(No Model.)

C. G. BUCHANAN.

MAGNETIC ORE SEPARATOR.

No. 548,176. Patented Oct. 22, 1895.

Fig. 1.

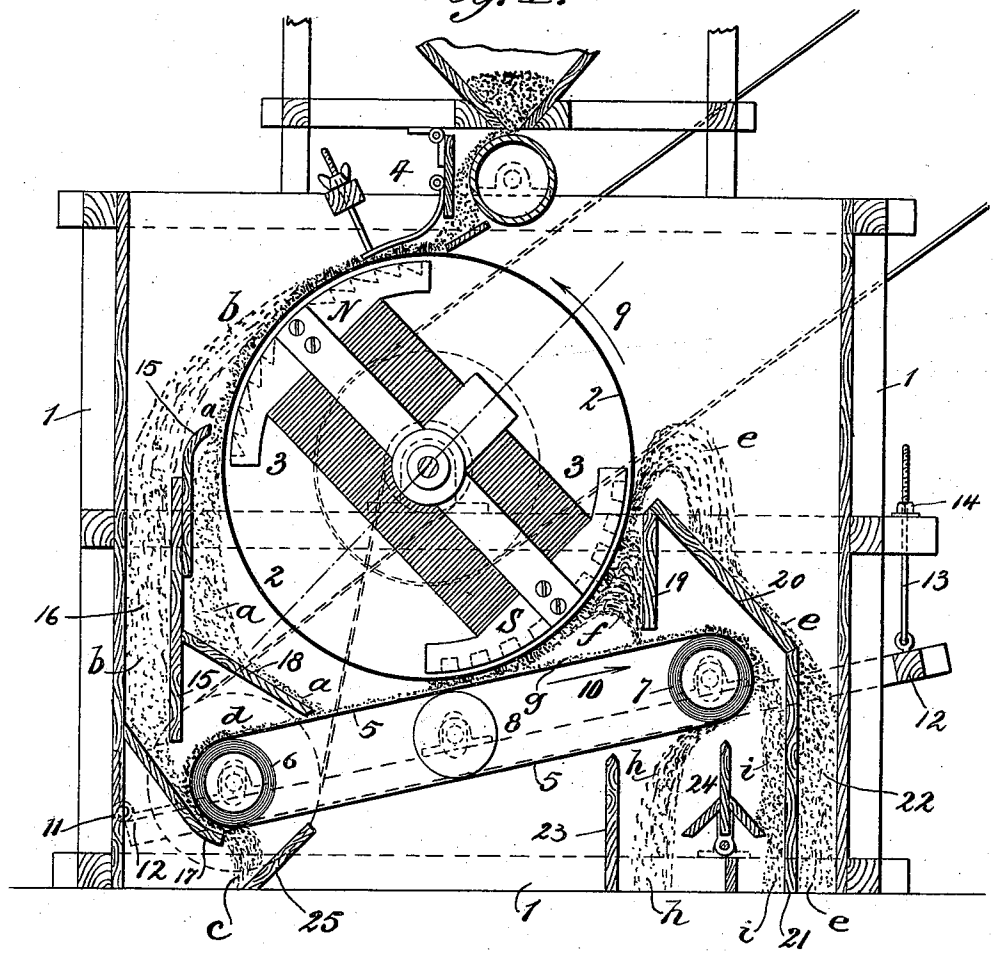
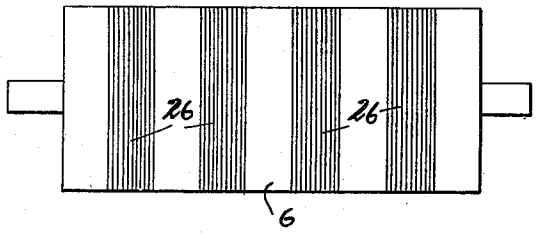


Fig. 2.



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MAGNETIC ORE-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 548,176, dated October 22, 1895.

Application filed February 13, 1895. Serial No. 538,175. (No model.)

