(No Model.) 3 Sheets—Sheet 1.

H. CARMICHAEL.

MAGNETIC SEPARATOR.

No. 521,906. Patented June 26, 1894.

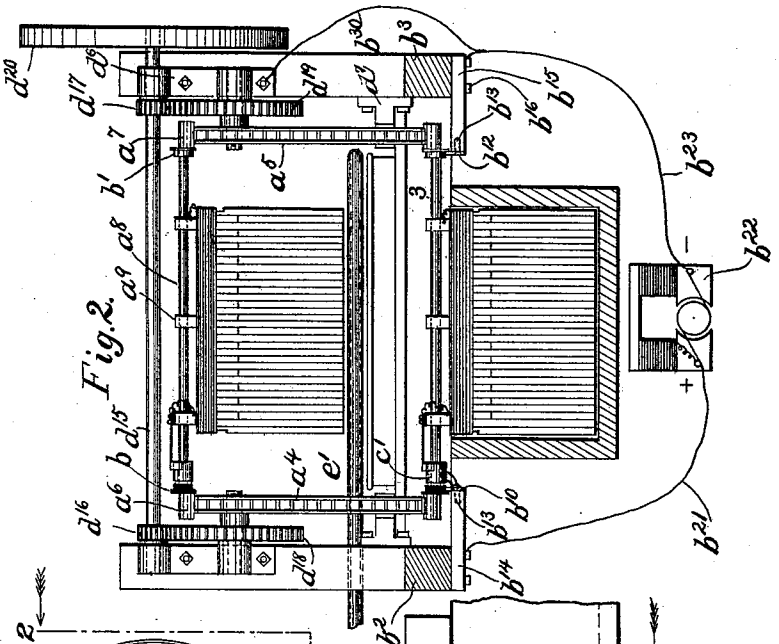

Fig. 2.

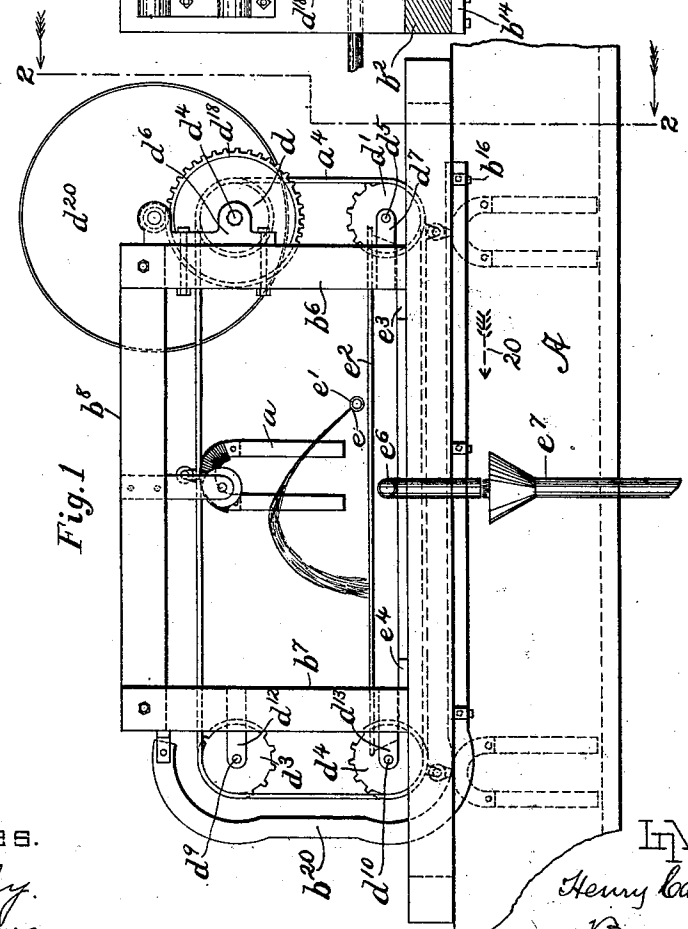

Fig. 1

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(No Model.) 3 Sheets—Sheet 2.

