(No Model.)

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MAGNETIC SEPARATOR.

No. 567,381. Patented Sept. 8, 1896.

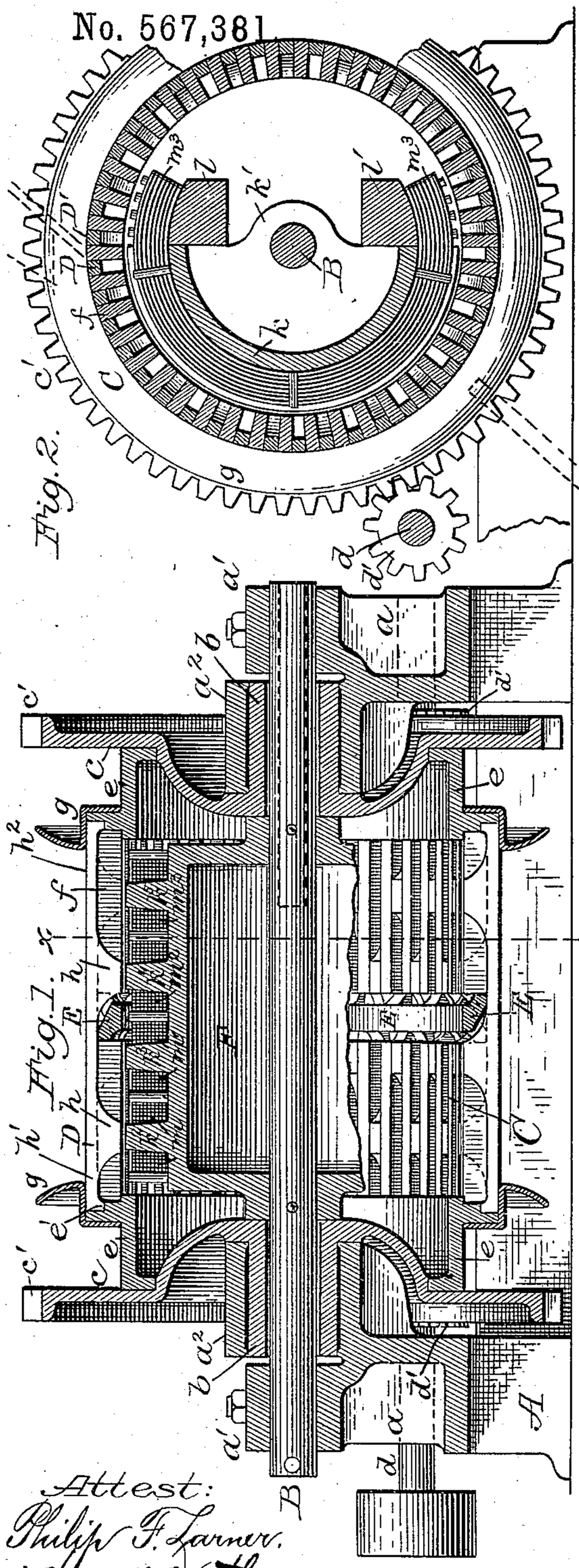

Fig. 2.

Fig. 1.