To all whom it may concern:

Be it known that I, CHARLES G. BUCHANAN, a citizen of the United States, residing at Brooklyn, in the county of Kings and State of New York, have invented new and useful Improvements in Magnetic Ore-Separators, of which the following is a specification.

My invention relates to magnetic ore-separators of that class in which the crushed ores are fed by gravity upon a drum which rotates around relatively-stationary magnets located in its interior.

The invention has for its object to effect a closer and more satisfactory separation than has heretofore been attained in or by one machine and with but one handling of the ore required to feed it to the machine.

It has been practically demonstrated in the separation of magnetic iron from the rock which accompanies it that if the magnetic intensity of the machine through which the ore is passed is uniformly very great perfect separation cannot be accomplished, due to the fact that pure rock or tailings particles happening to come between the magnetic particles and the drum are crowded to the drum by the attraction of the magnets for the magnetites which hold them to the drum until both are carried out of the magnetic field, whereupon the magnetites or rich heads and middlings and the accompanying pure rock or tailings are dropped into the same bin or receptacle, the result being that the separated product does not contain an average of more than fifty-eight per cent. of iron. By my improvements it is possible to obtain approximately sixty-eight per cent. of magnetic iron, and by handling the ore but once to feed it through a single machine.

The invention will first be described, and then will be particularly defined in claims hereinafter set forth.

Reference is to be had to the accompanying drawings, forming part of this specification, and in which similar reference letters and numerals indicate like parts in both the views.

Figure 1 is a transverse vertical section of an ore-separator made in accordance with my invention, and Fig. 2 is a side elevation of one of the magnetic rolls over which the lower carrier-belt of the machine travels.

In carrying out my invention in the preferred manner I provide any suitable frame-work 1, in which is journaled a drum or cylinder 2. Within the drum are held in stationary relation thereto any approved form of magnets 3—one or more—whose poles face the periphery of the drum and tend to attract to it the magnetic or valuable particles of the ore. Any suitable hopper, roller, and adjustable-apron feed device (jointly represented by the numeral 4) may be employed to feed the ore in proper quantity and in a layer of suitable thickness over the adjacent face of the drum. Below the drum, and preferably having a more or less slanting or inclined position, is arranged an endless carrier-belt 5, which preferably runs over a pair of strongly-magnetic rolls 6 7 and has an intermediate support for its upper ore-carrying side on or by one or more plain or non-magnetic rollers 8, one only being shown in the drawings. Suitable belt-and-pulley gearing (indicated mainly by dotted lines in Fig. 1 of the drawings) rotates the drum in direction of the arrow 9 and moves the upper side of the carrier-belt in direction of the arrow 10.

A specially-important feature of construction and operation consists in making the carrier-belt 5 adjustable toward and from the drum 2, in order to either lessen or intensify the magnetic field at the interval of space between the drum and carrier-belt. This adjustment of the belt 5 may be effected in various ways. A preferred method consists in hinging to the main frame at 11 the auxiliary frame 12, on which the belt-carrying rollers 6 7 8 are journaled, and in sustaining the other end of this frame by one or more hangers 13, screw-threaded into nuts 14, held on the main frame 1. The side walls of the frame are slotted, as indicated by dotted lines, to allow movement of the protruding ends of the belt-roller shafts during adjustments of the belt. By manipulating the nuts the traveling carrier-belt may be adjusted and securely held in any desired or necessary relation to the rotating drum to control or regulate the intensity of the magnetic field nearest the carrier-belt relatively to the partly-separated ores conveyed by said belt.

At the side toward which the drum 2 ro-

tates is arranged a vertical partition 15 thereby forming a chute 16, at the bottom of which is an inclined apron 17, which at its preferably-curved lower part approaches quite closely to that portion of the carrier-belt 5 which travels over the magnetic roll 6. Another inclined apron 18, joined to the partition 15, extends at its lower end nearly to the carrier-belt 5, at a point a little beyond the magnetic roll 6. An upright ore-fender 19 is arranged above the carrier-belt 5 and at the opposite side of the drum and near the farthest magnetic roll 7, while an inclined apron 20, which meets the fender 19 at its upper edge, is connected at its lower edge with a vertical partition 21, said parts 20 21 being arranged mainly in rear of the roll 7 and the belt 5, traveling thereover. The partition 21 is separated from the rear side wall of the main frame to form a chute 22, and between the partition 21 and another vertical partition 23 is arranged a gate 24, which is hinged at its lower edge and at its upper edge faces the carrier-belt 5, where it passes under the magnetic roll 7. The gate 24 and a partition below it separate the middlings and the pure-rock tailings discharged from the carrier-belt next the roll 7. A slanting apron 25 facilitates discharge of pure-rock tailings next the other magnetic roll 6.

