May 12, 1931. J. N. McCRACKEN 1,804,998

METHOD OF AND MEANS FOR COLLECTING MAGNETIC MATERIALS AND SEPARATING THEM FROM OTHER MATERIALS

Filed May 16, 1928 2 Sheets-Sheet 1

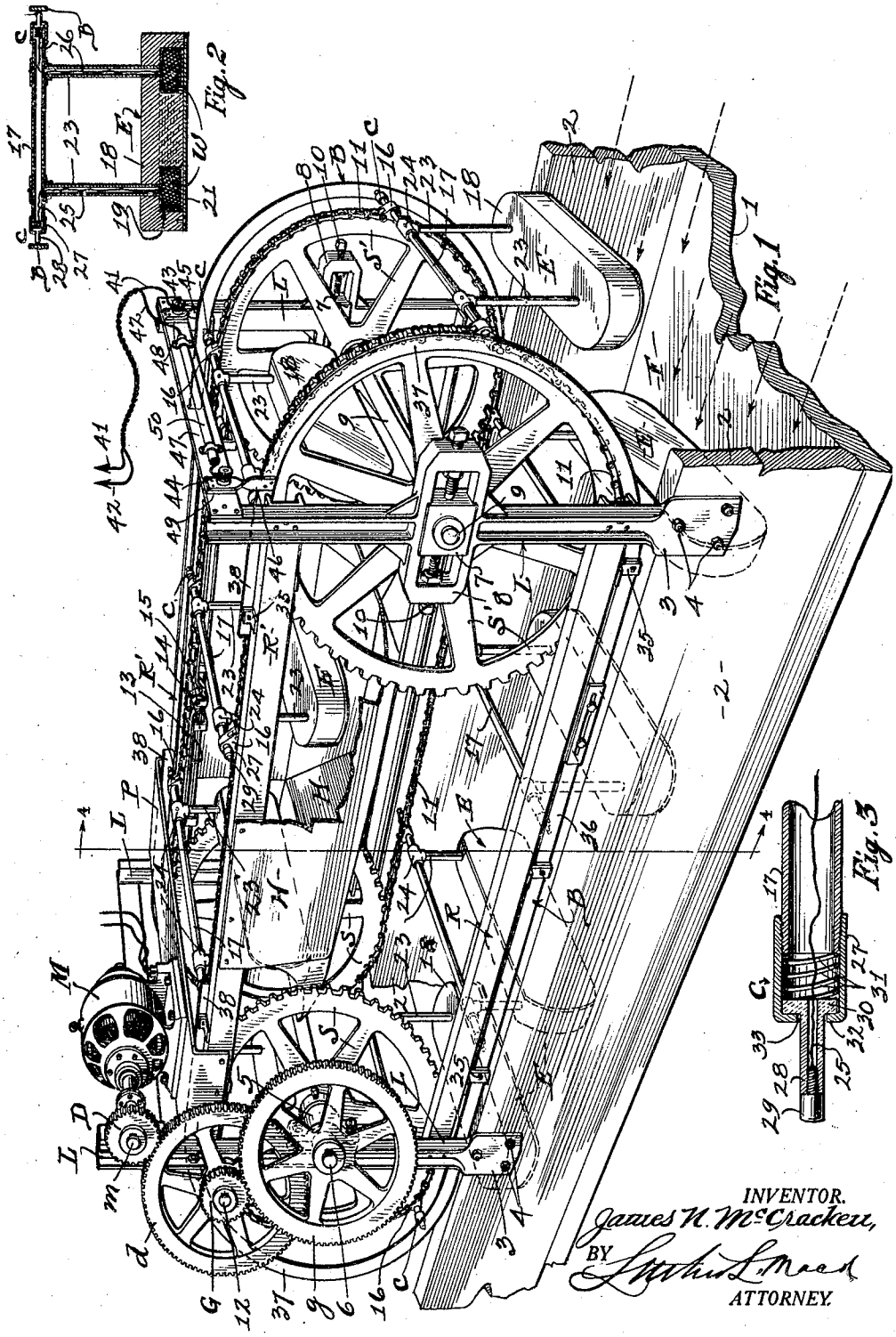


Fig. 1

Fig. 2

Fig. 3

INVENTOR.
James N. McCracken,
BY Arthur L. Mead
ATTORNEY.

