July 23, 1957 H. THOMA 2,800,230

MAGNETIC SEPARATORS

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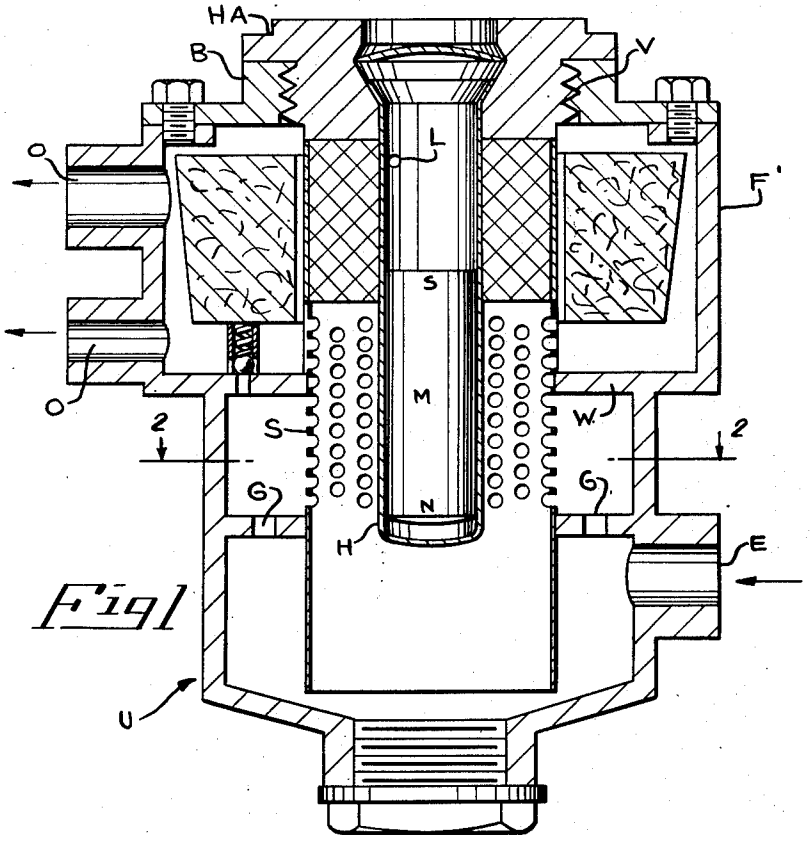


Fig 1

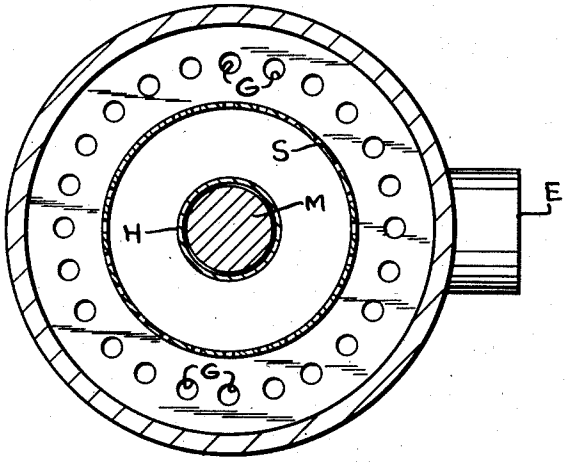


Fig 2

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MAGNETIC SEPARATORS

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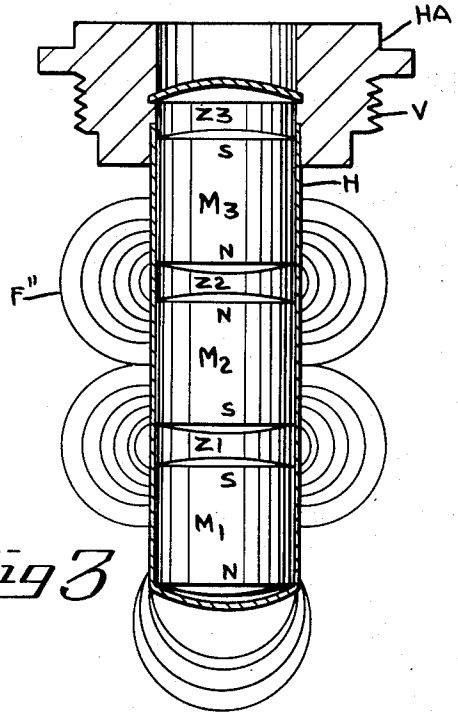


