

L. G. ROWAND.
MAGNETIC SEPARATOR.
APPLICATION FILED JUNE 21, 1917.

1,303,397.

Patented May 13, 1919.

3 SHEETS—SHEET 1.

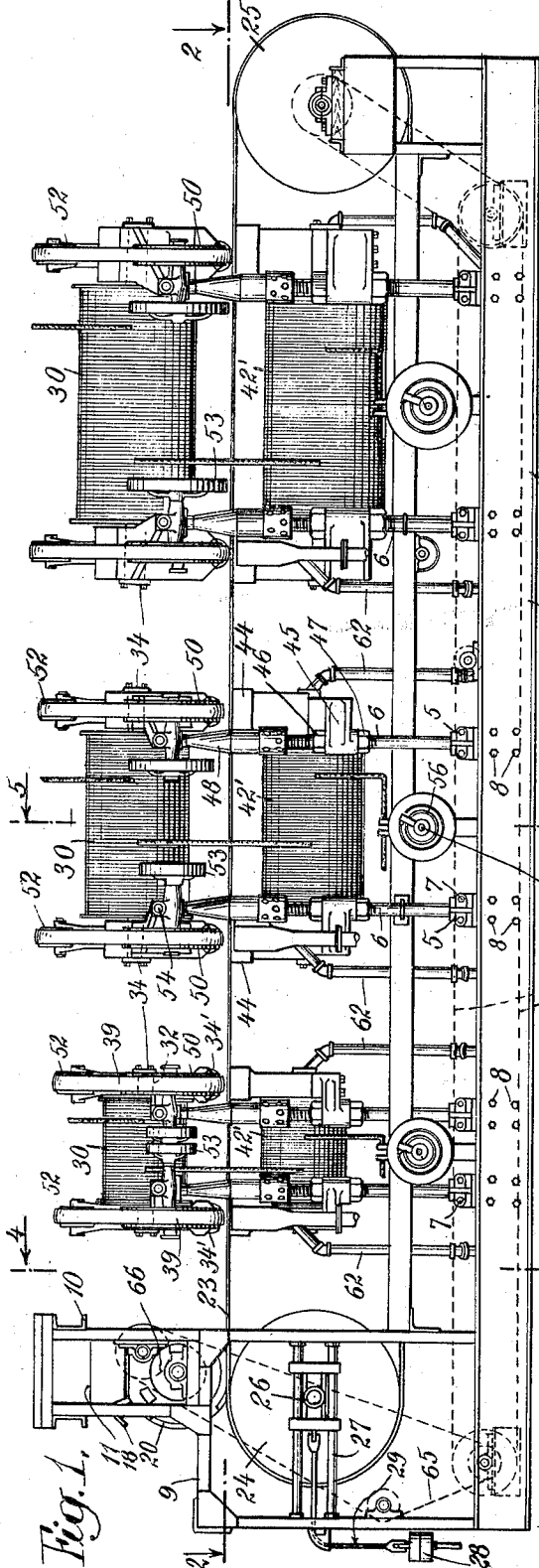
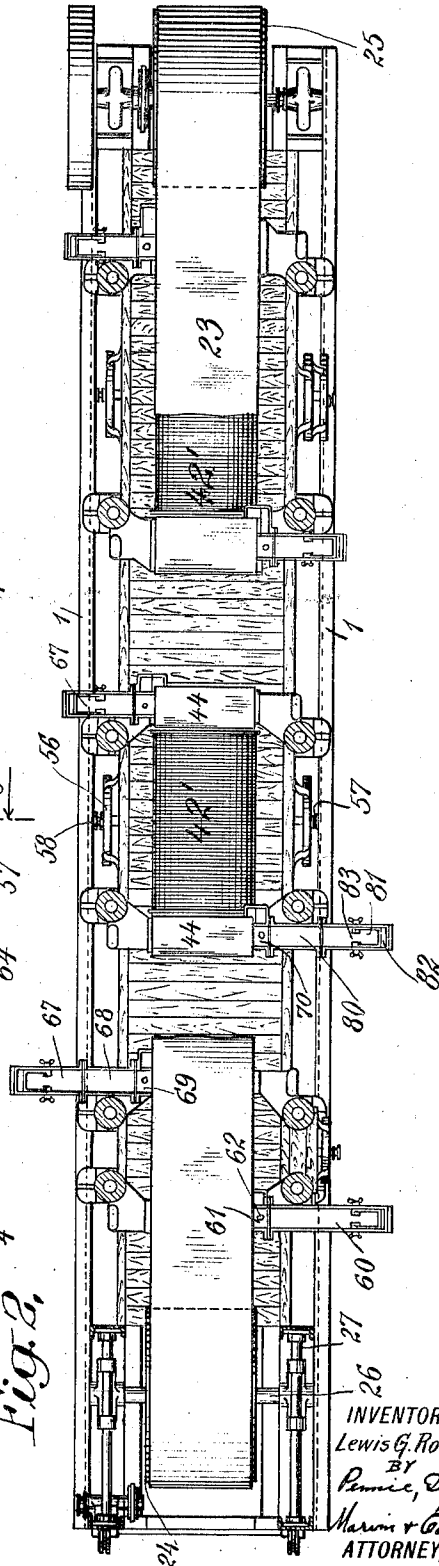


Fig. 1.



