(No Model.)

E. FERRARIS.

MAGNETIC SEPARATOR.

No. 468,599. Patented Feb. 9, 1892.

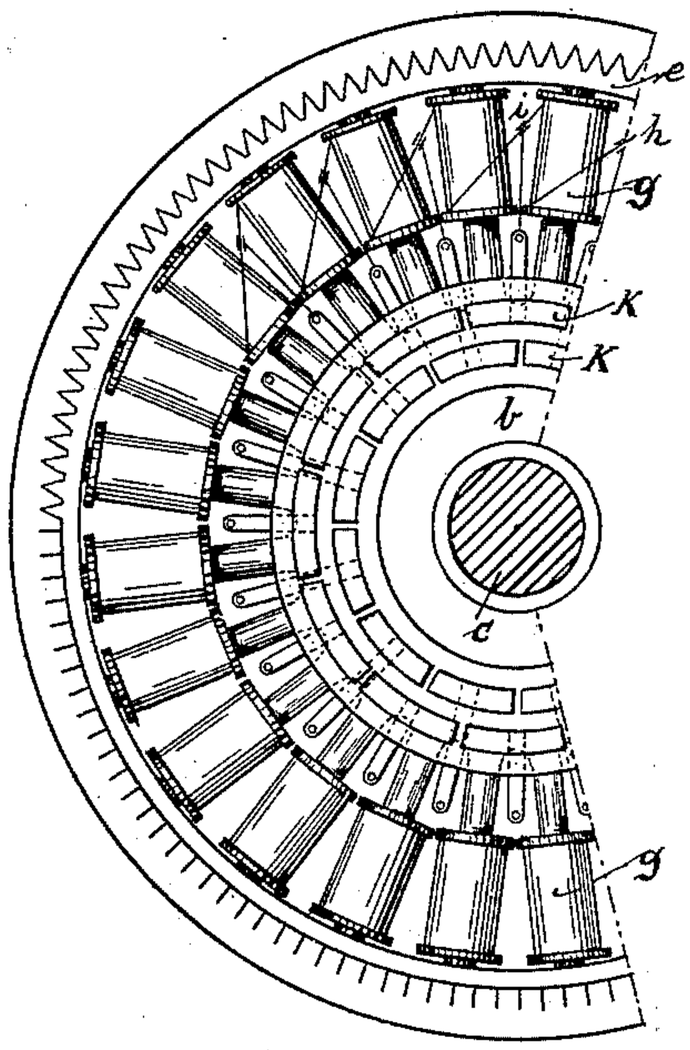


Fig. 1.