Fig 3

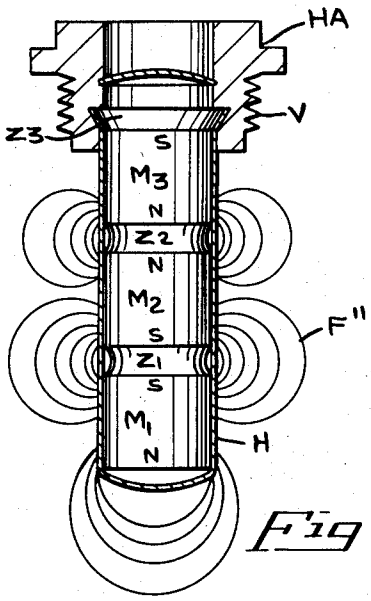


Fig 4

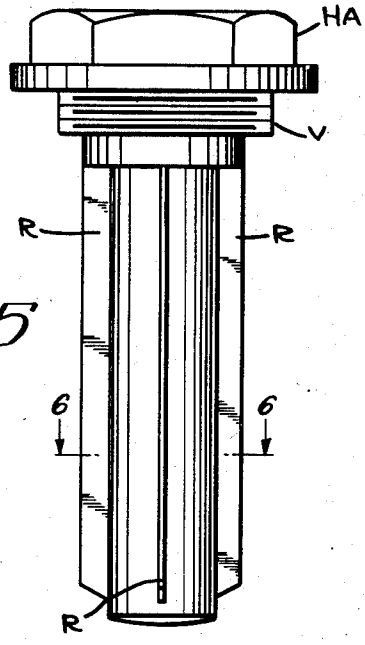


Fig 5

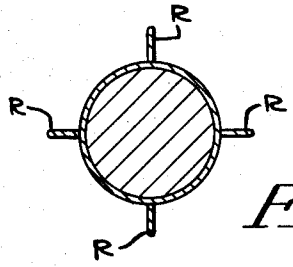


Fig 6

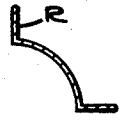


Fig 7

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MAGNETIC SEPARATORS

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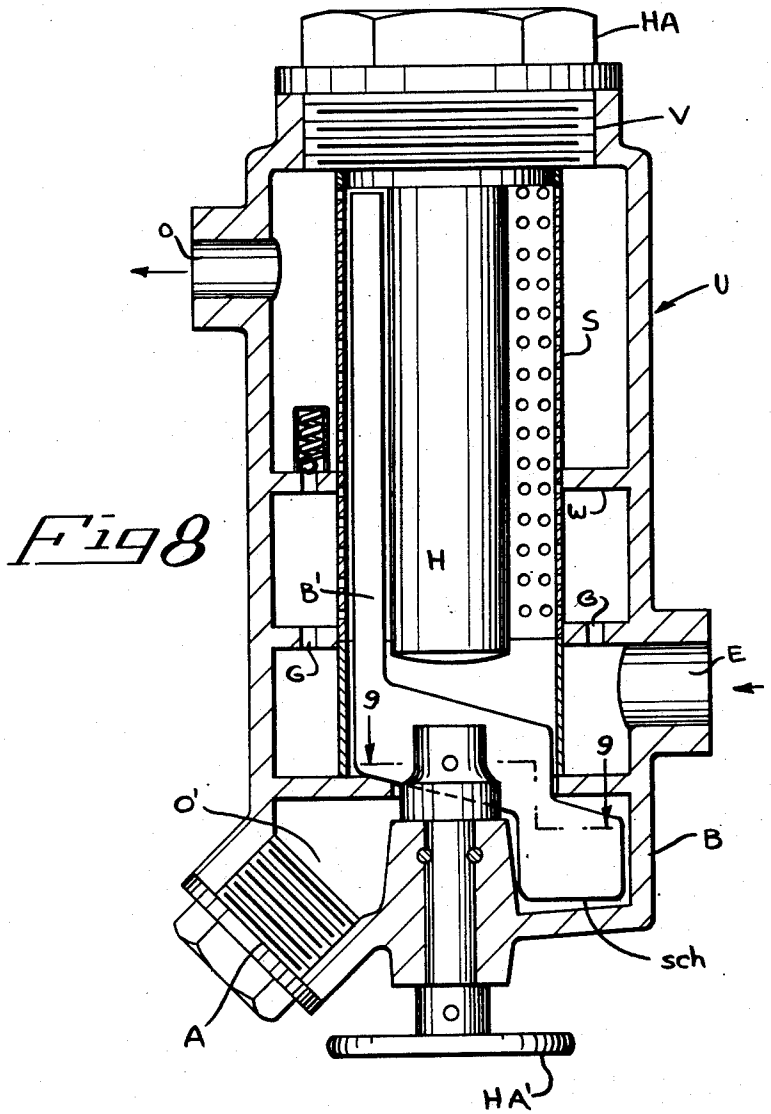


