J. B. ETHERINGTON.

MAGNETIC SEPARATOR FOR ORES.

APPLICATION FILED JAN. 24, 1910.

1,006,835. **Patented Oct. 24, 1911.**

4 SHEETS—SHEET 1.

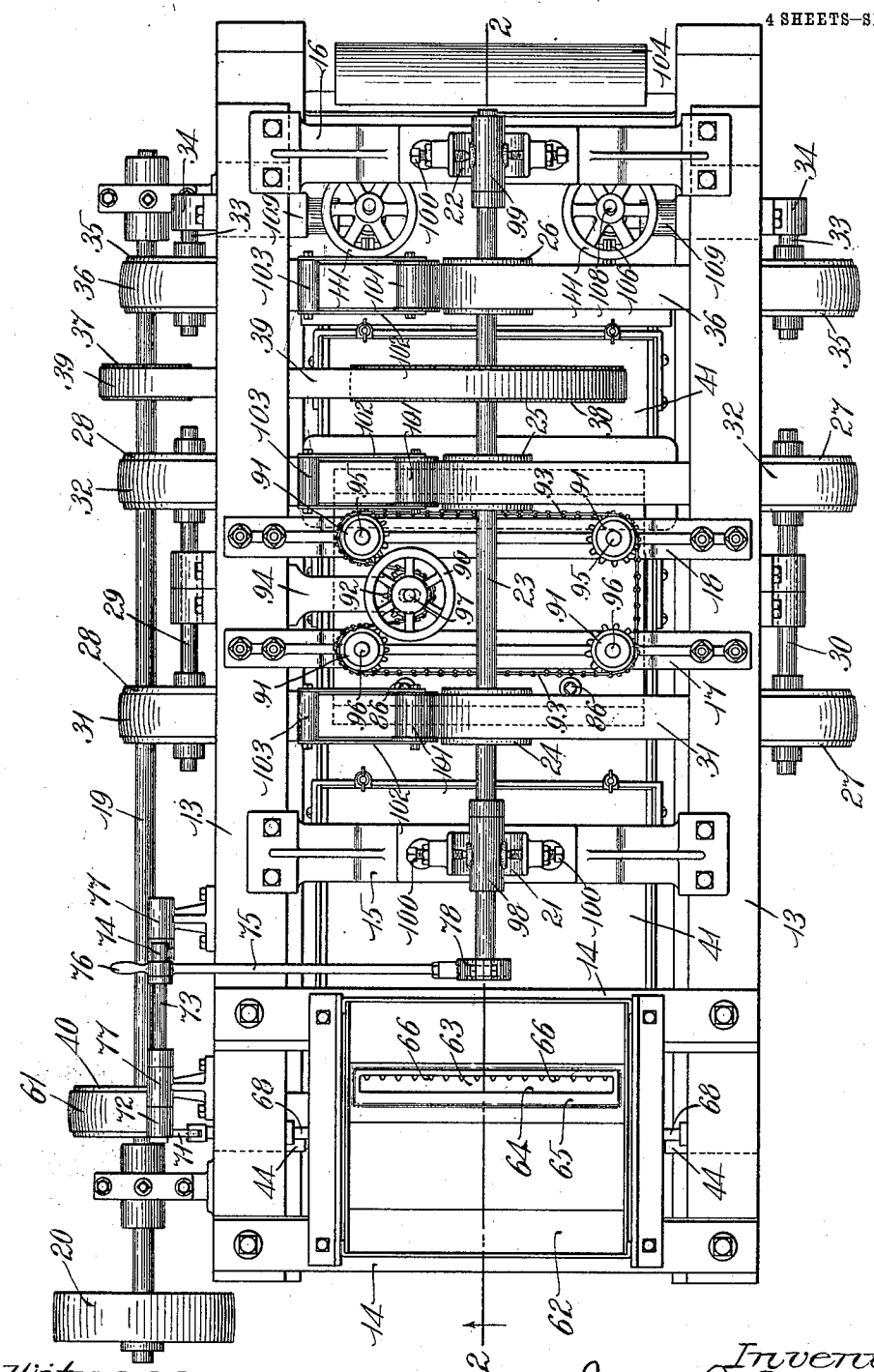


Fig. 1.

