A. F. JOBKE.

MAGNETIC ORE SEPARATOR.

APPLICATION FILED FEB. 9, 1911.

1,157,543. Patented Oct. 19, 1915.

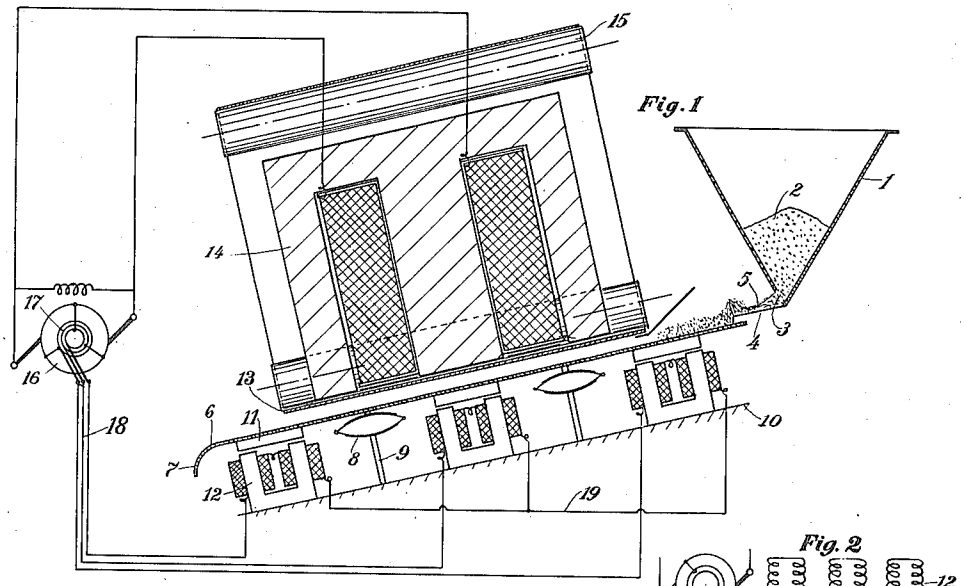



Fig. 1

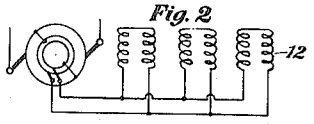



Fig. 2

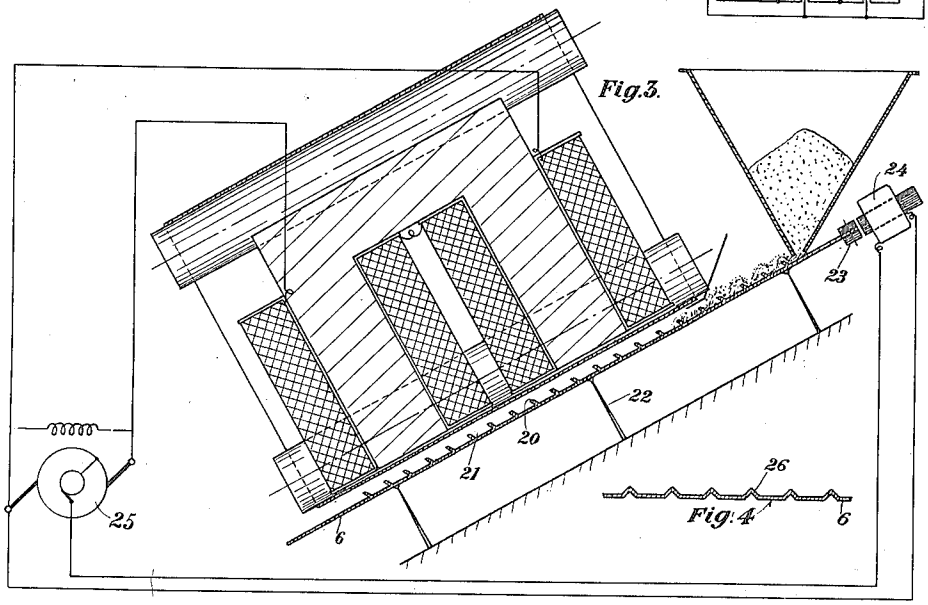



Fig. 3.




Fig. 4

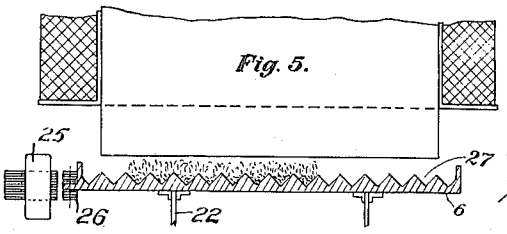



Fig. 5.

WITNESSES

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# UNITED STATES PATENT OFFICE.