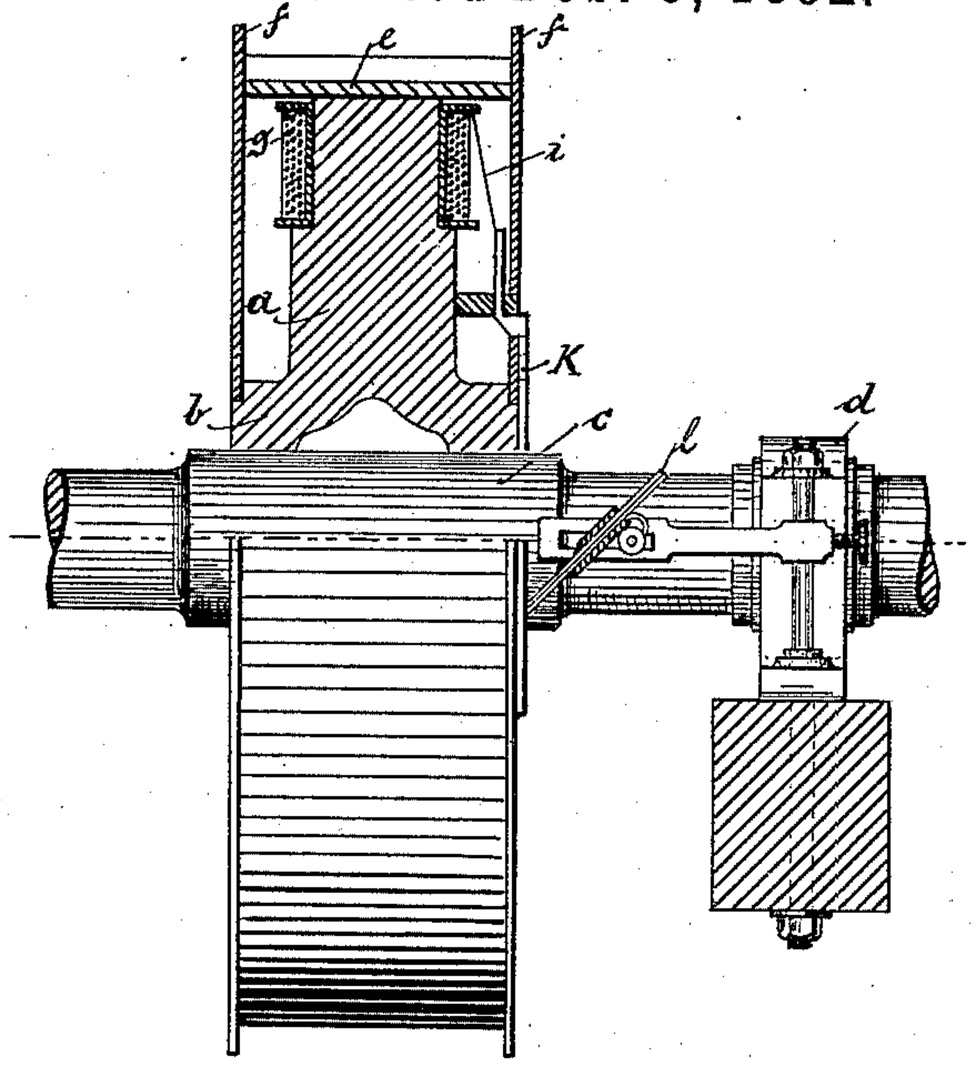


Fig. 2.

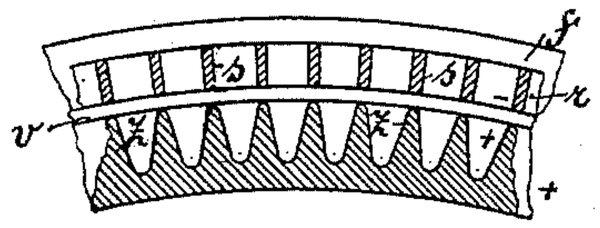


Fig. 5.

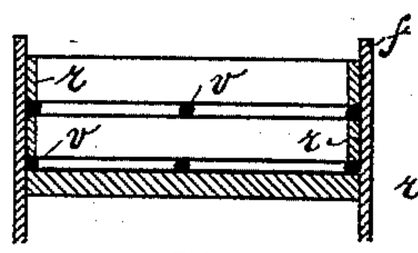


Fig. 7.

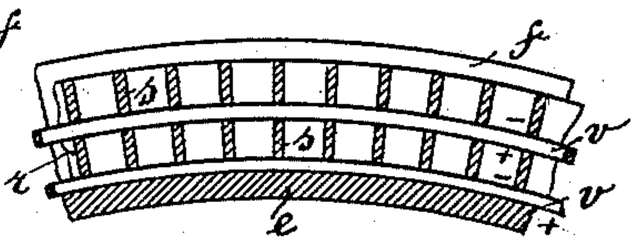


Fig. 6.

Fig. 3.

