May 22, 1962 D. B. PALL 3,035,703

MAGNETIC FILTER UNIT

Filed Nov. 14, 1957

FIG.1.

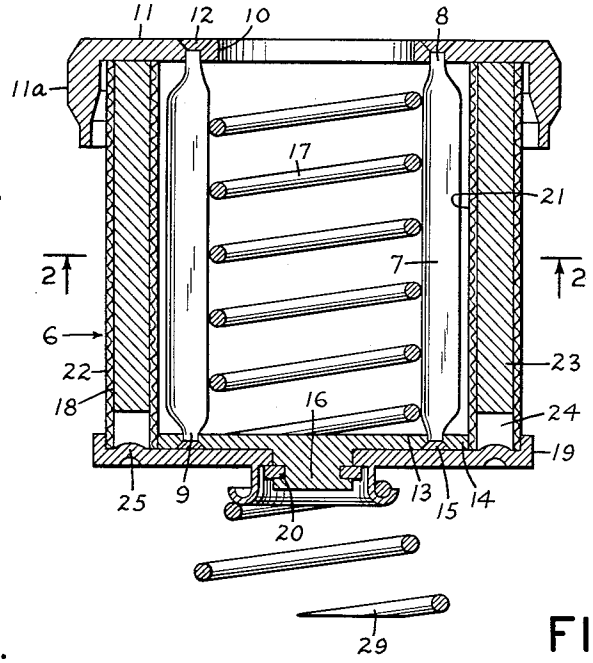


FIG.3.

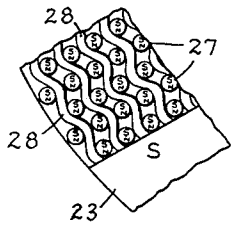


FIG.4.

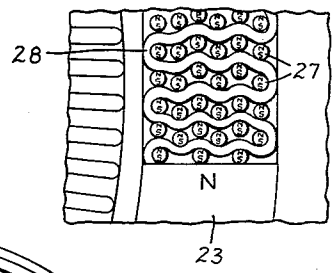
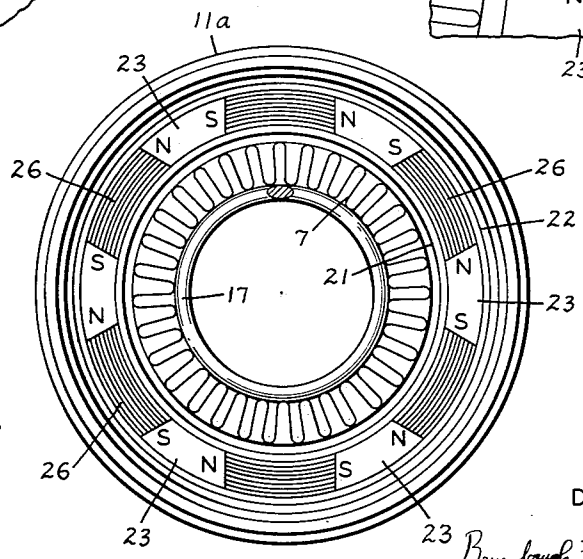


FIG.2.



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United States Patent Office 3,035,703 Patented May 22, 1962

3,035,703

MAGNETIC FILTER UNIT

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Filed Nov. 14, 1957, Ser. No. 696,521
10 Claims. (Cl. 210—223)

This invention relates to magnetic filter units and, more particularly, to a filter unit wherein the removal of magnetizable particles is accomplished by a wire mesh having magnetic poles induced therein.

This application is a continuation-in-part of United States application Serial No. 625,445, filed November 30, 1956.

In the removal of foreign substances from a fluid it is well known to utilize a magnetic field to attract and retain fine magnetizable particles which may pass through a filtering screen. Heretofore, however, in magnetic separators devised for this purpose the gap between the magnetic pole pieces has been great enough to permit substantial quantities of magnetic material to pass through the magnetic field without being attracted to and retained by one of the pole pieces. Further, the high rate of fluid flow required in modern circulating systems causes the magnetizable particles to pass through the magnetic field of conventional magnetic traps at higher velocity, decreasing the time during which the particle may be attracted toward a pole piece, thus permitting even larger numbers of magnetizable particles to escape the trap.

Accordingly, it is an object of this invention to provide a new and improved magnetic filter capable of removing a high percentage of magnetizable particles from a fluid flowing at high velocity.

Another object of the invention is to provide a new and improved magnetic filter having a minimum magnetic field gap.

A further object of the invention is to provide a magnetic filter having a high capacity for magnetic impurities.

