MEANS FOR REMOVING PARA-MAGNETIC PARTICLES FROM FLUIDS

FIG. 1

FIG. 2

FIG. 3

FIG. 4

INVENTOR
S. M. MORIYA

Agent.
MEANS FOR REMOVING PARA-MAGNETIC PARTICLES FROM FLUIDS

Saburo Miyata Moriya, Tokyo, Japan (1960 Tomioka-Machi, Kanazawa-ku, Yokohama, Japan)

Filed July 1, 1957, Ser. No. 669,113

7 Claims. (Cl. 210—223)

This invention relates to a means and method of removing para-magnetic particles from fluids, and more particularly to a magnetic filter means for attracting and removing para-magnetic material from a fluid passing therethrough. It is especially useful in removing particles of para-magnetic material from machine tool coolants and from the lubricating oil used in internal combustion engines.

Prior art devices of this general nature have not achieved success, first, for the reason that the magnets are too costly; second, the field could not be concentrated in the desired area; and third, absence of a sufficient number of magnetic attracting edges.

An object of the present invention is the provision of a magnetic filter unit making maximum use of the space about a magnet and between the poles thereof.

Another object of this invention is the provision of a magnetic filter having a minimum of expensive magnet material or high permeability alloy therein.

Another object of this invention is the use of a plurality of permanent magnets arranged for even distribution of magnetic force or field in the filtering area.

A further object of this invention is the provision of a great length and multiplicity of magnetically attractive edges within a restricted space.

An additional object of this invention is the provision of a filtering means for removal of para-magnetic particles from fluids in which the filtering element comprises ferro-magnetic material readily demagnetized for cleaning by being removed from the magnetic field.

These and other objects will appear in connection with the following detailed specification and the accompanying drawings forming a part thereof.

In the drawings, wherein like characters of reference indicate like parts throughout the several figures;

Fig. 1 is an axial section through one form of this invention;
Fig. 2 is an axial section of a modification;
Fig. 3 is an axial section of a further modification;
Fig. 4 is a top view partly in section of a further modification, with the filtering element shown in plan;
Fig. 5 is a perspective of one form of element formed of punched or expanded metal;
Fig. 6 is a transverse section of a filter element formed of punched or expanded metal;
Fig. 7 is a fragmentary perspective of another form of filtering element;
Fig. 8 is a fragmentary plan view of another form of filter element;
Fig. 9 is a fragmentary section vertically through a portion of the filter medium of Fig. 8;
Fig. 10 is a fragmentary axial section through a modified filter having two forms of filtering;
Fig. 11 is a fragmentary axial section of a filter having still another form of filtering element;
Fig. 12 is a fragmentary elevation of another form of filter element, and

Fig. 13 is a section through the filter medium of Fig. 12.

In the construction of the magnetic filters now to be described, I may use any suitable magnets, but I prefer to use magnets constructed according to the disclosure of my pending application Serial No. 666,703, filed June 14, 1957.

Referring now to Fig. 1, a filter 1 for removing ferromagnetic material from fluids includes a cylindrical casing 2, preferably of non-magnetizable material and having a cover 3, a bottom 4. Within the casing 1, I arrange an annular series of preferably cylindrical magnet 5 and a similar axial magnet 6, each enclosed in a tubular sheath or shield 7 of non-magnetic or non-magnetizable material. The magnets 2 are held in firm contact with pole pieces 4, 4' by means of spring 8.

The arrangement of the magnets 2 relative to the pole pieces 4, 4' produces an even distribution of magnetic flux in the pole pieces.

A filter element 5 comprising a plurality of discs 7 of the type shown in Fig. 8 is arranged one above the other and in physical contact with the casing 1 and with the pole pieces 4, 4'. Each of the discs 7, as shown in Fig. 8, has a plurality of perforations 8 formed by punching lug members 9 from the disc and bending them substantially perpendicularly to the plane of the disc. The discs 7 are arranged with the members 9 in staggered relation, alternating with spaces 8 on another disc, as is apparent in Fig. 1. If the pole pieces 4, 4' are N and S as shown in Fig. 1, each of the members 9 will have N and S poles, as shown in Fig. 9. It should be apparent that this is a result of the staggered arrangement noted above. A plurality of openings 8 are formed in the discs 7 to accommodate the magnets 2 with their shields 3.

A modified form of magnet filter is shown in Fig. 2 having a plurality of magnets 102 each having a shield 103 of non-magnetic material.