The wire 26 of the magnetic rolls 6 7 may be wound in any manner, and preferably within peripheral grooves or channels of the rolls, it only being necessary that the current induced in the rolls shall be sufficiently strong or intense to act properly upon the ore through the carrier-belt 5 as it travels around the rolls.

The continuous operation of the apparatus is as follows: The crushed ore being fed by the devices 4 upon the periphery of the rotating drum 2 flows down the face of the drum by gravity, aided by the drum's rotation, a peripheral speed of about five hundred feet per minute being imparted to the drum. As the ore is fed upon the drum at a point opposite the upper or north poles of the magnets 3, the latter exert an attractive force tending to hold the magnetites to the drum, while the centrifugal force developed by rotation of the drum tends to throw the ore particles therefrom, particularly those containing little or no magnetic particles or pure ore. These counteracting forces effect the first separation of the ore into heads *a* and tailings *b*, the latter falling over beyond or outside of the partition 15 and down the chute 16 upon the lower apron 17, where they come under the attractive influence of the magnetic roll 6 and into contact with the carrier-belt 5, running thereover. At this roll 6 a second separation is effected into tailings *c* and middlings *d*. These tailings *c* have no practical value as ore and fall past the chute-apron 25 from the machine, while the middlings *d*, separated from the mass *b* by the magnetic roll 6, are carried forward by the belt 5 past the lower edge of the inclined apron 18, where they are met by a layer or stratum of the first heads *a*, which flows down said apron upon the traveling belt. The commingled heads *a* and middlings *d* are carried forward by the belt 5 until they reach the lower central portion of the rotating drum and the attractive field of the opposite poles of the magnets 3 and at a point preferably directly over the belt-sustaining roll 8. At this point a third separation is effected into rich heads *e* and middlings *f* and less valuable tailings *g*. The heads *e* and middlings *f* are held to the drum by the magnets 3 and are carried upward together some little distance beyond the point of the third separation next the belt 5 and until the centrifugal force developed by the rotating drum overcomes the attractive influence of the magnets sufficiently to allow the less rich middlings *f* to be thrown off from the drum and against the opposing fender 19, while the rich magnetites or heads *e* will be held to the drum by the magnets until they are carried upward by the drum and out of their field, whereupon the centrifugal force again asserts itself and throws said rich heads *e* outward from the drum at a point about level with the top of the fender 19 and apron 20, and the heads are received on said apron and fall through the chute 22 to any suitable receptacle, while the middlings *f* are deflected by the fender 19 and fall upon the carrier-belt 5. A fourth separation thus is effected behind the fender 19 into the rich heads *e* and middlings *f* by the counteracting influences of magnetic and centrifugal forces.

While the heads *e* are thrown over and discharged, as above described, the middlings, after downward deflection by the fender 19, commingle with the tailings *g*, now moving forward on the belt 5 from the place of the above-named third separation and at a point behind the forward magnetic roll 7. As the commingled particles *f g* are carried over this roll by the belt 5, a fifth and final separation is effected by said roll aided by gravity, and the valuable middlings *h* drop at one side of gate 24 and may be profitably worked over by again passing them through the machine or otherwise, while the comparatively worthless tailings *i* drop at the other side of the gate and may be utilized with the other pure-rock tailings *c* in any approved manner.

