

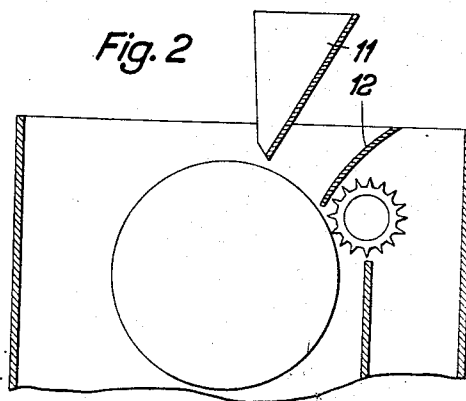
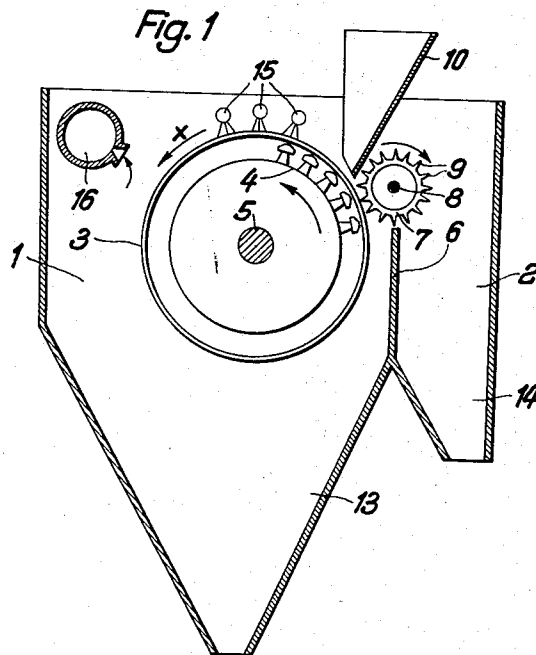
June 21, 1955

E. A. LAURILA
DRUM MAGNET SEPARATOR

2,711,249

Filed May 20, 1954

4 Sheets-Sheet 1



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Fig. 3

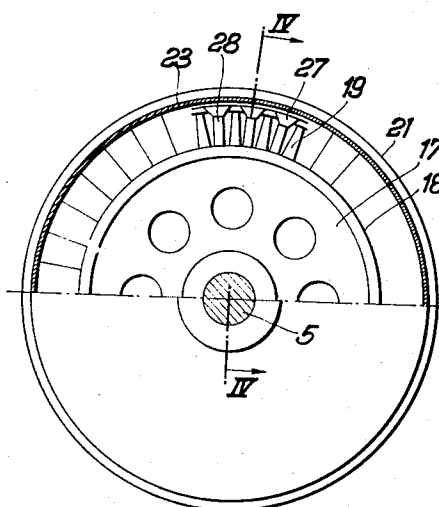


Fig. 4

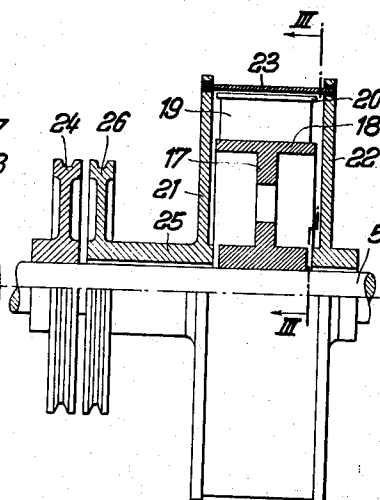


Fig. 5

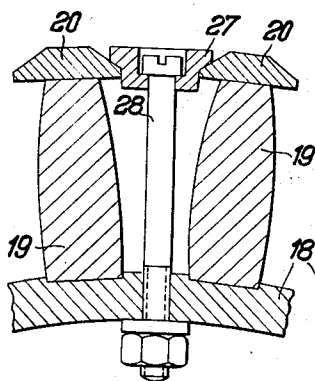
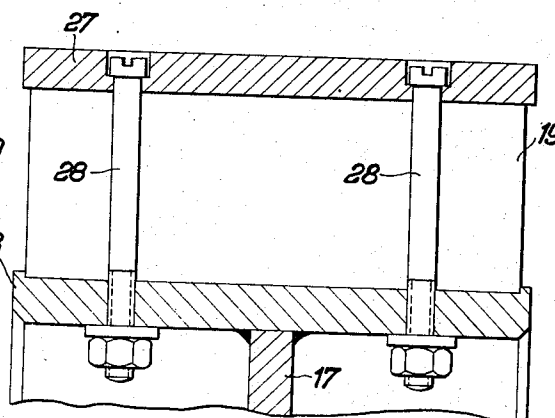