INVENTOR
Lewis G. Rowand
BY
Rennie, Davis,
Marion & Edwards
ATTORNEYS.

L. G. ROWAND.
MAGNETIC SEPARATOR.
APPLICATION FILED JUNE 21, 1917.

1,303,397.

Patented May 13, 1919.

3 SHEETS—SHEET 2.

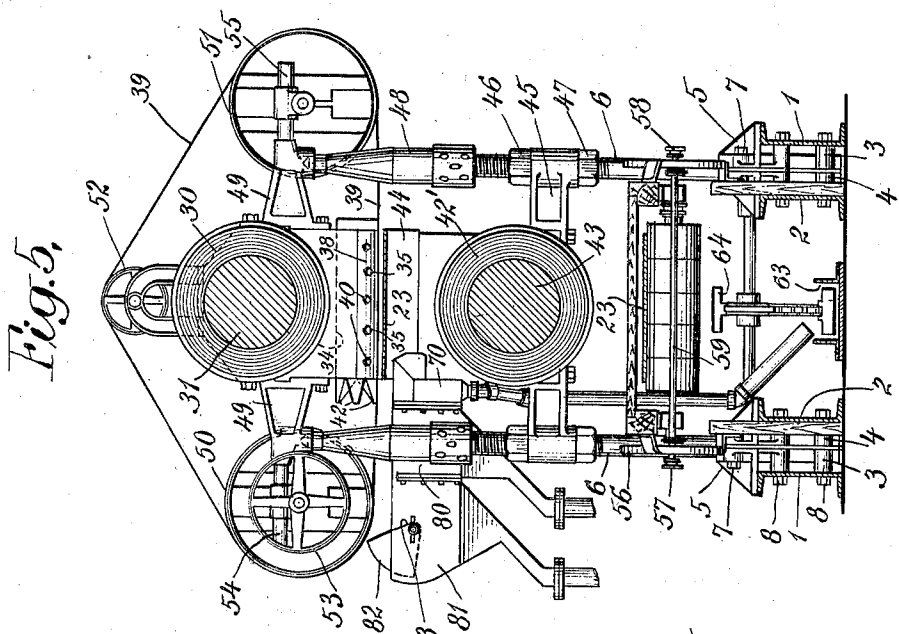


Fig. 4.

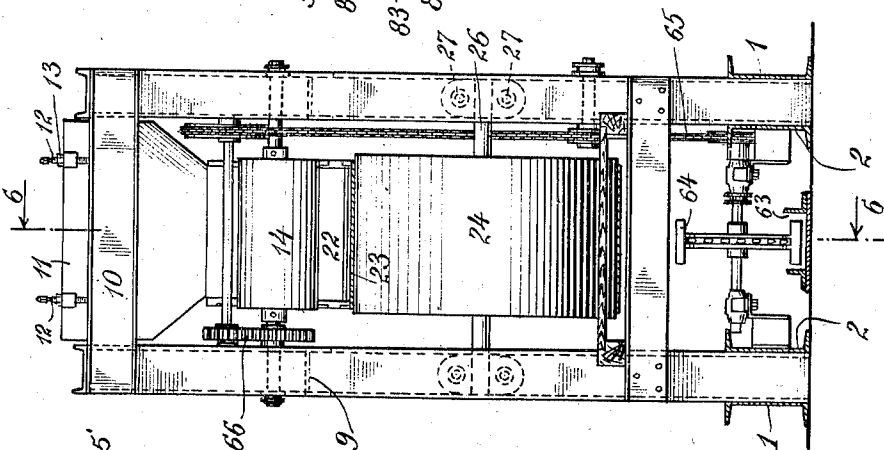
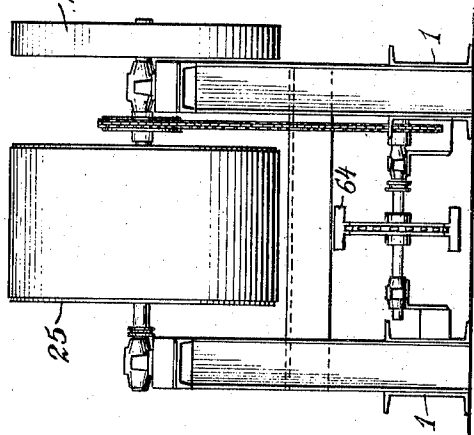


Fig. 3.



