J. P. BETHKE.

MAGNETIC SEPARATOR.

APPLICATION FILED NOV. 5, 1917.

1,369,516. Patented Feb. 22, 1921.

Fig. 1.

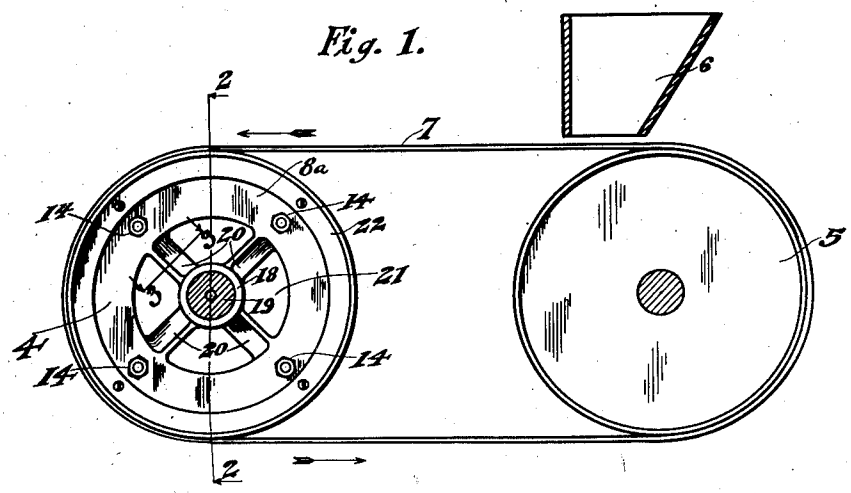


Fig. 2.

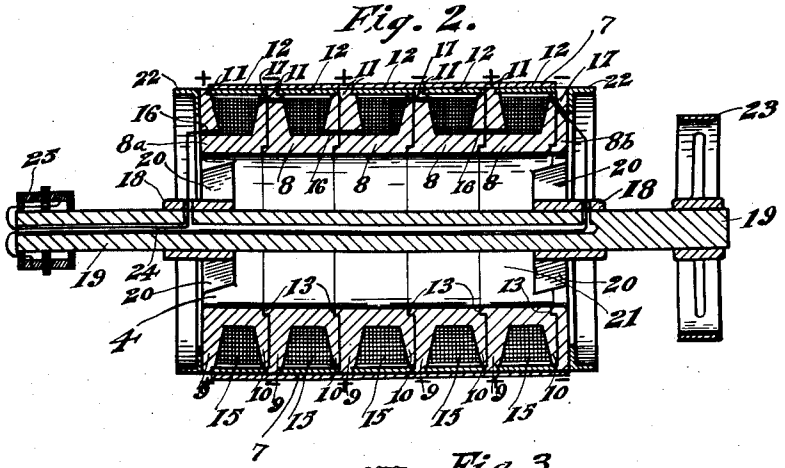
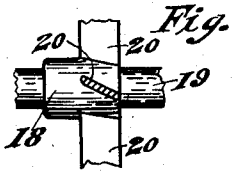


Fig. 3.



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MAGNETIC SEPARATOR.

1,369,516. Specification of Letters Patent. Patented Feb. 22, 1921.

Application filed November 5, 1917. Serial No. 200,354.

To all whom it may concern:

Be it known that I, JOHN P. BETHKE, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented new and useful Improvements in Magnetic Separators, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to certain new and useful improvements in magnetic pulleys, and particularly such magnetic pulleys as are used in magnetic separators.

The objects of my invention are to produce a magnetic pulley, which will have a maximum efficiency or separating capacity for a given expenditure of electrical energy; which will be of minimum bulk and weight for a given separating capacity, and which can be economically produced.

A magnetic pulley should be capable of developing, for a given expenditure of electrical energy, a maximum flux through the space about the poles, and a feature of importance is to have this magnetic flux increase in density at a rapid rate near the pole pieces whereby the portative force of the magnetic pulley is greatly increased. To this end the poles of the magnetic pulley of my invention are formed to afford an extreme convergence of the lines of force toward the pole faces, the faces of the poles being adapted to this object.

