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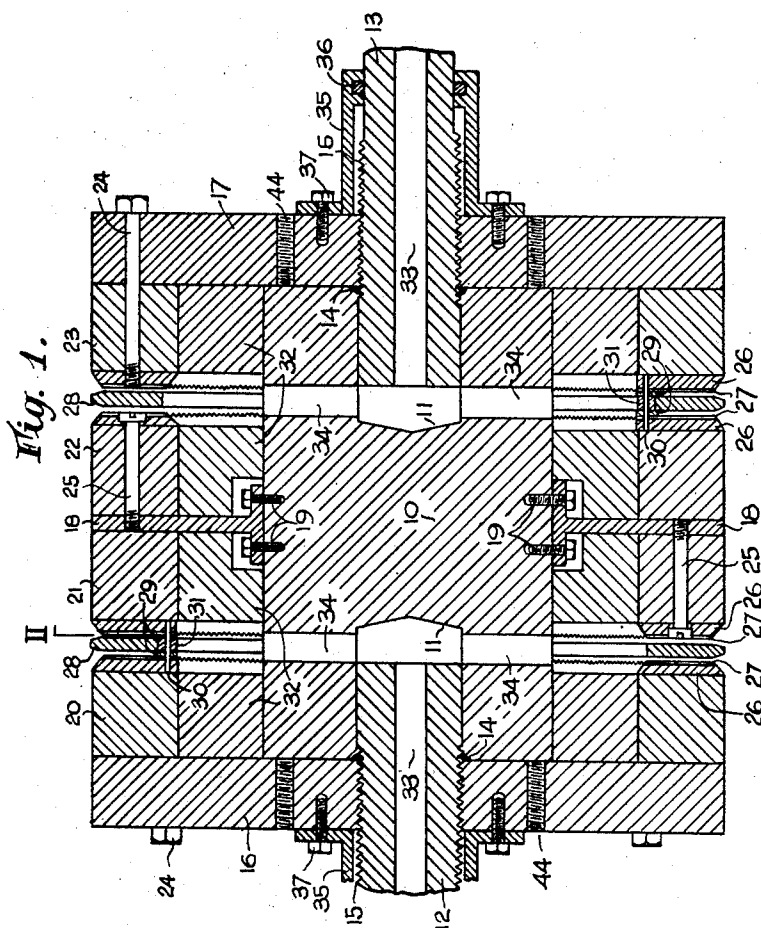
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MEANS FOR MAGNETICALLY SEPARATING SOLID MAGNETIC
PARTICLES FROM A FLUID CURRENT

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3 Sheets-Sheet 1



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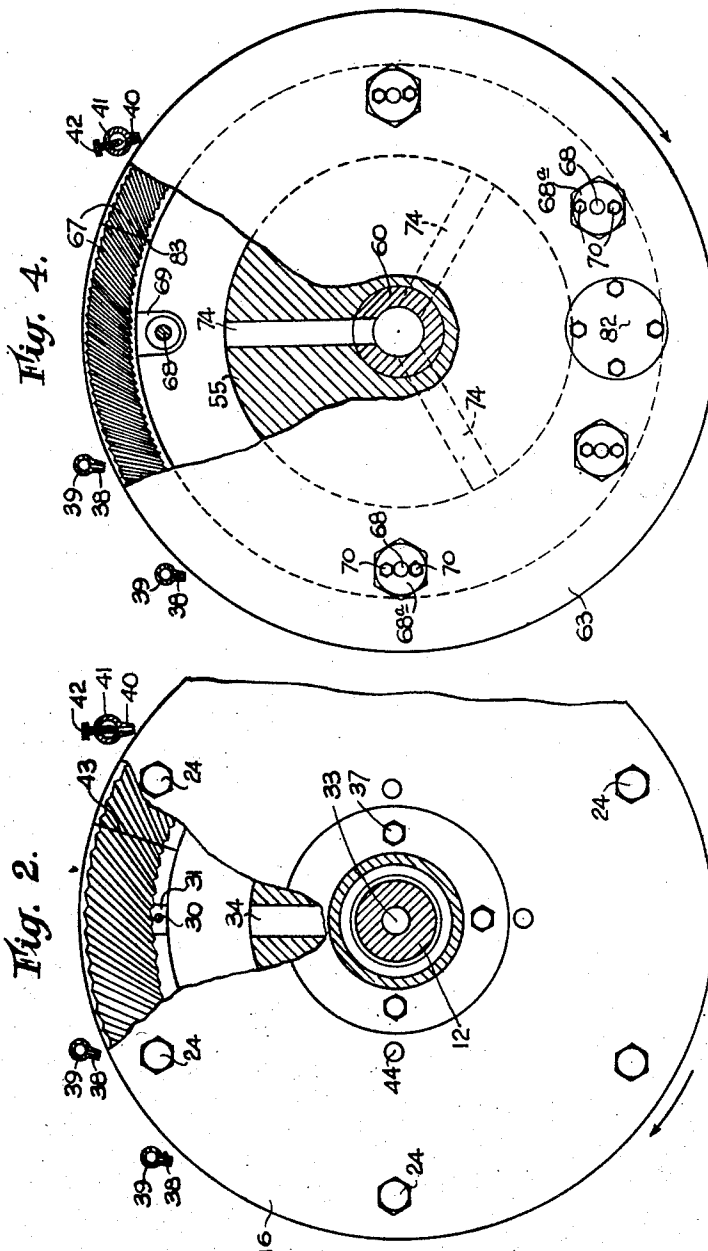
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3 Sheets-Sheet 2



