G. ULLRICH.

MAGNETIC DRUM SEPARATOR.

APPLICATION FILED FEB. 9, 1916.

1,324,529.

Patented Dec. 9, 1919.

4 SHEETS—SHEET 1.

FIG. 1

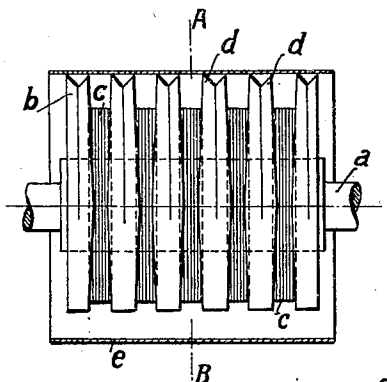
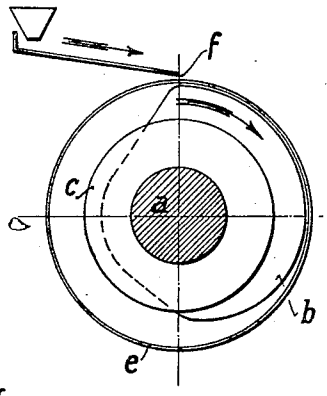


FIG. 2



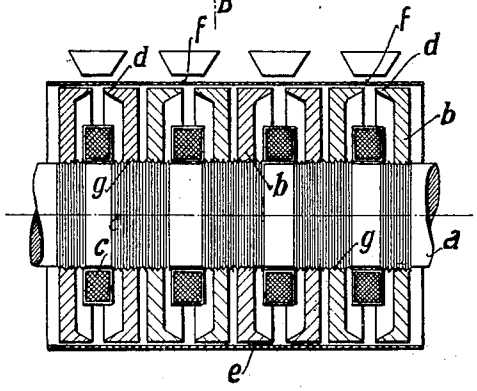


FIG. 3

FIG. 4

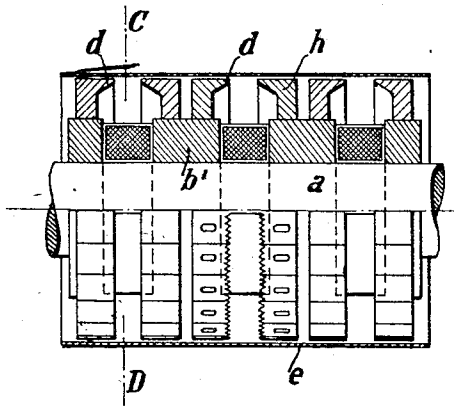
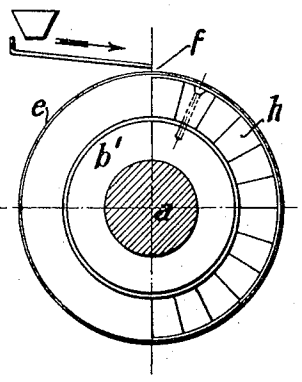


FIG. 5



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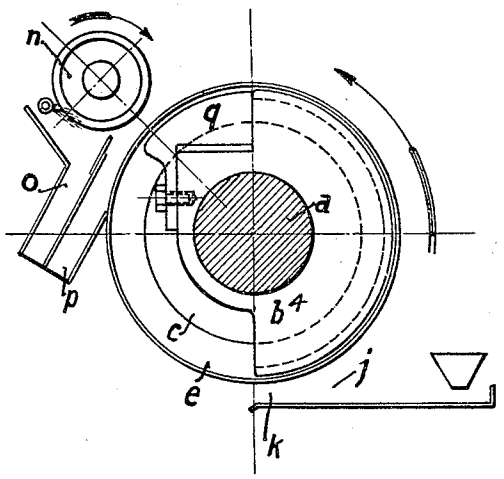
4 SHEETS—SHEET 2.

FIG. 9



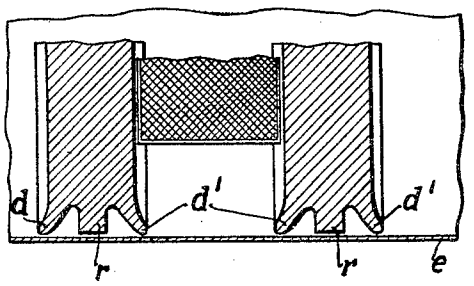


FIG. 10

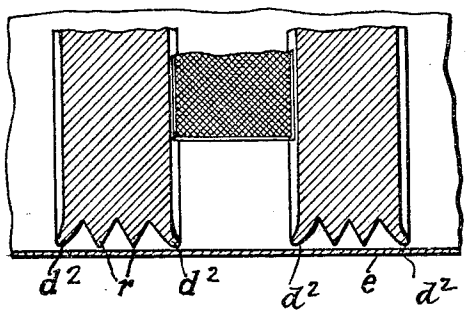


FIG. 11

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4 SHEETS—SHEET 3.