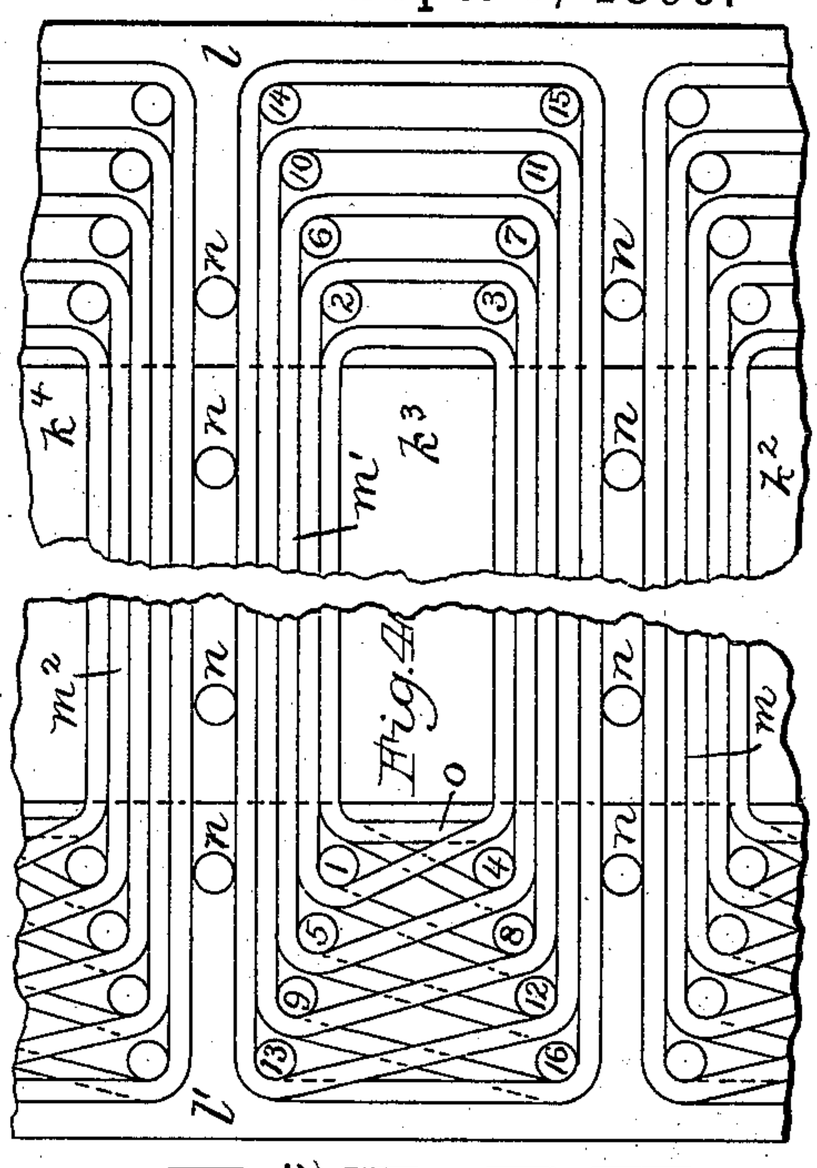

Fig. 4.

Fig. 5. Fig. 6.

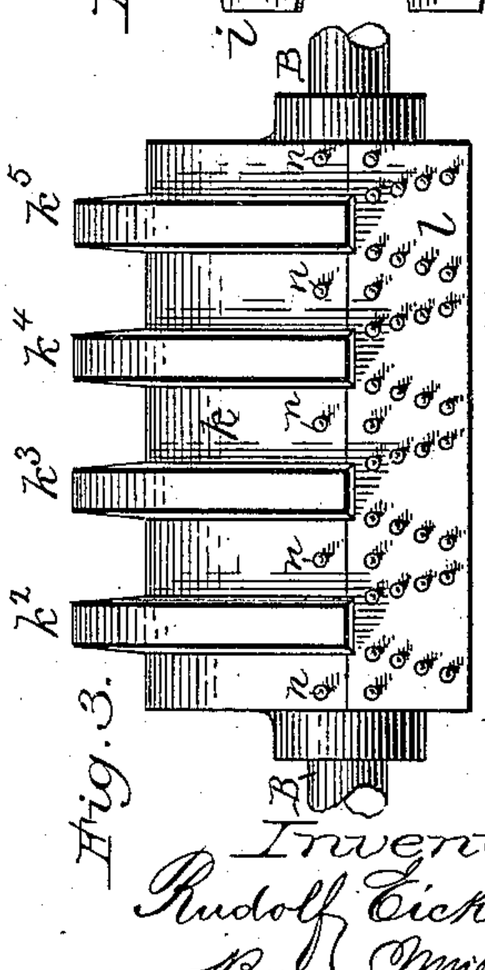

Fig. 3.

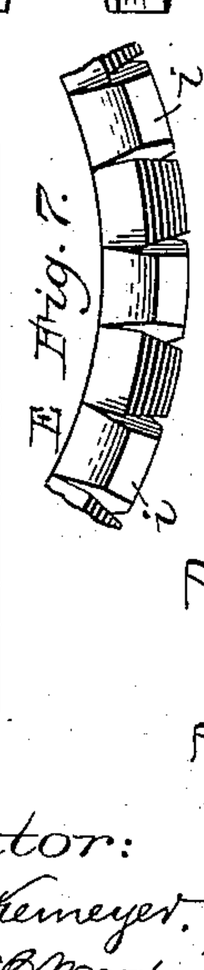

Fig. 7.

Fig. 8.

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UNITED STATES PATENT OFFICE.

RUDOLF EICKEMEYER, OF YONKERS, NEW YORK; RUDOLF EICKEMEYER, JR., EXECUTOR OF SAID RUDOLF EICKEMEYER, DECEASED.

MAGNETIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 567,381, dated September 8, 1896.

Application filed January 10, 1890. Serial No. 336,510. (No model.)