H. CARMICHAEL.

MAGNETIC SEPARATOR.

No. 521,906. Patented June 26, 1894.

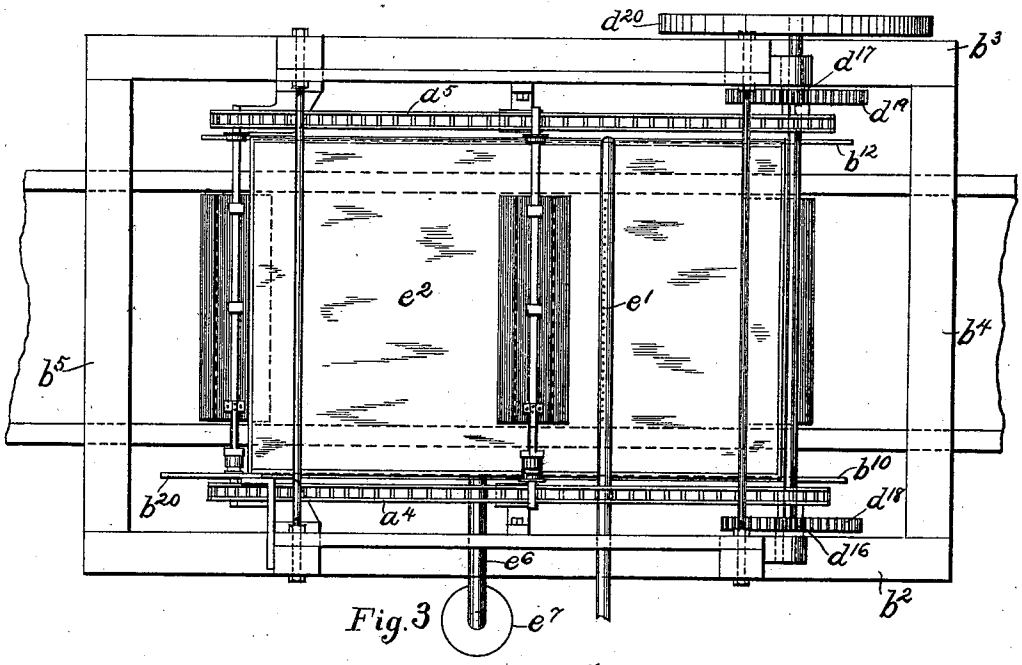

Fig. 3

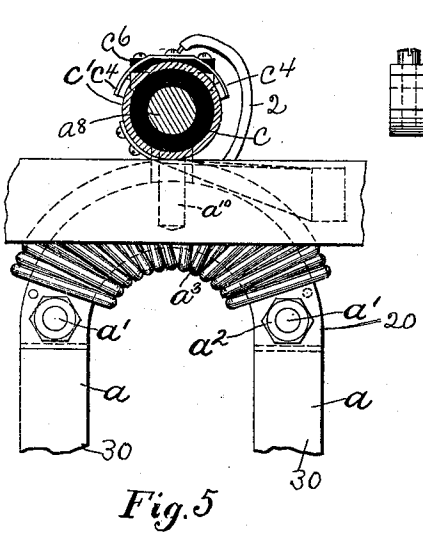

Fig. 5

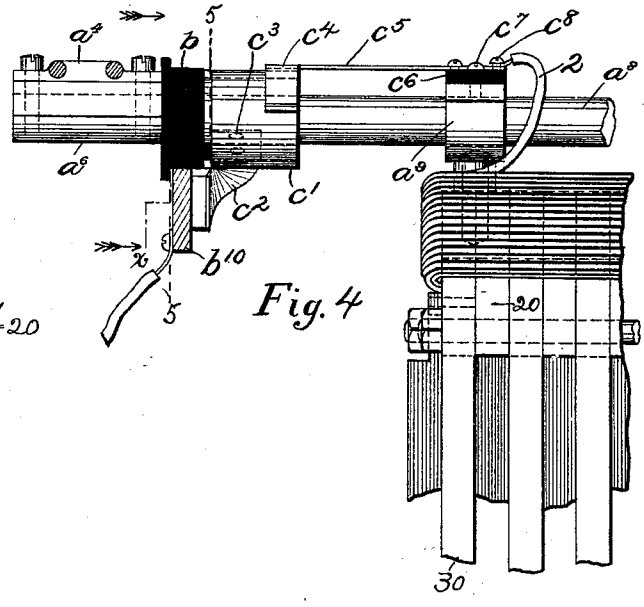

Fig. 4

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(No Model.) 3 Sheets—Sheet 3.

H. CARMICHAEL.

MAGNETIC SEPARATOR.

No. 521,906. Patented June 26, 1894.

