

Oct. 26, 1948.

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2,452,220

MAGNETIC SEPARATOR

Filed May 17, 1943

4 Sheets-Sheet 1

FIG. 1.

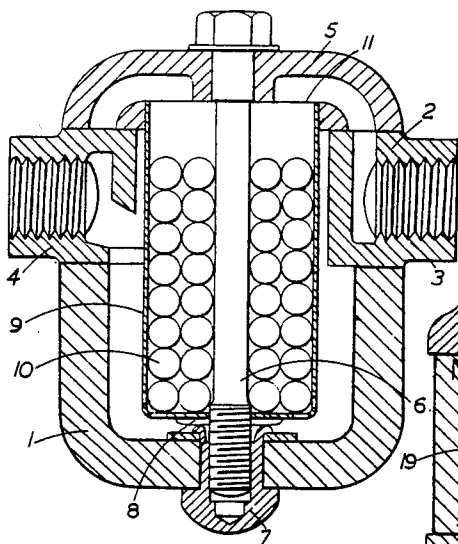


FIG. 2.

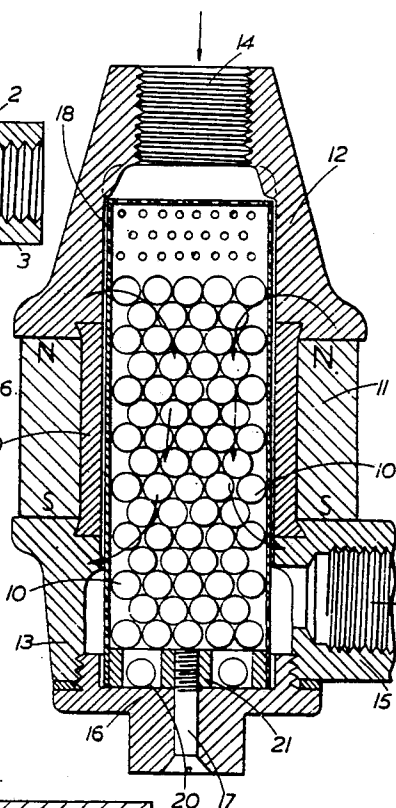
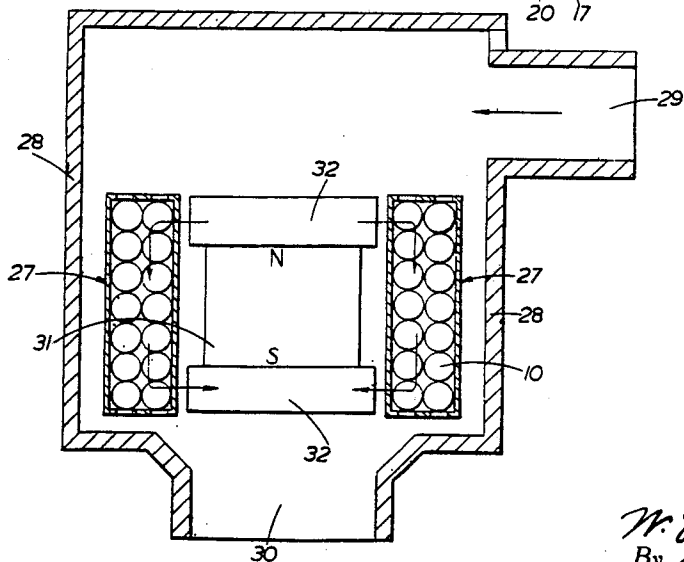


FIG. 4.