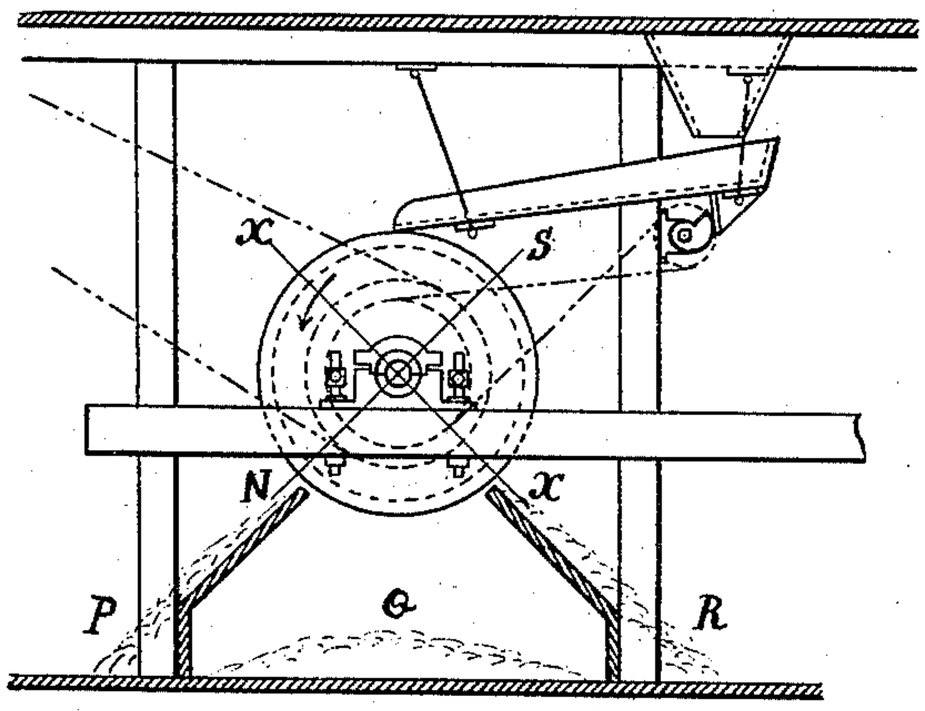
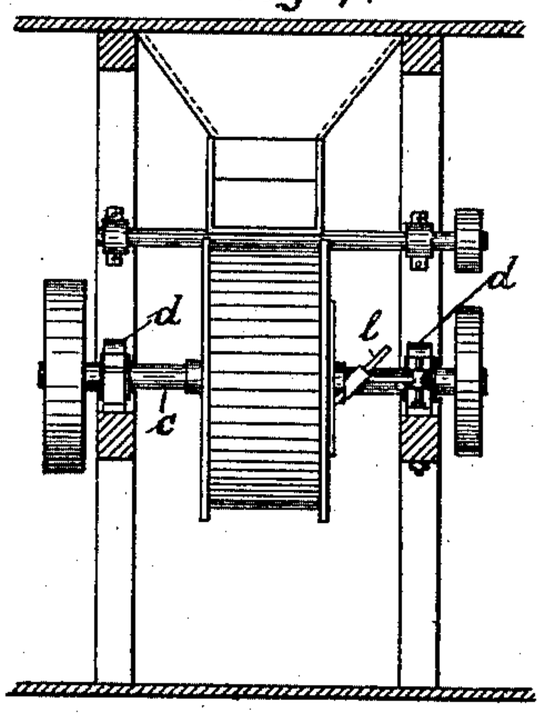


Fig. 4.



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UNITED STATES PATENT OFFICE.

ERMINIO FERRARIS, OF TURIN, ITALY.

MAGNETIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 468,599, dated February 9, 1892.

Application filed March 13, 1891. Serial No. 384,974. (No model.)

To all whom it may concern:

Be it known that I, ERMINIO FERRARIS, a subject of the King of Italy, and a resident of the city of Turin, in the Kingdom of Italy, have invented certain new and useful Dynamic Magnetic Wheels for the Separation of Mineral Ores by Means of Electricity; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an apparatus for separating ores and metals by the aid of electricity.

The invention consists in an arrangement on the arms of a wheel of a number of electromagnets, which are connected with one another and with a commutator located at right angles to the axis of the wheel, and of a rim or crown of magnetic metal surrounding the wheel, on which rim the ore or metal is carried and separated by the change of the electric current.