Fig. 6



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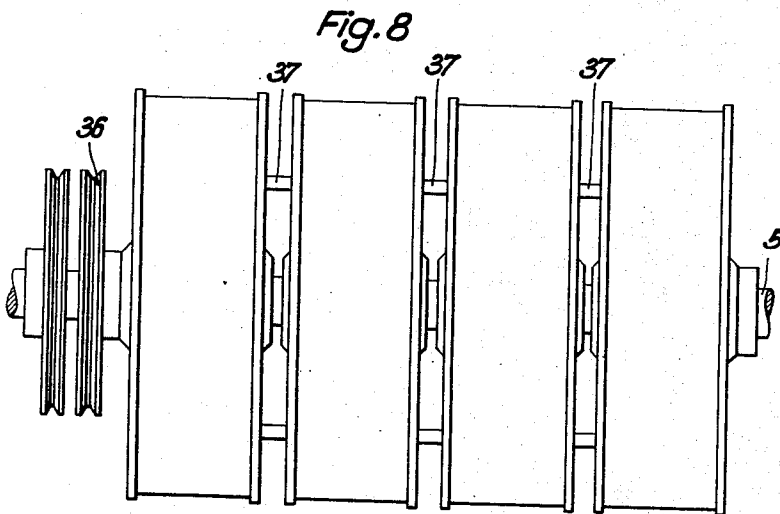
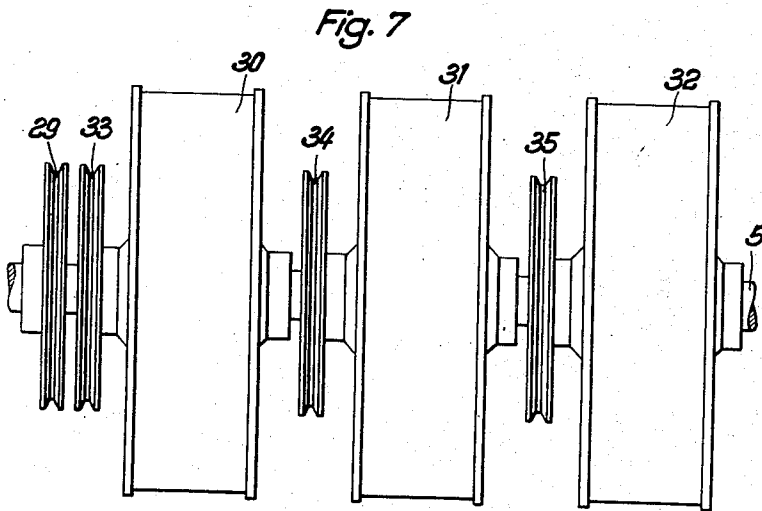
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Fig. 9

