Nov. 14, 1933. R. H. STEARNS 1,934,742

MAGNETIC SEPARATING DEVICE

Filed Sept. 26, 1927

Fig. 1.

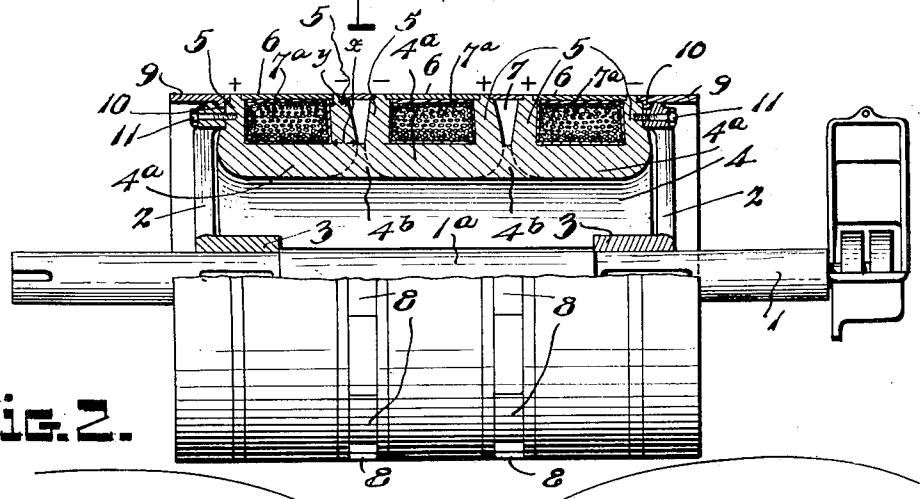


Fig. 2.

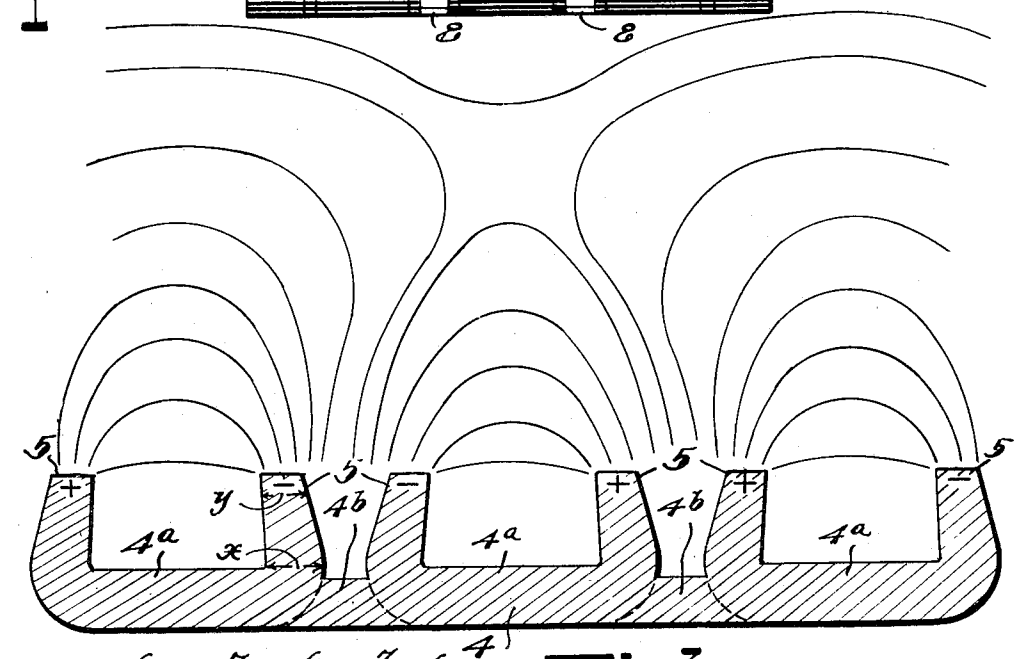
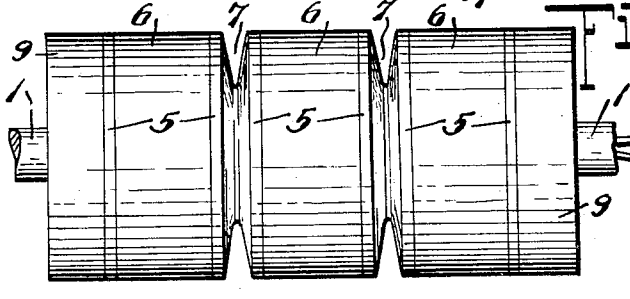


Fig. 3.