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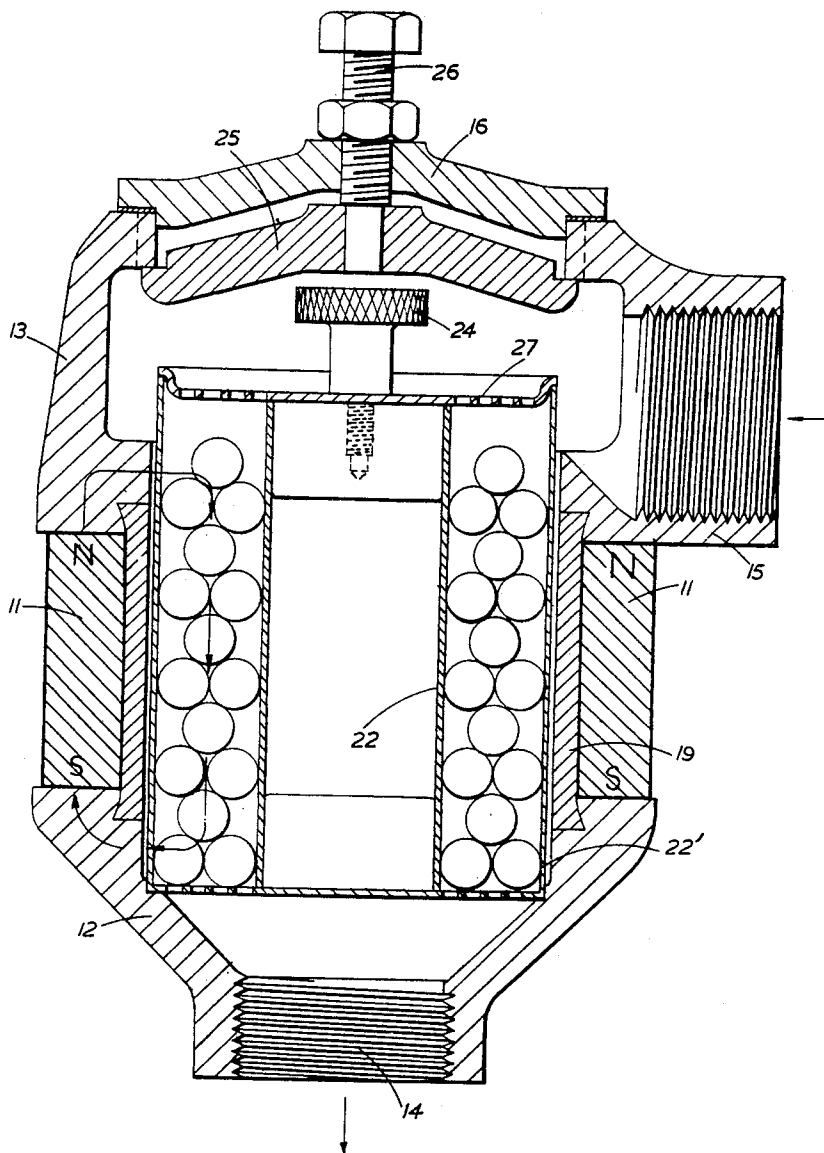
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FIG. 3.