Witnesses.
K. M. Sullivan
Harold C. Haskell.

Inventor:
James B. Etherington
by Chas. F. Perkins Atty

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

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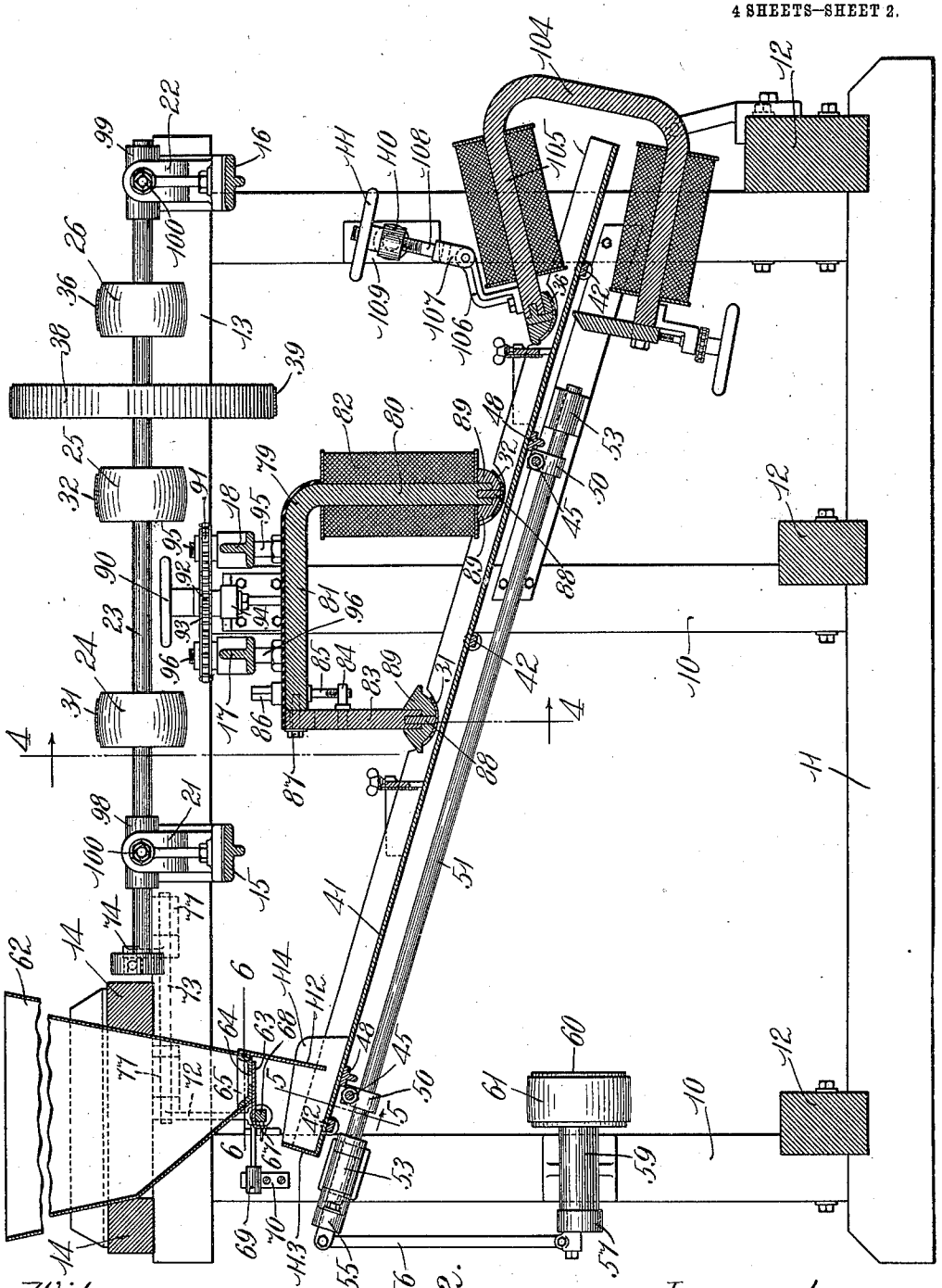
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4 SHEETS—SHEET 2.



Witnesses.
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Fig. 2.