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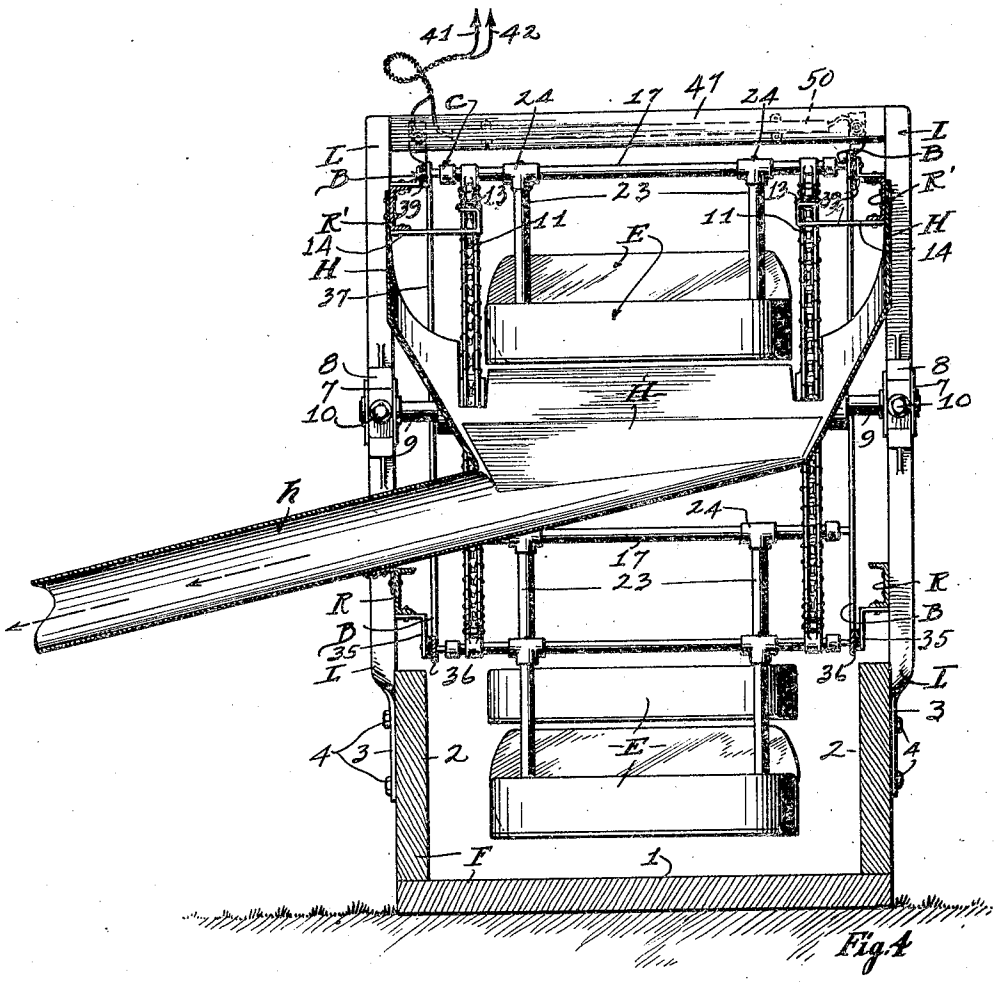


Fig. 4

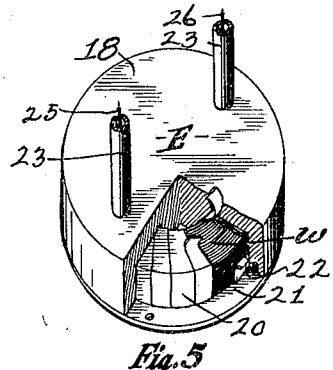


Fig. 5

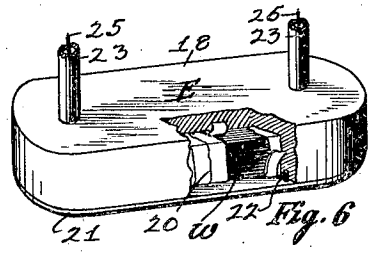


Fig. 6

INVENTOR.
James N. McCracken
BY Luther L. Mead
ATTORNEY.

Patented May 12, 1931 1,804,998

UNITED STATES PATENT OFFICE

JAMES N. McCRACKEN, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO BLACKSAND MINING AND MANUFACTURING COMPANY, LTD.

METHOD OF AND MEANS FOR COLLECTING MAGNETIC MATERIALS AND SEPARATING THEM FROM OTHER MATERIALS

Application filed May 16, 1928. Serial No. 278,509.