AUGUST F. JOBKE, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO JOHN G. BURNS, DANIEL BINGHAM, KATHERINE CRUMAY, THOMAS HIGGINS, AND H. P. GAZZAM, ALL OF PITTSBURGH, PENNSYLVANIA.

## MAGNETIC ORE-SEPARATOR.

1,157,543. Specification of Letters Patent. Patented Oct. 19, 1915.

Application filed February 9, 1911. Serial No. 607,513.

*To all whom it may concern:*

Be it known that I, AUGUST F. JOBKE, a citizen of the United States of America, residing at Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Magnetic Ore-Separators, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to magnetic ore separators, and the object of the invention is the provision of positive and reliable means, in a manner as will be hereinafter set forth, for agitating, disintegrating and disseminating ore as it is fed by gravity into and beyond a magnetic field, whereby small particles, that would not otherwise be exposed, will be exposed and subjected to the action of the magnetic field.

Another object of the invention is to provide electrical means for feeding ore into a magnetic field by gravity and subjecting the gravity fed ore to an undulatory movement that causes the ore to be thoroughly agitated so as to expose such particles that are subjectable to a magnetic field, thereby allowing the magnetic field to attract such particles as would be covered and escape the magnetic field if the ore was simply carried through the field without being agitated.

I am aware that the feeding of ore by gravity into a magnetic separator is old, but has proved a failure on account of the ore taking a high velocity which prevents the magnets of the separator from attracting small particles, thereby rendering the component of magnetism so small in proportion to the gravity component that many particles escape that should be attracted and collected by the magnets. In my invention, I have devised a third component produced by vibratory and reciprocatory movements that immediately place small particles of ore into the magnetic field, thereby causing all small particles passing through the magnetic field to be at one time or another subjected to magnetic influences.

It is a well known fact that to impart a vibratory movement to a body through the medium of an electrical device considerable power is required, particularly to raise the vibrations to the necessary amplitude to obtain the desired result in connection with my invention, therefore I have devised mechanical means to impart to the body a natural frequency equal to the given frequency of the electrical device, and in this manner a resonating electrical and mechanical system is provided that requires a minimum degree of energy for overcoming losses of friction of air and ore particles.

The invention will be better understood when reference is had to the drawing and the detail description thereof. In the drawing I have illustrated the preferred embodiments of the invention, but it is to be understood that the structural elements thereof are susceptible to such changes and modifications as fall within the scope of the appended claims.

In the drawing:—Figure 1 is a diagrammatic longitudinal sectional view of a separator constructed in accordance with this invention, Fig. 2 is a diagrammatic view of a modified form of actuating means, Fig. 3 is a diagrammatic longitudinal sectional view of a modified form of separator, showing a reciprocatory gravity conveyer, Fig. 4 is a detail sectional view of a modified form of conveyer, and Fig. 5 is a transverse sectional view of another modified form of conveyer.

The reference numeral 1 denotes a hopper of a conventional form adapted to contain ore 2 fed by gravity through the open end 3 of said hopper, the open end 3 giving free passage to the ore, which will pass on to an inclined metallic plate 4, the ore being prevented from flowing over this plate after a heaping bevel or pile is established at the end of said plate.

6 denotes an inclined conveyer having the upper end thereof beneath the lower end of the plate 4 and the lower end thereof curved, as at 7 to discharge the non-magnetic ore from the separator. The inclined conveyer 6 has the under side thereof connected to a plurality of elliptical springs 8, carried by suitable supports 9 erected upon a foundation 10, said leaf springs yieldably supporting the conveyer and producing an undulatory or vibrating movement of the same, as will hereinafter appear.

Fixed to the under side of the conveyer 6 at suitable points are armatures 11 of electro-magnets 12 mounted upon the foundation 10.

Located above the conveyer 6 is a trans-

verse movable collecting apron 13 and an electro-magnet 14, the apron 13 being designed and movably mounted upon rollers 15 whereby magnetic particles attracted by the electro-magnet 14 will be conveyed to a suitable receptacle.

As a source of power in connection with the electro-magnets 14 and 12, I have shown a generator 16 and this generator can be conveniently used when no other alternating current is available by providing the generator with small collecting rings 17 which are connected to the armature winding, similar to a rotary converter. The rings 17 are connected at three equidistant points in the armature and therefore deliver a three-phase current to the three electro-magnets 12. It will be noted that a wire 18 is connected to one pole of each electro-magnet and the other poles connected by a wire 19, thereby producing an excitation for the electro-magnets which imparts alternately to said magnets the maximum peak of pull, thus causing the conveyer 6 to vibrate in an undulatory manner.

In case two collecting rings are used, as shown in Fig. 2, which are connected to opposite points of the armature winding, the electro-magnets are simply connected in parallel or in series to insure an even torque, thereby simply causing the conveyer 6 to vibrate in a vertical plane.