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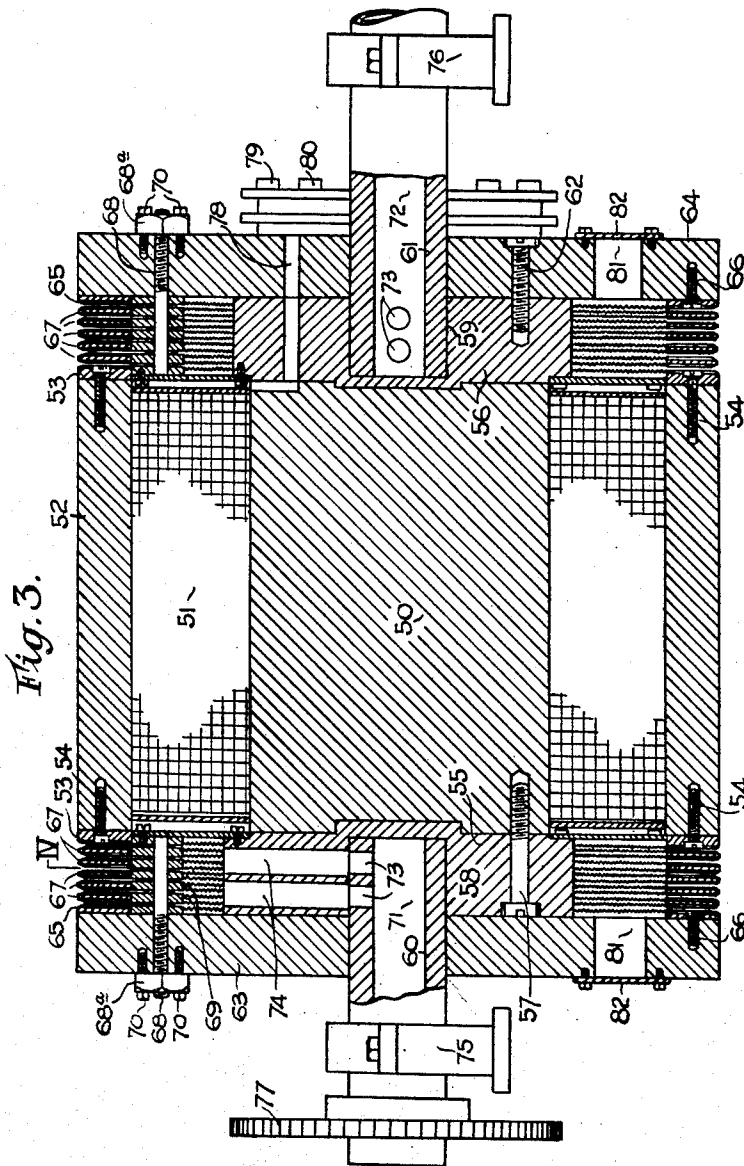
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MEANS FOR MAGNETICALLY SEPARATING SOLID MAGNETIC PARTICLES FROM A FLUID CURRENT

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1 Claim. (Cl. 210-222)

This invention relates to means for magnetically separating solid magnetic particles of suitable size range from a fluid current in which they are suspended.