This invention relates to a means and a method for effecting the separation of magnetic sands or other magnetic substances, from non-magnetic sands or substances, and it is especially applicable to mining, where it is required to collect and to discharge a maximum of such magnetic substances as are commingled with water or other fluids and are found in large quantities in rivers, streams, sluice ways and the like.

By my invention I contemplate the extraction of magnetic materials from non-magnetic materials, and in order to effect this extraction I cause a series of charged electro-magnets, suspended from an endless carrier, to be immersed and moved in a river, stream or passage so that the magnetic materials, such as black sand, are accumulated from the conglomerate and are automatically elevated and discharged from the magnets while the latter are de-energized.

One object of this invention is, therefore, to provide suitable means for energizing the magnets while they are submerged in the stream or sluice and for de-energizing the magnets after the accumulation of the magnetic materials thereon so that the materials may be discharged from the stream or sluice and may be disposed of for further use.

Another object of my invention is to provide a machine adapted to be mounted on a sluice box, through which the ore is conveyed by a stream of water or by some other means, and including a plurality of electro-magnets mounted at intervals on a conveyer and arranged so as to be submerged, and to travel, in a sluice box in the direction of the flow of water, but at a slower speed, so that the black sand washed down through the box by means of the water will be attracted by the magnets and that large quantities of the sand will be collected on the magnets and will subsequently be elevated to a point above the stream of water and will finally be discharged for further treatment.

Other objects are to include means for energizing the magnets during a major portion of each cycle of operation, and for de-energizing the magnets during certain intervals in order to discharge the accumulated sand from the magnets.

A further object of the invention is to provide liquid-tight enclosures for the wirings of the electro-magnets and thereby to assure a satisfactory operation of the machine.

Other objects may appear as the description progresses.

In the accompanying drawings, I show a practical embodiment of my invention for carrying out the above objects, and in these drawings,

Figure 1 is a perspective view of the assembled machine mounted in an operative position on a sluice box;

Figure 2 is a cross section of one of the electro-magnets and means for operably supporting it in its operative position;

Figure 3 is a fragmentary enlarged section of one of a plurality of resilient contacts, by means of which an electric current is transmitted to the electro-magnets;

Figure 4 is a transverse sectional elevation on line 4—4 of Figure 1; and

Figures 5 and 6 are perspective views, partially broken away, of circular and oblong forms of electro-magnets.

The complete machine, as shown in Figure 1, is mounted on a sluice box or flume F, which has a bottom 1 and sides 2. The machine includes a frame having at each of its corners a preferably channeled leg L, and each of the legs is provided with a foot 3 adapted to be bolted to the respective side 2 of the sluice box by means of bolts or screws 4. The legs L at each side of the frame are connected by means of a channeled rail R at the bottom and a similar rail R′ at the top of the frame.

One end of the machine is provided with bearings 5, which are secured to the respective opposite legs L and have a shaft 6 journaled therein. Each of the legs L at the other end or the front of the machine has therein a bearing block 7, slidably mounted in a yoke 8, which preferably is integral with the respective leg and extends in parallelism with the rails R and R′. A shaft 9 is journaled in the bearing blocks 7, while screws 10 in the end portions of the respective yokes 8 are adapted to press with their inner ends

against the bearing blocks 7 so as to lock the latter within the yokes and thus to hold the shaft 9 in parallelism with, and at a desired distance from, the shaft 6.

The shaft 6 has fixed thereon by suitable means a pair of large sprocket wheels S within the frame of the machine, and the shaft 9 has fixed thereon a pair of similar sprocket wheels S′ so that the latter sprocket wheels respectively are in alinement with the former. The wheels S and S′ at each side of the machine are connected by endless belts or sprocket chains 11, which together constitute a conveyer and are adjusted to their proper tension over the wheels in accordance with the adjustment of the shaft 9 relative to the shaft 6 by the screws 10.

A transverse plate P, connecting the upper rails R′ with each other, has mounted on its top a motor M provided with a shaft *m*, which extends from the motor outside of one of the legs L and has on this extension fixed a pinion D, and a countershaft 12 is rotatably mounted on the respective leg L and has on it fixed a gear *d* so that the latter meshes with the pinion D and is adapted to be driven thereby.

The countershaft 12 has also a pinion G fixed thereon outside of the gear *d*, and the shaft 6 has fixed thereon a gear *g* which meshes with the pinion G. Thus, when the motor M is in operation, the shaft 6 is caused to rotate at a reduced rate of speed in order to effect a proper traveling speed of the chains 11 of the conveyer over the sprocket wheels S and S′, and thereby to assure a successful operation of the machine.