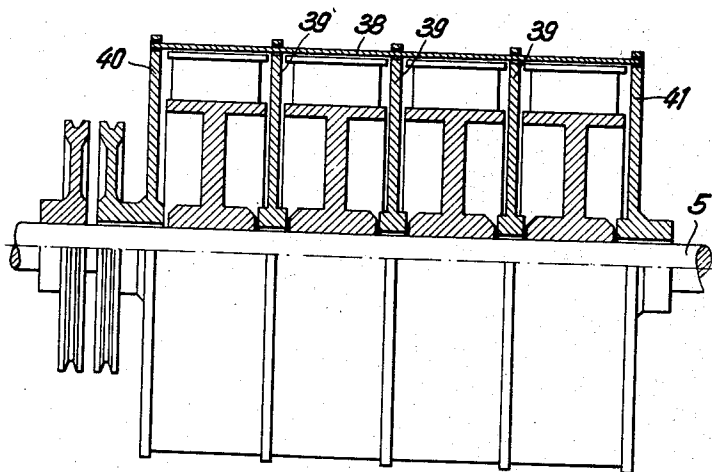
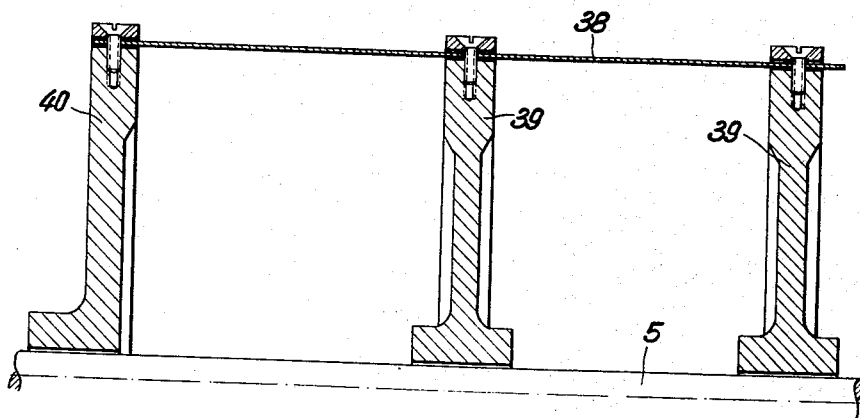


Fig. 10



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2,711,249

DRUM MAGNET SEPARATOR

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6 Claims. (Cl. 209—219)

Various kinds of drum magnet separators have been known for carrying out a magnetic separation of finely divided magnetic materials into magnetic and non-magnetic constituents. The magnetic field of these separators may be produced by means of a multipolar magnet system which is either fixed within a rotating drum cover or rotates in synchronism therewith. As is known, it is the function of the magnetic field to hold the magnetic particles fast to the drum cover while the non-magnetic particles are carried away by reason of gravity, centrifugal force or by rinsing or blowing off.

In the case where a slowly rotating separator with fixed magnets is used, it has been shown that the separating effect is particularly poor if the magnetic field is formed either by direct current magnets or permanent magnets, because in such cases the finely divided particles tend to roll together upon the drum cover to form dense accumulations. For this reason magnetic separators have heretofore been constructed whose magnet system displays alternating polarity in the direction of work, or rotates, or is driven by alternating current.

However, all such previous devices have been either too complex, expensive and difficult to manufacture or have not been able to provide a uniform magnetic field, or have had other difficulties. The present invention which overcomes the above disadvantages, relates to a drum magnet separator whose construction is based upon theoretical and practical investigations concerning the effect of a magnetic field upon finely divided magnetic material. These investigations have led, among others, to the following conclusions:

1. The best results are obtained when the magnetic field produces an attractive force, directed against the drum cover and acting upon the magnetic particles, which is distributed as uniformly as possible over the entire separating surface.

2. The movement of the magnetic field with respect to the drum cover must be so chosen that the magnetic particles lie loosely with respect to each other. Theoretically considered, only those magnetic fields are adapted for practical use, whose field strength vectors appear to be rotating with respect to a given point upon the drum cover. If, simultaneously, the magnetic attractive force, referred to above, is as uniform as possible, then the field vector will turn rather uniformly. The magnetic particles have a tendency to retain their polarity due to the hysteresis phenomenon, so that they are put into a turning movement. Since the magnetic field simultaneously pulls the particles against the drum cover, the particles will roll off the cover. So long as the circumferential speed of the magnetic field is small, the particles will roll in the form of magnetic accumulations; if, however, the circumferential speed exceeds a certain value, then the particles will roll individually.

A magnetic field that fulfills the requirements set forth above may be produced without great difficulties if one employs a multipolar magnet having at least 12 and preferably 32 to 48 magnet poles, whereby the poles

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underlie the drum cover and almost fill the space between the drum cover, and the drum. The poles should be, furthermore, so magnetized that north and south polarities alternate with each other.

5 For this construction permanent magnets are better suited than electromagnets.

In order to attain a sufficient field strength at the outer surface of the drum cover, it is necessary to form the drum in such a manner that the distance between the magnet poles or pole shoes and the outer surface of the drum cover is as small as possible. In order that the necessary requirements are fulfilled, the magnet must cover the entire circumference of the drum. Furthermore, the magnet must be able to turn independently of the turning of the drum, because the difference between the circumferential speed of the magnet field and that of the drum cover is determinative of the loosening up of the accumulations of magnetic particles.