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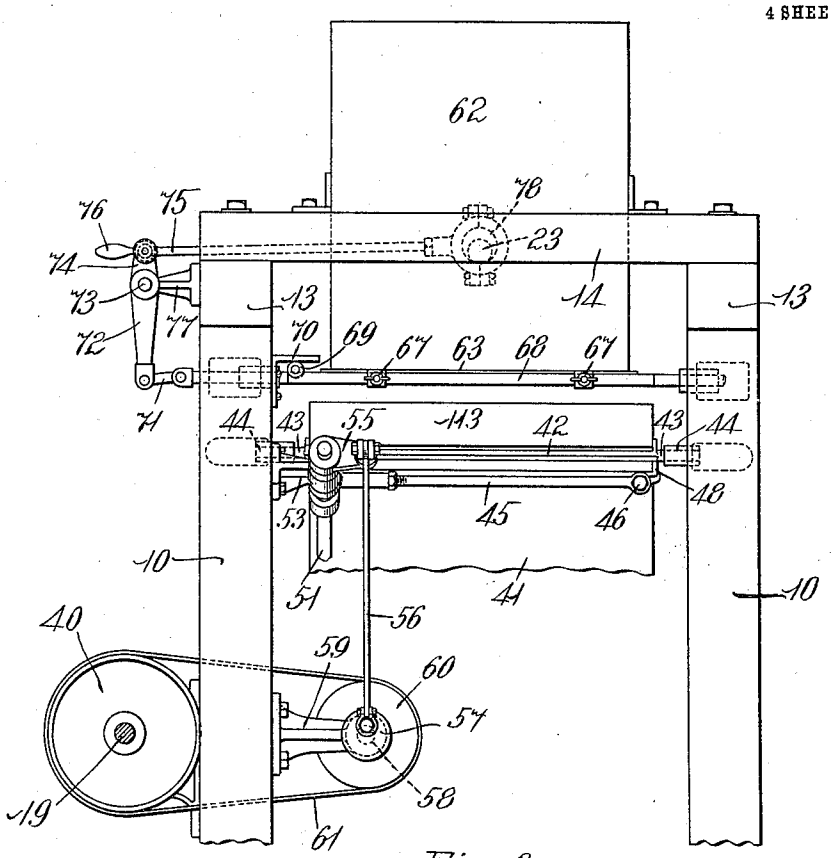
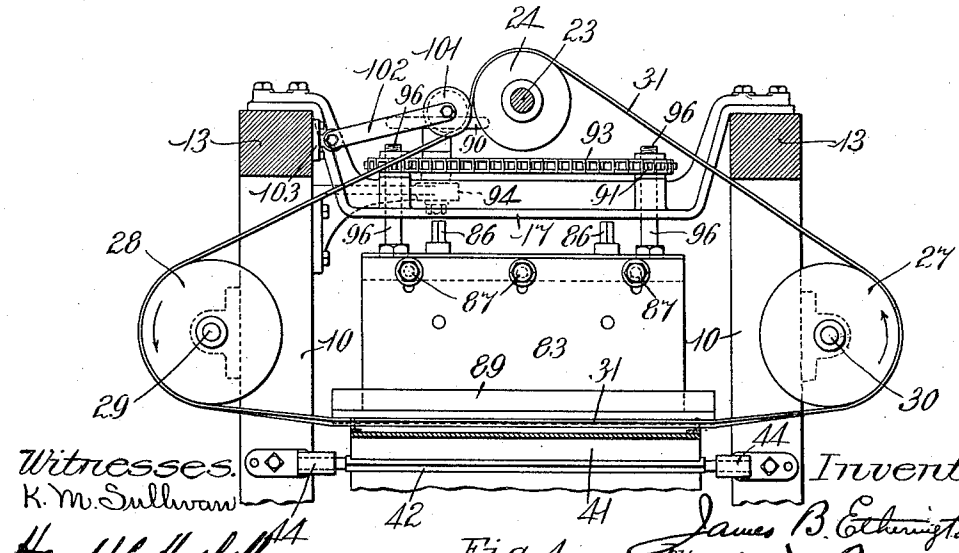


Fig. 3.



Witnesses.
K. M. Sullivan
Harold C. Haskell

Fig. 4.

Inventor:
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4 SHEETS—SHEET 4.