Fig 8

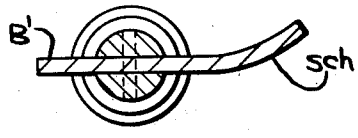


Fig 9

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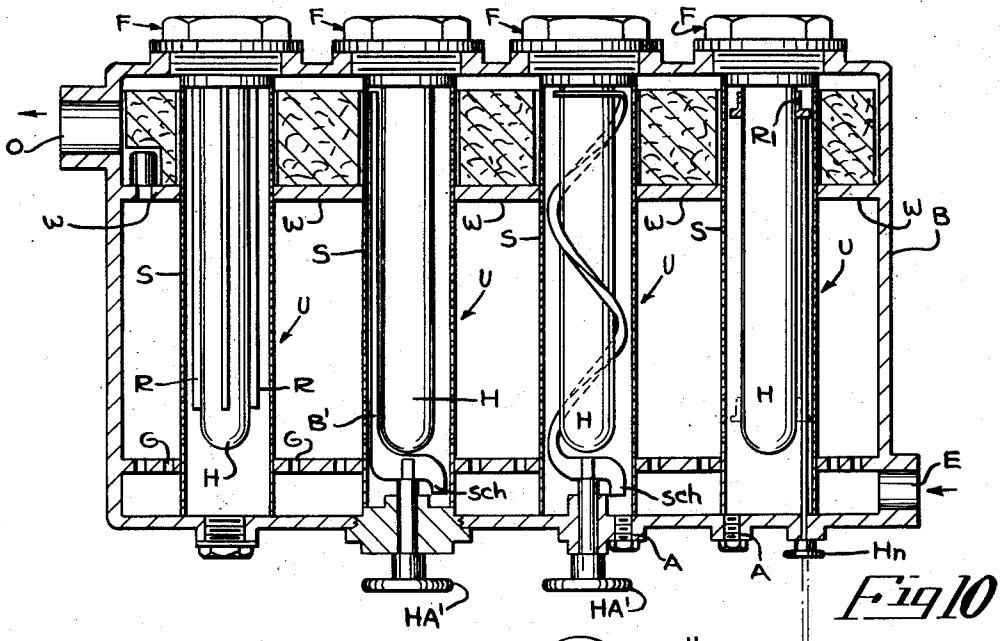