In Fig. 3 of the drawing there is illustrated a modification of the invention, wherein the conveyer 6 is placed at a greater inclination and in order to prevent the ore from rapidly sliding over the same, the conveyer is provided with transversely arranged and angularly disposed ribs 20, these ribs providing transverse pockets 21, and when the conveyer 6 is shifted the ore within the pockets is elevated and discharged at an angle to enter the next lowermost pocket and eventually be discharged from the lower end of the conveyer. It is during the transfer of the ore from one pocket to the other that the fine particles of ore are suspended or thrown into the magnetic field and can be separated from the non-magnetic material. In this instance, vertical springs 22 are employed for supporting the conveyer 6 in a manner that said conveyer can be shifted, and to shift said conveyer, the upper end of said conveyer is provided with an armature 23 in connection with an electro-magnet 24, said electro-magnet being in circuit with a generator 25 having a single collector ring. When the electro-magnet 24 is energized, a reciprocatory movement is imparted to the conveyer 6 and as the ore is automatically fed to the conveyer from the hopper 1 (the plate 4 being dispensed with in this instance), the ore will be gradually shifted downwardly upon the conveyer into and through the magnetic field.

Various means can be employed for retarding the ore upon the conveyer 6 in lieu of the ribs 20, therefore in Figs. 4 and 5 of the drawing the conveyer in the first instance is provided with inverted V-shaped ribs 26, while in the latter instance the conveyer has V-shaped longitudinal pockets 27, the walls of which have a tendency to throw the ore upwardly when an oscillatory movement is imparted to the conveyer supported upon the upper ends of the springs 22. The oscillatory movement is imparted to the conveyer through the medium of an electro-magnet $25^a$ located at one side thereof and adapted to attract an armature $26^a$, carried by the edge of the conveyer. The ore is sufficiently agitated to liberate magnetic particles, the particles being placed in a field that is more conducive to their attraction than if said particles were at rest.

In the operation of the separator, reference being had to Fig. 1 of the drawing, the hopper 1 constitutes an important factor, particularly the plate 4 in connection with said hopper, as the supply of ore 5 upon the plate 4 constitutes automatic means for shutting off a supply of ore in the cessation in the operation of the separator. It is obvious that when the electrical devices are placed out of operation that the ore remaining upon the conveyer 6 will retain the heap of ore 5 and consequently the flow of ore will be retarded until the separator is again placed in operation.

A conductive plate can be selected for the conveyer 6 and when placed in the field of an alternating current electro-magnet, currents are produced which will have a tendency to move the plate out of the stronger field, and as vibrations can be produced in this manner, it is not essential that the armatures 11 be utilized, however, it is preferable to have the pure magnetic action, as this application requires less power on account of its perfect action and prevents any action of alternating currents upon the ore particles.

As will be seen, each of the devices shown in the drawings operates to throw the material away from the carrier in a direction opposing that of gravity. As the surface of the conveyer has its general direction of length inclined, the particular movements of the conveyer act to cause the direction of movement of the particles to be at substantial right angles to the direction of length of the conveyer; consequently the particles on their return movement to the conveyer after being thrown will drop on to a different part of the surface, the opposite movements of the particles being first at an angle to the vertical, followed by the movement in a vertical direction. This is provided in Fig. 1 by reason of the movement of the conveyer in directions at substantial right

angles to the direction of length of the conveyer, the inclination of the surface being such as to cause the material not to travel freely over the surface of its own accord due to gravitation; in the construction of the remaining figures, this action is due to the particular configuration of the surface, together with the movements of the conveyer through the means shown and described. However, the feature above indicated is but one of the particular features which produce the desired results, the rapidity of movements of the conveyer forming one of the essentials of an apparatus for my purpose, rather than the length of the throw of the material, the general idea being to cause the particles to be moved in the direction of the separating magnet and so agitated as to practically provide a surety that all particles will be exposed to the action of the magnet during the travel over the conveyer.

By the use of the actuating means indicated, viz., the movement of the conveyer in one direction under the action of magnetic attraction, the opposing movement being provided by resilient means placed under tension by the movement produced by the magnets, the rapidity in number of movements is increased to an extent to provide for maximum operation, and at the same time the action is such as to greatly eliminate noise, etc., in operation.

To produce the desired result, the rapidity of the pulsations is such as to practically maintain the fed material in action, although the inclination is such as to substantially prevent movement unaided by the pulsating action. As heretofore pointed out, the means for this purpose disclosed in the drawings is the electrical mechanism which produces a comparatively high frequency of operation, being in excess of five pulsations per second of time, a frequency which exceeds any that is provided by mechanical structures, so far as known to me.

