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This invention relates to improvements in magnetic separators and concentrators.

Broadly stated, it is the primary object of the present invention to provide a novel and improved form of magnetic separating device organized to treat the material in cascade throughout a series of successive treatment operations, and providing an unusually wide range of adjustment from a very slight magnetic attraction to a remarkably high magnetic attraction, whereby a single piece of apparatus is adapted for use to perform a large number of different separating and concentrating operations with exceptional efficiency.

There are a number of important features which differentiate this device from previously known mechanisms for magnetic separation. These will be pointed out in the specification and claims. Specifically, however, my purposes include the provision of means wherein the efficiency of the apparatus is improved by reason of a closed circuit arrangement having a field core through which some of the magnetic material may be discharged, the frame-like form of the field core and the means for properly adjusting it, and the means for controlling the flow of material with respect to such core, constituting some of the more important features of the present invention.

Another object of the invention is to provide a novel means for handling extremely fine materials, either wet or dry, through the use of a secondary magnet or field core by which a substantially closed magnetic path is provided in order to increase the intensity of the flux at the point of separation.

It is a further object of the invention to provide an organization in which magnetic lag or reluctance is overcome by an arrangement which enables the material to be handled at any desired speed, while preserving it in substantially a state of rest with reference to successive parts of the apparatus while it is being acted upon magnetically. This is very important because the time interval of magnetic treatment permitted by this arrangement enables the treatment of materials of high magnetic reluctance.

Further objects include the provision of a novel and improved form of pole piece, the provision of a novel and improved material handling means, and the provision of an organization in which means is provided for varying the magnetic force acting upon the material in a series of successive stages so that, if desired, such force may be made to increase in each of a number of successive stages from a minimum to a maximum value.

In the drawings:
- Figure 1 is a vertical transverse section through the apparatus embodying the invention.
- Figure 2 is a fragmentary front elevation of the device shown in Fig. 1.
- Figure 3 is a fragmentary side elevation of the device shown in Fig. 1.
- Figure 4 is a detail in horizontal section through the device shown in Fig. 1.
- Figure 5 is a view partially in side elevation and partially in transverse section through a single unit of a modified embodiment of the invention.
- Figure 6 is a fragmentary detail in perspective showing the magnet, adjustable pole piece, field core, and roll, of the device shown in Fig. 6.
- Figure 7 is a diagrammatic view similar to Fig. 1 showing an embodiment of the invention particularly adapted to handle very fine dry material.
- Figure 8 is a view partially in side elevation and partially in section, showing a modified embodiment of the invention in which the material is filtered in liquid to facilitate the separating operation.

Like parts are identified by the same reference characters throughout the several views.

In the construction shown in Figs. 1 to 4, inclusive, a heavy structural steel frame 10 is preferably provided for mounting the various elements of the invention. This frame includes horizontal supports at 6, 8 and 11, and a base 12. The motor 18 and gear box 16 through which the movable portions of the apparatus are driven by a belt 21, are conveniently mounted on the top frame bar 11. Also in the top of the frame is the hopper 17 into which is introduced the material to be treated.

The belt 21 drives a pulley 22 and a shaft 23 which carries roll 24. From this shaft is driven the pulley 20 of a feeding device which includes the toothed roller 26 and the gate plate 27, which is adjustable to afford a greater or less opening by means of the hand operated pinion 28 and the rack teeth 29 on the under surface of the plate.

In leaving the hopper 17, the material passes over a series of speed checking baffle plates which are duplicated in successive conduits for each stage in the cascade treatment of the material. These baffles are designated by reference characters 30, 31, and 32 respectively. As clearly shown in the drawings these baffles are organized in a sort of throat through which the material passes.
with controlled speed to each successive roll. The final baffle 32 discharges the material across a substantially horizontal portion. The composite result only slightly exceeds the "angle of rest" as viewed in Fig. 1, and prevents the material would collect on the feeder were it not for the fact that the roll turning in proximity thereto is constantly removing some of the material from the edge of the plate at a rate corresponding to the peripheral rate of movement of the roll. But with continuous regulated feeding of material from the hopper and a continuous movement of the roll or rolls turning in proximity to the lower edge of the last baffle in each series, the material is prevented from coming to rest at its angle of repose, and therefore continuous feeding in a thin layer or film becomes possible, whereas attempts here-tofore made to feed material vertically to the top of a revolving roller have been unsuccessful in preventing intermittent feeding of relatively thick batches with intervening spaces in which the surface of the roller is substantially bare. The efficiency of a magnetic separator of this type is quite largely dependent upon maintaining a continuous feed of a thin layer of material of substantially uniform thickness across the line of concentrated magnetic flux, and by utilizing means for regulating the feed of the material, in combination with means for utilizing the rotary movement of the roller to constantly distribute material tending to come to rest at an angle of repose, the foregoing requirement for high efficiency can be met.