Preferably the chains 11 of the conveyer are supported on tracks 13, attached to the rails R′ by brackets 14. As shown in Fig. 1, these tracks may also be provided with anti-friction rollers 15, over which the chains run, the tracks and the rollers being suitably arranged so as to carry the chains with a minimum amount of friction and wear.

At regularly spaced portions the chains 11 are provided with a plurality of bearing links 16, the links on one of the chains being directly opposite to the respective links on the other chain, and in each pair of opposite links is a tube 17 loosely journaled. Each of the tubes 17 supports an electro-magnet E, which is enclosed in a metallic body 18 of suitable cross section and is provided with an annular or oblong recess 19, in which is mounted a coil of insulated wire W. These coils of wire are taped, as shown at 20, so as to insulate them completely from the bodies 18, and the coils are removably held in the respective bodies 18 by non-magnetic plates 21, which are removably attached to the bodies 18 by means of a plurality of screws 22.

The means by which each tube 17 supports the respective body 18 includes a pair of tubes 23, each of which is at one end secured to the respective body 18 and is at its other end secured to the stem of a T 24, the heads of the T's encompassing, and being suitably fixed to, the respective tubes 17, so that, on account of the pivotal connection of the tubes 17 with the bearing links 16, the bodies 18 always are pendent from the links. One terminal 25 of each wire coil W extends through the respective body 18 and through one of the tubes 23 therefor into the respective supporting tube 17 and toward the near end of the latter, while the terminal 26 of the coil extends through the body and through the other tube 23 therefor into the supporting tube and toward the other end thereof, as shown in detail in Fig. 2, and the terminals are respectively attached to contact devices C, shown in detail in Fig. 3. By this construction the bodies 18, together with the plates 21 and the tubes 23 and 17, constitute liquid-tight enclosures for the wirings of the respective electro-magnets E.

Each of these contact devices includes a ferrule 27, which is adapted to be screwed upon either end of any of the tubes 17, and has reciprocatively mounted therein a stem 28, and a contact tip 29 preferably has a screw connection with the outer end of the stem 28, and is connected by soldering or some other suitable means with the respective wire terminal 25 or 26. Within each ferrule 27 the stem 28 is provided with a head 30, and between this head and the end of the respective tube 17 a coiled spring 31 is held in compression. Thus each spring 31 serves to hold the respective head 30 outwardly against the inwardly turned end 32 of the respective ferrule 27, the stem 28 extending through an opening 33 in the end 32 of the ferrule.

The contact tips 29 are adapted to frictionally engage bus-bars B, which are attached to the rails R and R′ by brackets 35, and have lower horizontal portions 36, curved end portions 37, and upper horizontal portions 38 so arranged that the horizontal portions 36 and 38 of the bus-bars respectively are in the plane of movement of the contact devices C and that therefore, when the chains 11 are moving horizontally at the top and the bottom of the machine, the tips 29 respectively engage these portions of the bars, while the curved portions 37 at the ends are respectively concentric with the axes of the shafts 6 and 9, so that, when the contacts C are moved over the sprocket wheels S and S′, the tips 29 remain in contact with the bars B.

It should be noted, however, that at the top of the machine the horizontal portions 38 of the bars are substantially spaced apart, so that, during a considerable period of the travel of the electro-magnets E, the magnets are de-energized, while, during the remaining period of the travel throughout the length of the bus-bars B, the magnets are energized, as hereinafter described. Of course, the bars B, as shown in Fig. 4, are insulated from the

frame of the machine by means of insulating blocks 39 of a suitable size and character.

At the front end of the machine, as shown in Fig. 1, two wires 41 and 42 of an electric supply system are connected, respectively, with terminals 43 and 44, which are at opposite sides of the machine, and are mounted on brackets 45 and 46, respectively, and the brackets are secured at their lower ends to the bars B and are insulated from a transverse frame member 47 by means of insulating blocks 48 and 49. The wire 42 is extended through an insulating tube 50, suitably mounted on the transverse member 47, as shown.

Thus an electric current is conducted to the bus-bars B, so that, when the machine is in operation and the electro-magnets are thereby moved, and when the contacts C at the ends of the tubes 17 frictionally engage the bars, the respective coils W are energized by being connected with the two poles of the circuit, and the magnets E, in which the coils are respectively mounted, are thereby connected in multiple with the circuit.