FIG. 6.

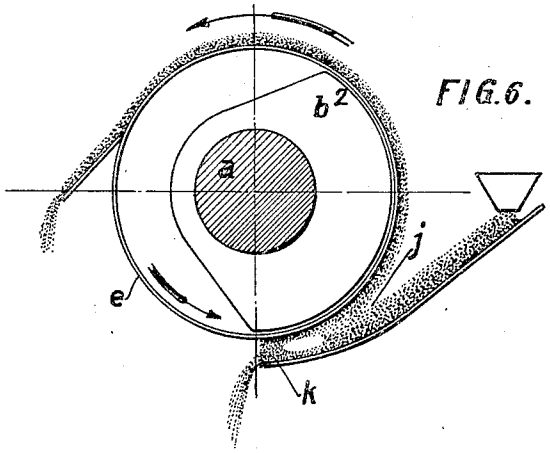


FIG. 7

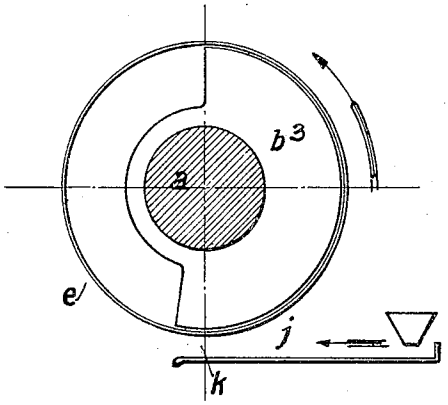
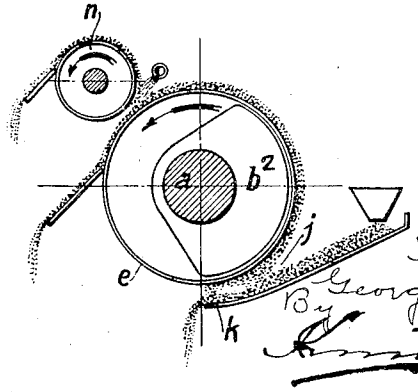


FIG. 8



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4 SHEETS—SHEET 4.

FIG. 12.

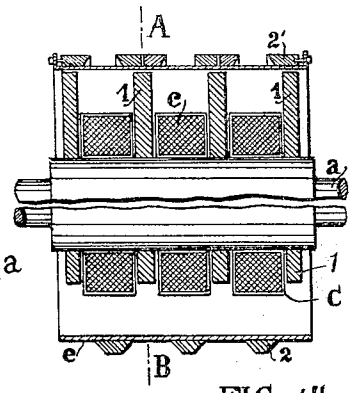


FIG. 12a

FIG. 13.

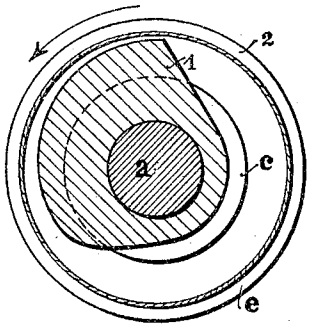


FIG. 14.

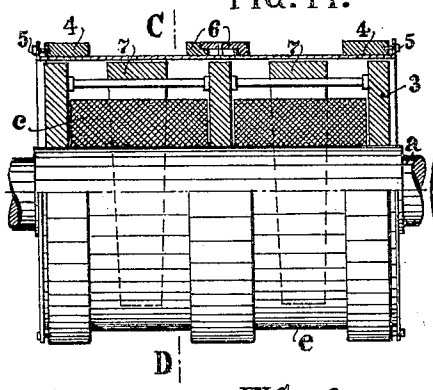


FIG. 15.