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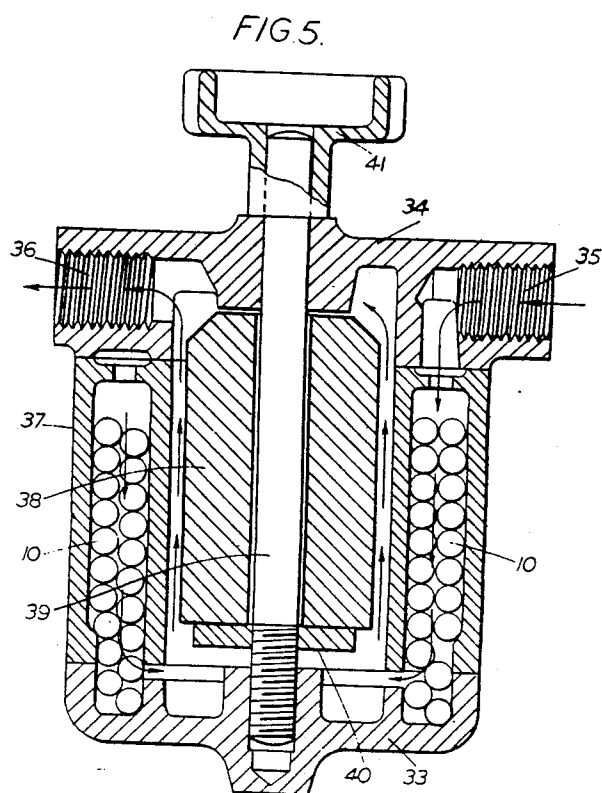
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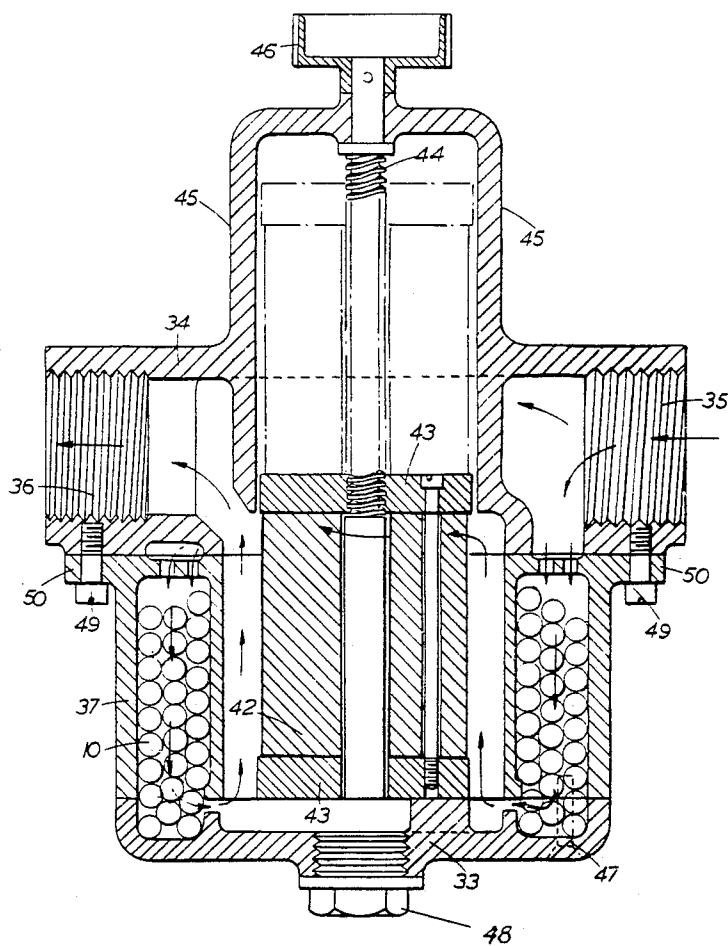
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FIG. 6.



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UNITED STATES PATENT OFFICE

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MAGNETIC SEPARATOR

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In Great Britain May 19, 1942

3 Claims. (Cl. 210—1.5)

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This invention relates to magnetic separators of the kind designed to abstract particles of ferrous metals from a fluid and in particular a liquid such as lubricating oil.

According to the invention the liquid is caused to pass or percolate through a collection of elements of magnetic material preferably of spherical shape, arranged in the flux path or field of a magnetic system. Thus in accordance with the invention a column of balls or other elements of magnetic material may be axially associated with a magnetic system having its poles in proximity to the ends of the column.

The invention includes magnetic separators wherein the magnetic system is annular, and the balls or other elements are contained in a basket or container of non-magnetic material disposed axially within the magnet system, the end portions of said basket or container being perforated to allow the passage of liquid therethrough in the axial direction. It also includes magnetic separators wherein the magnet system is removably associated with the column of balls or the like, whereby said balls or the like may be demagnetised for cleaning purposes.

According to another feature of the invention the balls are contained in an annular basket or container and the magnetic system is disposed axially therein, the end portion of said basket or container being perforated to allow the passage of liquid therethrough in the axial direction.