In the accompanying drawings, Figure 1 is a part side view of the wheel with one of the side flanges removed. Fig. 2 is a half-elevation of the wheel and a half-section through the center thereof. Figs. 3 and 4 are views of the apparatus in the working position. Figs. 5 and 6 are sectional views of a portion of the rim of wheels of modified forms. Fig. 7 is a cross-sectional view of the wheel-rim shown in Fig. 6.

The principle on which the construction of the apparatus is based is similar to that of the Gramme (Pacinotti) ring.

a are the arms of the wheel, cast in one piece with the boss *b*. The wheel is fixed on a horizontal shaft *c*, carried in bearings *d* and driven through band-pulleys, or in another suitable way. On each of the arms *a* there is a bobbin *g*, all the bobbins being of like form and connected in series, one behind the other, so that they form one single uninterrupted circuit.

h are the wires connecting the bobbins successively with one another. From these wires *h* there are wires *i*, terminating in a commutator *k*, located at one side of the wheel and at right angles to the axis of the same. The elements of the commutator, corresponding in number to the number of the bobbins, bear alternately on two circles concentric with the wheel.

l l are two brushes placed diametrically opposite each other and each always bearing against at least two commutator elements.

e is the rim or crown of magnetic metal surrounding the arms or spokes *a*.

f f are side plates of non-magnetic metal which cover the two sides of the wheel from above the rim or crown *e* to the boss.

When an electric current is conducted through the brushes, it branches off, as in the Pacinotti ring, into two currents, which excite in the two halves of the wheel magnets of unlike name, one half being south magnetic and the other half north magnetic. As, however, the brushes are each in contact with two commutator elements at the same time, no current passes through the intermediate bobbin and the corresponding segment of rim *e* remains neutral. In this way with a wheel of twenty-four elements eleven twenty-fourths of the rim or crown *e* is north magnetic, eleven twenty-fourths south magnetic and one plus one twenty-fourths neutral. As, however, the rim or crown forms a closed circle, it has always a tendency to divert the lines of force. The consequence is that as regards the exterior effect the magnetization of the rim or crown decreases from the two poles to the neutral diameter.

In the length of wire passing from one bobbin to another connection is formed in the electric circuit through a wire *i* with a segment of the commutator *k*, as in the Pacinotti ring, with the difference that in my wheel the bobbins are located on the arms or spokes, whereas in the Pacinotti ring the bobbins are on the outer ring. In my wheel the commutator-segments are placed alternately in two circles, whereas Pacinotti's commutator is in a single circle. When the current from one of the brushes *l* is conducted through a commutator-segment and through the connecting-wire *i*, it separates into two currents, each of which passes through half the number of bobbins, to be conducted out through the second brush. As, however, each of the currents passes through half the number of bobbins in an opposite direction, they excite poles of unlike name. For example, if the contact diameter of the brushes were hori-

zontal all the top arms might be north magnetic and all the lower arms of the wheel south magnetic. Therefore there are always two points in the wheel-rim which are equidistant from the extreme north and south magnets. These points are neutral, and as they are opposite each other on the wheel-rim the diameter connecting them forms a neutral zone or axis, which is augmented through the brushes being simultaneously in contact with the segments of the two commutator-circles. The current does not pass through the bobbin, which by its ends is in connection with the two commutator-segments in contact with the brush. Therefore the bobbin remains unmagnetized until one of the two segments passes away from the brush.

If in the manner shown in Figs. 3 and 4 comminuted ore is conducted onto the wheel and an electric current passed into the same through brushes *l*, the apparatus will not only separate the thoroughly-magnetic metal from the non-magnetic metal, but also ores and metals of an intermediate degree of magnetism and of different kinds, such as copper ore containing iron, from which lead and iron may in this way be separated; also, more or less magnetic metals, such as nickel, iron, zinc, &c.