Magnetic separators as hitherto constructed have usually comprised a drum rotatable about its axis and having interiorly thereof a plurality of fixed magnets disposed in close proximity to a desired area of the interior cylindrical wall of the drum, magnetic-particle-carrying matter being fed against that portion of the drum periphery overlying the fixed magnets so that the magnetic particles adhere to the drum and are carried to a discharge position, the non-magnetic matter, being unaffected by the magnets, passing to another collecting position. The magnetic-particle-carrying matter, whether wet or dry, may be delivered downwardly by gravity against the drum, or, if wet, may so be circulated about the container as to wash against the rotating drum which is partly submerged in the liquid.

In the case of a wet magnetic separator for weakly magnetic particles, there is the fundamental difficulty that while there must be relative movement between the particle bearing fluid and the magnet or magnetic effecting the separation to bring the magnetic particles into the magnetic field, such movement of the fluid tends to wash the magnetic particles away from the magnets again.

While an obvious solution to this difficulty is to rotate the drum very slowly, this reduces the capacity of the separator to an uneconomical extent and also reduces its efficiency somewhat, since the eddies caused by the turbulent flow of the fluid, if not too violent, assist in bringing the magnetic particles into the region of magnetic attraction.

It is the object of the present invention to provide improved means for separating magnetic particles from a fluid current (which may be a liquid or gas) in which such particles are carried.

The means for magnetically separating magnetic particles from a fluid current according to the present invention comprises a cylindrical rotating magnet assembly mounted for rotation about its longitudinal axis and having at least one pair of opposed poles spaced slightly apart to provide therebetween an annular gap having a mean plane disposed at right angles to the axis of rotation of the magnet assembly; means for delivering a current of magnetic-particle-carrying fluid in a substantially axial direction into said magnet assembly and thence in a direction outwardly thereof through the gap between said opposed poles whereby magnetic particles are separated by the magnets from the fluid, and a fluid jet sweeping said gap at a zone thereof for removing the particles adhering to the magnet poles.

The pole surfaces, which preferably have bevelled edges, are provided with irregular surfaces of suitable form, to cause local concentrations in the magnetic flux at the peaks of such irregularities to which the particles are more strongly attracted and from which they are less easily washed by the fluid current from which they have been removed.

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The irregularities in the pole surfaces may conveniently take the form of shallow, closely disposed grooves which are preferably arranged substantially radially or obliquely across the pole faces, and in the case of obliquely disposed grooves, these are preferably inclined forwardly to the direction of rotation of the magnet, or may be a combination of grooves intersecting one another. In a less preferred arrangement the grooves are arranged annularly and concentrically around the surfaces of the magnet poles.

The grooves and ridges between the grooves may be of any suitable cross-sectional shape, and the ridges on one pole face may be disposed opposite the ridges of the other pole face.

If desired more than one annular gap may be provided each between a pair of opposed annular poles in the magnetic circuit.

Referring to the drawings filed herewith:

Fig. 1 is a sectional elevation of one form of magnetic separator employing a permanent magnet, made according to the present invention;

Fig. 2 is an end elevation of the separator of Fig. 1 partly broken away on the line II, Fig. 1;

Fig. 3 is a similar view to Fig. 1 showing a modified form of magnetic separator, employing an electro-magnet, and

Fig. 4 is an end elevation of the separator of Fig. 3, partly broken away on the line IV, Fig. 3.

Referring to Figs. 1 and 2, the separator comprises a cylindrical body portion 10 of magnetic material provided at each end with an axially disposed bore 11 for the reception of one of a pair of hollow shafts 12, 13 which are welded to the body 10 as shown at 14, the shafts 12, 13 being screw-threaded at 15 to receive end members 16, 17 of greater diameter than the body 10.