To all whom it may concern:

Be it known that I, RUDOLF EICKEMEYER, of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Magnetic Separators; and I do hereby declare that the following specification, taken in connection with the drawings furnished, and forming a part thereof, is a clear, true, and complete description of my invention.

My said improvements are specially applicable to that type of magnetic separators which was disclosed in United States Letters Patent to Jonas Wenstrom, No. 373,211, November 15, 1887, but certain portions of my invention will be found useful in other forms of machines.

In the Wenstrom electromagnetic separators, as heretofore constructed, a stationary cylindrical iron core, having projecting peripheral flanges of an irregular annular form, has been provided with circular field-coils, each located between two flanges, and developing opposite polarity therein, the edges of the main or front portions of said flanges serving as pole-faces, over and closely adjacent to which a set of soft-iron separating-bars are progressively moved. Said bars are parts of a rotative drum, and after they pass the front portions of said flanges or pole-faces they are intended to be so far freed from magnetism as to enable them to drop the metal theretofore collected and carried by them, said bars in their discharging positions being more or less remote from the rear side of the electromagnet. Inasmuch as said field-coils are circular, and as only a little more than one-half of the peripheries of the flanges are utilized as pole-faces, it follows that the magnetic field developed from nearly one-half of each coil is projected rearwardly from the pole-faces and practically wasted, if not actually objectionable in its effects, because of its liability to more or less magnetize the bars after they have reached their discharging positions.

One object of my present invention is to concentrate all of the energizing capacity of field-coils upon the effective pole-faces, and so that the electromagnet can project its magnetic field only in the direction of those bars which are for the time being engaged in collecting and carrying their loads of iron and steel, resulting in economically securing higher efficiency in the machine; and to this end one portion of my invention involves a novel form of electromagnet devised by me, including a novel system of winding, of special value in connection with rib pole faces or cheeks, convex and segmental in form.

In certain forms of the Wenstrom machine the magnetism is well restricted, but this is due to the fact that in them permanent horse-shoe magnets are employed, and hence there is no such wide-spread magnetic field as is incident to all field-coils as heretofore employed in what are known as "bar-machines," as distinguished from those having cylinders composed of non-conducting material, whether with or without radially-projecting iron studs or pins.

Another object of my present invention is to centrally support the separating-bars while they are moving in front of the pole-faces, this being important in machines of considerable size having long bars, which have heretofore been liable to spring into contact with centrally-located pole-faces and result in making a heavy drag on the drum, a consequent waste in motive power and objectionable wear and tear of the parts thus in contact. This portion of my invention involves the novel combination with the bars or drum which carries them of one or more interior supporting-rings, which effectually brace the bars against inward deflection by the magnet.

Another portion of my invention includes a novel construction of the bearings of the drum or cylinder which carries the separating-bars, with a view to facilitating lubrication and obviating undue exposure to dirt and dust at the bearings; and still further, I seek to obviate torsional or twisting strains on the bar-drum, and this is effected by providing both heads of the drum with toothed peripheries and driving the drum by means of a counter-shaft provided with separate pinions for respectively engaging with the two heads of the drum, this being a feature of great practical value in view of the composite character of the body or shell of the drum and the heavy drag by the magnets upon the bars

and all of said drag being substantially at one side of the axis of the drum. In these machines as heretofore constructed the electromagnet has been so organized as to necessitate separating or carrying bars of two different forms, alternating with each other, but I have now so devised the magnet that all of the bars may have depending cheeks and yet be exact counterparts, thus simplifying and economizing in the construction of the bars and of the machine and in assembling its parts.

To more particularly describe my invention, I will refer to the accompanying drawings, and after describing the same in detail the features deemed novel will be specified in the several clauses of claim hereunto annexed.

Referring to the drawings, Figure 1 illustrates one of my improved magnetic separators in longitudinal central vertical section, the lower portion of the electromagnet being broken away to better disclose a portion of the bar-supporting ring inside of the drum. Fig. 2 is a vertical cross-section of the same on line *x*, Fig. 1. Fig. 3 is a view of the electromagnet-base, or main core, and its ribs detached, and without the field-coils. Fig. 4 in plane projection illustrates the novel winding on the electromagnet. Figs. 5, 6, and 7 illustrate portions of the bar-supporting ring, respectively in top, bottom, and side views. Fig. 8 illustrates one of the counterpart separating-bars detached from its drum, said bar being shown in side view and cross-section or end view.