Several magnetic separators according to the invention are illustrated by way of example in the drawing.

Fig. 1 shows a side view of a magnetic separator and a schematic representation of the individual parts.

Fig. 2 shows the same separator with a different arrangement of individual parts.

Fig. 3 is a partly sectional and partly elevational side view of a magnetic drum embodying the invention.

Fig. 4 is a partly sectional and partly elevational view of the structure of Fig. 3 taken perpendicular to the view of Fig. 3.

Fig. 5 is a cross-sectional view showing the details of the magnet system.

Fig. 6 is a sectional view perpendicular to Fig. 5.

Figs. 7 and 8 are elevational views showing two kinds of drum units.

Fig. 9 represents a magnet drum consisting of a plurality of drum units, the upper half being in longitudinal section and the lower half in elevation.

Fig. 10 is an enlarged sectional view of a unit of the magnet system of the drum shown in Fig. 9.

Referring in greater detail to the drawings, the casing of the magnetic separator comprises two chambers 1 and 2 which extend downward in the shape of a funnel. In chamber 1 is arranged the magnetic drum, which consists of the drum cover 3 and the magnetic system 4 enclosed therein. The drum cover and the magnetic system are rotatably mounted upon the shaft 5; they may, as indicated in Fig. 1, rotate in the same direction and with different speed, or also in opposite directions.

Above a separating wall 6 arranged between the chambers 1 and 2 there is provided a removal cylinder 7 composed of soft iron which rotates in opposite directions to that of the magnetic system 4, but preferably with the same circumferential speed as the latter, and is provided with knife-shaped cleats radial to the cylinder axis 8 or with pointed projections uniformly distributed upon the surface of the cylinder 7, whereby the magnetic material that is supplied to the magnetic drum 3, and held fast thereon, is taken off from the drum. The supply of material is effected through a chute 10, which, according to Fig. 1, has its lower end extending between the magnetic drum and the removal cylinder thereby also serving as a deflecting wall for the material that is thrown off the removal cylinder. As shown by Fig. 2 the supply chute 11 and the deflecting wall 12 may also be arranged independently of each other.

The material supplied to the drum cover 3, that rotates in the direction of the arrow, is carried along thereby. The nonmagnetic constituents fall off the cover and are removed from the funnel 13, while the magnetic constituents are carried along by the drum cover, are removed by the cylinder 7, and are drawn off through the funnel 14.

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Above the drum cover 3, blowing nozzles 15 are provided through which air is blown against the material lying on the cover in order to bring about a further loosening up of the material, whereby the separation into magnetic and non-magnetic constituents is supported.

Preferably a suction tube 16 is arranged at a suitable location in the chamber 1, through which the dust developed during the operation is continually drawn off.

In the following there is described a separating drum embodying the invention.

Upon the shaft 5 there is affixed a disc 17 whose flange 18 consists of a material having good magnetic conductivity, for example, of a carbon-free steel. Upon the flange there are arranged in uniform distribution and in even numbers the pole pieces 19, at least 12 in number and preferably between about 30 and 48. One should choose the greatest possible numbers of pole pieces in order to obtain a magnetic field of the most uniform strength, since such a field is the most favorable for producing a rolling movement of the particles upon the drum cover. The pole pieces may be electro-magnetically actuated or they may be formed of permanent magnets. The cross section of the pole pieces, in the case of permanent magnets, preferably increases towards the middle of the drum, and the side wall of the pole pieces are outwardly bent surfaces (compare Fig. 5). The pole shoes 20 are provided upon the outwardly lying front sides of the pole pieces and these likewise consist of a material having good magnetic conductivity, for example, of a carbon-free steel. The outer surface of the pole shoes is preferably formed cylindrically or polygonally.

Upon the axle 5 there is mounted on each side of the disc 17 a disc 21 and 22 respectively, these discs being loosely rotatable. The discs 21 and 22 carry at their circumference, the drum cover 23 which is composed of a non-magnetic material, for example, of austenitic steel, German silver or synthetic resin, having a high electrical resistance and a thickness of at most, about 2 mm. preferably 0.5 to 0.8 mm. The thinner the cover, the stronger is the effective magnetic field and the more certain are the otherwise occurring vortex currents avoided. The attachment of the drum cover to the discs 21 and 22 may be made in any desired suitable manner, for example, by screwing, welding, soldering, gluing and the like.