Fig 10

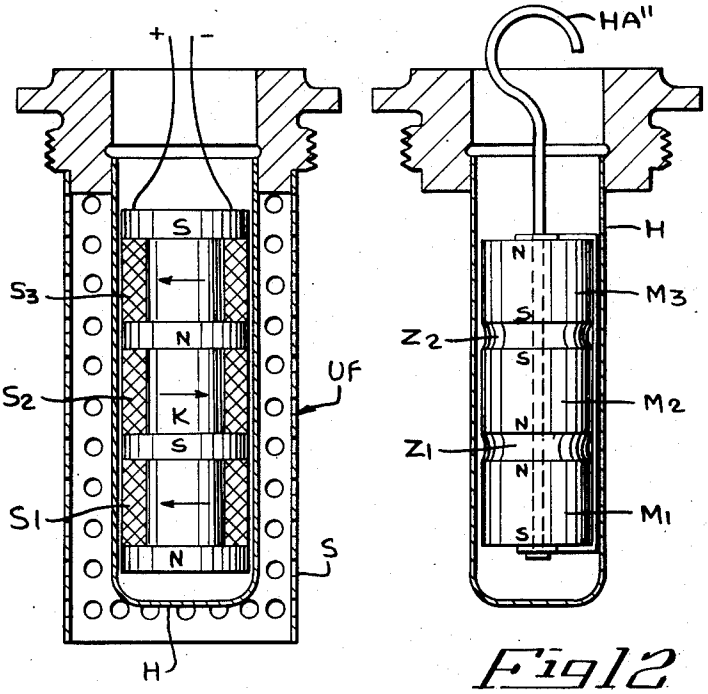


Fig 11

Fig 12

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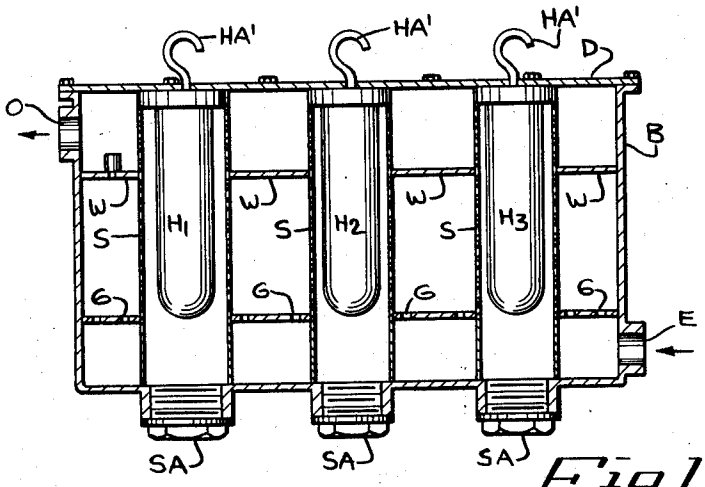


Fig13

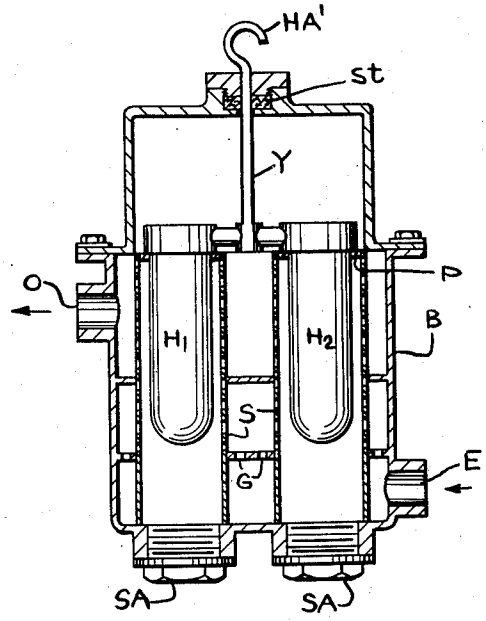


Fig14

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United States Patent Office 2,800,230 Patented July 23, 1957

2,800,230

MAGNETIC SEPARATORS

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Application July 14, 1954, Serial No. 443,319

Claims priority, application Germany July 15, 1953

5 Claims. (Cl. 210—223)

The present invention relates to magnetic separators and more particularly to multiple unit separators which are energized by permanent magnets or electro-magnets to remove magnetizable foreign bodies out of circulating liquids, predominantly oil, or from circulating granular masses, for instance, small particles or grains of metal, etc.

The known separators of this type heretofore used have the disadvantage that they allow a large number of particles, even magnetic or magnetizable particles, to pass by unimpeded. Furthermore, such separators are very difficult to clean so that they rapidly fail during operation.

With the above in view it is an object of the present invention to provide a magnetic separator system for the ready removal of particles from any system of feeding or lubrication in an engine and the like.

Another object of my invention is to provide a separator for use in connection with lubricating systems for the removal of magnetizable and like particles from the system, thereby reducing the wear and tear of the moving parts in said system.

One other object of the invention is to provide a separator wherein the walls of the same are lined with non-magnetic material to avoid flaking off of the magnetic walls of the separator.

A further object of my invention is to provide a magnetic separator having at least one encased rod-like smooth magnet with a plurality of poles in a casing thru which flows a fluid to be cleansed and in which the casing for the magnet serves as a conductor.

Other objects and features of my invention will become apparent from the herein following description taken in conjunction with the accompanying drawings.

The invention comprises on the one hand in conducting liquid, for instance oil to be purified in an oil lubricating or circulating system, in such a manner by the use of non-magnetic guiding walls or baffles that those parts of the magnetic field which do not exert any separating action cannot be passed through by the oil. Furthermore, these non-magnetic walls or bodies also have the property of greatly facilitating the cleaning of the separator. In this connection it will be noted that the most effective permanent magnets consist of materials which are brittle, friable and provided with a rough surface so that the removal of the separated adherent material is not only made difficult but in addition fragments of this brittle material which are frequently extremely hard, frequently flake off and enter the oil circuit. Some magnet bodies consist of a compressed powder which very readily disintegrates when wiped. In both such cases, according to my invention, the lining of the magnet with a non-magnetic material such as brass, plastic or the like is advantageous also for this reason.