As the two halves of the wheel form opposite magnets, a portion of the magnetism near the neutral zone will be equalized or rendered uniform by the rim, the more so as this latter is composed of magnetic metal, such as cast or wrought iron or steel, and forms a kind of armature for the adjacent magnets of unlike name. For this reason the magnetism near the neutral zones will be weaker than in the middle between the same. In this way is explained the graduation of the attractive force of the wheel-rim from the poles to the neutral zones, (neutral axis.) The diameter connecting the poles is at right angles to the neutral axis. The pieces of ore or metal attached to the wheel-rim will therefore not drop therefrom all at the same time, but at different intervals of time, according to their varying magnetic properties, those which are highly magnetic accompanying the wheel-rim as far as the neutral zone, but the less magnetic leaving the same so soon as the attractive force is overcome by the weight of the material.

P Q R, Fig. 3, indicate, by way of example, the places where metals of different degrees of magnetism would fall from the wheel-rim, P being the place for the least magnetic metal, Q that for a metal of a higher degree of magnetism, and R that for a thoroughly-magnetic metal.

In order to increase the surface of contact and to retain the materials under treatment for a longer time on the rim *e*, this is provided with teeth or with iron blades placed radially, as shown in Fig. 1. The intensity of the magnetization of the wheel may be brought so high that materials in pieces of any desired size may be treated, provided that the distance between the rim-teeth or the width of the cells is properly proportioned to the size of the pieces.

To obtain the most suitable inclination of the neutral axis, as shown at X, Fig. 3, the connecting-wire of two bobbins next to each other should be connected not to the commutator element located directly below it, as, for the sake of simplicity, is shown in Fig. 1, but to the commutator element which forms the same angle with the said connecting-wire as that inclosed between the contact diameter of the brushes and the desired pole diameter.

The intensity of the magnetic field at the circumference of the wheel, and consequently, also, the useful effect of the wheel, may be considerably increased by constructing the wheel-rim armature, as shown in Fig. 5, in the case of a toothed rim, or, as shown in Figs. 6 and 7, in the case of a rim set out with blades or bars. In the first case a second concentric armature is laid round the wheel-rim. It consists of iron blades or bars *s*, equal in number to the teeth, the blades being fixed to the two iron side rings *r*, located between the non-magnetic side plates *f*. Each of the iron blades *s* stands radially opposite a tooth *z*, and their inner edges are held by two or more wires *v* of non-magnetic metal at a short distance from the points of the teeth. By this means an energetic magnetic field is formed in the spaces between the teeth *z* and blades *s*, and the lines of force are inclosed within the wheel-rim armature, so as not to be uselessly dissipated in the surrounding space. In this respect the arrangement shown in Figs. 6 and 7 is still more suitable, as here the first or inner blade-armature is also held at a short distance from the circumference of the wheel by non-magnetic wires or parts *v*. The two armatures of like form, and placed the one over the other, form with the corresponding side rings, each for itself, an armature inclosed in itself and are magnetically insulated from each other and from the circumference of the wheel.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A dynamo-magnetic wheel for separating by the aid of electricity different kinds of ores and metals, consisting of electro-magnets *g*, mounted on the arms of the wheel, which magnets are in connection with each other and with a commutator *k*, of brushes *l*, each of which is always in contact with two commutator elements, and of wheel rim or crown *e*, inclosing the electro-magnets, substantially as described and shown.

2. In a dynamo-magnetic wheel for separating by the aid of electricity different kinds of ores and metals, a wheel-rim provided with teeth, in combination with a second armature placed concentrically round the wheel-rim and composed of iron blades or bars *s*, equal in number to the teeth, which blades or bars

are fixed to two side rings *r* and insulated from the wheel-rim, substantially as described and shown.

3. In a dynamo-magnetic wheel for separating by the aid of electricity different kinds of ores and metals, a wheel-rim furnished with iron blades or bars, in combination with several armatures of like construction placed one above the other, which, with the corresponding side rings *r*, form each for itself an armature inclosed in itself and insulated from each other and from the wheel-rim, substantially as described and shown.

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

ERMINIO FERRARIS.

Witnesses:

LÉON DE COCUTRIX,

BARDELLI FELICE.