It will be noted, by reference to Figs. 1 and 4, that the electro-magnets E, while of the same character and general size, are arranged so that each magnet is at an angle to the adjacent magnets; that is, the magnets are preferably grouped so as to be alternately in a horizontal position and alternately in a vertical position, and the length of each body 18 and the spacing of the body from the sides 2 of the sluice of flume F are such that the body, during its travel with the conveyer chains 11, has a sufficient clearance between the sprocket wheels S or S'.

The upper portion of the machine between the pairs of sprocket wheels S and S' is provided with a hopper H, which is open at its top and ends so as to permit the movement of the conveyer chains 11, the electro-magnets E and their conveyer connections longitudinally through the hopper, and the hopper is provided with a discharge spout *h*, which extends transversely downwardly on an inclined plane through an opening in the side of the machine, as shown in Fig. 4, for the purpose hereinafter described.

In operation, with the machine mounted on a sluice box or flume and arranged in a proper position so that the electro-magnets E, during their travel through the sluice box, are slightly above the bottom 1 thereof, the sand and gravel which is washed down through the inclined flume is collected by magnetic attraction upon the bodies 18 of the magnets E and is drawn through the water in the box for the length of the machine, and is thence elevated over the sprocket wheels S and carried to a point centrally between the ends of the machine, it being assumed that the magnets travel in the direction indicated by the dotted-line arrows in Fig. 1.

As each of the electro-magnets E moves into position over the hopper H, the contacts C of the magnet disengage the portions 38 of the bus-bars B, thereby de-energizing the coils W and thereby causing the accumulated black sand carried by the magnets E to be dropped into the hopper H, from which it will be discharged by gravity through the spout *h* to desired points for further treatment.

The electro-magnets E in the group of horizontally disposed magnets serve mainly to collect the sand at or near to the bottom of the sluice box or flume, while the magnets in the group of vertically disposed magnets serve mainly to collect the sand which is in suspension in the water, so that such particles of sand as are not in a position for collection by a magnet in one group will be collected by a magnet in the other group. In this connection, it may be noted that the direction of the movement of the electro-magnets E through the flume corresponds to the direction of the movement of the water or material through the flume, but the speed of the electro-magnets is so much less than the speed of the water or the material that a sufficient agitation results and that thereby the sand is maintained in suspension while it is passing the machine.

I have found in practice that it is not always necessary to move the sand through the flume by means of a stream of water, for the reason that under certain conditions the material may be moved by gravity down through the inclined sluice, flume, or trough, on which the machine is mounted, and the electro-magnets E will in this instance also serve to attract the iron sand and to collect it from the moving material very satisfactorily.

Thus, it will be observed that in order to carry out my improved method of collecting black sand from ores, I provide a means in the form of a thoroughly efficient device which operates continuously without manual attention, for collecting and removing the valuable minerals from the ores and for discharging the minerals without appreciable loss in volume. I am, therefore, enabled to commercially collect at a profit such valuable minerals as are present in the black sand and, consequently, my method has a decided advantage over the methods heretofore known in the art.

It should be understood that the form of the electro-magnets E is immaterial to my invention, since the magnets may be made to conform to the flume or other passage in which they are used, and I conceive it to be possible to further modify or change my invention within the scope of the appended

claims without departing from the spirit thereof.

What I claim is:

1. A method of separating magnetic materials from non-magnetic materials, the method consisting in arranging a series of electro-magnets so that the magnets are alternately in a substantially horizontal position and alternately in a substantially vertical position; moving a mixed volume of the materials in a passage; causing the magnets to be energized and, while energized, to move through the mixed volume of materials so that some portions of the magnetic materials will be collected by the horizontally disposed magnets, while other portions of the magnetic materials will be collected by the vertically disposed magnets; continuing the movement of the electro-magnets out of the passage; and causing the magnets to be de-energized during a period of their travel out of the passage, thereby effecting the discharge of the collected magnetic materials from the magnets.

2. A method of separating magnetic materials from non-magnetic materials, the method consisting in arranging a series of electro-magnets so that the magnets are alternately in a substantially horizontal position and alternately in a substantially vertical position; moving a mixed volume of the materials and a volume of liquid in a passage so that, while some portions of the materials are at or near to the bottom of the passage, other portions of the materials are held in suspension in the liquid; causing the magnets to be energized and, while energized, to move through the mixed volumes of the materials and the liquid so that such portions of the magnetic materials as are at or near to the bottom of the passage will be collected mainly by the horizontally disposed magnets, while such portions of the magnetic materials as are held in suspension in the liquid will be collected mainly by the vertically disposed magnets; continuing the movement of the electro-magnets out of the passage; and causing the magnets to be de-energized during a period of their travel out of the passage, thereby effecting the discharge of the collected materials from the magnets.