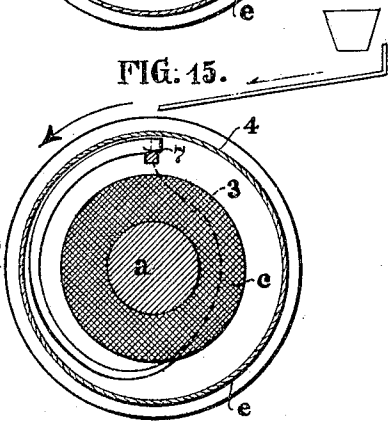


FIG. 16.

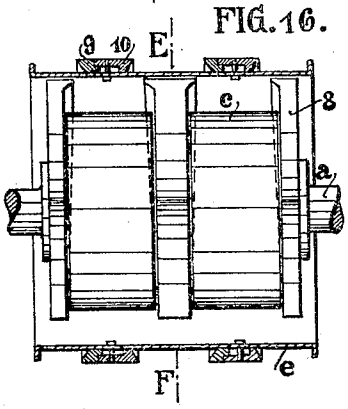
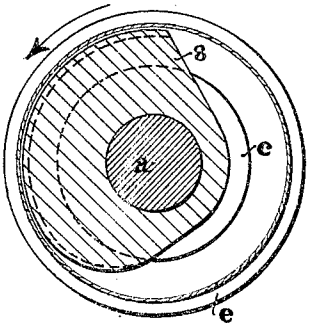


FIG. 17.



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UNITED STATES PATENT OFFICE.

GEORG ULLRICH, OF MAGDEBURG, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE CHEMICAL FOUNDATION, INC., A CORPORATION OF DELAWARE.

MAGNETIC DRUM-SEPARATOR.

1,324,529. Specification of Letters Patent. **Patented Dec. 9, 1919.**

Application filed February 9, 1916. Serial No. 77,305.

To all whom it may concern:

Be it known that I, GEORG ULLRICH, engineer, a subject of the German Emperor, residing at 2 Winterfeldtstrasse, Magdeburg, Germany, have invented certain new and useful Improvements in Magnetic Drum-Separators, of which the following is a specification.

This invention relates to magnetic separators of the kind in which the magnetic pole is surrounded by the delivery drum and comprises two or more plates arranged adjacent to one another, two adjacent plates forming a magnetic field. In separators of this type the edges of the plates are spaced equally and therefore constitute a magnetic field of equal strength throughout.

In accordance with this invention, the pole plates are constituted with respect to one another in such a manner that the individual fields formed by two adjacent plates increase or decrease or alternately increase and decrease in the direction in which the material to be treated is fed. This may be effected, for instance, by varying the spacing of the edges of the pole plates. The spacing may, for instance decrease in the direction in which the material is fed so that a magnetic field of increasing strength is thereby produced. In this manner a premature discharge of the magnetically weak or of coarse but magnetically strong material is prevented on account of the fact that such material is introduced between non-magnetic material. The increase of the intensity of the field may take place gradually or step by step and may be capable of regulation in both cases. Moreover, by angularly adjusting the plates upon the shaft on which they are mounted, the effective initial intensity of the field may also be varied. If desired, the spacing of the edges of the plates may be increased in order to weaken the field. The spacing of the edges of the plates may also be increased or decreased in order to allow the field to act with different intensities.

The variation of the field may also be effected by varying the distance of the effective peripheral surfaces of the plates from the delivery drum in the direction of rotation of the latter; or variation of the field may be effected by providing within the said drum between the pole plates, rings comprising sections made of magnetic material and acting as auxiliary pole pieces the width of which increases or decreases or alternately increases and decreases in the direction of rotation of the delivery drum.

All the rings and all the ring sections may be mounted so as to be capable of displacement axially for the purpose of varying the intensity of the field.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawings, in which:—

Figure 1 shows one constructional form of separator of the drum type embodying the invention, the delivery drum being shown in longitudinal section.

Fig. 2 is a cross section taken on the line A—B of Fig. 1.

Fig. 3 shows in longitudinal section another constructional form.

Fig. 4 shows partly in longitudinal section and partly in side elevation a further constructional form.

Fig. 5 is a cross-section taken on the line C—D of Fig. 4.

Figs. 6 to 8 show in cross section other embodiments of the invention.

Figs. 9 to 11 show modified forms of the magnetic poles.

Fig. 12 shows in longitudinal section the upper half of a separator in which the delivery drum is equipped with induction rings provided opposite each pole.