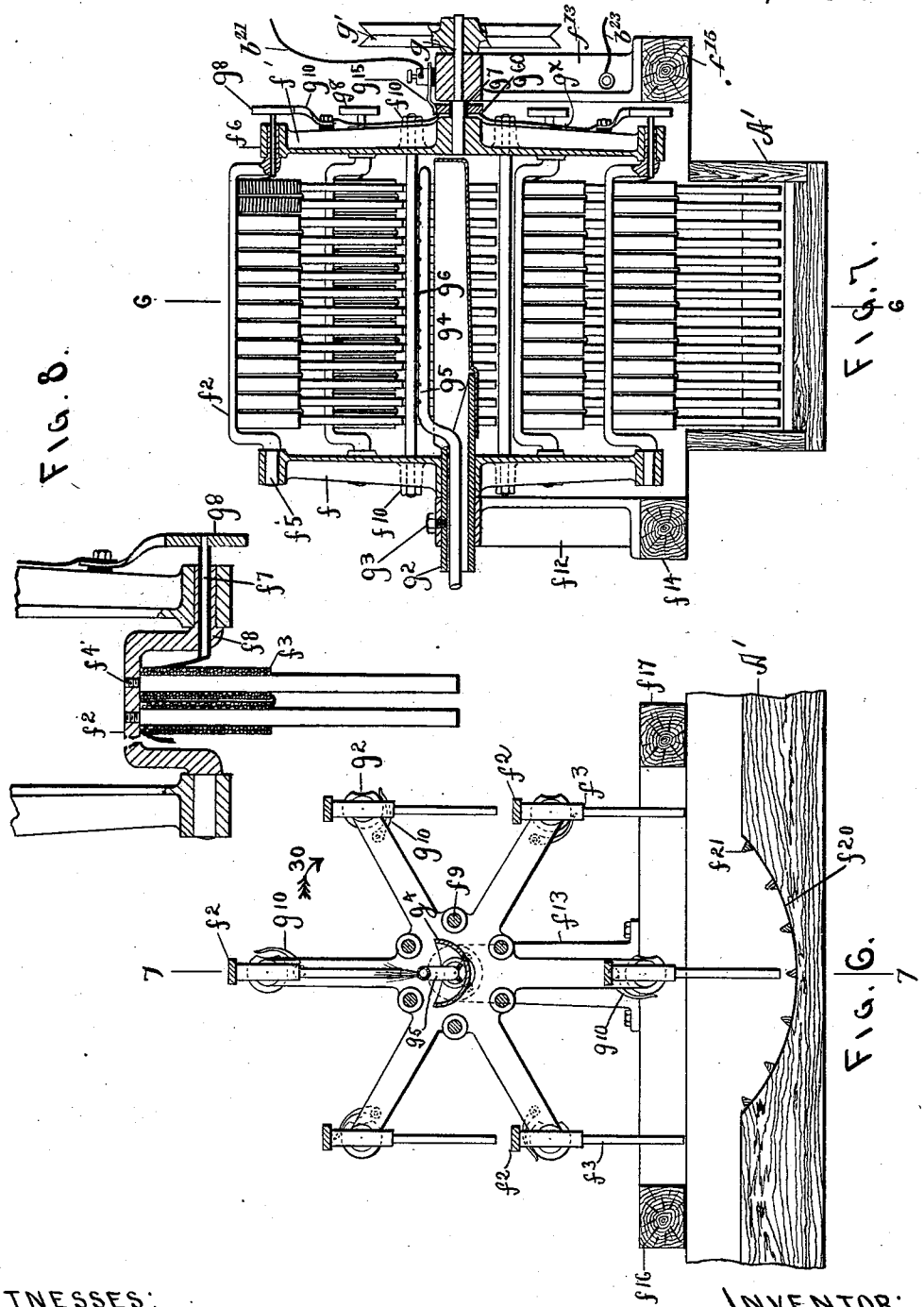

FIG. 8.

FIG. 7.

FIG. 6.

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UNITED STATES PATENT OFFICE.

HENRY CARMICHAEL, OF MALDEN, MASSACHUSETTS.

MAGNETIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 521,906, dated June 26, 1894.

Application filed November 29, 1893. Serial No. 492,352. (No model.)

To all whom it may concern:

Be it known that I, HENRY CARMICHAEL, residing in Malden, in the county of Middlesex and State of Massachusetts, have invented an Improvement in Magnetic Separators, of which the following description, in connection with the accompanying drawings, is a specification, like letters and figures on the drawings representing like parts.

This invention relates to a magnetic separator especially adapted to be used in removing iron particles from fluid pulp.

In accordance with this invention, a movable or traveling carrier or support has pivotally secured to it preferably a plurality of electro-magnets, which may and preferably will be constructed as will be described to obtain a staggered effect by which the iron particles may be more thoroughly removed without agitating or disturbing the fluid pulp.

Another feature of this invention consists in removing the particles magnetically affixed to the magnets preferably by hydraulic means as will be described, the electro-magnets at such time being automatically cut out of the electric circuit, to enable the particles to be more easily washed from the magnets into a suitable receptacle.

The traveling carrier referred to, may and preferably will be made as endless chains or belts to which the magnets are pivotally secured, whereby the magnetic separator may be used with a substantially long straight trough, which may be the usual sand settling vat through which the pulp is run, and in which the magnets may act on the pulp for a substantially long time before being removed therefrom.