The rate of flow from a hopper across an inclined feedway of ordinary type cannot be properly controlled. But by employing a baffle 32, offset by the flange at its lower end from the vertical center line of the roll, I provide an angle in which the material would reach substantially a state of repose but for the action of the rotating roll in withdrawing material from the bottom at a rate proportioned to the rate of roll rotation. If the baffle is set at approximately an angle of repose for such material, the friction of the rollers will carry it upwards by the upward movement of the roll and no longer offers any resistance to the rolling of the roller ceases to rotate. This motion arresting frictional force is reduced by the use of baffles 31, which also assist in predetermining the thickness of the layer of flowing material.

It is also an important feature of my invention to provide the electromagnetic with pole pieces which are formed to concentrate the magnetic flux along a substantially horizontal line in a vertical plane, which is only slightly below the top of the roller, and in a vertical plane which is crossed by the roll at a point where the pole piece is abruptly receding from said plane below said concentrated flux. With this arrangement, the pole piece is in a position to cooperate with the baffle in checking the flow of material immediately when the power is shut off and thus allow the material to instantly come to rest at said angle of repose without lodging accumulated material against said pole piece.

Just beyond each roll is a dividing gate 33 mounted on a rock shaft 35 having an arm 37 adjustable by means of the bolt 33 and hand nut 33' shown in Fig. 3. Through means hereinafter to be described the magnetic and non-magnetic material is discharged from the roll upon different trajectories and a separation is effected by means of the gate, the magnetic material falling down the left hand side of the gate as viewed in Fig. 1 through a delivery spout 38, and the material which has not yet responded to the magnetic separation being discharged to the right of the gate, as viewed in Fig. 1, and passing through the next throat to the succeeding roll.

In this manner the material separated from the general mass by roll 24 is discharged through the uppermost of the spouts 38. The material separated by the second roll 30 is discharged through the third spout 39, and the material separated by rolls 42 and 43 respectively, is discharged through the fourth and fifth spouts 50. It will be noted that the feed of the material from one stage of separation to the next is achieved by gravity throughout a series of stages. The only moving parts of the apparatus are the feeder above described and the successive rolls, which are driven by suitable belting and pulleys shown in Figs. 1 and 2.

The electromagnetic portion of the apparatus will now be described.

Supported on each pair of frame members 5 and 8 is a powerful electromagnet 59 which may include a plurality of series cores 35 of like polarity, connected at top and bottom by pole pieces 52 and 53. It will be noted that the poles and extremities 55 of each pole piece is brought to a blunt apex abutting degrees above the horizontal center line of the adjacent pole piece, and slightly spaced from the roll. Below the apex 55 the pole piece has a curvilinear contour at 57 so patterned as to represent a trajectory curve deviating somewhat from the maximum trajectory of material delivered from the roll. The form of this face of the pole piece is such as to concentrate the magnetic flux upon the material at the point where separation should be effected and to provide beyond that point a rapidly and somewhat uniformly diminishing intensity of flux.

All the several rolls 24, 42, 41, 42, and 43, are made of magnetical material and there is a transfer of flux between these rolls and the several pole apices to which they are respectively adjacent. The intensity would be small, however, were it not for the fact that a substantially magnetic flux exists of motion around the roll and rods 41, 42, and 43, without interfering with the discharge of the magnetic material separated from the mass under treatment.

For this purpose I employ secondary magnets at 30 of magnetic material, each of which is in the form of a hollow frame through which one of the spouts 39 may extend. The secondary magnets or field members 50 have arcuate surfaces poles 61 in extremely close proximity to the adjacent rolls so as to minimize the air gap and assure a high flow of flux through the circuit represented by the magnetic cores 51, to the poles 53 and 54, the field members 60, and the intervening rolls. Each of the rolls 40, 41, 42, and 43, is journaled in suitable bearing members 63 mounted on the field frames 69 as best shown in Figs. 3 and 4.

The entire assembly of field frame 69 and the rolls mounted thereon, is adjustable for the purpose of varying the gap between the magnetic rolls and the poles of the adjacent magnets. It is possible, moreover, for the magnets to be adjusted independently of the other. The means for effecting this adjustment will now be described.