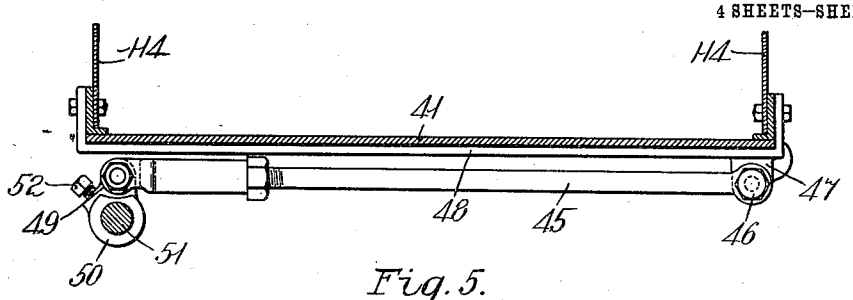


Fig. 5.

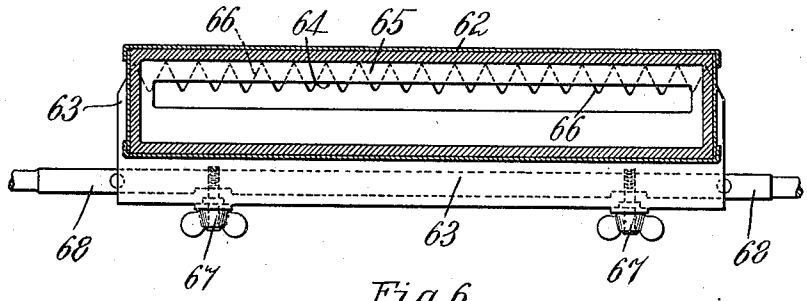


Fig. 6.

Witnesses.
K. M. Sullivan
Harold C. Haskell.

Inventor:
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by Chas. A. Perkins Atty

COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

JAMES B. ETHERINGTON, OF WINTHROP, MASSACHUSETTS, ASSIGNOR TO CAMPBELL MAGNETIC SEPARATING COMPANY, A CORPORATION OF ARIZONA TERRITORY.

MAGNETIC SEPARATOR FOR ORES.

1,006,835. Specification of Letters Patent. Patented Oct. 24, 1911.

Application filed January 24, 1910. Serial No. 539,741.

To all whom it may concern:

Be it known that I, JAMES B. ETHERINGTON, a citizen of the United States, residing at Winthrop, in the county of Suffolk and State of Massachusetts, have invented new and useful Improvements in Magnetic Separators for Ores, of which the following is a specification.

My invention relates to machines for the separation of magnetic particles from ore-pulp, and its objects are to provide means for the uniform adjustment of the magnets, to effect a steady and regular movement of the table across the line of feed, and to confine the table against movement in any other direction, to furnish means for readily removing and replacing said belts, and to effect a more economical and compact arrangement of the various parts.

My invention consists in supporting the table upon a plurality of horizontal bars arranged to vibrate in guides transversely to the line of feed of the ore, and in constructing suitable shafting and connections adapted to effect said vibrations.

My invention further consists in arranging the shafting and pulleys so as to permit the ready attachment and removal of the endless ore carrying belts, and in arranging gravity actuated idler rolls to automatically take up the slack in said belts.

My invention further consists in other modifications and improvements hereinafter more specifically pointed out and claimed.

Henry F. Campbell, late of Melrose, Massachusetts, deceased, has described a complete apparatus of similar character in Letters Patent No. 770,796, dated September 27, 1904, reference to which is hereby made for a full description of the apparatus to which the invention relates, as in the drawings of my invention I have shown only such portions and modifications thereof as are necessary to illustrate the particular invention herein described and claimed.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which like numerals indicate corresponding parts throughout the several views.

Figure 1 is a plan view of my improved machine, Fig. 2 is a longitudinal section of my machine on line 2—2 of Fig. 1 looking in the direction of the arrow, the main shaft and belts not being shown. Fig. 3 is a rear elevation of a portion of my invention showing the hopper and table and mechanism for operating the same. Fig. 4 is a vertical section of the upper portion of my machine showing on line 4—4 of Fig. 2 looking in the direction of the arrow, and showing the shafting and pulleys for operating one of the ore carrying belts, together with the gravity actuated idler roll for taking up the slack of said belt. Fig. 5 is a vertical section of the table on line 5—5 of Fig. 2, looking in the direction of the arrow, and showing the counter shaft and rod for effecting the vibration of said table. Fig. 6 is a horizontal section on line 6—6 of Fig. 2, showing the feed plate and operating and supporting rod therefor.