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MAGNETIC SEPARATING DEVICE

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Serial No. 221,932

11 Claims. (Cl. 209—219)

This invention relates to improvements in magnetic separating devices and has particular reference to a magnetic pulley electrically energized.

It is the principal object of the invention to provide a rotatable separating device or pulley having greatly increased depth of magnetic field as compared with multiple pole magnetic pulleys heretofore known.

More specifically stated, it is my purpose to provide a novel and improved magnetic separator structure in which a series of annular magnets of horseshoe cross section is so organized that each magnet is complete within independent pole pieces and adapted to function individually as well as to coact with the other magnets of the series.

It is a further purpose of the invention to wind the several magnets aforesaid in such a way that when their respective windings are energized, adjacent pole pieces will be of like polarity, whereby to project the fields between such pole pieces outwardly from the face of the magnet.

Another object of the invention relates to the provision of cooling means for exterior surfaces of the magnets while providing for the adequate support of a belt utilizing the peripheries of the magnetic poles as a pulley.

A still further object of the invention is to provide annular magnetic poles of uniform cross section at all radial distances from the core of the magnets, whereby to provide uniform flux concentration throughout the radial extent of the poles without choking or expanding the flux paths and without waste of metal.

Referring to the accompanying drawing:—

Figure 1 is a view partly in elevation and partly in section, of a magnetic pulley or separating device embodying my invention, the widening of the coil cavity toward its base being exaggerated.

Figure 2 is a diagrammatic view illustrative of the paths of the lines of magnetic flux creating the magnetic field at the periphery of the pulley.

Figure 3 is a view in elevation of the form of the invention in which the spaces between the poles are wholly uncovered.

As a premise to the description now to be given, it is noted that while I use my device herein set forth primarily for the purposes of a magnetic pulley separator, the principles of its construction are susceptible of being availed of when the device is used solely as a separator and independently of any pulley function which it may perform in conjunction with a belt.

Describing the separating device hereof in detail, therefore, I refer to the accompanying drawing, in which 1 designates a shaft forming the axis of the magnetic pulley illustrated. Upon the shaft 1 are mounted spaced spiders 2 of like construction, keyed or otherwise attached to the shaft, and applied to the shaft from opposite ends thereof, which are reduced to receive the hub portions 3 of said spiders. The central or larger portion 1*a* of the shaft 1 therefore provides a central abutment limiting the movement of the spiders 2 toward each other and when the body portion of the pulley is attached to said spiders preventing longitudinal movement of the pulley upon the shaft 1. The pulley or separator body is designated 4 and is cast integral as illustrated, though it may be comprised of a single annular magnet or a series of axially aligned annular magnets 4*a* of horseshoe cross section with their annular poles projecting outwardly and their inner peripheral portions integrally joined.

The dotted lines in Figure 1 and Figure 2 are not employed to show openings, but merely to indicate theoretical boundaries between the component parts 4*a* of the integral casting which function as magnets and those other parts 4*b* of the casting which merely join the magnets together while providing a metallic flux path facilitating magnetic interaction between the several poles.

As previously suggested, my design of separator or pulley contemplates that the magnets 4*a* not only be individual complete horseshoe magnets but the adjacent poles of the said magnets are spaced apart and preferably diverge from one another as illustrated, so that they are separated a material distance. To provide a pulley periphery and to facilitate diffusion of the magnetic flux, over the surface of the pulley or separating device, I apply to each of the magnets 4*a* between the poles thereof, the bands or annular plates 6 made of magnetic material such as steel or the like, said bands spanning the space between the poles and forming coil covers for the coils of conducting wire, designated 7*a*, which coils are seated in the space between the poles or sides of each magnet. The inner walls of the poles or sides of each magnet 4*a* preferably diverge slightly toward the bottom of the coil cavities established by the spaces between said poles, the purpose of this construction being to prevent slipping or movement of the coil windings disposed in said coil cavities, due to expansion and contraction incident to the heating up and cooling off of the pulley structure as the electric current supplying the same is turned on and off.