3. A machine of the character described, comprising a conveyor adapted to be mounted so as to move longitudinally of a passage through which a mixed volume of magnetic materials and non-magnetic materials is caused to travel; means for moving the conveyor; a series of electro-magnets mounted on the conveyor so as to be pendent therefrom and, during a period of the movement of the conveyor, to travel through the passage; and means connecting the magnets in circuit with a source of electric energy so as to close the circuit in order to energize the magnets during the period of their travel through the passage and thereby to cause the magnetic materials to be collected by the magnets, and to open the circuit during a period when the magnets are out of the passage in order to de-energize the magnets and thereby to cause the collected materials to be discharged from the magnets, which are arranged alternately in a substantially horizontal position and alternately in a substantially vertical position, so that some portions of the magnetic materials will be collected by the horizontally disposed magnets, while other portions of the magnetic materials will be collected by the vertically disposed magnets.

4. A machine of the character described, comprising a conveyor adapted to be mounted so as to move longitudinally of a passage, through which a mixed volume of magnetic materials and non-magnetic materials and a volume of liquid are caused to travel, so that, while some portions of the materials are at or near to the bottom of the passage, other portions of the materials are held in suspension in the liquid; means for moving the conveyor; electro-magnets mounted on the conveyor so as to be pendent therefrom and, during a period of the movement of the conveyor, to travel through the passage; and means connecting the magnets in circuit with a source of electric energy so as to close the circuit in order to energize the magnets during the period of their travel through the passage and thereby to cause the magnetic materials to be collected by the magnets, and to open the circuit during a period when the magnets are out of the passage in order to de-energize the magnets and thereby to cause the collected materials to be discharged from the magnets, which are arranged in groups, so that the magnets in each group are at an angle to the other group magnets and that such portions of the magnetic materials as are at or near to the bottom of the passage will be collected mainly by the magnets in one group, while such portions of the magnetic materials as are held in suspension in the liquid will be collected mainly by the other group magnets.

5. A machine of the character described, comprising a conveyor adapted to be mounted so as to move longitudinally of a passage, through which a mixed volume of magnetic materials and non-magnetic materials and a volume of liquid are caused to travel, so that, while some portions of the materials are at or near to the bottom of the passage, other portions of the materials are held in suspension in the liquid; means for moving the conveyor; electro-magnets mounted on the conveyor so as to be pendent therefrom and, during a period of the movement of the conveyor, to travel through the passage; and means connecting the magnets in circuit with a source of electric energy so as to close the

circuit in order to energize the magnets during the period of their travel through the passage and thereby to cause the magnetic materials to be collected by the magnets, and to open the circuit during a period when the magnets are out of the passage in order to de-energize the magnets and thereby to cause the collected materials to be discharged from the magnets, which are arranged so that each magnet is at an angle to the adjacent magnets and that such portions of the magnetic materials as are at or near to the bottom of the passage will be collected mainly by magnets arranged at one angle, while such portions of the magnetic materials as are held in suspension in the liquid will be collected mainly by magnets arranged at another angle.

6. A machine of the character described, comprising a conveyor adapted to be mounted so as to move longitudinally of a passage, through which a mixed volume of magnetic materials and non-magnetic materials and a volume of liquid are caused to travel, so that, while some portions of the materials are at or near to the bottom of the passage, other portions of the materials are held in suspension in the liquid; means for moving the conveyor; electro-magnets mounted on the conveyor so as to be pendent therefrom and, during a period of the movement of the conveyor, to travel through the passage; and means connecting the magnets in circuit with a source of electric energy so as to close the circuit in order to energize the magnets during the period of their travel through the passage and thereby to cause the magnetic materials to be collected by the magnets, and to open the circuit during a period when the magnets are out of the passage in order to de-energize the magnets and thereby to cause the collected materials to be discharged from the magnets, which are arranged alternately in a substantially horizontal position and alternately in a substantially vertical position, so that such portions of the magnetic materials as are at or near to the bottom of the passage will be collected mainly by the horizontally disposed magnets, while such portions of the magnetic materials as are held in suspension in the liquid will be collected mainly by the vertically disposed magnets.

JAMES N. McCRACKEN.