I desire to call attention to the fact that magnetic ore particles that could be freely suspended in the air with no other force to influence them but that of a strong magnet will be the most susceptible to the influence of the magnets and this is only accomplished at the moment when the particles are thrown upwardly and reach a limit where they will be at rest for an instant, the velocity being zero. When this point of rest is located close to the pole of an electromagnet, the smallest magnetic force possible will attract the particles. This is particularly true in connection with the modifications shown in Figs. 3 to 5 inclusive where the particles are caused to reach a point of rest easily influenced by a magnet.

What I claim is:—

1. Means for feeding material into a separating gap comprising an inclined conveyer surface adapted to receive the material from a source of supply, and means for moving said surface to cause the material to be intermittently thrown in directions perpendicular to the plane of such surface, whereby the material will be caused to travel lengthwise of the conveyer, said means including electro-magnetic mechanism for providing rapid pulsations to the conveyer by magnetic attraction.

2. Means for feeding material into a separating gap, comprising an inclined conveyer adapted to receive the material from a source of supply, and means for providing rapid pulsations of relatively short length to the conveyer by magnetic attraction in directions at right angles to the direction of length of the conveyer to cause the material to travel lengthwise of the conveyer and be intermittently thrown into the space above the surface of the conveyer.

3. Means for feeding material into a separating gap, comprising an inclined conveyer adapted to receive the material from a source of supply, and means for providing rapid pulsations of relatively short length to the conveyer in directions at right angles to the direction of length of the conveyer to cause the material to travel lengthwise of the conveyer and be intermittently thrown into the space above the surface of the conveyer, said means including an electromagnet adapted to move the conveyer in one direction by magnetic attraction.

4. Means for feeding material into a separating gap, comprising an inclined conveyer adapted to receive the material from a source of supply, and means for providing rapid pulsations of short length to the conveyer, in directions to cause the material to be thrown therefrom in a direction perpendicular to the plane of the conveyer surface and opposing gravity, the return movement of the material under the action of gravity placing it in an advanced position with respect to the direction of length of the conveyer.

5. Means for feeding material into a separating gap, comprising an inclined conveyer adapted to receive the material from a source of supply, and means for providing rapid pulsations of short length to the conveyer, in directions to cause the material to be thrown therefrom in a direction perpendicular to the plane of the conveyer surface and opposing gravity, the returning movement of the material under action of gravity placing it in an advanced position with respect to the direction of length of the conveyer, said means including an electromagnet adapted to move the conveyer in one direction by magnetic attraction.

6. In means for feeding material into a separating gap with a substantially uniform thickness of material and in combina-

tion, a material-receiving plate adapted to receive the material from a source of supply, said plate having its direction of length inclined to the horizontal in the direction of flow of the material, and means for moving said plate in a direction at substantial right angles to the direction of length of the plate to place it under tension, the opposite movement of the plate being provided by said tension, said movements being exerted in a direction to cause the material to be intermittently thrown perpendicular to the plane of the plate.

7. In means for feeding material into a separating gap with a substantially uniform thickness of material and in combination, a material-receiving plate adapted to receive the material from a source of supply, said plate having its direction of length inclined to the horizontal in the direction of flow of the material, and means for moving said plate by magnetic attraction in a direction at substantial right angles to the direction of length of the plate to place it under tension, the opposite movement of the plate being provided by such tension, said movements being exerted in a direction to cause the material to be intermittently thrown perpendicular to the plane of the plate.

8. In means for feeding material into a separating gap with a substantially uniform thickness of material and in combination, a material-receiving plate adapted to receive the material from a source of supply, said plate having its direction of length inclined to the horizontal in the direction of flow of the material, a resilient support for said plate, and means for moving said plate by magnetic attraction to place it under tension, the opposite movement of the plate being provided by said tension, both movements being in direction substantially perpendicular to the direction of length of the plate.

9. In means for feeding material into a separating gap with a substantially uniform thickness of material and in combination, a material-receiving plate adapted to receive the material from a source of supply, said plate having its direction of length inclined to the horizontal in the direction of flow of the material, an armature carried by and positioned beneath said plate, and an electromagnet adapted to coöperate with said armature to move said plate to place it under tension, the opposite movement of the plate being provided by the tension, both movements being in direction substantially perpendicular to the direction of length of the plate.

10. In means for feeding material into a separating gap with a substantially uniform thickness of material and in combination, a material-receiving plate adapted to receive the material from a source of supply, said plate having its direction of length inclined to the horizontal in the direction of flow of the material, and means for imparting movements to said plate in opposite directions, said movements being in directions substantially perpendicular to the direction of length of the plate for causing the material to be thrown therefrom in a direction opposing gravity, the return movement of the material being by gravity, the combined movements acting to advance the material in the direction of length of the plate.

In testimony whereof I affix my signature in the presence of two witnesses.

AUGUST F. JOBKE.

Witnesses:
KARL H. BUTLER,
MAX H. SROLOVITZ.