In the drawings—

Fig. 1 shows an elevation and cross-sectional view of a preferred embodiment of my invention.

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1.

Figs. 3 and 4 show elevations of a separator element forming part of the invention.

Fig. 5 shows in elevation a form of construction which may replace the element shown in Fig. 4.

Fig. 6 is a sectional view taken on line 6—6 of Fig. 5.

Fig. 7 is a sectional view of a detail of a portion of Fig. 6.

Fig. 8 is a vertical sectional view of another embodiment of the invention.

Fig. 9 is a section taken on line 9—9 of Fig. 8.

Fig. 10 is a sectional view of a battery of separators forming part of the invention.

Figs. 11 and 12 show modifications of the internal arrangement of a separator unit according to the invention, and

Figs. 13 and 14 show further modification of magnetic separator elements arranged in the same housing.

Referring now to the drawings wherein like reference characters refer to like parts thruout, it will be noted that Figures 1 and 2 show as indicated a preferred embodiment of the invention in cross-section wherein M is a magnet bar or core which for instance has its north pole at N and its south pole at S. This magnet bar is generally of a round or cylindrical cross-section. However, a bar of square or polygonal cross-section may also be used in accordance with my invention, this latter type of section having particularly strong magnetic fields at its corners and is therefore sometimes to be preferred. Around the magnet bar there is placed a protective jacket H conforming with or adapted to the cross-section of the magnet M but preferably allowing for a slight clearance, as shown. The jacket H accordingly will have as shown a round tubular cross-section when a round magnet bar is used. Said jacket H consists of non-magnetic material such as brass, aluminum, or plastic, or a tube of hard treated or untreated paper or the like. In this manner there is provided an extremely smooth magnet bar, which has the special feature that it can be very easily cleaned inasmuch as the smooth non-magnetic surface does not oppose any resistance to the wiping off of the material which has been separated out of the fluid passing thru the device as shown. Furthermore, magnet M is protected against damage and flaking off of its parts. Also, it can be readily removed, with its jacket or housing H, which jacket has an upper part HA whose top portion has thread V meshing with the threaded portion of a suitable container B to which a liquid or fluid to be cleansed of magnetic or magnetizable impurities is for example fed into the unit U at inlet E while the purified liquid or fluid leaves the separator tank F at outlets O.

It is to be noted and it is extremely important that the liquid or fluid which is to be purified is not introduced into any parts of the magnetic field at which there does not exist a sufficient magnetic gradient as required according to the invention in order to remove the impurities in a successive and continuous manner. Such a defect would be present in the separator according to Figures 1 and 2 if the container B consisted of magnetic material, for instance iron, inasmuch as it is obvious that any ferro-magnetic bodies which were carried along would adhere to the walls of the container B when passed near said walls. While on the other hand, it will adhere to the jacket H if it passes close to the latter and therefore there accordingly exists in the center between the wall of the container B and the jacket H a rather wide zone in which the ferro-magnetic bodies are attracted neither inwards to the magnet M nor outward to the outer container wall B. Inasmuch as the maximum flow of velocity prevails precisely here in the center between the surface of the magnet and the container wall B, and inasmuch as the viscous wall friction which is considerable, particularly in the case of oil, does not enter into appearance here,

the action of this separator is good only when the container. B is made of non-magnetic material, in which connection it may then also be advantageous to make the same preferably smaller than that shown in the drawing.

It is still more advantageous, however, to place a cylinder S made of non-magnetic material, for example of brass or of plastic material around the magnet bar M, and concentric to same, and to insert a barrier wall W which at the same time forces the liquid which is passing through ports G to enter the cylinder S, which may be perforated or consist of a screen, and pass in the vicinity of the surface of the magnet M or the jacket H. In this connection, the perforated cylinder S at the same time acts as a rectifier or as a means of reducing the turbulence in the fluid as it passes thru the unit U. Said cylinder S suppresses any unnecessary turbulence of the liquid passing through during the separating process and thus also increases, by virtue of this effect of pure fluid dynamics, the efficiency of the magnetic filter. The cylinder S can be made so that it can be readily removed by unscrewing the part HA with its thread V so as to permit scraping off of any foreign bodies possibly adhering to same or in order to remove the sludge which frequently settles on the bottom of the separator.