These and other features of this invention will be pointed out in the claims at the end of this specification.

Figure 1 is a side elevation of a magnetic separator embodying this invention, the pulp vat or trough being broken off; Fig. 2, a section on the line 2—2, Fig. 1, looking in the direction of the arrow thereon; Fig. 3, a top or plan view of the apparatus shown in Fig. 1; Fig. 4, a detail on an enlarged scale to more clearly show the construction of the magnets and the devices employed in conducting the current thereto; Fig. 5, a sectional detail on the line 5—5, Fig. 4, to be referred to; Fig. 6, a vertical longitudinal section of a modified form of apparatus, the section being taken on the line 6—6, Fig. 7; Fig. 7, a transverse vertical section on the line 7—7, Fig. 6, and Fig. 8, a sectional detail to be referred to.

Referring to Fig. 1, A represents a trough or receptacle to contain fluid pulp, which, for the best results, is flowed or run through the said trough and in which it is acted upon by one or more magnetic separators.

The magnetic separators are preferably made as shown in Figs. 1 to 5 inclusive and each consists of a number of substantially horse-shoe shaped electro-magnets a, firmly secured together as by bolts or rods a', the said magnets, for the best results, having one leg or pole as 20 much shorter than the other leg or pole 30, and the short leg 20 of one magnet being secured to the long leg 30 of adjacent magnets, as best shown in Fig. 4. The number of magnets a are secured together to form a compound magnet having two substantially long pole pieces provided with passageways, the passageways of one pole piece being opposite the solid parts of the other pole piece.