Referring to the drawing, the main frame of the machine may be of any suitable material and appropriate construction, but in the preferred form here shown is rectangular in shape and is composed of uprights 10 supported upon the stringers 11, cross pieces 12, string-pieces 13, lateral strips 14, brackets 15, 16, 17 and 18 all being of the strongest materials and bolted together to give the entire structure great rigidity and permanence.

A shaft 19 is mounted in suitable bearings on the frame work and is provided with pulleys 20, 37 and 40, the pulley 20 being adapted to be connected by a belt to any suitable source of power.

Mounted in suitable bearings 21 and 22 and supported by the brackets 15 and 16, is a shaft 23 upon which are secured the four pulleys 24, 25, 26 and 28; the said shaft 23 being operated from the main shaft by means of the belt 39 connecting said pulleys 37 and 38. On opposite sides of the machine are the pulleys 27 and 28 mounted upon studs 30 and 29 respectively, and connected with said pulleys 24 and 25 by the ore belts 31 and 32.

Upon the studs 33 secured in brackets 34 on opposite sides of the main frame, are mounted the pulleys 35, which are connected to said pulley 26 by the lower ore belt 36. Preferably each of said pulleys 27, 28 and 35 and their attachments are located upon the main frame to permit the ore belts to pass under the pole pieces so as to minimize the friction between the same and I have

therefore shown the periphery of each of said pulleys situated at but a slight distance above the poles of the magnets.

The table or carrier 41 is supported upon the transverse rods 42 to which it is attached by rivets or other suitable means, the said rods extending beneath the table (see Figs. 3 and 4) and protruding on both sides of the same, and each end of said rods preferably terminating in the round bar 43 the better to engage in the bearings 44 secured to the uprights 10. (See Figs. 3 and 4). In my preferred form of construction I employ three of the rods 42 as may be seen from inspection of Fig. 2, the same being supported by said bearings 44 which are carried upon a plate and bolted to each of the three pairs of uprights 10. In order that the said rods may have a slight lateral movement, a narrow space is left between the faces of each of said bearings and the edge of the table. (See Fig. 4).

To effect the lateral throw or shake of the table, I preferably employ the rods 45 (see Figs. 2, 3 and 5) which are here shown as two in number and located respectively near the receiving and discharging ends thereof. One end of each of said rods is pivotally secured to one edge of the table by a bolt 46 engaging with the plate 47 integral with the U-shaped casting 48 which extends beneath the table and is firmly bolted to each side of the same. The opposite end of each of said rods is connected with a crank 49 upon the collar 50 which is mounted upon the counter shaft 51 and secured thereon by the binding screw 52. (See Fig. 5.) The shaft 51 is mounted beneath one edge of the table in suitable bearings 53, 53 secured in any desired manner to the frame work, and carrying at the end thereof, the lever 55 normally extending in a horizontal direction. A rod 56 serves to connect the lever 55 with a crank 57 upon the end of the shaft 58 which is journaled in the bearing 59 secured by suitable means to the upright 10. (See Figs. 2 and 3.) The shaft 58 is driven by a pulley 60 mounted thereon and connected to the pulley 40 on the main shaft 19 by the belt 61.