These and other objects of the invention are accomplished by providing filter units having magnetic pole pieces generating a magnetic field transverse to the direction of fluid flow. Within the magnetic field are placed a group of closely spaced magnetizable strands wherein magnetic poles are induced across their diameter by the magnetic field. In this manner magnetizable particles contained in a fluid flowing through the filter are caused to pass in close proximity to a magnetized element with no substantial increase in the resistance to the fluid flow. Filters arranged in this manner also provide a very large area of magnetized surface capable of retaining foreign particles. thus greatly increasing the impurity capacity of the filter unit.

In one embodiment of the filter according to the invention, a wire mesh having magnetizable wires running in one direction and nonmagnetic wires interwoven between them may be interposed between the magnetic pole pieces with the magnetizable wires positioned transverse to the magnetic field.

Further objects and advantages of the invention will be apparent from a reading of the following description in conjunction with the accompanying drawings, in which:

FIG. 1 is a view in longitudinal section of a typical filter element arranged in accordance with the invention;

FIG. 2 is a view in transverse section taken on the line 2—2 of FIG. 1 looking in the direction of the arrows;

FIG. 3 is an enlarged fragmentary view showing a portion of the magnetic filter element of FIG. 2; and,

FIG. 4 is an enlarged fragmentary view similar to that of FIG. 3 showing another arrangement of the magnetic filter element.

Referring to FIGS. 1 and 2 there is shown a typical

embodiment of a filter unit including a magnetic trap arranged in accordance with the invention which is adapted to attract and retain fine metallic particles that might otherwise pass the filter screen and find their way through the filter. The filter unit, identified generally by the numeral **6**, includes a filter element **7** in the form of a corrugated tubular member made of woven wire mesh, which may be of the type described in copending United States application Serial No. 625,445, filed November 30, 1956, but is preferably formed of unsintered mesh, and compressed at its respective ends **8** and **9**. The upper end **8** is disposed between an apertured inner ring **10** and a flanged outer ring **11** with a metallic weld **12** integrating the three metal parts. The other end **9** of the filter element is secured between inner and outer rings **13** and **14** respectively by a metallic weld **15**, the inner ring **13** comprising a cap member sealing off the end of the filter element **7**. The cap portion of the inner ring **13** includes a central outwardly directed lug **16**.

Fitted within the filter element **7** is a compression member which can take the form of a spring **17** and disposed outside the filter element **7** is a magnetic trap, indicated generally by the numeral **18**, of generally tubular shape, abutted at one of its ends against the ring **11** inside a shoulder **11***a* formed thereon. At its other end the magnetic trap **18** is engaged by a holding plate **19** which is centrally apertured to fit over the lug **16** of the ring **13** and held in place by means, for example, of a conventional snap ring **20**.

The magnetic trap **18** includes a pair of concentric tubular noncorrugated wire mesh elements **21** and **22** between which are fitted a series of elongated, angularly spaced, permanent magnet bars **23**, as best seen in FIG. 2. The magnetized bars **23**, which can be formed of Alnico V, are shaped on their inner and outer surfaces to conform to the generally cylindrical curvature of the embracing mesh portions **21** and **22** and they are polarized across their widths and arranged north pole to south pole around the filter element. As best seen in FIG. 1, the lower ends of the magnetic elements **23** terminate short of the holding plate **19** to form a space **24** within which is disposed a positioning boss **25** struck upwardly from the holding plate.

In the spaces between adjacent magnetic bars **23** are fitted stacks **26** of woven wire mesh formed of magnetic strands **27** running parallel to the edge surfaces of the magnetic bars and nonmagnetic strands **28** which may be of nonmagnetic stainless steel, for example, interwoven therebetween. Each of the stacks **26** may be comprised of, for example, five separate layers of woven wire mesh, or if desired, a single wire mesh folded in accordion fashion so that the nonmagnetic strands **28** run back and forth between the magnetized bars **23**. In another typical arrangement, illustrated in FIG. 4, the stack **26** comprises a wire screen folded in accordion fashion so that the folds run perpendicular to the magnetic field and parallel to the direction of fluid flow.

As best seen in FIGS. 3 and 4, the magnetic field between the permanent magnets **23** induces magnetic poles N and S across the diameter of the magnetic strands **27** to form a myriad of magnets for attracting particles of magnetic material from the fluid which passes therethrough. Inasmuch as the gap between adjacent strands **27** is small it will be readily apparent that particles of magnetic material contained in the fluid are strongly attracted by the induced magnetic poles and have a minimum distance to travel to a strand which is capable of retaining them. Further, the great number of magnetized strands exposed to the passing fluid provide a large storage area for the magnetic particles removed from the fluid, thereby increasing the impurity capacity of the filter unit.