It will be apparent from the foregoing, that

owing to the manner of spacing the adjacent poles 5 of the magnets 4*a*, I provide a considerable exposed superficial area intermediate said poles from which heat generating in the use of the device may radiate off and become dissipated. The outer sides of each magnet therefore being exposed, afford radiating surfaces and cool the device materially. In small pulleys, the cavities 7 intermediate adjacent poles of the magnets will form annular grooves around the pulley and not interfere with the use of the appliance as a pulley. In larger constructions, however, it is preferred to cover the spaces between the adjacent poles of a series of magnets with annular gratings or skeleton-like or solid plates, designated 8. These plates may be joined together in a ring-like structure or they may be entirely separate and fastened to the magnets at their pole extremities in any substantial manner.

My pulley body 4 is assembled with the remaining portions of the pulley by arranging the integral casting comprising the series of magnets 4*a* between the spiders 2, bronze end rings 9 having previously been assembled so that their inwardly projecting flanges 10 are between the spiders and the adjacent poles of the end magnets. Thereupon, the spiders are connected with the body structure by screws 11 passing through the spiders and entering reduced sized threaded openings in the body structure, and specifically the end magnets.

The coil windings 7*a* of the various magnets 4*a* are so wound as to provide poles of the positive and negative characterizations designated upon the drawing, and it will be evident that on this account, as nearly as I am able to interpret the actual operation of my magnetic device, the application of electric current to the windings 7*a* will produce a deep magnetic field, one which is deeper than any such field I have been able heretofore to obtain by the use of other magnetic structures, and I think the results I have achieved are due to the employment of the horseshoe design of magnet with the magnets arranged so that their poles are spaced apart and the coils wound so as to obtain adjacent poles of like polarity in adjacent magnets. According to experimental data, the disclosed construction results in 9 separate and distinct flux paths between the several poles, such paths being closed through the core portions of the individual magnets 4*a* and through the integral connecting webs 4*b*. As compared with annular magnets having poles alternating in polarity and consequently tending to establish direct flux paths immediately adjacent the face of the magnet, the present device projects its flux paths outwardly, each pole apparently interacting with each other pole in a deep field of well distributed intensity.

Another especial feature of novelty of my invention, resides in the peculiar formation incident to the proportioning of the cross sections of the poles of the magnets in their relation to the amount of metal at the base, for the purpose of preventing concentration of the magnetic flux at the periphery of the pulley and at the outermost portions of the poles themselves.

Describing this phase of the invention more fully, it is noted that my construction of the several magnets 4*a* is such that the area of the cross sections of the poles throughout the entire flux path to the periphery of the pulley is so calculated as to be constant, and equal from the innermost portions of the poles to the outermost portions thereof. It is by this method of formation of the poles that I obtain a maximum efficiency of my magnetic separating device in conjunction with the economical use of metal making up the body structure. Thus, it is that if a cross section of a pole 5 of the magnet be taken at its base at *x*, as shown in Figure 1, the annular area in square inches at such cross section will be equivalent to the area of the cross section at the point designated Y. The foregoing applies also, substantially speaking, to the outermost or peripheral portions of the annular poles 5 in view of the fact that I employ steel bands or rings 6. For all practical purposes, the rings or coil covers 6 of magnetizable material, while truly separate from the body structure, actually function as extensions of the poles in so far as is permitted by the saturation which they speedily reach because of their extremely small cross section.

It is noted that the coil covers or rings 6 are countersunk grooves in the outermost portions of the annular poles 5, after a known manner.

I have made careful comparison of the efficiency of a magnet constructed in accordance with the invention hereof, and magnets of equal size and containing substantially an equal amount of wire and metal, and I have found a tremendous increase in the pull of the magnet of the present invention as compared with prior constructions for the same purpose. The depth of the magnetic field as produced by the present invention is about 100% increased, and tests on the present construction reveal an increase in the magnetic pull of some 60 to 70%.

It is to be borne in mind that in the actual making of my invention for commercial use, I contemplate the building of my separator body structure of different lengths, and sizes, increased lengths being provided by casting additional magnets on said body structure integral therewith. In any pulley having more than a single magnet, the number of annular poles provided by the design herein disclosed will be greater than would be the case in the ordinary pulley construction.