It is desirable to have the pole pieces constructed so that they become fairly saturated so as to afford a high permeability for the metal of the magnetic pulley when separating magnetic materials from those that are non-magnetic.

It is also very desirable that a magnetic pulley should be so contoured as to expose a considerable surface area for heat radiation, thereby making it possible to utilize a larger amperage than can be delivered through the windings in a pulley having less heat radiating surface.

To secure these and other desirable advantages, I provide a magnetic pulley in which the pole pieces are arranged so that the magnetic flux set up by the magnets will converge rapidly in the region of the pole pieces, and that they will come to great magnetic density when supplied by magnetic material which may act as a keeper.

I also provide openings in the magnetic pulley for supplying air to the interior thereof, and means for causing the air to circulate freely through the openings.

Referring to the drawings Figure 1 is a side elevation of a magnetic pulley separator, comprising my invention.

Fig. 2 is a longitudinal sectional elevation through the magnetic pulley, taken at line 2—2 of Fig. 1.

Fig. 3 is a fractional sectional view taken on line 3—3 of Fig. 1, and illustrating the fan-like arms at the ends of the magnetic pulley.

A magnetic separator embodying my invention and shown in Fig. 1 has at its discharge end a magnetic pulley 4, and at the other end a plain or non-magnetic pulley 5. The material to be separated is fed through a hopper 6, or other suitable means, onto belt 7, which belt, moving in the direction of the arrows as indicated in Fig. 1, causes the material to pass over the magnetic pulley 4, the non-magnetic material dropping downward, and the magnetic substances being attracted and held tightly to the face of the belt, as long as the belt is in contact with the pulley, whereby these magnetic or magnetizable materials are carried underneath the pulley, and beyond a vertical plane through the pulley on the return side. The belt then mechanically conveys such material out of proximity to the pulley, and away from the magnetic field, the material being eventually allowed to drop at a substantial distance from the non-magnetic material which either drops vertically from the downwardly moving side of the pulley, at a tangent to its surface, or is thrown rearwardly from the vertical path by centrifugal force.

The magnetic pulley 4 comprises a number of sections of magnetic or magnetizable material, and each section 8 preferably has the general form of a spool, provided with a head at each end thereof in the form of an annular flange having a conical inner surface. These spool heads or flanges are respectively marked 9 and 10 in the drawing. Their outer margins are cylindrical, but are narrow, since the end faces of the

spool heads, are in radial planes, whereas the inner surfaces of the heads are conical, as above stated. The flanges or spool heads constitute magnet pole pieces, and the tapering form of their inner surfaces concentrate the magnetic flux at their relatively narrow peripheral margins with dovetailed grooves 11 extending around their rims, for the purpose of holding the non-magnetic shields 12 tightly in place on the magnetic pulley. The sections 8 are provided on their inner edges with offsets 13, so that when they are mounted together they may be drawn up tightly together, and act as one drum. The bolts 14 extend through the magnetic pulley from end to end, and are used for drawing the sections together and holding them, with the non-magnetic shields 12 tightly in place. The spaces thus formed between the flanges 9 and 10, are arranged to contain the energizing coils 15. These coils are thoroughly insulated in any well known manner, and are protected against external injury by means of the non-magnetic shields 12, which extend around the entire pulley. The coils are wound in separate units on the sections 8, and so connected together through the ducts 16 and 17 that when energized alternate magnetic poles are produced as indicated in Fig. 2. The end sections of the magnetic pulleys 8^a and 8^b are provided with hubs 18 for mounting on the shaft 19. The radial arms 20 are fan-like blades, arranged to cause a circulation of air through the open interior 21, of the magnetic pulley when the same is rotated in operation, thereby dissipating the heat which rises in the windings, and is conveyed through the metal of the sections 8 to the inside surface of the pulley. The inside surface of the magnetic pulley may be ribbed to further increase the radiating capacity thereof. The ends of the magnetic pulley are provided with non-magnetic flange rings 22. The shaft 19 is supplied with a drive pulley 23 for rotating the magnetic pulley, and ducts 24 are provided in the shaft for containing the lead wires which extend from the collector ring 25 to the coils 15, and serve to supply electric current to the coils for energizing the same.

