniform fields, following each other closely. In this way very strong and uniform magnetic fields are set up between the bars, and the ore or material in passing these fields becomes stratified, as it were, the magnetic particles turning on their axes as they change from field to field, and thus gradually working their way onto the top of the material. The transverse bars may, if desired, be placed at an angle or slope across the magnetic table or plane and may be straight, curved, or wavy in form. After this preliminary treatment the ore is brought under the action of a second set of magnets, which may be termed the "separating-magnets." These are arranged above the ore and serve to attract the magnetic material, which now forms the top layer of the ore, and can therefore leave it freely without carrying off any of the non-magnetic material. Instead of allowing the attracted particles to adhere directly to the separator-magnets the faces of the latter may be protected and covered by an endless traveling belt, of rubber, canvas, or other suitable material. In the latter case the magnetic portion of the ore adheres to the face of this belt and is thereby carried away some distance from the magnetic table or plane before it detaches itself from the belt, and hence it can be very easily guided away from the stream of non-magnetic material without any fine adjustments of the chutes or guiding devices being necessary, as is the case in many magnetic separators.

In the accompanying drawings, Figure 1 is a side view, partly in section; and Fig. 2 is a plan showing one construction of the improved separator. Fig. 3 is a plan and Fig. 4 an end view illustrating the magnetic system belonging to the magnetic plane or table, Fig. 3 being partly in section on the line 3 3, Fig. 4. Fig. 5 is a section on 5 5, Fig. 3. Fig. 6 is a side view showing one of the stationary separating-magnets. Fig. 7 is a horizontal section on the line 7 7, Fig. 6. Fig. 8 is a part section on the line 8 8, Fig. 6.

Referring more particularly to Figs. 1 and 2, the apparatus is mounted on a suitable frame *a* and comprises a hopper *b* for feeding the ore, a reciprocating inclined tray *c*, of brass or other suitable non-magnetic material, down which the ore slides, and a chute *d* for guiding the separated magnetic portion away from the non-magnetic portion of the material. The tray *c* is arranged to work above the magnetic plane, which is composed of a number of bars *e*, extending across the under side of the tray. These bars are only, say, about one centimeter apart, and as they alternate in polarity a great number of long narrow magnetic fields are produced, across which the ore has to pass. At the lower end of the tray is the separating-magnet system, which com-

prises a number of curved segmental bars *f*, whose polarities alternate like those of the bars *e*, but which are arranged at right angles to the latter, (see dotted lines, Fig. 2,) so that they are in line with the motion of the material. The construction of these magnet systems will now be described. Taking first that of the magnetic plane or table, the bars *e* are mounted upon the poles of two powerful horseshoe-electromagnets *g*, whose pole-pieces are formed with projections *h*, as shown more clearly in Fig. 5, and the bars *e* are secured to these projections. The projections on the north poles alternate with those on the south poles, so that the bars mounted on them pass midway between those of the south poles. By making the spaces between the projections somewhat deep in relation to the distance between the bars, as shown, there is practically no magnetic leakage between a north pole and the south bars passing over it, and vice versa. The spaces between the bars *e* may be filled up with white metal or other suitable non-magnetic material. By arranging the poles of the magnets *g* at regular intervals along the bars *e*, as shown, the said bars become magnetized uniformly, or practically so, throughout their length. There may be any desired number of magnets *g*, according to the width of the tray; but two are considered sufficient for a width of, say, twenty-six inches.

In the separator magnetic system the curved bars *f*, which are shown as segments of ninety degrees, are mounted on the poles of the magnet *i*. This magnet extends the whole width of the tray and has enlarged pole-pieces formed (see Fig. 8) with projections *j* analogous to those of the magnets *g* to carry the bars *f*.

The endless belt traveling over the face of the separator-magnet is shown at *k*. It extends round a pair of drums *l m*, any suitable means being employed for keeping the belt tight. The drum *l* is mounted on a shaft driven by a belt on a pulley *n*. From another pulley, *o*, on this shaft a belt extends over a pulley *p* on the shaft of an eccentric *q*, which through its rod *r* serves to reciprocate the tray *c*.

To readily adjust the slope of the tray *c* and its associated parts, the magnets *g* are carried by a frame *s*, hung from a cross-shaft *t*. This shaft and that of the eccentric *q*, as well as the hopper *b*, are all mounted in the same bearing-blocks *u*. By inserting packing-pieces under these blocks the hopper and the upper end of the magnet-frame and tray can be set at any desired height, according to the inclination required.