When the perforated cylinder S is present, the container B can also be made of iron inasmuch as the liquid is necessarily conveyed in the vicinity of the magnet M or in the vicinity of the jacket H surrounding same. The barrier wall W may also, provided it is not too thick, be made of iron inasmuch as its disturbing influence is only local and therefore negligible.

The principle of the magnetic separator in accordance with the invention as shown in Figures 1 and 2 can be further improved in various ways, for instance on the one hand by increasing the magnetic field action and on the other hand by improving its cleaning possibilities. An increase of the magnetic field action is obtained if, as shown in Figure 3, instead of having only one magnet M in the jacket H which supports the magnet a plurality of magnets M_1, M_2, M_3, is so arranged that similarly magnetized magnet poles face each other, thereby setting up a magnetic repulsion in said areas. In Figure 3, for example, there is shown a removable separator element of this kind which is contained by the jacket H, said element fitting into a separator unit of the kind such as shown in Figure 1. Said jacket H contains within it for purposes of illustration three magnets or plugs, M_1, M_2, M_3, of round or polygonal cross-section which are so arranged with respect to each other by means of the intermediate nonmagnetic separator pieces Z1 and Z2 and also an upper spacer member Z3. It will be noted that south and north poles always face each other. In this way there is produced, in addition to the fields which are present as in the embodiment shown in Figure 1 at the ends of a composite magnet bar, a form of magnetic field which is very suitable for the filtration, shown as F'' in Figures 3 or 4, and also at two further places of the total length of the magnetic filter element. When a larger number of plugs or magnets M is selected, the number of these separating magnetic field concentrations can also be increased.

The intermediate members, Z_1, Z_2, Z_3, may consist of non-magnetic material such as plastic, wood, etc., but they may also be made of soft iron, in which case, it will be advantageous to flute them as shown for instance in Figure 4. By thus placing together the different magnet pieces M held by a common packet H and having similar poles facing each other, there is produced an extremely effective separator element, i. e., a separator element in which strong magnetic fields of high magnetic gradient are arranged in a long, smoothly extending flow path, which insures removal of magnetic particles from the liquid to be treated, and which flows thru unit U and which reduces as much as possible any turbulence in the fluid.

In addition to the above, further improvements relating to ease of cleaning the separator elements shown in Figures 1 to 4 are shown. In Figures 5 and 6 is shown by way of example a separator element having an internal magnetic arrangement in accordance with Figures 1 to 4 in connection with which there are provided a plurality of ribs R which are soldered or pressed on to the outer periphery of the jacket H. The purpose of this construction is to prevent the separator material adhering to the separator element from being scraped off upon the unscrewing or removal of the separator element, by mistake as a result of the eccentric guiding of the separator element. In this connection, it will be noted also that these ribs R in the same way as the jacket H are appropriately made of non-magnetic material, for instance of several segments R of pressed sheet brass riveted together, each of which segments R has a shape as shown in Figure 7. Furthermore, the ribs R are also advantageous from a standpoint of flow dynamics inasmuch as, in a manner similar to the cylinder S, they minimize the turbulence of the flowing liquid in the same manner as a guide wall or baffle. Said jacket H furthermore has a similar action inasmuch as it, in the same manner as the cylinder S, avoids unnecessary turbulence at the ends of the magnet or magnets, and furthermore blocks off magnetically-inactive parts of the field so that they cannot be passed through by the liquid.

In Figure 8 is shown another arrangement of the invention which provides for the removal from the separator element U of the material which has been separated out from the fluid being treated. In this case, the jacket H, has an internal arrangement corresponding to that in Figures 1 to 4. It is, for instance, smooth on the outside and is not provided with the ribs of the jacket H shown in Figures 5 to 7. In this embodiment is provided a scraper B' which is elongated and flat or provided with a twist or bend. Preferably, band B' is also non-magnetic and is arranged alongside the contour of jacket H or placed around the jacket H in the manner of a helical thread. This scraper B' can be turned from outside of the unit U, for instance by means of the hand wheel HA' connected therewith, whereby any magnetic material adhering to jacket H is wiped off from its external surface and is collected in the correspondingly large lower part O' of the separator container B, from where it can then be removed periodically by the diagonally disposed outlet A forming part of Unit U. An extension *Sch* of scraper B' having a paddle-like or propeller-like appearance or shape can in this connection facilitate the removal of the sludge which has been separated out. In this connection see Figures 9 and 10. In accordance with the invention it is not necessary to use any special housing for each separator element, as shown for instance in Figure 1. Rather said separator elements U can very advantageously also be arranged in batteries and in one and the same housing. Figure 10 shows for example a separator arrangement in which a large number of separator elements U made according to Figures 1 to 4 in a common container or housing B. Each separator element F is surrounded with a perforated sheet metal cylinder S in the same manner as described in connection with Figure 1, whereby a uniform passage of the liquid which is to be treated and which is as far as possible free of turbulence is effected at each separator element. A separating wall W is provided so that the inactive parts of the magnetic field are blocked off in the manner according to the invention. In other words, it will be noted that in effect the entire liquid which passes through the separator is conducted in a dependable manner through the active magnetic field of at least one separator element and thus unaffected fluid flows such as are present in other known designs and which are not exposed at all to active parts of the magnetic field, are avoided. Each separator element can in this connection utilize as required, additional devices for facilitating the cleaning.