Fig. 12ª, a similar view of a lower half of a separator where the drum is provided with induction rings between the poles, the poles in both cases being stationary and comprising plates of equal width throughout and the effective peripheral surfaces of the said plates being increasingly spaced from the inner surface of the drum in the direction of rotation of the latter.

Fig. 13 is a cross section taken on the line A—B of Fig. 12ª.

Fig. 14 shows partly in elevation and partly in longitudinal section a separator in which the delivery drum is equipped with induction rings disposed opposite the stationary pole plates and of equal width throughout, auxiliary poles being interposed between the induction rings at points intermediate the pole plates, the width of the auxiliary poles decreasing in the direction of rotation of the drum.

Fig. 15 is a cross section on the lines C—D of Fig. 14.

Fig. 16 shows a further constructional

form of separator in which the delivery drum is equipped with induction rings disposed between the pole plates the width of which decreases in the direction of rotation of the drum, the effective peripheral surfaces of the plates being uniformly spaced from the inner surface of the drum.

Fig. 17 is a cross section on the line E—F of Fig. 16.

Referring first particularly to Fig. 1, a shaft *a* carries pole plates *b* which are spaced apart and remain stationary during the operation of the separator, coils *c* being provided in the spaces afforded between the plates *b* which are preferably formed with inturned flanges having sharpened edges *d*. The edges *d* of each two adjacent pole plates form a magnetic field and all the pole plates are surrounded by a common rotary delivery drum *e*.

In Figs. 1 to 4, the supply of the raw material is effected at the top of the drum. The decrease of the spacing of the edges of the plates from the drum may take place gradually.

As in dealing with the various kinds of ores there is the danger of a premature discharge of the magnetic material at an earlier or a later moment, the poles are collectively or individually rotatable about the shaft *a* in order to obviate this defect, in such a manner that all or several fields can be rotated collectively or individually with respect to the point *f* at which the raw material is supplied.

The individual displacement of the fields is particularly advantageous when a plurality of kinds of ores are to be treated one next to the other by the same separator, as by suitable adjustment of the individual fields their field intensity can be readily adapted to suit the magnetic properties of the particular ore in question.

The increase of the intensity of the field may be rendered adjustable in different ways. In Fig. 3 this adjutsment is effected by means of the screw threads *g*.

In Figs. 4 and 5 the plates *b* are provided on their peripheries with pole pieces *h* which for the purpose of varying the intensity of the field, can be adjusted axially by sliding the same on the plates *b'* axially. The increase of the intensity of the field is effected in this case step by step, each step being adjustable independently of the others.

In the forms shown in Figs. 6 to 8, the raw material is supplied beneath the drum *e* so that the magnetic material is attracted upward from the non-magnetic material. Although an increase of the intensity of the field is obtained in this case in the manner above described the discharge of the material does not take place in the same direction but in the opposite direction to that of the supply of the raw material. The following result is obtained in conjunction with the increasing field: In the weaker portion *j* of the field first entered by the raw material, the strongly magnetic material is attracted in the first instance while in the intenser portion *k* of the field, the weakly magnetic material is attracted onto the delivery drum. Since the said drum rotates in the opposite direction to the supply of the raw material, the weakly magnetic material is first attracted on to the drum, this layer being then covered by a layer of the strongly magnetic material. In this manner two sorts of materials of different permeability are obtained separately in two superposed layers, the strongly magnetic material forming the top layer holding the layer of weakly magnetic material fast on the drum *e*. The modified form of plate shown in Figs. 6 and 8 is designated b^2, while the form shown in Fig. 7 is designated b^3.

This separate deposition of ores of different permeability is facilitated by a gradual or step by step increase of the field effected in the maner hereinbefore described.

The removal of the magnetic material from the delivery drum may be effected in such a manner that both kinds of ores are removed simultaneously as shown in Figs. 6 and 7, or separately as shown in Figs. 8 and 9. For the latter purpose, there is provided a magnetic roller *n* (or any other suitable magnetic device) which removes the upper layer consisting of the strongly magnetic material and leads it away separately into a collector *o*, Fig. 9, while the weakly magnetic material drops off the drum *e* and is delivered into another collector *p*.

In order to regulate the magnetic field at the point where the strongly magnetic material is removed, so that the most complete removal of this material is effected, a preferably adjustable pole shoe *q* carried by pole plate b^4 may be provided at that point, as illustrated in Fig. 9.