To regulate the attractive action of the separate magnets, an adjusting-screw *v* is provided, by which the lower end of the tray can be moved toward or away from the magnet-face.

The hopper *b* has a feed-roller *w* at its lower part driven by a belt from the shaft of the drum *l*, by which the material can be fed at any desired rate, according to the size of the pulley on the roller-axle. The roller works in a lip or trough *x*, and on it rests one side *y* of the hopper, this side being hinged at its upper edge. The motion of the roller produces a shaking or jarring of this hinged side, and so causes the material to pass down readily into the trough *x*.

The action of the apparatus is as follows: The ore falls from the feed-hopper onto the reciprocating tray *c*, down which it passes slowly over the magnet-bars *e*. The magnetic particles in passing from field to field between the bars are caused to turn over backward and forward, owing to the changes of polarity and the reciprocation of the tray, and are gradually worked up onto the top, forming a layer over the rest of the material. By the time the bottom of the tray is reached this preliminary separation is practically complete, and when the ore comes under the influence of the separator-magnets the top magnetic layer is attracted toward the poles and adheres to the belt *k* without carrying with it any of the non-magnetic matter next to the surface of the tray. The attracted particles adhere to the belt until they leave the field of the separator-magnets, when they drop on the left side of the chute *d*, whereas the non-magnetic material drops directly off the end of the tray onto the right side of the chute. A considerable space thus exists between the point where the non-magnetic material falls from the tray and that where the magnetic material falls from the belt, thus rendering it very easy to keep the two kinds of material separate and avoiding any necessity for a fine adjustment of the chute *d*, such as is required in systems where the two streams of material simply branch away from each other.

The magnets of the magnetic plane are inclosed in a suitable dust-tight casing, (not shown,) as may be also the other parts of the apparatus as far as possible.

In some cases the separator-magnet may be replaced by a rotating magnetic wheel which consists of, say, four radial magnets mounted on a shaft and provided with circular bars analogous to the bars *f*, but forming complete rings, which constitute the periphery of the wheel. The belt may then travel directly around this wheel, the material being attracted to the belt from the edge of the tray exactly as in the former arrangement. In other cases these peripheral rings may be divided into segments, each set of segments having its own radial magnets. When such an arrangement is employed, a suitable commutator may be provided on the shaft to energize only that magnet or magnets which may be in the lower or attracting position, the other magnets being cut out until they reach this position. By this means a considerable saving of current is attained. A suitable brush may be

provided in this or the former arrangement to insure the proper removal of the magnetic material from the belt.

The bars *f* of the separator-magnets may, if desired, be arranged transversely of the apparatus—that is, parallel with the bars *e*. Moreover, instead of employing the reciprocating tray *c* an endless belt might be arranged to convey the material over the magnetic table, as will be readily understood.

It should be explained that the capital letters "N. S." are used throughout merely in the usual way to distinguish north from south poles.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. A magnetic separator comprising a set of magnet-bars for sorting the material, and another set of curved magnet-bars at right angles to the first set and overlapping the lower end of said first set for the purpose of separating the sorted material, substantially as described.

2. A magnetic separator comprising a set of magnet-bars, means for moving the material transversely over said magnets, another set of curved magnet-bars at right angles to the first set, and an endless belt traveling against the under side of said curved bars to withdraw the magnetic material from the vicinity of the first set of bars, substantially as described.

3. A magnetic separator comprising horseshoe-magnets having wide poles, a series of teeth or projections on said poles, the teeth or projections on the north poles alternating with those on the south poles, magnet-bars connected at intermediate points in their length to said teeth or projections, a reciprocating inclined tray, means for moving said tray to and fro above said magnet-bars, and a separating-magnet at the lower end of said tray, substantially as described.

4. A magnetic separator comprising horseshoe-magnets having wide poles, a series of teeth or projections on said poles, the teeth or projections on the north poles alternating with those on the south poles, magnet-bars connected at intermediate points in their length to said teeth or projections, a reciprocating inclined tray, means for moving said tray to and fro above said magnet-bars, a separating-magnet at the lower end of said tray, and an endless belt for carrying the magnetic material away from the falling stream of non-magnetic material, substantially as described.

In testimony whereof I have hereunto set my hand, in presence of two subscribing witnesses, this 17th day of March, 1902.

FREDERICK JOHN KING.

Witnesses:
C. BARNARD BURDON,
T. J. OSMAN.