Each of the field frames is supported on a bar 65 which is horizontally adjustable in a slot 66.
in one of the frame members 6 and 8. The bar 65 provides a support upon which the entire frame 60 may be moved bodily or may be moved pivotally, its position being determined by links 67 and 68 connected to its upper and lower portions respectively and pivoted at 69 to nuts 70 (Fig. 5) which are adjustable on screw 71 by means of shafts 72 and capscrews 73. Material from links 67 and 68 is connected with the field frame 60 immediately adjacent one of the rolls mounted thereon, it will be obvious that the position of each roll will be accurately fixed by the adjacent links, irrespective of adjustment of the other roll through the actuation of the other link by the connections described.

In Figs. 5 and 6 I have illustrated a modified construction employing only a single roll and providing the magnet 50' with a pole member 54' with which the field frame 60' is integral, as clearly shown in Fig. 6. In order to provide for necessary adjustments in this form of the device, the upper pole 53' of the magnet 50' is provided with a dove-tailed guideway at 75 complementary to the end of the core 78, upon which the pole member 53' is movable as a slide. For adjusting it I may employ a screw at 79 fixed by collar 81 against movement with respect to its mounting plate 88 and turned by means of a hand wheel 81 to turn in a threaded eye 82 on the slideable pole piece 89. Otherwise the device shown in Figs. 5 and 6 involves only such minor changes of design as might be expected in a simplified unit of this type.

Where special separating or concentrating functions are to be performed it may be desirable that the first roll 24 should be operated in a field of less strength than succeeding rolls, the succeeding rolls having their strength successively increased to the maximum. An organization for this purpose is shown in Fig. 1 in which there is a polar extension 58 leading from the pole member 55 of the first magnet 56. It will be noted that there is no field or armature frame for this roll and that the magnetic effect is therefore very weak. Any magnetic material drawn from the mass by such an arrangement, and passing down the chute 59, will have very high magnetic characteristics.

The auxiliary pole extension 58 will take some of the power from pole 55 so that the flux on roll 49 will not be as concentrated as would be the case if the extension 66 were not used. Thus, the spout 29 below roll 49 will also handle magnetic material of relatively high magnetic characteristics. The full strength of the magnets will be exerted on rolls 61, 62 and 63.

The operation will now be summarized.

The material fed into the hopper at 11 is discharged under the control of plate 27 and fed across a series of baffles terminating in the spout 23 from which such material passes to the first roll, 24. Assuming this roll to be energized weakly, by means of an extension pole 58, the strongest of the magnetic material in the mass under treatment will adhere to the magnetized roll 24 until projected therefrom by the increasing gravity effect (as the magnetic material passes to the under side of the roll) or centrifugal force, or both. In any event, the magnetic material will leave the roll upon a different trajectory from that followed by the material which is not so greatly attracted by the roll. The valve 35 permits a very fine adjustment to be made to separate the trajectory of the non-magnetic material from that of the magnetic material, whereby the less highly attracted material will pass to the right of the valve, as viewed in Fig. 1, for further treatment.

The gear box 16 includes the change speed mechanism, not shown in detail, to enable the several rolls to be operated with any desired rate of rotation. As above indicated, the material will not feed across the rolls except by the rotation of the rolls and consequently the rate of rotation is a matter of significance controlling the rate of feed as well as the development of centrifugal force.

In the material remaining in the mass after the first treatment is passed over the second roll 49 at a rate likewise determinable by the rate of roll rotation. Here the flux meets with increased concentration due to the field 60 and a further separation occurs. Again the valve 35 is adjusted to pass the highly attracted material down the adjacent spout 39 while the remainder of the mass passes to roll 41 for additional treatment.

Rolls 41, 42 and 43 not only have their respective flux density intensified by the presence of the field members 86, but also by the absence of any detracting element such as the extension 88. Upon each of these rolls in sequence, the material is subjected to magnetic attraction of high intensity and the last of the magnetic material is extracted from the mass before the mass reaches the end of the series and is finally discharged through the spout 51. Any desired means may be used to restore or convey from the machine the material discharged from the several spouts.

It will be noted that only one handling of the material is necessary, although it is treated magnetically several times in quick succession. Where magnetic separators are operated in cascade as in the construction shown in Figs. 1 to 4, the polarity of the successive rolls should alternate.