Above the upper end of the table is the receiving hopper 62 having a V-shaped bottom and suitably supported by the frame work as shown, said hopper discharging directly upon the table below. At the mouth of said hopper is a narrow opening 64 extending from one side of the hopper to the other, and being formed in a casting 65 secured within the lower portion of said hopper. Directly beneath the opening 64 and in close contact with said casting is a flat metallic plate 63, supported on and secured to the rod 68 and having at the edge thereof the angular reëntrant openings 66 through which the ore passes, and which may be varied in size by means of the adjusting screws 67 which permit the plate 63 to be moved to the desired position. (See Fig. 6.) To effect said adjustment the heads of the screws 67 are permanently mounted in a downwardly extending flange of the plate 63, the body of said screws passing through suitable openings in the same and engaging with threaded openings in the supporting rod 68. A transverse movement of the discharge plate 63 is effected by mounting the ends of the rod 68 which project on each side of the hopper in bearings similar to bearings 44 sustaining the rods 42, and allowing for adequate play thereof. Secured to rod 68 near one end of the same is the small roller 69 extending in a direction parallel to said plate 63 and engaging with the arm of a bracket 70 attached to the upright 10. (See Fig. 3.) The purpose of said roller and bracket is to steady the discharge plate 63 and maintain its close relation with the mouth of the hopper. The said end of said rod 68 is further extended through the bearing therefor and engages with the link 71 which is connected with the lever 72 splined to the counter shaft 73, said shaft being journaled in the bearings 77 suitably secured to the frame work of the machine and carrying thereon the upwardly extending arm 74. Resting upon the top of said arm 74 and detachably connected therewith is the rod 75, having the handle 76 for lifting the same from engagement with the arm 74, and being operated by the eccentric 78 on the shaft 23.

The construction of the magnet above the table is as follows:—The core 79 shown here bent substantially at right angles at about the middle portion thereof is secured by its horizontal upper arm to the lower ends of the adjusting screws 95 and 96. The lower arm of said core 79 is wound by the coil 82 and terminates in the removable pole piece 88 protected on each side by the wooden guards 89. The said pole piece is secured to the end of the core by being received and held in a recess therein, binding screws (not shown) being employed to retain said pole piece in proper position. (See Fig. 2.) The guards 89 are preferably constructed of wood, but may be of any other suitable diamagnetic material. They are preferably so formed and disposed as to completely cover the sides of said pole piece and the joint between the same and the core of the magnet, thereby preventing the attracted particles of the ore from attaching themselves to any portion of the end of the magnet except to the exposed surface of the pole piece directly above the table. The upper arm of said core at the end thereof is secured by bolts or screws to the vertical plate 83 terminating in a removable pole piece and guards similar to the other arm of the core. The said plate

83 is made further adjustable to and from the table by means of adjusting screw 86 engaging at its lower end 85 with the screw threaded opening in the ears 84 secured to said plate, the openings provided for screws 87 in said plate being of sufficient vertical extension as to permit this to be done. The vertical adjustment of both pole pieces with relation to the table is brought about by means of the adjusting screws 95 and 96 which are mounted in the brackets 17 and 18, and which bear at their upper ends the sprocket wheels 91, 91 connected by an endless chain 93 to the sprocket wheel 92 on the pin 97 mounted in the bracket 94 and carrying the hand wheel 90. By turning the said hand wheel all the sprockets are simultaneously affected, and a uniform and even adjustment of the pole to or from the table at once secured. By extending the core of the magnet in the manner described, I am enabled to dispense with the coil winding formerly required for the upper magnet, and I have discovered in practice that the magnetic field of the pole of the upper arm though somewhat weaker than that of the lower arm is nevertheless ample for the purposes of the machine, it being desirable as set forth in said prior Letters Patent to Campbell to have the ore subjected to a gradually increasing magnetic field as the same proceeds down the table.

To insure the ready installation and removal of the ore belts the pulleys 27, 28 and 35 are arranged to be at the extremities of the axles and studs bearing the same as may readily be seen by inspection of Fig. 1. Furthermore the bearings 21 and 22 are provided with covers 98 and 99 normally secured in position by the binding screws 100, and constructed to be easily and quickly removed when desired. It has been my experience in using the Campbell apparatus above referred to that the arrangement is such that the only way in which an endless ore belt could be removed therefrom is by cutting off the same, and to install a belt upon said apparatus it is necessary to measure off the exact length of strap and then to stitch the two ends together to form the belt,—a proceeding requiring some time and labor and necessitating the stoppage of the machine during a prolonged interval. In my machine, however, to remove or install a belt, it is only required to take off the covers 98 and 99 when either end of the shaft 23 may be raised, and any or all of the belts be removed and replaced without difficulty. Thus I am enabled through the improved arrangement of parts above described, to dispense with the cutting free of the old and worn out ore belts and with the necessity of stitching the ends of the strap together to form new belts when the old belts are replaced. In the practical use of my machine I keep a number of endless ore belts on hand, and am able to replace old belts in an exceedingly short interval of time, not necessitating stopping the machine more than a small fraction of the time required for such replacement in the old Campbell apparatus. To take up the slack of said ore belts when in use I prefer to employ the gravity actuated idler rolls 101, each of which is secured to one end of an arm 102, the opposite end being pivoted to a bracket 103 affixed to the string-piece 13. (See Fig. 4.)