The magnets a in the present construction are preferably secured together by means of nuts a^2 on the opposite ends of the tie rods a', so as to practically form one substantially long or wide horse-shoe magnet of substantially the width of the trough A, the magnet, thus formed, having passageways or openings between adjacent long legs 30 on one half or pole of the magnet and like passageways or openings between adjacent legs 30 of the other half or pole of the said magnet, the legs 30 of one half or pole of the assembled horse-shoe magnet being substantially opposite the passageways of the other half or pole of the said magnet.

The compound horse-shoe magnet as above described may and preferably will have its crown encircled by a winding a^3 of wire, electrically connected to a source of supply as will be described.

The compound magnet is pivotally secured to a movable support or carrier, which in the apparatus shown in Figs. 1 to 5 inclusive, consists of two endless bands, belts or link chains

a^4 a^5 preferably the latter, the said link chains as represented in Fig. 2, having secured to or forming part of them hubs or bearing blocks a^6 a^7, in which are supported the ends of a preferably round rod a^8 upon which is hung the compound magnet, which may be accomplished as herein represented by eyebolts a^9, through the eyes of which the rod a^8 is extended, and which may be fastened to the compound magnet by providing the shanks a^{10} (see dotted lines Fig. 5) with screw-threads to enter threaded sockets in the compound magnet. The eyebolts a^9 fit loose on the rod a^8 so as to permit the compound magnet to hang substantially perpendicular at all times for a purpose as will be described. The rod a^8 is preferably provided at or near its opposite ends with guide rolls or wheels b b' and for the best results, the wheel or roll b is of insulating material and the wheel or roll b' is of conducting material, such, for instance, as brass, for a purpose as will be described.

The wheels or rolls b b' are designed in the travel of the sprocket chains, effected as will be described, to run on tracks at the opposite sides of the frame-work supporting the apparatus above the trough A. This frame-work may be of any suitable construction and is shown as composed of a bottom frame comprising side pieces b^2 b^3 and end pieces b^4 b^5 (see Fig. 3), two uprights b^6 b^7 erected from each side piece, and top pieces b^8 connecting the said uprights. The tracks referred to are represented in Figs. 1 and 2 as metal strips b^{10} b^{12} secured, as by counter-sunk screws b^{13} (see dotted lines Figs. 1 and 2), to brackets b^{14} b^{15} fastened to the sides b^2 b^3 respectively, by screws b^{16}. The track b^{10} at the rear end of the apparatus may and preferably will be provided with a curved extension b^{20}, (see Fig. 1) while the track b^{12} may extend only from the upright b^6 to the upright b^7.

The tracks b^{10} b^{12} may and preferably will form part of the electric circuit to be hereinafter described, one wire as b^{21} of a dynamo or other source of electricity b^{22} being joined to a bracket b^{14}, and the other wire as b^{23} being joined to a bracket b^{15} as shown in Fig. 2.

The coil or winding a^3 of the compound magnet is designed to be connected in circuit with the dynamo b^{22}, which may be accomplished as shown in Figs. 2 and 4. The rod a^8 adjacent to the guide roll or wheel b has fast on it a collar or hub c of insulating material encircled by a band or ring c' of conducting material, and represented as of substantially the same length as the said hub. The ring or band c' is adapted to be electrically connected with the track b^{10} by a brush or arm c^2 represented in Fig. 4 as secured to the ring c by screws c^3. The ring or band c' has co-operating with it a conducting brush c^4 having an arm c^5 secured to an insulating block or support c^6 fastened as by screws c^7 to one of the eyebolts a^9 (see Fig. 4). The arm c^5 has connected to it as by screw c^8 one end 2 of the coil or winding a^3 of the compound magnet, the other end 3 being preferably connected to an eyebolt adjacent to the opposite side of the apparatus, the end 3 of the coil or winding being thus electrically connected to the rod a^8 and the metal portion of the operating parts of the apparatus.