Intermediate of its length, the body portion 10 is provided with a flange 18 secured thereto by screws 19, said flange 18 having substantially the same overall diameter as the end members 16, 17.

A plurality of permanent magnets 20, 21, 22 and 23 of annular form and of overall diameter substantially the same as the end members 16, 17 are mounted between said end members and the flange 18, the magnets 20, 23 being secured respectively to the end members 16, 17 by screws 24, and the magnets 21, 22 being secured to the flange 18 by screws 25. Each magnet is provided with an annular pole piece 26, said pole pieces 26 being secured to their respective magnets by the screws 24, 25 as the case may be, and are provided with grooves 27. The grooves may be of any suitable form and arrangement such for example as those previously described.

The magnets 20, 21 and 22, 23 are arranged in pairs with their respective pole pieces 26 spaced slightly apart and in opposing relation one to the other, an intermediate pole piece 28 being disposed in the gap between each pair of magnets and maintained in spaced relation to the pole pieces 26 by non-magnetic spacing members 29 secured in position by a pin 30, said pin passing through a lug 31 of non-magnetic material brazed or otherwise secured to the intermediate pole piece 28.

While only one intermediate pole piece 28 is shown between each pair of poles in Fig. 1, a plurality of such intermediate pole pieces may be provided in the manner shown in Fig. 3.

The intermediate pole piece 28 may, as shown, have plain faces or may be grooved similarly to the pole pieces 26.

Filling pieces 32 of non-magnetic material such for example as wood or rubber are provided between the magnets and the body 10.

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The pole pieces 26, 28 are, as shown at 43 (Fig. 2) divided into segments for ease of assembly and dismantling.

The shafts 12, 13 are each provided with an axial passage 33 communicating with substantially radial passages 34 in the body 10 in turn communicating with the gaps between the magnet poles, covers 35, having sealing rings 36 being provided over the shafts 12, 13 and secured to the end members 16, 17 by screws 37.

The shafts 12, 13 are mounted in bearings (not shown) for rotation, together with the separator, by suitable driving means (also not shown).

As shown in Fig. 2 nozzles 38 are provided for directing a jet of air or water through each of the gaps between the magnet poles at a pressure sufficient only to remove non-magnetic matter adhering to the magnetic particles held by the magnets without disturbing the magnetic particles, a further jet of air or water of sufficiently greater strength as to remove the cleaned magnetic particles from the magnets being delivered into each gap from a nozzle 40, the nozzles being fed with fluid respectively from supply pipes 39, 41. A needle or like valve 42 is provided in association with each nozzle 40 for regulating the flow of fluid, and similar valves may be provided, if desired, in association with the nozzles 38. Separate nozzles 38 and 40 are provided for each gap.

If desired, the jets from the nozzles 38, 40 may be arranged to issue substantially radially or tangentially from the nozzles and may be rotatable in known manner, the direction of issue of the jets and, if desired, the rotation thereof being effected by the fluid issuing from oblique ports in the side walls of the nozzles, the arrangement being such that the fluid is directed against the surfaces of the magnet poles while passing through the gap.

In order to facilitate the dismantling of the separator against the large attractive force of the magnets, the end plates 16, 17 are screwed on to the shafts 12, 13 and to assist in starting unscrewing of the end plates, screw-holes 44 are provided in said end plates into which non-magnetic screws (not shown) are adapted to be screwed to lift the end plates slightly away from the body 10, lubricant being introduced through the holes 41 prior to insertion of the screws.

In use, the separator is caused to rotate, and magnetic-particle-carrying liquid is fed at low pressure from a supply source (not shown) through the passages 33, 34 in the shafts 12, 13 and body portion 10 respectively, the feed pressure being insufficient to lift the liquid more than slightly above the ends of the passages 34 when said passages are disposed above the axis of rotation of the separator, so that the greater part of the liquid flows into the gaps between the magnet poles below the axis of rotation of the separator. The magnetic particles are attracted to and retained by the magnet poles, while the liquid flows out of the separator for collection. As the separator rotates, the magnetic particles are carried upwardly by the magnet poles past the nozzles 38, and any non-magnetic matter adhering to the magnetic particles is removed by the jets of air or water issuing from said nozzles. The cleaned magnetic particles are then carried by the magnet poles past the nozzles 40 and removed by the jet of air or water issuing therefrom for collection in a suitable receptacle.