Apparatus for carrying the invention into practice may take various forms. For example, it may consist of a, preferably, circular magnet clamped between a pair of mild steel castings the upper of which forms an inlet chamber for the fluid being treated and the lower casting forms an outlet chamber for the purified fluid. Between these chambers a renewable basket containing a number of mild steel balls is arranged. The basket may be of annular form introduced through an opening in the top inlet chamber and supported on a shoulder formed on the interior of the bottom outlet chamber casting. The basket may be provided with a perforated bottom and a perforated closure cap and the opening in the top cover may be closed by any suitable cover adapted to be removably secured in position. The fluid to be treated may pass into the top chamber through a suitably disposed port and the filtered fluid may pass out through a hole in the bottom outlet chamber.

Alternatively the basket provided with a perforated top carrying the mild steel balls may be

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introduced through an opening in the bottom outlet casting and the fluid to be treated introduced into the top inlet chamber through a central inlet port or opening.

In order that the invention may be clearly understood and readily carried into practice a number of constructions according thereto are illustrated, by way of example only, in the accompanying drawings, in which—

Figure 1 is an axial section of a construction employing an annular magnet surrounding a central container for the balls or the like.

Figure 2 is a similar view of another construction of greater capacity, with the magnet encircling the casing of the device.

Figure 3 is a similar view of a modified construction similar to Figure 2, but of still greater capacity, and having an annular ball container or basket.

Figure 4 is a diagrammatic sectional view of another construction in which a central magnet is surrounded by an annular ball container or basket.

Figure 5 is an axial section of still another construction having a central magnet, but with the surrounding annular ball container embodied in the casing of the device, and

Figure 6 is an axial section of a modified construction similar to Figure 5, adapted to allow removal of the magnet from within the ball container without dismantling the device.

Referring to Figure 1, the filter casing comprises a cup-shaped lower portion 1 made of suitable steel and magnetised to constitute a permanent magnet, an intermediate cast iron ring 2 having a liquid inlet fitting 3 and a liquid outlet fitting 4, and a cast iron dished cover plate 5. The casing is held in assembly by an axial bolt 6, which screws into a bush 7 in the bottom of magnet cup 1. Surrounding the bolt 6, and supported by a taper pin 8 passing through the bolt, is a basket 9 of brass, copper or other non-magnetic material, containing a filling of mild steel balls 10. The basket 9 has an open mouth 11 which fits into the central cavity of cover plate 5 and its bottom portion is perforated.

The oil or other liquid containing ferrous impurities to be removed enters by the inlet fitting 3 and flows into the top of basket 9, whence it flows downwardly over the mild steel balls 10 which are magnetised by magnet 1, and eventually passes out of the device by fitting 4. Ferrous impurities in the liquid will remain adherent to the balls 10 and these may be periodi-

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cally washed free of the impurities whilst remaining in the basket 9, since the basket 9 may be readily removed from the filter complete with end cover 5 and central rod 6 by simply unscrewing rod 6 from screw bush 7.

In the construction illustrated by Figure 2, the casing is built up from an annular magnet 11 surrounding a sleeve 19 of non-magnetic material disposed between two malleable iron end caps 12 and 13, of which the former is formed with the axial oil inlet opening 14 and the latter is formed with the radial oil outlet member 15. The lower end cap 13 also has its lower wall formed by a removable cover 16 on which is mounted by means of screw 17 a non-magnetic sheet metal basket 18 containing the mild steel balls 10. The upper and lower end portions of this basket only are perforated, the medial portion being unperforated. As shown the non-magnetic sleeve 19 is bonded at its ends into the end caps 12 and 13 and it may, for example, be made of brass or aluminium.

The magnetic flux will pass, as indicated by the arrows, through the balls 10, which will accordingly become magnetised and attract to them particles of magnetic material suspended in the oil flowing through the interstices between the balls. It will be appreciated that the basket 18 may be readily removed from the filter, for cleaning purposes, by unscrewing the lower cover plate 16. When it is desired to replace the balls 10 by others, say, for example, of a different diameter, the screw 17 is removed, to allow the removal of the basket 18 from the cover plate 16, and consequent uncovering of the holes 20 in the end plate 21 of the basket. The balls 10 may be removed from and loaded into the basket 18 through the holes 20.