The link chains a^4 a^5 may and preferably will carry a plurality of compound magnets, and in the present instance, three magnets are shown as carried by them, they being secured to the chains at substantially equal distances apart. The link chains in the present construction of apparatus, are shown as passed about four sprocket wheels d d' d^2 d^3 supported at each side of the frame-work of the machine, the sprocket wheels d d' being mounted on shafts d^4 d^5 having bearings in brackets d^6 d^7 attached to the upright b^6, at one end of the apparatus, and the sprocket wheels d^3 d^4 being mounted on shafts d^9 d^{10} having bearings in brackets d^{12} d^{13} attached to the upright b^7 at the opposite end of the apparatus.

The sprocket wheels and link chains are driven from a main shaft d^{15} having bearings in the brackets d^6 and provided as shown in Fig. 2 with pinions d^{16} d^{17} in mesh with gears d^{18} d^{19} on the sprocket wheel shafts d^4, the shaft d^{15} being also provided with a driving pulley d^{20} adapted to be belted to any suitable driving mechanism and not herein shown. The pulley d^{20} and its shaft d^{15} are preferably driven so as to cause the endless link chains a^4 a^5 to travel in the direction indicated by arrow 20, Fig. 1, which carry the magnetic separators through the pulp or other material in the trough A in the direction of arrow 20. As the magnetic separator travels through the trough in the direction of arrow 20, it is magnetized by the current from the dynamo b^{22}, by reason of its winding or coil a^3 being included in circuit with the said dynamo, which as above described is effected by the brush c^2 making contact with the track b^{10}. This circuit may be traced in Fig. 2 as follows,—viz:—from the positive brush of the dynamo by wire b^{21} to a bracket b^{14}, thence by the track b^{10}, brush c^2, to conducting band or ring c', thence by the brush c^4, arm c^5, end 2 of the coil or winding a^3 of the compound magnet, through said coil to the eyebolt a^9 to which the end 3 of the said coil is connected, thence by the rod a^8, guide wheel b', track b^{12}, bracket b^{15} and wire b^{23} to the negative brush of the dynamo. I prefer to connect the metal portions of the driving mechanism with the return wire to the dynamo, which may be accomplished by connecting the bracket d^6 on the right hand side of the apparatus (viewing Fig. 2) with the wire b^{23} by the wire b^{30}, so that in case the conducting wheel b' should become accidentally insulated from its track b^{12}, the circuit of the dynamo may remain complete, through the sprocket wheels or chains, bracket d^6 and wires b^{30} b^{23} to the negative brush of the

dynamo. The circuit through the winding coil of the compound magnet remains complete while the said magnet is being carried from one end of the apparatus to the other through the pulp in the trough A, and during its passage therethrough, the poles of the electro-magnet attract any particles of iron, which may be in the pulp. These iron particles adhere to the poles of the magnet until the latter is removed from the pulp, and for the best results, until the traveling carrier has passed over the sprocket wheel d^3, at which time I prefer to interrupt the electric circuit and thereby destroy in the main the magnetic attraction of the compound magnet, which is accomplished in the apparatus shown in Figs. 1 and 2 by omitting the tracks b^{10} b^{12} from the upper portion of the framework.

By reason of the compound magnet being pivotally supported by its carrier, the said magnet hangs substantially perpendicular during the travel of the said carrier, and especially during the time the magnet is out of the pulp, which permits of easy dislodgment of the particles adhering to the poles of the magnet. These particles may and preferably will be removed by hydraulic means, such as fine streams or jets of water played upon the poles of the magnet while the latter is suspended above and out of the trough as represented in Fig. 1. The water streams or jets may be formed by fine openings or perforations e in a water supply pipe e' extended across the apparatus above the trough A, and the particles thus detached, may be washed into a suitable pan or receptacle e^2, located between the sides of the frame-work and supported upon cross pieces e^3 e^4 (see Fig. 1), secured to or forming part of the frame-work.

The wash pan e^2 may be provided with a suitable discharge or outlet pipe e^6 herein-shown as located in its side and adapted to discharge into a waste pipe e^7 located on the outside of the vat or trough A. I may prefer to employ the compound magnet shown in Figs. 1 to 5 inclusive, and also the form of endless carrier therein shown, but I do not desire to limit my invention in this respect, as the said electro-magnet and its carrier may be made in other forms.