At the lower end of the table and practically inclosing the same is the horse-shoe magnet 104 which is constructed and supported except as hereinafter stated, in a manner similar to the horse-shoe magnet shown in the specification and drawings of Letters Patent to Campbell aforesaid, to which reference is hereby made for a more particular description of said magnet. In my invention, however, I prefer to employ different means of adjustable support for the upper arm of said horse-shoe magnet than that shown by Campbell. At each end of said arm 105, I secure a narrow angle iron 106 which is pivoted at its upper end to a holder 107 firmly secured to the head of the adjusting screw 108. Upon a bracket 109 secured to the upright 10 is pivotally mounted the collar 110, through which passes the threaded end of said screw 108 which engages with the screw threaded opening of a hand wheel 111. By constructing said support with the pivotal points described, and by employing two of said supports each at the edge of said magnet, I am enabled to make a much more accurate adjustment than heretofore, the supporting arm of Campbell not having any pivotal points or double means of adjustment and requiring the upper and lower arms of the magnet to be hinged in order to secure its effective operation.

In constructing my improved hopper I prefer to employ a metallic curtain or guard 112, the upper edge of which is secured to the base of the hopper, and which serves to prevent the ore particles from scattering or flying and permits the same to be guided to the upper portion of the table. In conjunction with said curtain 112, I also prefer to use guard 113 which is secured to the upper end of said table and has walls 114 extending upwardly therefrom the better to catch and distribute the ore.

The operation of my improved machine is similar to that of the Campbell apparatus above referred to. The ore either pulverized or in otherwise suitable condition is introduced into the hopper 62 and falls therefrom upon the head of the table 41. The amount of ore falling from said hopper is regulated by the size of the openings left

between the edge of the plate 64 and the edge of the hopper and the said ore being governed in its discharge by the movement of said plate 63 crossing the mouth of the hopper. The ore falling upon the top of the table is agitated by the movement of the table from side to side produced by the rocking motion of the shaft 54 imparted to the table by the rod 45. The effect of such agitation is to cause the ore to be shaken down the table and to be removed in the manner and form described in the said Campbell machine.

While I have above set forth specifically my various improvements upon said Campbell machine I by no means desire to limit myself to the precise device shown since it is obvious that changes and modifications could be made and improvements made without departing from the object of my invention.

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

1. In a magnetic separating machine, a frame, magnets and pulley studs secured to said frame, means for carrying ore through the fields of said magnets, pulleys carrying the ore belts and mounted upon said studs, a shaft readily removable from one of its bearings, and having a plurality of pulleys mounted thereon and adapted to drive the ore belts, said shaft extending longitudinally of said frame and while in operative position obstructing a free passage to the introduction and removal of the ore belts, and permitting the introduction and removal of the ore belts when the end of said shaft is removed from its bearings.

2. In a magnetic separating machine, a frame, an inclined table supported thereon, a horse-shoe magnet arranged to have the core pieces terminating in its poles on opposite sides of the table, said magnet being pivotally mounted on said frame and having its said core pieces located at a fixed distance apart, combined with a device for simultaneously adjusting said poles in relation to said table consisting of arms attached to the core piece of said magnet above the table, adjusting screws pivotally attached to said arms, said screws being suitably supported upon the frame of the machine.

3. In a magnetic separating machine, a frame, an inclined table supported thereon, a horse-shoe magnet arranged to have the core pieces terminating in its poles located respectively above and below said table and at a fixed distance apart, said magnet being pivotally mounted on said frame, combined with a device for simultaneously adjusting said poles in relation to said table consisting of two arms attached to opposite sides of the core piece above the table, adjusting screws pivotally secured to said arms, two collars each pivotally mounted upon said frame at the sides thereof and supporting said adjusting screws.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses, this seventh day of January 1910.

JAMES B. ETHERINGTON.

Witnesses:
ELMER L. BRIGGS,
A. G. SULLIVAN.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."