With the above construction the basket of balls is removable from the bottom of the filter casing, but obviously the device may be readily modified to permit removal of the basket in the upward direction. For example the filter body of Figure 2 may be simply inverted, so that the outlet 15 becomes the inlet, and the inlet 14 becomes the outlet, and instead of attaching the basket 18 to the end cover 16 (now at the top), the end plate 21 of the basket may merely be fitted with a handle or knob by which it may be lifted out of the filter when the cover 16 at the upper end is removed. Such a modified construction is illustrated by Figure 3.

Figure 3 also illustrates certain other modifications of construction consequent upon the construction of the filter of larger size, to be of greater capacity. Thus the balls 10 are contained in a basket having an annular filling space defined by an internal wall 22 spaced from the external wall 22' so that the central part of the space within the magnet 11, when the magnet is of large diameter, will be practically free of magnetic flux, is clear of balls 10. Otherwise a large proportion of the oil flowing through the filter would not flow over balls which were highly magnetised and imperfect action of the filter device would result. The end walls only of the basket are perforated, where they lie over the annular filling space of the basket.

The basket is provided on top with a knob 24 whereby it may be lifted out of the filter body when the cover 16 is removed. In this construction instead of the cover 16 screwing onto or into the end member 13 of the casing, it is fastened in position by an internal bridge member 25,

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tightened up or loosened, when required, by an external bolt 26.

Figure 4 illustrates diagrammatically another modified construction, in which the magnet is disposed within the filter member 27, which, like Figure 3, consists of an annular ball containing basket. This is housed in a non-magnetic casing 28 having a radial inlet 29 at the top and an axial outlet 30 at the bottom.

The magnet 31 is disposed in this case between a pair of mild steel pole pieces 32; and the magnetic flux between the edges of the pole pieces passes through the annular column of steel balls 10 in the oil channel of the filter device.

Figure 5 illustrates another construction of filter device according to the invention in which, like Figure 4, the balls 10 form a column in an annular oil passage encircling an axially disposed magnet. In this construction also the magnet is axially removable from within the filter member and the oil inlet and outlet are both at the top of the device.

In this construction the casing comprises three parts, viz., a pair of malleable iron end caps 33 and 34, the latter having inlet and outlet openings 35 and 36 respectively, and an intermediate body portion 37 of non-magnetic material. The intermediate body portion 37 consists of an annular brass casing which has a hollow or cavity wall, which contains the balls 10. The upper end of said member 37 is perforated to communicate with the inlet opening 35 of the end cap 34, whilst its lower end is open and the end cap 33 is so shaped as to allow the oil passing downwardly through member 37 to enter laterally into the central compartment containing the magnet 38, which fits into said compartment with sufficient clearance to allow the oil to travel upwardly and discharge through outlet 36 of the upper end cap 34.

The magnet 38 is mounted on a non-magnetic rod 39 which passes through end cap 34 and carries a hand wheel 41, by which the rod 39 may be rotated. The magnet is supported on rod 39 by a washer 40 screwed on to rod 39 and the lower end of the rod is screw threaded for engagement in a screwed socket in the lower end plate 33. After unscrewing the wheel 41 and removing the magnet 38 in the axial direction the ball casing 37 can be removed for cleaning purposes, when required.

Figure 6 illustrates another construction of filter device according to the invention, in which the magnetic system may be, as it were, "switched off," so that the mild steel balls 10 become demagnetised, thus enabling the swarf collected thereon to be swilled out of the filter by flushing it through with a cleansing fluid.

It will be appreciated that in the case of Figure 5 the balls are demagnetised by removal of the magnet 38, but this involves dismantling the filter device, whereas in the case of Figure 6 the balls can be demagnetised without dismantling the filter device.