It is particularly to be noted that the present device is such that it will accurately retain any adjustment in which its parts have been fixed and, moreover, that it may be adjusted while the machine is in motion without interfering in any way with any adjustment other than the particular one which is manipulated. The machine may be made sufficiently heavy so that it cannot possibly yield under the pull of even the strongest electromagnet. The primary magnets 30 and their respective field frames or secondary magnets 96, instead of being adjusted with reference to the frame, are adjusted with reference to each other, the screw 71 being fixed against axial movement with respect to the pole, and a nut being linked tightly to the field frame or secondary magnet 99. When any one of the rolls 29—38 is adjusted with respect to the adjacent magnetic pole, its adjustment will be permanent until a readjustment is made.

Associated with each one of the field frames or secondary magnets 96, is a chute 59 which is continuous, except for openings for the magnetic poles, for the whole height of the frame 99. This chute is rigidly connected with the frame 98 to take up all of its adjusting movements, and it carries the several baffles 33, 31 and 32, the valve 35, and the spout 39, pertaining to each of the rolls mounted on that particular frame. Thus the adjustment of one or more of the magnetic gaps does not in any way affect the relation of the rolls to the baffles and other parts associated therewith, and the gap may be adjusted with the machine in operation without in any sense altering the flow of the material.
In many respects the devices shown in Figs. 7 and 8 are quite different from those previously described, although the characteristic secondary magnet or field frame is found in each of these embodiments of the invention.

The construction shown in Fig. 7 is adapted to handle extremely fine, flour-like material. The hopper 170 is mounted upon a chute 270, the lower end portion 271 of which is adjustable by a pinion 28 and resting at its upper end upon a support 99. The hopper 170 is spaced above the chute 270 and provided with bottom and front face of screen cloth at 99 through which the material to be separated is sifted in a thin layer on to the chute. The chute and hopper are caused to vibrate by a conventional vibrator suspended on the chute 271 and comprising the usual A.C. coil 92 and loose core laminations 93, the vibrations of which shake the hopper 170 to sift material through the screening and, through vibration, to ensure the feed of such material down the spout 270.

The primary magnet 50 and the secondary magnet 60 may also be like that shown in Fig. 1, although the polar projections 61 are preferably bored at 510 to provide air passages 514 through which air may be blown to dislodge from the rolls the fine magnetic material which may tend to cling thereto beyond the vertical center line of the rolls.

The primary magnet 50 is similar to that previously described, but the pole pieces 550 will be noted to be located below the horizontal center line of the respective adjacent rolls by about 45°. The adjustable extension 271 of the feed spout 270, and the similarly adjustable extension 272 of the spout 320 will be needed to deliver the material to the roll 43 directly in the portion of the magnetic field which is of maximum intensity. The adjustment will preferably be such that the material will come to rest adjacent the roll except as the rotation of the roll is continuously aided by a fine film of the flour-like material from the delivery edge of the adjustable spout extension. Since the material is moving exactly at the speed of the roll at this point, the magnetic particles will cling tightly to the roll while the non-magnetic particles will tend to drop, separation being made by means of the valve 35 in each instance.

As in the modifications previously described, the valves 35, discharge spout 39, and all necessary baffles, are mounted on the conduit or chute 88, which, together with the respective rolls 42 and 43, is made fast to the secondary magnet or field frame 60 to partake of the adjustment thereof in a manner previously described.

In the construction shown in Fig. 8 the invention is modified to adapt it for use in a wet operation. In this device, although two rolls are used, they are used in parallel and the material is treated but once in the particular piece of apparatus shown in Fig. 8.

The material to be treated enters the apparatus simultaneously through the two hoppers 95. Associated with each is a water spray 96 for sluicing the material down the hopper. The rolls 41 are partially submerged in a body of water 97 held in tank 98. In order that the primary magnet may be kept dry it is located above the water level, and in this instance the primary magnet 50, rather than the secondary magnet 60, is provided with the pole pieces 61 which partially surround the respective rolls so as to deliver flux thereto without substantial concentration.

The secondary magnet or field frame 60 is submerged in tank 98 and in this device, it is the secondary magnet 60 that is adapted to accommodate the apices 551 concentrating magnetic flux on a limited portion of the peripheral area of the rolls 41. The surfaces of the poles 551 of the secondary magnet 60 are preferably covered with a 10 non-magnetic coating at 99 so that there will be little or no magnetic field established in passing roll 41 to cling to the field frame.