The magnets 102 are arranged in two annular groups 10 and 11 with like poles, south in this view, opposed and having a common disc pole piece 12. The opposite poles are provided with pole pieces 13 and 13', which in this case are both north poles. The pole pieces 12, 13 and 13' are preferably formed of magnetically permeable material of low retentivity, such as mild steel. The pole pieces 13, 13' are each somewhat larger than the pole piece 12 and a dirt filter 14 is placed between them and about the pole piece 12. The dirt filter 14 comprises a pair of coaxial spaced apart cylindrical screens 15, 16 having an annular space therebetween. The annular space between the screens 15, 16 is filled with filter material 17 such as steel wool, cotton linters or other desirable filtering material, for the purpose of removing dirt or sludge from fluids passing therethrough.

The pole pieces 12, 13 and 13' are circular in plan and are each respectively provided with openings 18, 19 and 20 to accommodate a bolt 21 having a tubular portion 22 provided with openings 23 in the wall thereof. Fluid will circulate as indicated by the arrow 26. Para-magnetic particles, I provide a magnetic filter 24 comprising a plurality of disc like members 25 as shown in cross section in Fig. 6, preferably formed of expanded metal or punched metal expanded in opposite directions from a median plane. The disc like filter members 25 are arranged to substantially completely fill the space within the screen filter 14 and the pole pieces 12, 13 and 13'. The arrangement is such that in the lower portion between the pole pieces 12 and 13', the upper edges or knees 26 of the discs will be south poles and the lower edges or knees 27 will be north poles. In the space between the pole pieces 12 and 13, the polarity of the discs is reversed relative to that of the discs just mentioned.
In Fig. 6 there is shown the arrangement as a disc would appear in the upper part of the filter of Fig. 2. Here it will be noted that the length of a magnet element 28 when the disc is magnetized, as in use, will be much greater than its width. More about this later herein.

In Fig. 3, a modification of the structure of Fig. 2 is shown. Here the magnets 202 and shields 203 are grouped around a tube 29 having a plurality of perforations 30. The pole pieces 31 and 32 are provided with hubs 33 and 34 respectively to space the magnets 202 from the tube 29. The common pole piece 35 has a pair of hubs 36, 37, similar to the hubs 33, 34. The whole assembly of magnets 203 is surrounded by a screen 38 of non-permeable material. The tube 29 is closed as at 39 and is threaded into an opening 40 in the pole piece 32. A pole piece 41 is placed adjacent the pole piece 33 and the whole assembly is clamped together by means of a nut 42 threaded on the tube 29. In the space between the pole pieces 41 a magnetic filter comprising a plurality of annuli 43 formed of the material described in connection with Fig. 2, and shown in detail in Fig. 5.

In Fig. 4, I show a modified form of filter partly in section. Here, a plurality of magnets 302 are grouped in spaced relation about a perforated tube 44. The magnets 303 are also separated by shielding bars 45 of non-magnetic material. The whole group is surrounded and enclosed in a tube 46 of non-magnetic material. The numeral 47 represents one of a plurality of annuli similar to the annuli 43.

A modified form of magnetic filter element is shown in Fig. 7 in which a ribbon 48 of permeable material is cut or punched as a dental bar having teeth 49 and spaces 50. In use ribbons 48 may be rolled into a convoluted spiral and a plurality of such spirals may be stacked in the flux area of a filter structure in much the same manner as the stacking of the annuli 24 and 43.

The letters N and S relate to the polarities as when placed in the field of a magnet such as that shown in Fig. 1.

In Fig. 10, I show a fragment of a filter similar to the filter shown in Fig. 2 having a modified dirt or sludge filter. Here the arrangement of the magnets 402 and shield 403 is the same as the magnets 102 and the shields 103 previously described. A plurality of plates 107 are used as a magnetic filter in the same manner as the plates 7 described in connection with Fig. 1. The pole piece 112‘ correspond to the pole pieces 12 and 13’ of Fig. 2, and the tube 123 corresponds to the tube 23 of Fig. 2. In lieu of a dirt filter 14 I provide a dirt filter 114 comprising an inner cylindrical screen 115 and an outer cylindrical screen 116, both of non-magnetic material, between which there is a filter element 11 of woven steel wool, cotton linters or other suitable material for the removal of dirt and sludge from fluid passing therethrough.

The fragmentary view in Fig. 11 shows a portion of a filter having a different type of magnetic filtering material. Here the magnets 502 and shields 503 are shown with a S pole piece 213, similar to pole piece 13 previously described.

Numerals 101 denotes a casing enclosing the filter elements. The space within the casing 101, and between the pole pieces 51 is filled with a plurality of hollow balls 51 having openings therein. The balls 51 are heterogeneously arranged, but have N and S poles as indicated.

In Figs. 12 and 13 a modified form magnetic filter element is shown. Bars 53 of ferro-magnetic material, preferably mild steel of low retentivity, are woven with wires 54 of non-magnetic material to form a fabric. This fabric may be rolled or plastically deformed between pole pieces as in the poles 4, 4' of Fig. 1. When so situated the polarities will be as indicated by the letters N and S.