It will be seen that while effecting the first separation into heads *a* and tailings *b* the attractive force of the poles N of the drum-magnets 3 is constant or invariable at any given point relatively to the ore particles passing downward over the drum; but at the other side of the drum the intensity of the field of the opposite poles S of the magnets may be varied at will at the point nearest the traveling belt 5 and where the third separation is effected by direct influence of the magnets by simply adjusting the carrier-belt nearer to

or farther from the drum by manipulating the nuts 14 of the hangers 13 or in any other approved manner should the belt be otherwise supported than by the hinges and hangers shown in the drawings. This capacity for variation of the intensity of the magnetic field next the traveling belt by adjusting the belt relatively to the periphery of the drum is important, as it allows compensations to be made for varying grades of ores, whereby the third separation directly by the magnets at the adjacent running face of the belt, and also the fourth separation into heads and middlings *e f* by the opposed influences of magnetic attraction and centrifugal force, may be regulated or controlled with nicety to assure the best results.

By inclining the ore-carrying side of the endless belt 5 out of the horizontal, and preferably upward in direction of its travel, a helpful agitation of the ore particles on the belt is obtained by gravity when the particles are out of the attractive influence of the drum-magnets, and this belt inclination also assists the separation in the magnetic field by interposing the action of gravity.

It is obvious that parts of my invention may be used without other parts—as, for instance, I may use the drum with interior magnets and an endless belt running at its bights over non-magnetic rollers, or I may use a magnetic roll at either one of the bights of the ore-carrying belt or one magnetic roll at each bight thereof, as it may be desirable to effect a greater or less number of separations of ores of various grades, or to effect the separations at preferred parts of the apparatus, the maximum number of separations being effected when two magnetic rolls, with necessary guides for the ore, are used, as shown in the drawings.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, and an endless belt below the drum with its ore carrying side within the influence of the magnets.

2. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, and an endless belt below the drum with its ore carrying side within the influence of the magnets and adapted for adjustment toward and from the drum to modify the magnetic field relatively to the ore carried by the belt.

3. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, and an endless belt below the drum with its ore carrying side within the influence of the drum magnets, said belt being inclined to facilitate agitation of the ore particles carried by it.

4. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, and an endless belt below the drum and running at one or both of its bights over a magnetic roll or rolls, and with its ore carrying side within the influence of the drum magnets.

5. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, and an endless belt below the drum and running at one or both of its bights over a magnetic roll or rolls and with its ore carrying side within the influence of the drum magnets, said belt adapted for adjustment toward and from the drum to modify the field of the drum magnets relatively to the ore carried by the belt.

6. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running at its rear bight over a magnetic roll and with its ore carrying side within the influence of the drum magnets, guides conducting the first separated heads onto the belt at a place forward of its rear magnetic roll and beyond its influence, and guides conducting the first separated tailings to the belt and within the influence of said rear magnetic roll, whereby three separations of the ore are or may be effected.

7. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running at its rear bight over a magnetic roll and with its ore carrying side within the influence of the drum magnets, said belt also being adapted for adjustment toward and from the drum to modify the field of the drum magnets relatively to the ore carried by the belt, guides conducting the first separated heads onto the belt at a place forward of its rear magnetic roll and beyond its influence, and guides conducting the first separated tailings to the belt and within the influence of said rear magnetic roll, whereby three separations of the ore may be effected, and the third separation may be regulated by varying the intensity of the magnetic field of the drum magnets facing the ore carrying belt.

8. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running at its rear bight over a magnetic roll and with its ore carrying side within the influence of the drum magnets and inclined to facilitate agitation of the ore particles, guides conducting the first separated heads onto a belt at a place forward of its rear magnetic roll and beyond its influence, and guides conducting the first separated tailings to the belt and within the influence of said magnetic roll.

9. A magnetic ore separator, comprising a

revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running below the drum and with its ore carrying side within the influence of the drum magnets, and a fender and apron arranged next the farther side of the drum, said fender intercepting middlings thrown from the drum by centrifugal force within the magnetic field, and the apron guiding delivery of heads thrown from the drum, whereby a distinct separation is effected by counteracting magnetic and centrifugal forces at a point beyond the separation effected directly next the carrier belt by the drum magnets.

10. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running below the drum and over a magnetic roll at its forward bight, and bringing the ore it carries into the influence of both the drum magnets and the magnetic roll, a fender and apron arranged next the farther side of the drum, said fender intercepting middlings thrown from the drum by centrifugal force and within the magnetic field of the drum magnets and discharging them upon the belt in front of said forward magnetic roll which effects another separation into middlings and tailings, and said apron guiding the delivery of heads thrown from the drum by centrifugal force at the farther edge of or beyond the magnetic field of the drum magnets, whereby three separations are effected, one directly at or from the belt by the drum magnets, another by counteracting magnetic and centrifugal forces behind the fender, and another separation at or by the forward magnetic roll.

11. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running below the drum and over a magnetic roll at its forward bight and bringing the ore it carries into the influence of both the drum magnets and the magnetic roll, said belt also being adapted for adjustment toward and from the drum to modify the field of the drum magnets relatively to the ore on the belt, a fender and apron arranged next the farther side of the drum, said fender intercepting middlings thrown from the drum by centrifugal force and within the magnetic field of the drum magnets and discharging them upon the belt in front of said forward magnetic roll which effects another separation into middlings and tailings, and said apron guiding the delivery of heads thrown from the drum by centrifugal force at the farther edge of or beyond the magnetic field of the drum magnets, whereby three separations are effected, one directly at or from the belt by the drum magnets, another by counteracting magnetic and centrifugal forces behind the fender, and another separation at or by the forward magnetic roll, and whereby also the first two above named separations may be modified by adjusting the carrier belt relatively to the field of the drum magnets.

12. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running at its bight over rear and front magnetic rolls and with its ore carrying side within the influence of the drum magnets, guides conducting the first separated heads onto the belt at a place forward of its rear magnetic roll and beyond its influence, guides conducting the first separated tailings to the belt and within the influence of the rear magnetic roll, and a fender and apron arranged next the farther side of the drum, whereby five successive separations of the ore are effected.

13. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, an endless belt running at its bights over rear and front magnetic rolls and with its ore carrying side within the influence of the drum magnets, said belt also being adapted for adjustment toward and from the drum to modify the field of the drum magnets relatively to the ore carried by the belt, guides conducting the first separated heads onto the belt at a place forward of its rear magnetic roll and beyond its influence, guides conducting the first separated tailings to the belt and within the influence of the rear magnetic roll, and a fender and apron arranged next the farther side of the drum, whereby five successive separations of the ore are effected, and the third and fourth separations may be modified by adjusting the carrier belt relatively to the field of the drum magnets.

14. A magnetic ore separator, comprising a revoluble drum, devices for feeding ore thereon, relatively stationary magnets within the drum, and an endless belt running below the drum and with its ore carrying side within the influence of the drum magnets, said belt rollers or guides being sustained by a frame which is hinged at one end and is adjustable at the other end, to modify the field of the drum magnets relatively to the ore carried by the belt.

15. The combination, in a magnetic ore separator, of a drum 2, magnets 3 therein, feeding devices for the ore, an endless carrier belt 5 running over a rear magnetic roll 6, and guides 15, 17, 18, for the ore next the roll 6, substantially as described.

16. The combination, in a magnetic ore separator, of a drum 2, magnets 3 therein, feeding devices for the ore, an endless carrier belt 5 running over a forward magnetic roll 7, guides leading the ore to the belt, and a fender and apron 19, 20 next the roll, substantially as described.

17. The combination, in a magnetic ore separator, of a drum 2, magnets 3 therein, feeding devices for the ore, an endless carrier belt

5 running over rear and front magnetic rolls 6, 7, and guides 15, 17, 18, 19, 20, for the ore, substantially as described.

18. The combination, in a magnetic ore separator, of a drum 2, magnets 3 therein, feeding devices for the ore, an endless carrier belt 5 running over rear and front magnetic rolls 6, 7, sustained on a frame 12 hinged at 11 at one end, and having adjustable braces 13, 14 at the other end, and guides 15, 17, 18, 19, 20, for the ore, substantially as described.

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

CHARLES G. BUCHANAN.

Witnesses:
ALVIN K. GOODWIN,
CHAS. W. THOMPSON.