The hoppers 95 lead to a point below water level immediately adjacent the apices 551 of the secondary magnets, where the magnetic field is most intense. The rotation of the rolls 41 in the direction indicated by the arrows will facilitate the discharge of water material across the gap between the rolls 41 and the polar apices 551. Beyond this gap are the adjustable valves 100 leading through a central funnel-shaped receptacle 101 for the magnetic material which is efficiently attracted by the rolls to be carried past the valves. The non-magnetic material will fall at one side or the other of the secondary magnet 60 and outside of the adjustable gates 105. When a sufficient amount has accumulated in the tank 99 the tank may be drained through pipe 102 under the control of valve 103. A similar pipe 104 controlled by valve 105 is provided for the drainage of the chamber 101 in which the magnetic material accumulates.

In order to prevent the magnetic material from continuing to adhere to the rolls 41, spray pipes are provided at 106 to wash the ascending side of each roll. Surplus water accumulating in the tank 99 between the intervals of withdrawal of the solid material therewith, is drained off by means of an overflow pipe 107.

In this form of the device, the rolls being associated with the primary magnet 50, it is the primary magnet which is adjusted in order to vary the flux gap between the rolls and the apices 551. For this purpose the primary magnet is suspended on screws 12 adjustable by means of wheels 13 in the nuts 14 connected with the magnet structure.

Any suitable means may be employed in the Fig. 7 and Fig. 8 devices to provide for the rotation of the rolls at predetermined rates.

I claim:

1. In a magnetic separator, the combination with a magnet provided with spaced poles, of a field frame provided with spaced poles complementary to those of the magnet, rolls mounted on the field frame and positioned between its poles and those of the magnet, a conduit system for delivering material successively over said rolls, said system being carried by the field frame, and means for bodily adjusting said field frame respecting said magnet whereby to vary the flux gap between the respective rolls and the poles of said magnet without affecting the feed of material respecting said rolls.

2. In a magnetic separator, the combination with a magnet having spaced poles, of an apertured field frame having complementary poles, rolls mounted directly on the field frame adjacent the poles thereof and between the field frame poles and those of the magnet, means mounted on said field frame for feeding material successively over said rolls, means carried by the field frame for separating from such material adjacent each roll that portion of the ma-
terial magnetically adherent to the roll to a predetermined degree, a spout for the discharge of said last mentioned portion of the material through a part of the field frame, and means for independently adjusting either end of the field frame bodily with respect to the adjacent pole of the magnet, wherein to regulate the flux gap between said pole and the adjacent pole independently.

3. In a magnetic separator, the combination of a plurality of magnets each having upper and lower poles, a field frame with complementary port dimensions associated with each magnet, rolls carried by the respective field frame adjacent the respective poles thereof, means for adjusting selectively each end of each field frame with respect to the adjacent pole of the magnet, wherein to vary the flux gap between one of the rolls and the adjacent magnetic pole, material conduits carried by each field frame including means for guiding material over the successive rolls of said field frame, each of said conduits having a hopper at its upper end and a plurality of discharge spouts for relatively magnetic and nonmagnetic material respectively, and means carried by said conduits for effecting the separation of such material, the hopper of the conduit connected with the lower field frame being of sufficient length to receive relatively less-magnetic material from the hopper discharge spout of the conduit connected with the upper field frame throughout a normal range of adjusted positions of the respective frames, whereby adjustments may be effected with the device in operation without affecting the functioning of said conduits or separating means.

4. In a magnetic separator, the combination with a core having vertically spaced poles with laterally projecting apices and a winding on said core intermediate of said apices, of magnetic rolls associated with the respective apices spaced in relation thereto, a secondary magnet in the form of a hollow frame having laterally projecting poles arcuately spaced and in close proximity to the said rolls, whereby to complete an electromagnetic circuit from said core through said rolls and poles, means for feeding material on to the uppermost of said rolls, means for rotating said rolls, means for feeding outwardly through said secondary magnet a portion of said material having a shorter trajectory in its discharge from said uppermost roll, and means for feeding the remainder of said material across the lowermost rolls and for separating a portion of said material according to its trajectory thereon.

5. In a magnetic separator, the combination with a core having vertically spaced laterally projecting poles and an electromagnetic winding on said core intermediate of said poles, of a pair of rolls associated with the respective poles of said core, and a secondary magnet having poles associated with the respective rolls and comprising a frame member having an opening, means supporting said rolls upon said frame member, and means for feeding material through said rolls in series and including means for diverting a portion of said material through said frame member.