Referring to Figs. 6, 7 and 8, I have shown a modified form of apparatus in which the traveling carrier is shown as consisting of two spider-like frames $f\,f'$, each frame consisting of a hub provided with a plurality of radial arms, and the arms of the said spider-like frames support in suitable bearings, bars f^2 carrying electro-magnets f^3. The electro-magnets f^3 may be secured to the bar f^2 in any suitable manner and represented in Fig. 8 as having their cores or poles provided with a screw-threaded end f^4 to enter suitable threaded sockets in the bar f^2, which is preferably made of brass or other non-magnetic material. The bar f^2 is represented in Figs. 6 and 8 as substantially yoke-shaped and is provided with journals f^5 f^6, having bearings in the arms of the frames $f\,f'$. The journal f^6 is represented as made hollow and has extended through it a conducting rod f^7 separated from the frame and from the bar f^2 by insulating material f^8, and projecting beyond the arm of the spider-like frame f', for a purpose as will be described.

The spider-like frames $f\,f'$ may be firmly secured together by tie bars f^9 provided on the outside of the frame with nuts f^{10}. The spider-like frames when coupled together constitute the traveling carrier for the electro-magnets f^3 and is rotatably supported upon a suitable frame-work shown as two uprights f^{12} f^{13}, secured to an open frame-work comprising side pieces f^{14} f^{15} (see Fig. 7) and end pieces f^{16} f^{17} (see Fig. 6) below which is located a vat A' preferably of the shape represented in Fig. 6, it having a concaved portion f^{20} preferably provided with transverse ribs or riffles f^{21}, which concavity permits of a substantially deep body of pulp to be assembled and through which the electro-magnets f^3 constituting the magnetic separator, are carried by the traveling carrier.

In the constructions shown in Figs. 6 to 8 inclusive, the side frame f' is provided with a journal g supported in the upright f^{13} and provided as shown with a driving pulley g'. The side frame f is represented as mounted upon a substantially large pipe, tube or sleeve g^2 extended through the upright f^{12} and through a suitable opening or hole in the frame f, the said tube or sleeve being represented in Fig. 7 as fastened to the upright f^{12} by a screw g^3. The tube or sleeve g^2 has secured to or forming part of it a trough-like receptacle g^4 extended substantially across the apparatus to the side frame f', and in the present construction, the receptacle g^4 is represented as a separate piece from the tube g^2 and may be soldered or otherwise secured to the said tube. The tube g^2 has preferably extended through it and across the apparatus substantially in the center of the trough g^4, a water discharge pipe g^5 having perforations g^6 which project sprays or streams of water upward and onto the pole of the electro-magnets f^3 secured to the bar f^2, which is vertically above the said trough. The water supply pipe g^5 may be connected to a suitable source of supply.

The journal g of the side frame f' has mounted upon it a disk g^{60} of conducting material, which is electrically separated from the journal g and from the side frame f' by a sleeve g' of insulating material, and the said disk is designed in practice, to be electrically connected as will be described to a disk g^8 fastened to the rod f^7 carried by each bar f^2.

The electrical connection referred to, between the disk g^6 and the disk g^8 on each of the arms of the side frame f', may be effected as represented in Figs. 7 and 8, by connecting the disk g^{60} by a wire $g^\times$ to a contact spring