The attracting edges of the pole plates are preferably sharpened, as shown in Figs. 1, 3 and 4. In order to obtain a greater diffusion of the lines of force, one or more edges *r* or the like may be provided between the two edges *d'* and d^2 of each pole plate, as illustrated in Figs. 10 and 11 respectively.

Around the pole plates 1 (Figs. 12, 12^a and 13) the delivery drum *e* rotates, upon which drum induction rings 2 (shown in Fig. 12^a) are provided each disposed at a point midway between two adjacent pole plates 1, while in the form of invention shown in Fig. 12 induction rings 2' are provided on the said drum at points disposed opposite the pole plates. It will be noted from Fig. 13 that the distance of the effective peripheral surface of the pole plate from the drum varies in the direction of rotation of the latter. The lines of force leave

the pole plates 1, pass through the rings 2 and form between the same magnetic fields which vary in intensity in accordance with the distance of the effective peripheral surfaces of the pole plates from the rings secured to the drum.

In the form of separator illustrated in Figs. 14 and 15, induction rings 4 and 6 are provided on the drum at points disposed opposite the pole plates 3. In order to augment the increasing or decreasing variation of the field, a stationary ring section 7 is provided within the drum *e* between each two plates 3, the width of the said section 7 varying in the direction of rotation of the drum. The lines of force then pass between the induction rings 4 and 6 through the section 7. At the same time the advantage is obtained that the magnetic material is attracted by a plurality of edges in each field formed between two pole plates.

In the form of separator shown in Figs. 16 and 17, there are provided pole plates 8 the effective peripheral surfaces of which are disposed at a uniform distance from the inner surface of the drum *e*, while the width of the said plates varies circumferentially. Induction rings are secured externally upon the drum *e* at points disposed between the pole plates. Between these rings and the pole plates 8, the increasing or decreasing magnetic fields are formed. The said rings may each comprise, for instance, two ring sections 9 and 10 which can be adjusted axially independently of each other and are preferably provided with projections which overlap each other.

The intensity of the field may be regulated by adjusting the strongest zone of the ring, by rotating the pole plates to a greater or lesser extent, toward the point from which the material to be treated is supplied.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A magnetic separator of the kind described having a delivery drum, means for feeding material to be separated to said drum, magnetic poles within said drum, having means for increasing the intensity of the field along the periphery of the drum to cause layers of material of different permeability to be deposited on said drum, a magnetic roller and an adjustable counterpole disposed adjacent to the point of discharge from said drum of the magnetic material, for the purpose of removing the upper layer of strongly magnetic material in order to separate the material in accordance with its magnetic permeability.

2. In a magnetic separator of the kind described, a drum having pole plates within it, stationary induction ring segment members constituting auxiliary pole pieces being arranged within the delivery drum between the pole plates, the width of said members variable in the direction of rotation of the said drum, means for rotating the drum and means for delivering material to be separated into proximity thereto.

3. In a magnetic separator of the kind described, a delivery drum, stationary pole plates within the drum, induction ring segments located between the radial planes of the pole plates with the major portions thereof disposed at a distance from the drum in the direction of rotation of the latter and of a progressively variable width, and means for feeding material within the field of attraction of the rings.

4. In a magnetic separator of the kind described, a drum, stationary pole plates within the drum, the drum being provided with induction rings located between radial planes of the pole plates which are disposed at a progressively variable distance from the drum in the direction of rotation of the latter and are of a variable width, and means for feeding material within the field of attraction of the rings.

5. A magnetic separator of the kind described, comprising a drum, having stationary pole plates with auxiliary pole pieces within the drum, induction rings made of magnetic material being arranged upon the drum in such a manner that they form with the stationary pole plates and with the auxiliary pole pieces respectively variable magnetic fields, means for adjusting the said induction rings and ring members axially for the purpose specified, and means for feeding material within the field of attraction of the rings.

6. A magnetic separator of the kind described, comprising a drum, stationary pole plates with auxiliary pole pieces within the drum, induction rings made of magnetic material being arranged upon the drum in such a manner that they form with the stationary pole plates and with the auxiliary pole pieces respectively variable magnetic fields, means for adjusting said induction rings comprising overlapping parts, each of which is axially adjustable and means for feeding material within the field of attraction of the rings.

In testimony whereof the foregoing specification is signed in the presence of two witnesses.

GEORG ULLRICH.

Witnesses:
A. H. EMERMANN,
RONTHEMIS.