In the modification shown in Figs. 3 and 4, the general arrangement of the separator is substantially similar to that of the separator of Fig. 1 with the exception that an electro-magnet is employed instead of permanent magnets.

The separator comprises a cylindrical body 50 of magnetic material supporting the coil 51 of an electro-magnet, around which is a cylindrical cover 52, annular pole pieces 53 being secured by screws 54 to the ends of the cover 52. End members 55, 56 are secured to body 50 by screws 57 and are provided with bores 58, 59 in

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which are secured as by welding, two hollow shafts 60, 61 in co-axial relation one with the other.

Secured respectively to the end members 55, 56 by screws 62 are two end plates 63, 64 to which, in turn, are secured annular pole pieces 65 by screws 66, the end members 55, 56 serving to space the pole pieces 53, 65 apart.

A plurality of spaced-apart annular intermediate pole pieces 67 are interposed between the pole pieces 53, 65, said intermediate pole pieces 67 being supported by non-magnetic rods 68 passing through lugs 69 of non-magnetic material secured to the pole pieces 67, the rods 68 being screw threaded at one end to receive a securing nut 68a, normally held against unscrewing by set screws 70.

The shafts 60, 61 are provided with axial bores 71, 72 and radial passages 73 communicating with passages 74 in the end members 55, 56 said passages 74 in turn communicating with the gaps between the pole pieces 53, 65 and 67.

The shafts 60, 61 are supported in bearings 75, 76 and the shaft 60 is provided with a driving sprocket 77. Means (not shown) is provided for feeding magnetic-particle-carrying fluid to the bores 71, 72 of the shafts 60, 61.

A passage 78 is provided for the electrical leads from the coil 51 to slip rings 79, 80, brushes (not shown) making electrical connection in known manner with a source of electrical supply.

An inspection hole 81 and cover 82 therefor is provided in each end plate 63, 64.

The pole pieces 53, 65 and the intermediate pole pieces 67 are divided into segments as indicated at 83 (Fig. 4) to facilitate assembly and dismantling.

In use, the separator of Figs. 3 and 4 operates in substantially the same manner as that described with reference to Figs. 1 and 2, the magnetic-particle-carrying liquid being fed at low pressure through the passages 71, 72 and 73, 74 to flow through the gaps between the magnets which, as before described, separate the magnetic particles from the liquid, the magnetic particles being carried by the magnet poles past the washing nozzles 38 and finally removed for collection by a jet of air or water from the nozzle 40.

It will be understood that the invention is not restricted to the particular embodiments shown in the drawings, since many variations in constructional details and arrangement of the parts, such for example, as the number and disposition of the magnet pole pieces and intermediate pole pieces, are possible without departing from the scope of the invention.

In the case of a permanent magnet, the effective flux may be controlled by adjusting the widths and/or number of gaps between the poles, while in the case of an electro-magnet, the effective flux may be varied by varying the electric current to the magnet.

The width of the gaps between the magnet poles and the intermediate poles is determined by the amount of magnetic particles deposited on the poles, by the size of the particles and by the magnetic flux.

In the case of a magnetic separator for separating magnetic particles from a gas, the separator is substantially the same as those described above, the magnetic particles adhering to the magnet poles being removed by a jet of air, or other gas and blown into a suitable collecting receptacle.

What I claim and desire to secure by Letters Patent is:

A magnetic separator comprising a cylindrical magnet assembly mounted for rotation about its longitudinal axis, said magnet assembly having at least one pair of opposed poles slightly spaced apart to provide therebetween an annular gap having a mean plane disposed at right angles to the axis of rotation of the magnet assembly, means for

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delivering a current of magnetic-particle-carrying fluid in a substantially axial direction into said magnet assembly and thence in a direction outwardly thereof through the gap between said opposed annular poles whereby magnetic particles are separated by the magnets from the fluid.

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