or brush g^{10} secured to but insulated from each arm of the side frame f'. The disk g^8 is preferably notched or cut away on its periphery, as at g^{12} (see Fig. 6) to permit the circuit to be interrupted between the contact brush g^{10} and the disk g^8, when the latter is in a substantially vertical plane with the trough g^4, so that the electro-magnets f^3 carried by the bar f^2 may be demagnetized to permit the particles adhering to it, to be readily and easily detached from the cores of the said electro-magnet by the sprays or jets of water as represented in Fig. 6. The contact brush g^{10} normally engages the periphery of the disk g^8, and after the circuit of the electro-magnet has been interrupted as described, the disk g^8 is again brought into contact with its co-operating brush g^{10} when the traveling carrier moves in the direction indicated by arrow 30, Fig. 6, to again cause the magnets to be immersed in the pulp contained in or flowed through the vat or trough A'. The disk g^{60} on the shaft or journal g may be connected by the brush g^{15} to one wire of the circuit, which wire may be supposed to be the wire b^{21} connected to the positive brush of the dynamo b^{22} shown in Fig. 2, the other wire b^{23} from the dynamo being grounded or connected to the upright f^{13}, which is electrically connected with the frame f' by the journal g, and the said frame is electrically connected with the side frame f through the magnet supporting bars f^2, so that the frame-work of the apparatus shown in Figs. 6 to 8, inclusive, constitutes one side of the line or circuit wire, and the disk g^8, brush g^{10}, disk g^{60} and the brush g^{15} form part of the other side or line of the said circuit.

The carriers for the magnetic separators are herein-described as movable continuously in one direction, but I do not desire to limit my invention in this respect, as it is evident the said carriers may be given a reciprocating movement.

I claim—

1. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier or support, and a magnet pivotally attached to said carrier and a receptacle through which the said magnet is passed, substantially as described.

2. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier or support, an electro-magnet provided with a series of cores or legs and pivotally attached to the said carrier, and hydraulic means for acting upon the said legs, substantially as described.

3. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier, an electro-magnet pivotally supported therefrom above its center of gravity, whereby the said magnet is maintained in a substantially perpendicular position during the travel of the said carrier, a receptacle for the material to be freed from magnetic particles and means to connect the said electro-magnet in circuit when in its lowered position and passing through said receptacle, and means to disconnect the said electro-magnet when in its elevated position out of the said receptacle, substantially as described.

4. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier, a plurality of electro-magnets pivotally secured thereto, a water discharge pipe located within the movable carrier to act on an electro-magnet in its elevated position, and a trough or receptacle to receive the water discharged by the said pipe, substantially as described.

5. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier consisting of endless bands or chains, rods a^8 connected to the said chains to move therewith, a compound electro-magnet pivotally suspended from said rod and composed of a series of substantially horse-shoe shaped electro-magnets, each having a long and a short leg, the short leg of one electro-magnet being secured to the long leg of its contiguous or adjacent electro-magnet to stagger the long legs of the electro-magnets, substantially as described.

6. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier, an electro-magnet pivotally secured thereto and provided with a series of cores or legs staggered or alternately arranged, a receptacle for the material to be freed from magnetic particles through which the said electromagnet is carried substantially as described.

7. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier consisting of endless chains or bands a^4 a^5, rods a^8 connected therewith, a plurality of electro-magnets suspended on the said rods, conducting tracks extended in the direction of the said endless carrier, and a brush co-operating with one of the said tracks and electrically connected with the said electro-magnet, substantially as described.

8. In a magnetic separator, the combination of the following instrumentalities, viz:—a movable carrier consisting of endless chains or bands a^4 a^5, rods a^8, connected therewith, a plurality of electro-magnets suspended on the said rods, conducting tracks extended in the direction of the travel of the said endless carrier, a brush carried by the said rod but insulated therefrom and co-operating with one of the said tracks, and a guide wheel or roller mounted on the said rod and co-operating with the other of the said tracks, substantially as described.

9. In a magnetic separator, an electro-magnet provided with a back strap having depending from each side of it a plurality of poles or legs forming passageways, the said passageways between adjacent legs on one side of the back strap being substantially op-

posite the depending legs on the opposite side of the back strap to stagger the said passageways and legs, and a winding or coil upon the back strap, substantially as described.

10. In a magnetic separator for fluid pulp, a movable carrier or support and an electromagnet carried thereby and provided with a back strap having a plurality of poles or legs depending from opposite sides of the said back strap, the said poles or legs being separated to form passageways through which the pulp may pass, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HENRY CARMICHAEL.

Witnesses:
JAS. H. CHURCHILL,
J. MURPHY.