The general construction is similar to that of Figure 5, like parts being designated by the same reference figures, but the magnet 42 is provided with mild steel end caps or pole pieces 43, and is axially bored and threaded to fit on a rod 44 having a quick pitch screw thread thereon. The rod 44 depends axially within a chamber 45 formed integral with the upper end cap 34 and its external end is provided with a hand wheel 46. By rotation of rod 44 by the hand wheel 46 the magnet can either be raised into the dotted posi-

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tion clear of the ball casing 37 or lowered into the operative position, shown in full lines, in which the magnetic flux passes through the annular column of balls. When the magnet is in the raised position the wall of chamber 45, being of malleable iron, constitutes a keeper for the magnet system 42, 43. The lower malleable iron end cap is fastened to the intermediate member 37 by screws 47 and is provided with a removable screw plug 48 for drainage purposes when the filter chamber is being flushed out. The intermediate member 37 is fastened to the upper end cap 34 by screws 49 passing through a flange 50 on the upper end of member 37.

In all the cases described above the magnetic separation is effected in precisely similar manner, the path of the magnetic flux from the north pole of the magnet to its south pole being through the collection of mild steel balls, so that the liquid passing or percolating over or through the balls has its magnetic particles removed by magnetic action.

The use of balls of magnetic material is an advantageous arrangement, since, owing to the high self-demagnetising coefficient of a sphere, the energy stored in the surrounding gaps will not be seriously reduced, thus leaving a large percentage of the available energy for the extraction of magnetic particles. In addition, a separator embodying such balls will be very regular and uniform in its structure as regards the interstices between the balls, through which interstices the liquid is caused to flow. Therefore, the filtering action will be uniform, and as the separated material collects in the separator, the interstices will clog uniformly, and the period of useful life, before cleaning is required, will be much longer than would be the case with an irregular filling which requires relatively tight packing to establish a good flux path therethrough, and which would result in localized clogging relatively quickly by the separated material.

The use of a basket for carrying the balls or other alternative magnetic material is also advantageous in that when removed from the magnetic field the balls or other contents become demagnetised and can be readily cleaned by swilling in liquid or taken apart for cleaning, or in the case of a steel wool filter, replaced by a new unit.

I claim:

1. A magnetic separator for ferrous particle bearing liquids, comprising a magnet, an apertured non-magnetic container encircling said magnet, a plurality of balls of magnetic material loosely disposed in said container and supported thereby in the flux path of said magnet, said balls being in juxtaposition and forming a regular and uniformly arranged system of interstices between each other, means for directing the liquid in a

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path passing into and out of the container and through the interstices between the balls therein, and said container with the balls therein being separably assembled as a unit with the magnet and the liquid directing means aforesaid and displaceable relative thereto for cleaning purposes.

2. A magnetic separator for liquids, comprising a casing built up of a pair of end caps and an intermediate hollow cylindrical wall of non-magnetic material, balls of magnetic material in said hollow wall forming a regular and uniformly arranged system of interstices between each other through which the liquid may flow around the balls, said casing having liquid inlet and outlet openings communicating respectively with openings leading to the opposite ends of the cavity of said cylindrical wall, and a magnet disposed coaxially within said casing for producing a magnetic flux in the balls.

3. A magnetic separator for liquids, comprising a casing built up of a pair of end caps and an intermediate hollow cylindrical wall of non-magnetic material, balls of magnetic material in said hollow wall, said casing having liquid inlet and outlet openings communicating respectively with openings leading to the opposite ends of the cavity of said cylindrical wall, one of said end covers being provided with a cylindrical chamber and forming a coaxial extension of the space within said cylindrical wall of the casing, a bolt passing axially through said chamber and through the space within said cylindrical wall, a screw thread along the portion of said bolt outside the cylindrical wall, a magnet bored to slide along said bolt, on which it is mounted, said magnet having at one end a nut member engaging with the screw thread on said bolt, whereby on rotation of said bolt, said magnet may be moved axially from within said cylindrical wall to a position within said chamber.

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