As shown in Figs. 1 and 2, the frame A of the machine has a suitable base and two pillar-blocks *a a*, each of which is novel, in that it affords not only the usual support *a'* for receiving and firmly clamping the central or axial stationary bar or rod B, but also a large journal-box a^2, for receiving the hollow journals *b b* on the dished heads *c c* of the separating-drum C. Heretofore the separating-drum has been mounted directly upon the bar B, and this rendered lubrication difficult, and the bearings on the bar were exposed to fine dust and dirt from the interior of the drum, it being obvious that in the operation of these machines more or less floating abrasive matter is an inevitable incident. As now improved by me, these bearings at a^2 can be readily oiled, and they are not accessible to dust or dirt from the interior of the machine.

Both of the heads *c c* have toothed peripheries *c'*. A counter-shaft *d* has pinions *d d* for engaging with the two heads, so that when power is applied to the shaft the drum is revolved without such torsional strains as have heretofore been involved by driving the drum by gearing located at one end only. Each of the heads *c*, at their inner sides, carries an annular shell *e*, composed of non-magnetic metal. Said shells *e e*, at their inner edges or ends, are annularly recessed, as at *e'*, to afford a seat for the reception of the ends of the soft-iron bars D, and also the intervening non-magnetic bars *f*, all of said bars being confined in their seats by flanges *g g*, which are partially rectangular in cross-section, to afford a proper side contact with the adjacent portions of the shells *e e*, and also an overlying contact with the ends of the bars D and *f*; and the peripheral portions of said flanges curve or flare outwardly and serve as side guards or rims for the operating or working face of the drum.

The soft-iron collecting or separating bars D in my machine are exact counterparts, as distinguished from the bars in the machines disclosed in the said Wenstrom patent, wherein two distinct forms of bars are necessarily employed, one form alternating with the other, whereas in my machine, the bars being all alike, they need only to be reversed endwise for effecting the alternating arrangement. Each bar has two depending cheeks *h h*, nearer one end than the other, and hence said bars have what may be termed a "short end" *h'* and a "long end" h^2. As an entirely novel feature, I employ an internal annular brace, centrally located, for preventing the bars from being bent or deflected inwardly while passing over the faces of the electromagnet. This brace, in a desirable form, is a ring E, carried within the drum, and constructed or provided with a series of supporting-lugs *i i*, alternately projecting laterally, each serving to centrally support a bar closely adjacent to one of its cheeks, the wooden bars *f* being centrally cut away enough to freely accommodate the ring and to also bear thereon, and the inner surface of the ring is or may be nearly flush with the interior surface of the drum. The value of this supporting-ring is not dependent upon the precise form shown, nor upon the character of the internal magnet, although in the Wenstrom machine it would have to be located a little to the one side or the other of the middle of the bars, or two rings could well be employed, if desired.

The electromagnet F resembles that used in the Wenstrom machines to the extent that it is fixedly mounted on the central bar B and has pole-faces closely adjacent to the interior surface of the drum at one side of its axis and in line with the several rows of cheeks of a set of separating-bars; but said electromagnet is radically novel with respect of the energizing coils and the form and construction of the core, and its pole-face flanges or ribs, and also in the location of said core, as well as in the location of the winding within the drum C, so as to not have the core or winding extended materially to the rear of the axial line of the machine, or, in other words, so as to be as remote as possible from the rear side of the drum, at which point the bars discharge the metal, and for that reason they should be as free as possible from magnetizing influences.

The main core *k* is an iron casting, a segment of a cylinder in form, and having suit-

able end pieces k', provided with bored hubs for mounting it upon and keying or pinning it to the axial bar B, which is in turn fixedly clamped or otherwise secured against rotation in the supports a'. On the outer or convex surface of the main portion of the semi-cylindrical core k there are four projecting cores or segmental ribs k^2 k^3 k^4 k^5, all standing at right angles to the axis of the drum, and each at its outer surface affording a longitudinally convex pole-face, closely conforming throughout its length with a corresponding portion of the interior of the drum. Secured to and across the main core, near both ends of the segmental ribs or cores, there are two blocks l l', preferably of wood, and having surfaces which conform to the convex or circular surface of the main core, for affording supports for the ends of the windings or field-coils m m' m^2 m^3, respectively surrounding the four core-ribs. The mode of winding these energizing-coils is illustrated in Fig. 4, wherein a rib-core k^3 and parts of rib-cores k^2 and k^4 are shown in plane projections, (but centrally broken,) with a corresponding portion of the main core k and the end blocks l l'. In said blocks holes are bored for the reception of a set of pins or studs, respectively numbered from 1 to 16, and these are arranged in rows of four pins, each of said rows being located symmetrically, as if radiating from the four corners at the ends of the ribs. The prime value of these corner pins is in connection with the act of winding, and thereafter they serve as supports for the ends of the coils, but if the open spaces between the wires at the ends be well filled with solid plastic insulating matter and mere wrappings or binders be applied, the pins might be removed, said insulating matter then serving as an equivalent support.