In operation, the filter unit **6** is mounted in a hydraulic

system so that fluid can pass radially inwardly through the stacks of the magnetized mesh **26**, through the filter element **7**, and out through the opening in the ring **10**. In mounting the unit **6**, a conical spring **29** may be used to urge the unit toward a receiving surface in a housing (not shown) in the circulating system. A typical filter unit constructed in accordance with the invention has a mechanical filter component removal rating of 17 microns and a magnetic component rating of 2 microns with a flow rate of approximately 5 gallons per minute.

Although the invention has been described herein with respect to specific embodiments, many modifications and variations thereof can readily be visualized. For example, a single permanent magnet of cylindrical shape might be utilized having one angular gap in which the wire mesh stack is positioned. Also, the filter screen element may vary in size, shape or position, or an in-line magnetic trap comprised of adjacent magnetic bars and wire mesh stacks arranged in a flat disc shaped element, for example, might be utilized. Accordingly, the invention is not intended to be limited except as defined by the following claims.

I claim:

1. A magnetic filter for removing metallic particles from a fluid flowing therethrough, comprising means for generating a magnetic field and a filter element interposed in the magnetic field and in the fluid path comprising both nonmagnetic and magnetic material and having filter pore openings whose sides are enclosed at least partially by nonmagnetic material, the magnetic material being in the form of a plurality of separate parallel elements disposed at opposite sides of the pore openings and separated from each other by nonmagnetic material, and running in a direction transverse to the magnetic field, and the nonmagnetic material being disposed between and separating the elements of magnetic material.

2. A magnetic filter in accordance with claim 1 in which the filter element is in the form of a woven mesh, the magnetic material constituting filaments running in only one direction of the mesh.

3. A magnetic filter in accordance with claim 1 in which the filter element comprises interwoven metallic filaments disposed to define a series of pores therethrough, the filaments being deformed to form enlarged contiguous surfaces therebetween and the filaments in each of the faces of the material being deformed to form flattened coplanar surfaces, filaments running in one direction being of magnetic material and the remaining filaments being of nonmagnetic material.

4. A magnetic filter in accordance with claim 1 in which the filter element is in the form of a woven mesh, the magnetic material constituting filaments running in only one direction of the mesh, and the mesh being folded in accordion fashion.

5. A filter element for removing magnetizable metal particles from a fluid flowing therethrough comprising both nonmagnetic and magnetic material and having filter pore openings whose sides are enclosed at least partially by nonmagnetic material, the magnetic material being in the form of a plurality of separate parallel elements disposed at opposite sides of the pore openings and separated from each other by nonmagnetic material.

6. A filter element in accordance with claim 5 in the form of a woven mesh, the magnetic material constituting filaments running in only one direction of the mesh.

7. A filter element comprising interwoven metallic filaments disposed to define a series of pores therethrough, the filaments being deformed to form enlarged contiguous surfaces therebetween and the filaments in each of the faces of the material being deformed to form flattened coplanar surfaces, filaments running in one direction being of magnetic material and the remaining filaments being of nonmagnetic material.

8. In a filter, a corrugated wire, porous mesh body of generally tubular configuration with the corrugations extending generally axially thereof, said mesh body being supported in the fluid path and having compressed, flat edge portions at either end traversing the corrugations, inner and outer ring means having radially opposed surfaces embracing said flat edge portions, metallic weld means bonding, as an integral unit, the wire mesh and the edge pieces, and magnetic filter means supplemental to the corrugated mesh, said magnetic filter means comprising means for generating a magnetic field and a magnetic filter element supported in the fluid path, comprising permanent magnet means and a filter element extending between the poles of the permanent magnet means and in the fluid path, the filter element comprising both nonmagnetic and magnetic material, the magnetic material being in the form of a plurality of separate similarly oriented elements having the openings of the filter disposed therebetween, and running in a direction transverse to the magnetic field, and the nonmagnetic material being disposed between and separating the elements of magnetic material.

9. A filter as set forth in claim 8, said permanent magnet means comprising a plurality of permanent magnets arrayed in a circle in spaced-apart relationship, said magnets being arranged with opposing poles facing each other, and filter elements between each pair of permanent magnets.

10. A filter as set forth in claim 9, including, as an assembly, first and second concentric cylindrical wire mesh portions defining a toroidal space within which said permanent magnets and mesh sections are mounted.

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