For instance, by means of the ribs R one can prevent the inadvertent scraping off of the material which has been separated out of the fluid when unscrewing the separator elements, as explained in connection with Figures 5 to 7, or any mechanical cleaning devices which permit, in the manner of the embodiment of Figure 8, the scraping of the smooth surface of the jacket H during the operation without the necessity of taking anything apart. In this connection, for the sake of simplicity, such a cleaning scraper B' as shown in Figures 8 and 9 is not made helical but rather developed as a smooth scraper strip and possibly combined with the paddle Sch which may be somewhat curved, in order to facilitate the moving of the material which has been separated out to a discharge hole O'. Such a separator device can also be operated using electro-magnets instead of permanent magnets, particularly as the preferably round shape of the separator elements greatly facilitates the provision of coils.

In Figure 11 is shown for instance such an electro magnetic separator element UF. Analogously to the multiple part permanent magnet system shown in Figures 3 and 4, this separator element UF consists of for example three coils S1 to S3 respectively through which current passes and which can be arranged on a common core K. This core may consist in whole or in part of iron or of ferro-magnetic bodies or else contain non-magnetic intermediate pieces. The jacket H is placed over this body producing a smooth outer shape for the entire magnet structure thus eliminating turbulence of the liquid which flows thru the unit UF. The outer surface of said jacket H may also be provided with ribs as shown in Figs. 5 to 7 or may bear a mechanical scraping or cleaning device such as shown in Figures 8 to 10.

Figure 11 furthermore shows that even in the case of an electro-magnetic system instead of a single bar-shaped magnet several magnets of the same polarity can be arranged in tandem exactly as is advisable in the case of the permanent-magnet separators in accordance with the embodiment shown in Figures 3 and 4. For this purpose, it is only necessary to change the direction of the electro-magnetic excitation in the individual superimposed coils in each case as indicated by the horizontal arrows in Figure 11. In the case of electro-magnetic cleaning devices of this type the use of a non-magnetic jacket H is particularly advantageous as it prevents the penetration of iron particles, which have been separated out into the coil windings S1 to S3, and thus prevents the said windings from being short-circuited by such particles. Instead of a rotating cleaning member as shown for instance in Figures 7 to 8, there may also be used an axially movable disc, for instance a ring R1 as shown in Figure 10 and which can move over the jacket H with moderate clearance. When in the operating position ring R1 is approximately at the upper end of the separator element and can be moved downward as required by an axially movable actuating device Hn in order to scrape the separated material off from the surface of the jacket H. On the other hand the device Hn can also be of such a nature that a ring may in the case of a round jacket H be of round cross-section and in the case of a polygonal jacket, be a ring of polygonal cross-section, also it can be arranged in a stationary manner in the housing in the vicinity of the upper end of each separator element.

In the case of a plurality of adjacent elements, a plate may be used which is adapted to the outline of the jacket. If the magnetic separator elements are then moved upwards, this plate scrapes off the material which has been separated out whereupon the separator is again entirely ready for operation. In Figure 14 is shown such an arrangement by way of example. Jackets H1 and H2 hold respectively adjacent magnetic separator elements and are arranged also in perforated cylinders S in a common container B. The arrangement of the separator elements corresponds to the embodiments shown in Figures 1 to 4. However, they are not screwed firmly into the container B, as shown in said figures, but are axially movable in the container B by means of a common yoke Y and the handle HA'. A plate P is provided with recesses which properly fit the jackets H, which plate may also suitably be made of steel sheet with sharp edges, and which guides and supports the jackets H1. When the jackets H1 and H2 are pulled upward by the handle, the plate P scrapes off the material which has been separated out, as a result of which the said material drops to the bottom and can be removed periodically by removing the clean-out screws SA. Of course, it is possible in the same way to provide either one or a large number of separator elements in the filter. Said jackets H, may in this case be of round or polygonal cross-section, entirely in accord with the requirements as set forth herein. If a stuffing box St is provided, it is possible to clean the separator even in operation if the liquid has a certain excess pressure within the container B.