Other rows of pins n occupy holes in the main core k, centrally between the rib-cores, and serve as side supports for the coils. In winding the rib-core k^3, for instance, the initial end of wire is held at o. The wire is thence carried and bent around the corner of the core, inside of pin 1, thence along that side of the core, and completely around and in contact with the two sides and farther end back to the inner side of the inner corner pin 4, thence around pins 1, 2, 3, 4, 5, and 6, and so on, consecutively, until the pin 16 has been turned, thus completing one layer of coils. The second layer is formed by carrying the wire from pin 16 around pins 13, 14, 15, and 16, and thence around pins 9, 10, 11, and 12, to pins 5, 6, 7, and 8, to pins 1, 2, 3, 4, and thence inside of the pin 1, around the core again, and so on until the requisite number of layers have been wound. The terminals of the wires are properly connected in series, and are connected with appropriate conductors, which, as heretofore, extend outward within a portion of the central supporting-bar B, which is hollow from one of its ends for a sufficient portion of its length to afford a suitable passage for the wires and admit of their outside connection with an electric generator. The coils are energized, so as, for instance, to develop "N" polarity in the rib-cores k^2 and k^4 and "S" polarity in cores k^3 and k^5, so that one half of the bars while passing the faces of these magnet-cores will be of one polarity and the other half of opposite polarity, as, for instance, the bar D, of Figs. 1 and 2, has its cheeks h h in proper relation to the pole-faces of rib-cores k^2 and k^4, and bar D', being reversed, end for end, has its cheeks overlying the faces of cores k^3 k^5, and so on throughout the entire set of bars.

The ordinary feeding and conducting chutes are indicated in dotted lines in Fig. 2, and it will be understood that the machine is adapted to extract magnetic metal from sand, earth, powdered ore or slag, and shop sweepings, all well dried, so as to be run freely and in thin streams upon the drums, as in prior machines of this general class.

It will be seen that the electromagnet influences the bars while passing through one hundred and eighty degrees of their circular path, and that during the remainder of their course they are not exposed to any rearwardly-projected magnetic field, and hence in my machine no metal is continuously carried by the bars throughout their circular path; and further, it will be seen that with my magnet all of the winding is so disposed with relation to the rib-core faces as to develop higher magnetic efficiency by the use of a given quantity of wire, both in weight and length, than if the same wire was embodied in a circular field-coil, as heretofore; and also, that my coils will require less electric energy for developing a magnetic field of given efficiency than a circular coil would require.

With the prior circular field-coils more or less of the frame as well as the heads of the drum are magnetized, and thereby more or less magnetizing all of the bars throughout their path; but my field-coils are so restricted in their inductive action as to only affect the separating-bars while in their working or collecting positions. This restriction of the projected magnetic field is also secured by me by the use of longitudinally-arranged cores and coils in the magnetic system, by which the bars are oppositely polarized intermittingly, as disclosed by me in a contemporaneous application for patent. (See Serial No. 338,399.)

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

1. The combination substantially as hereinbefore described, of a rotative drum provided with longitudinal separating-bars of iron, and an interior stationary electromagnet, having a series of ribs or cores, segmental in form and each inclosed longitudinally by its own winding or field-coil.

2. In a magnetic separator, an electromagnet rib or core, segmental in form, and pro-

vided with a field-coil composed of wire wound in symmetrical coils and layers, parallel with the sides of the rib or core, and supported by means of pins or studs at the two ends of the core.

3. An electromagnet-core for use in magnetic separators, composed of a main core, semicylindrical in form, mounted upon a stationary axial supporting-bar, and having a series of smaller segmental cores or ribs, each projecting from the main core, at right angles to its convex face, and in a plane at right angles to the axial line of the main core.

4. In a magnetic separator, the combination of a drum, having a set of longitudinal separating-bars of iron, an interior electromagnet, and an internal ring, carried by the drum for supporting all of the bars centrally, substantially as described, whereby said bars are braced against undue deflection by the magnet.

5. In a magnetic separating-drum, a set of iron separating-bars, which are counterparts in form, and have a like number of cheeks located nearer one end of the bar than the other for coöperating with appropriate interior magnetic pole-faces, substantially as described, whereby said bars being alternately reversed endwise are each enabled to coöperate with pole-faces of like polarity, and to be also oppositely polarized alternately.

RUDOLF EICKEMEYER.

Witnesses:
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JOHN L. CLARK.