When the pole pieces are constructed as hereinbefore shown and described, the proper energization of the exciting coils will afford great magnetic strength to the pole pieces when separating magnetic from non-magnetic materials. The pole pieces decreasing in cross-sectional area toward their peripheries, cause the concentration of magnetic flux in that direction, as above explained, thereby producing a magnet of high intensity. It will be readily understood from an inspection of the drawings that while the coils 15 are protected on all sides the walls of metal between the coils and the interior of the magnetic pulley are comparatively thin and heat within may be readily dissipated. By this means it is possible to work the winding safely at a much higher current density, thus further affording greater strength to the magnets than heretofore possible.

I do not wish to be limited to the precise construction herein shown, but desire that my invention be construed as providing the means set forth in the appended claims whereby the rate of convergence of the magnetic lines of force toward the poles is very rapid and is greatly increased over that in magnetic pulleys of the prior art, and whereby dissipation of heat is permitted from the interior of the pulley, thus allowing the contained energizing winding to be worked at a much greater current density than heretofore possible, thereby materially increasing the separating capacity of the magnetic pulley.

I claim for my invention:—

1. The combination with a supporting shaft, of a magnetic pulley mounted thereon, and having an inner cylinder spaced from the periphery of the pulley and inclosing a longitudinally extending annular cavity between the shaft and the peripheral portion of the pulley, said cavity being open to the exterior at the respective ends of the pulley, a set of blades disposed in said cavity, and positioned to serve as fan blades to maintain circulation of air through said cavity, and a set of pole pieces provided with energizing windings located between the inner cylinder and the periphery of the pulley, and protected from dust by said inner cylinder.

2. A magnetic pulley in tubular form, in combination with an axial support, and a set of fan blades supporting the peripheral portions of the pulley from the axial portions, and adapted to maintain an air current through the pulley from one end to the other, said peripheral portions of the pulley including a supporting cylinder and a set of pole pieces having windings mounted thereon, and provided with annular covers.

3. A magnetic pulley comprising a set of spools having integral end heads and disposed end to end, an energizing winding upon each spool between the heads of the said spool, peripheral bands of non-magnetizable material covering the windings between the respective ends of the spools, and means for binding the spools together.

4. A magnetic pulley comprising a set of spools disposed end to end, and each provided with an energizing winding, peripheral bands of non-magnetizable material covering the windings between the respective ends of the spools, means for binding the spools together, said spools having annular head pieces at their respective ends, provided with circular peripheries, and said bands being mounted upon said head pieces,

with their peripheral surfaces coinciding with exposed surfaces of the head pieces between them, to form a continuous smooth surfaced cylinder.

5. A magnetic pulley comprising a set of coil supporting spools, arranged end to end in interlocking relation to each other, and with the heads of the spools constituting pole pieces, coils mounted upon the respective spools, and provided with a covering of non-magnetizable material between the pole pieces.

6. A magnetic pulley comprising a set of coil supporting spools, arranged end to end, and with the heads of the spools abutting and constituting pole pieces, coils mounted upon the respective spools, and provided with a covering of non-magnetizable material between the pole pieces, each of the spools having a head provided with an annular shoulder with which the adjacent spool is adapted to interlock.

7. A magnetic pulley, including the combination of a supporting shaft, pulley heads secured to the shaft, and provided with openings concentric with and near the shaft, and a set of spools, clamped end to end between said heads in interlocking relation to each other, and each carrying an energizing winding, said spools being of sufficient diameter to provide an annular space between them and the shaft for air circulation, and the spool supports being adapted to promote air circulation through said space.

8. A magnetic pulley comprising a supporting shaft, a set of pulley heads secured to the shaft, and a set of spools clamped between the pulley heads, each spool being integrally headed at each end and provided with a winding, and having a peripheral surface in common with the surfaces of the other spools.

9. A magnetic pulley comprising a series of spools, each having spool heads at each end provided with conical inner surfaces, and having abutting end surfaces in radial planes, each of said spool heads having a peripheral belt receiving cylindrical surface, and all of said spools being rigidly secured together, end to end.