Of course in the case of a helical or flat cleaning or scraping device as shown in Figures 8 or 10, the movability of the jacket H and of the cleaning strip B can be dispensed with if one turns or axially moves the jacket H containing the magnet or magnets.

In the case of electro-magnetic separators of this type, the cleaning can be facilitated by shutting off the current during the cleaning. Due to this, the scraping or shaking off of the separated material from the jacket H is facilitated so that under certain circumstances it is not necessary to provide the unscrewing of each individual separator element.

In the case of separator elements provided with permanent magnets the same procedure can however be effected if the magnets are removed from the jacket. In Figure 12 is shown for instance such a separator element in connection with which three magnets M1 to M3, in precisely the same manner as described in Figure 3, are arranged with like poles in the axis of the jacket H. By means of the handle HA, the entire magnet system, regardless of the number of parts of which it consists, can be then removed in an upward direction. In this case all screw connections may be eliminated at this place if the jacket H is inserted in a liquid-tight manner in the wall of the separator and if one refrains, as for instance in the case of the embodiment according to Figure 1, from providing a hole L for pressure equalization between the separator housing and the inside of the jacket H.

Figure 13 shows that such a magnetic separator, particularly when a plurality of separator elements are to be arranged in one and the same housing, is much simpler. In this case, for instance three separator elements with the non-magnetic jackets H1, H2 and H3 are arranged rigidly on the cover D of the separator housing B. For the purpose of cleaning, the permanent magnet systems are pulled out of the separator jackets by means of the handle HA', whereupon the materials which have been separated out can be loosened from the jackets H, H2 and H3 even by hammer blows or vibration of the cover D, without any injury to the magnets. When electro-magnets are used to produce the magnetic field, in general it is merely necessary to shut off the current since they are not damaged even by vibrations. In such case removal of the electro-magnetic separator is unnecessary. In connection with these separators any permanently magnetic field which may be present can furthermore be removed in the manner known per se by a weak current in the opposite direction.

While preferred embodiments have been described and illustrated it will be noted that changes as to form, arrangement of parts and use of materials may be made without departing from the scope and spirit of the invention as claimed herein:

I claim:

1. Apparatus for the removal of magnetizable particles in a fluid system comprising a housing thru which a fluid moves, means conducting said fluid thru the housing, a

jacket set in the path of movement of said fluid, a magnet in the jacket for attracting magnetizable particles therein, concentric screen means around the jacket, and means for removing the particles attracted to the jacket by said magnet.

2. Apparatus for the removal of magnetizable material in a fluid system comprising a housing through which a fluid enters, cylindrical perforated means in said housing permitting the flow of fluid therethru, a jacket concentric with said perforated means, said jacket being non-magnetic, and magnetic means in said jacket for drawing particles of magnetizable material to the jacket without contacting the surface of said magnetic means, said magnetic means and jacket being removable from said housing and said cylindrical perforated means and said jacket being provided with scraping means for the removal of adhering, magnetizable material from the exterior of said jacket.

3. In a magnetic separator, an outer enclosing casing, a fluid inlet and outlet openings in said casing spaced from each other, a magnet within said casing, a non-magnetic impermeable jacket enclosing said magnet and having a smooth outer surface, a perforate baffle of non-magnetic material surrounding said jacket, said baffle being spaced from and located between the inner surface of said casing and the outer surface of said jacket, said inlet being upstream of said baffle and said baffle serving to guide the fluid in directed non-turbulent flow over the surface of said jacket.

4. The combination according to claim 3 in which the jacket is provided with a plurality of outwardly extending ribs having smooth outer surfaces.

5. In a magnetic separator, at least one stationary energized magnet near which a flow of liquid is passed, a non-magnetic jacket containing said at least one magnet, said jacket having a smooth outer surface which permits the liquid passed through the filter to be conducted smoothly and without unnecessary turbulence through the magnetic field produced by said at least one magnet, together with a movable scraper ring closely embracing said jacket and normally located near the top of said jacket and means for at will moving said scraper ring axially along the smooth outer surface of said jacket for scraping separated material from said outer surface of the jacket.

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