While I have shown individual magnets 4*a*, connected at their bottoms by the web 4*b*, I intend it to be well within the spirit of this invention to employ ribs for this purpose. Obviously these ribs may be cast integral with the magnets at their base portions, or inset in them, as desired. The use of ribs simply increases the heat radiating surface of each magnet.

Use of the word "annular" in the appended claims is intended merely to designate structures which are continuous about the center of rotation of the parts and does not necessary indicate that the outer peripheral surface of the pulley must be cylindrical rather than polygonal.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States, is:—

1. A magnetic separating device of the class described, comprising in combination, a magnetic body structure made up of a series of integrally cast annular magnets having a common core and distinct annular poles, the adjacent poles of the magnets being divergent from the base of the body structure toward the peripheries of said poles to provide heat radiating surfaces.

2. A magnetic separating device of the class described, comprising in combination, a magnetic body structure made up of a series of integrally cast annular magnets, having a common core and distinct annular poles, the adjacent poles of the

magnets being spaced apart from the base of the body structure toward the peripheries of said poles to provide heat radiating surfaces, and members bridging the spaces between the adjacent poles of the magnets and providing openings affording communication between such spaces and the atmosphere for the purpose described.

3. A magnetic separating device of the class described, comprising in combination, a magnetic body structure made up of a series of integrally cast annular magnets having a common core and continuous individual annular poles, the adjacent poles of the magnets being spaced apart from the base of the body structure toward the peripheries of said poles to provide heat radiating surfaces, and members located at intervals upon and bridging the spaces between the adjacent poles of the magnets.

4. A magnetic separating device comprising a pulley body including a continuous annular core provided integrally with a series of annular magnets of horseshoe cross section arranged in spaced relation means providing a magnetic flux path between their cores and electrical windings arranged to energize adjacent poles to render them of like polarity whereby the poles thereof are arranged to distribute magnetic flux over the periphery of the pulley body.

5. A magnetic separating device comprising a pulley body consisting of a series of individual annular magnets having a continuous common core and annular poles whereby each individual magnet is of horseshoe cross section, said magnets being arranged side by side with adjacent poles spaced apart and disposed to distribute a magnetic flux over the surface of the pulley body at the periphery thereof, adjacent poles of the magnets being of like polarity.

6. A magnetic separating device comprising a pulley body consisting of a series of individual magnets of horseshoe cross section with a common core and individual annular poles, adjacent poles being of like polarity and with adjacent poles spaced apart and disposed to distribute a magnetic flux over the surface of the pulley body at the periphery thereof, the poles of the said magnets being of constant cross sectional area from the base portions thereof to the peripheral portions whereby to prevent the concentration of flux issuing from the poles at the pulley periphery.

7. A magnetic separating device comprising a pulley body consisting of a series of individual annular magnets of horseshoe cross section and arranged side by side with adjacent poles spaced apart and disposed to distribute a magnetic flux over the surface of the pulley body at the periphery thereof, adjacent poles of the magnets being of like polarity, the said poles of the magnets being of substantially constant circumferential sectional area from the base portions thereof to the peripheral portions for the purpose described.

8. A magnetic separating device comprising the combination with a shaft, of a magnetic body extending about the shaft and supported therefrom and radially projecting peripherally extending pole flanges disposed in sets of two upon said body, the flanges of each such set being spaced from each other and provided with mutually converging end faces whereby to provide peripheral poles isolated magnetically from the corresponding pole of the adjacent set.

9. A magnetic separating device comprising the combination of a tubular central body with magnetic pole flanges arranged thereon in sets of two, the opposed faces of the flanges of each set being non-divergent in a radially outward direction and adapted to receive a compact winding therebetween, while the outer faces of the flanges of each set are mutually convergent in a radially outward direction whereby their peripheries are mutually isolated from the like flanges of an adjacent set and of reduced axial dimensions.

10. A magnetic separating device comprising the combination of a tubular central core having annular magnetic pole flanges integrally cast thereon in sets of two, the adjacent poles of consecutive sets being spaced apart and the sets being provided with windings adapted to energize said adjacent poles with like polarity.

11. A magnetic pulley, comprising a hollow core, a plurality of pairs of mutually spaced annular poles connected with and radially extending from said core, a coil disposed between each pair of poles, and means for energizing said coils with alternately reversed polarity whereby to provide a plurality of magnets having a common path of magnetic flux through said core.

ROSWELL H. STEARNS.