The magnets 2, 102, 202, etc. are shown as being single rods of highly permeable material, such as "Alnico" or "MK," both being well known and much used where powerful permanent magnets are desired. The above described magnets have their shields 3, 103, 203, etc. of non-magnetic or non-permeable material. They are of the form more particularly set forth in my copending application above referred to.

The object of the arrangement disclosed in that application and herein is to produce areas or fields of strong magnetic flux, with a minimum of expensive magnetic alloy material. This is accomplished by arranging small rod magnets, with suitable non-magnetic shields, uniformly symmetrically about an axis, so that all like poles produce flux in the same direction. The assembly thus formed is then provided with suitable pole pieces of ferro-magnetic material, preferably mild steel of low retentivity.

The magnetic filter elements herein described are preferably formed of mild steel of low retentivity. The arrangement of parts of these magnetic filter elements is such that there is formed a vast number of magnets having N and S poles as indicated on Figs. 5, 6, 7, 9, 12 and 13 when subjected to the magnetic flux of the magnets 2, 102, 202, etc. In this construction, the length of any magnet is greater than the thickness thereof. This results in a condition very favorable for the entrapment of small particles of para-magnetic material carried by fluids passing through or over the filter. In the constructions herein delineated, the flux produced by the magnets of highly permeable material is concentrated between the pole pieces of relatively inexpensive material such as the pole pieces 4, 4' etc. and results in magnetization of the magnetic filter media to produce a large number of magnet edges or individual poles. In some of the devices disclosed herein there may be hundreds or even thousands of feet of such magnetic attracting edges. In all cases each filter element has its individual polarity.

Ordinary filters depend upon the fineness of the material or the minuteness of the inter element spaces to restrict the passage of particulate material therethrough. Due to this, clogging results rather quickly, and great pressure is required to force fluids therethrough. The openings or passages through the magnetic filter of this invention are large, many times larger than the average of particles passing therethrough. The purpose of these filters is to divert fluids and present the multiplicity of magnetized edges to small streams of liquids and "coax" or attract thereto the particles of para-magnetic material. This is especially useful in filtering the coolants from a grinding machine or any other filter or device which is in a machine. Also it is useful in de-dusting the crank case oil of an internal combustion engine. For removing sludge and other dirt, other filters may be used or a combination filter, such as that shown in either Fig. 5 or Fig. 10 may be used to accomplish a complete filtering.

While electro magnets might be used, power failure renders them useless, therefore I prefer to use the powerful small magnets referred to above.

Cleaning is a simple operation. The filter assembly is disassembled and the screens, discs or the like are removed. Such removal usually demagnetizes them. The particles collected thereon can then be removed by washing with water or solvents.

While I have described specific forms of my invention, I do not wish to infer any limitations except as imposed by the appended claims.

What I claim is:

1. In a filter for removing paramagnetic material fluids; a generally longitudinally extending substantially cylindrical casing having upper and lower cover members, with an inlet in one cover and an outlet in the other cover, a permanent magnetic assembly consisting of a plurality of spaced apart bar magnets arranged in a circle about the longitudinal axis of the casing and having like poles of each of the magnets extending in the same direction, a disc pole piece of magnetizable material at either end
of said magnet assembly and in firm contact with each of the respective poles, providing an area of intense magnetic flux between the pole pieces, a plurality of closely spaced substantially parallel discs, of expanded metal substantially filling the flux area, the metal of said discs providing portions extending substantially transverse to the plane of the disc and having axial dimensions greater than the thickness of the metal of the discs, to provide a multiplicity of N and S poles in each disc.

2. The structure as defined in claim 1, wherein each magnet is a cylinder and each is enclosed in a closely fitting tube of non-magnetic material.

3. The structure as defined in claim 1, including a second magnet assembly in axial alignment with the first and having like poles opposed and including a common pole piece between the two assemblies.

4. The structure according to claim 1, having additional filter means for removing sludge.

5. The structure according to claim 4, wherein the sludge filter comprises an annulus of porous material surrounding the magnetic filter.

6. The structure according to claim 5, wherein the porous material is a batt of fibrous material.

7. The structure according to claim 6, wherein the fibrous material is steel wool.

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CERTIFICATE OF CORRECTION

Patent No. 2,951,586

Saburo Miyata Moriya

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 67, after "material" insert -- from --.

Signed and sealed this 4th day of April 1961.

(SEAL)
Attest: ERNEST W. SWIDER

XXX
Attesting Officer

ARThUR W. CROcker
Acting Commissioner of Patents