10. A magnetic pulley comprising a supporting shaft, a cylindrical barrel spaced therefrom, and provided with a series of energizing windings, annular flanges alternating in polarity, and projecting outwardly from said cylinder between the windings, and having converging side surfaces, said pole pieces being thereby adapted to concentrate the magnetic flux at the peripheries of said flanges, and along narrow annular zones at the periphery of the pulley.

11. A magnetic pulley comprising a shaft and a plurality of magnetic sections, adapted to be assembled thereon, an end flange on each of said sections adapted to interlock with the abutting end of the adjacent section, and spacer rings adapted to be held between the flanges of adjacent sections in assembled position.

12. A magnetic pulley composed of a plurality of duplicate magnetic sections, adapted to be assembled to form the pulley, each section comprising a coil spool having a large radial flange and a small radial flange, and a spacer ring fitting over said small flange and engaging said large flange.

13. A magnetic pulley comprising a plurality of axially alined separate magnetic spools, each spool comprising a body portion having an integral flange at each end, and having an exciting coil wound upon said body portion between said flanges, and means for rotatably supporting the spools.

14. A magnetic pulley comprising a plurality of axially alined separate magnetic spools, each spool comprising a body portion having an integral flange at each end and having an exciting coil wound upon said body portion between said flanges, means for rotatably supporting the spools, and means for accelerating the abstraction of heat from said pulley above the normal radiation from its exterior surfaces.

15. In a magnetic pulley, the combination with a shaft, of a plurality of magnetic spool sections each having integral flanges at each end, certain of said spools being independently supported upon said shaft, each of said spools having a separate winding thereon, and rings bridging the end flanges of said spools and having circular peripheries constituting a belt surface of said pulley.

16. In a magnetic pulley, the combination with a shaft, of a plurality of independent magnetic spool sections supported thereby, each of said spool sections having end flanges and a winding thereon, and rings bridging the space between the end flanges of said spools, the rings having circular peripheries constituting belt surfaces of said pulley.

17. A ventilated magnetic pulley comprising a plurality of hollow magnetic spool sections having flanges at each end and an exciting coil wound upon each spool section and positioned between said flanges, a shaft for rotatively carrying said spool sections, and means for spacing the inner periphery of said spool sections from said shaft, whereby ventilation is secured.

18. A magnetic pulley comprising a plurality of axially alined separate magnetic spools; each spool comprising a body portion having an integral flange at each end, said flanges having converging inner surfaces; an exciting coil wound upon each spool between its end flanges; means for rotatively supporting said spools; and means for accelerating the abstraction of heat from

said pulley above the normal radiation from the exterior surfaces; whereby increased current density within said coil is permitted and a free and unrestricted flux path is provided.

19. A magnetic pulley comprising a plurality of axially alined separate magnetic spools; each spool comprising a body portion having an integral flange at each end, said flanges having converging inner surfaces; and an exciting coil wound upon each spool between its end flanges; and means for rotatively supporting said spools; whereby a free and unrestricted flux path is provided.

20. A magnetic pulley having an interior cavity open to the exterior at a plurality of points, an energizing coil wound axially of said pulley, and means for insuring a positive circulation of a cooling medium through said pulley, whereby said pulley may be cooled both externally and internally.

21. A magnetic pulley comprising a shaft, a spool supported therefrom and arranged with an intervening space between it and the shaft, and an air forcing wing adapted, when the pulley is rotated, to cause air circulation through said space.

22. A magnetic pulley comprising a shaft, a series of concentric spools supported therefrom, each provided with an energizing winding and arranged with an annular cavity between them and said shaft, and a set of air circulating wings adapted to be rotated with the pulley and arranged to cause air circulation through said annular space.

23. The structure set forth in claim 22, in which said air circulating wings comprise supports and spacing members for some of the spools adapted to support the series of spools at both ends from said shaft.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

JOHN P. BETHKE.

Witnesses:
CHAS. STRASSMAN,
ROSE J. STRASSMAN.