6. In a magnetic separator, the combination with a primary magnet having spaced poles, of a secondary magnet having complementary poles spaced on one end of said magnets and positioned between the poles in fixed relation to the poles of the magnet on which it is mounted, a frame upon which the primary magnet is fixed, said frame being provided with a guide way upon which said secondary magnet is slidably and pivotally movable, and adjusting means extending between the respective magnets for the individual adjustment of either end of the secondary magnet directly with reference to the corresponding end of the primary magnet.

7. In a magnetic separator, the combination with a primary magnet comprising a core, spaced poles projecting laterally therefrom, and an electrical winding upon said core, of a secondary magnet comprising a frame having a central opening and provided with poles projecting laterally toward the poles of the primary magnet, magnetic rolls mounted between the respective poles of the primary and secondary magnets and each fixed against displacement with reference to the poles of one of said magnets, means for feeding material across said rolls and including separating equipment, and a discharge chute for some of said material extending through the opening of the secondary magnet, and means for effecting bodily adjustment between the poles of said magnets for the regulation of the flux gap between the respective rolls and the poles upon which said rolls are mounted.

8. In a magnetic separator, the combination with a receptacle for liquid, of a magnet having a winding above said liquid and poles projecting toward the surface thereof, rolls associated with the respective poles and partially submerged, and a secondary magnet without winding substantially wholly submerged in said liquid and comprising a core with an opening in its center and having peripherally spaced poles projecting upwardly to said rolls and the poles of the primary magnet, and discharge conduits extending from the rolls through the opening in its center.

9. In a magnetic separator, the combination with a receptacle for liquid, of a magnet having a winding above said liquid and poles projecting toward the surface thereof, rolls associated with the respective poles and partially submerged, and a secondary magnet without winding substantially wholly submerged in said liquid and having poles projecting upwardly to said rolls and the poles of the primary magnet, said secondary magnet comprising an open center frame and having a discharge conduit extending from one of the rolls through the opening in its center, together with means directly connecting the pole portions of the primary and secondary magnets for the individual adjustment of said pole portions with respect to each other, each of said rolls being fixed against displacement with reference to the poles of one of said magnets and adjustable therewith with reference to the corresponding pole portions of the other magnets.

10. In a magnetic separator, the combination with an electromagnet having upper and lower pole pieces and an intermediate winding, of a secondary magnet comprising a rectangular frame composed of magnetizable material, a support upon which the former and secondary magnet, and portions of the secondary magnet adjacent to the primary magnet are adjustably mounted for movement with reference to the poles of the primary magnet, a set of rolls respectively supported for adjustable movement in correspondence with the movements of the upper and lower portions of the secondary magnet and interposed between its poles and the poles of the primary magnet, and adjusting screws associated with the support and operatively connected to
effect independent adjustments of the upper and lower poles and associated rolls of the secondary magnet to independently vary their positions with reference to the poles of the primary magnet.

11. In a magnetic separator, the combination with a receptacle for liquid, of a magnet having a winding above the level of liquid in said receptacle and poles projecting downwardly, rolls connected with the respective poles and comprising magnetic material rotatable in the fields of the respective poles, each of said rolls being at least partially submerged, and a submerged secondary magnet comprising a substantially horizontal core frame open at its center and free of winding, provided with substantially diametrically spaced poles projecting upwardly into proximity with the respective rolls, feeding devices respectively arranged to deliver material to said last mentioned poles and beneath said rolls, submerged separating means between said rolls, and separate means for conveying from said receptacle the material separated.

12. In a magnetic separator, the combination with a receptacle for liquid, of a submerged magnet comprising a core open at its center and provided with upwardly extending poles at opposite sides, each of said poles having an upwardly directed apex for flux concentration, a second magnet suspended above the first and provided with downwardly directed poles, magnetic rolls rotatably connected with one of said magnets and disposed between the poles of the upper magnet and the poles of the lower magnet, means disposed within the core of the first mentioned magnet for effecting separation of material passing beneath said rolls, and means for delivering material toward the center of said first mentioned magnet across the poles thereof.

13. In a magnetic separator, the combination with a pole and a winding operatively connected for the energization thereof, an opposed pole, a core connected therewith and provided with a central aperture beneath said opposed pole, a roll carried by said core and disposed between said poles, bearing means upon which the roll is rotatably mounted, and conduit means for delivering material between said roll and said first mentioned pole, a separator beyond said roll, and a discharge spout connected with said core and leading from said separator through the aperture of said core, together with a support from which said core and spout and separator are unitarily adjustable.

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