To the axle 5 there is connected a driving disc 24 and to the extended hub 25 of the disc 21 there is connected a driving disc 26, so that the drum cover and the magnetic system surrounded thereby may be rotated independently of each other.

The pole pieces 19 with the pole shoes 20, that are loosely inserted in the flange 18, are firmly fixed to flange 18 by detents 27 which clampingly engage two adjacent pole shoes, these detents consisting of non-magnetic material, and being mounted on screws 28. Of course, there are other means for attaching the pole shoes such as, for example, the use of swallow tail shaped grooves in the flange 18, within which the correspondingly shaped pole shoes are fitted, as well as welding, soldering, or gluing.

The provision of the drum cover is particularly important for the most effective operation of the magnetic separator according to the invention. In order to attain a high field strength at the entire surface of the cover it is necessary that the same distance be maintained between the inner surface of the cover and the pole shoes at all points, which distance is to be maintained as small as is possible. This distance should not be allowed to either decrease nor increase upon rotation of the drum cover, so that the drum cover despite its slight thickness must have a sufficient solidity and above all must be substantially unbendable. In order to attain this, the circumference of the drum cover must be small in relation to the diameter of the drum. As an example for this, there may be mentioned a drum cover consisting of a 0.8 mm. thick austenitic rust-free steel sheet with a diameter of 400

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mm., which should have a circumference no longer than 150 mm., and preferably only 100 mm. long. Since, however, a magnetic separator having so short a drum cover would result, in a great majority of cases, in too small a capacity, according to the invention several such drums may be mounted upon the common driving shaft independently and spaced at small distances from each other (Figs. 7 and 8). In the embodiment, according to Fig. 7 there lies at one end of the driving shaft 5 the driving disc 29 for all magnetic systems, while for driving the drums 30, 31 and 32 there is provided in each case a driving disc 33, 34 and 35. In the embodiment according to Fig. 8 there is also provided for all drums a common driving disc 36. This is rendered possible because the drums are connected with each other by means of bolts 37.

The separating drum assembly of Figs. 9 and 10 differs from that of Figs. 7 and 8 in that not several individual drums lie side by side, but that all magnetic systems are surrounded by a common cover 38, which is supported by intermediate discs 39 between the individual magnet systems and by end discs 40, 41. This embodiment is substantially simpler and cheaper than the one of Figs. 7 and 8, and, furthermore, has the advantage that the drum cover may at any time, be tightened from one of the two front sides.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed in this invention is:

1. A magnetic separator for separating magnetizable particles from unmagnetizable particles comprising a rotatable drum consisting of a rotatable disc, a rotatable annular cover member mounted coaxially with said disc in spaced relation thereto, said disc and said cover member being arranged to rotate independently of each other, said cover member being constructed of a dielectric material, a plurality of pole pieces mounted between said disc and said cover member, the space between said disc and said cover member being annularly uniform and having a predetermined minimum width.

2. The separator of claim 1 wherein the thickness of said cover member does not exceed about 2 mm.

3. The separator of claim 1 wherein the pole pieces are permanent magnets which are provided with pole shoes of magnetic soft iron and which are uniformly distributed over the circumference of said disc, said disc being constructed of a material having good magnetic conductivity.

4. In combination, a rotatable drum comprising an inner rotatable member and an outer rotatable cover member coaxial with said inner member, a plurality of radially extending magnetic pole pieces between said inner and outer members, and a cylinder rotatably mounted adjacent said drum, said cylinder being adapted to rotate at the same speed but in the opposite direction relative to said drum, said cylinder having means on the periphery thereof for removing magnetically held particles from said drum.

5. The separator of claim 1 wherein a plurality of said drums are arranged laterally of each other on a common axle, said discs being connected to said axle for rotation therewith, and said cover members being loosely mounted on said axle, there being separate driving means for said axle and for said cover members.

6. The separator of claim 1 wherein a plurality of said discs are arranged laterally of each other on a common driving shaft, a common cover member overlying all of said discs, and means to rotate said cover member separately from said discs.

No references cited.