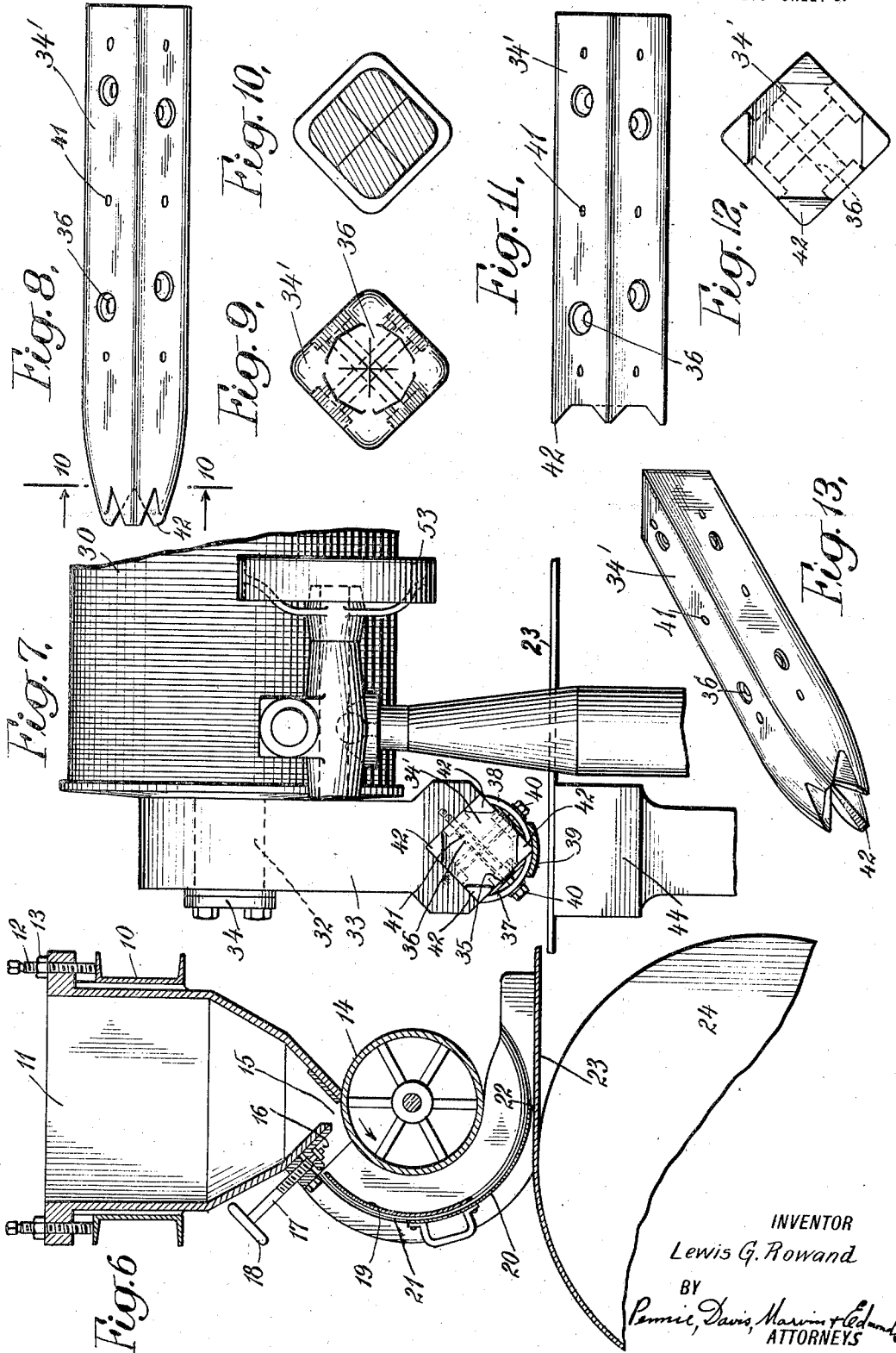
INVENTOR
Lewis G. Rowand

BY

Pennic, Davis, Marvin & Edmunds
ATTORNEYS

1,803,397.

Patented May 13, 1919.
3 SHEETS—SHEET 3.



INVENTOR
Lewis G. Rowand
BY
Perrin, Davis, Marmon & Edwards
ATTORNEYS

UNITED STATES PATENT OFFICE.

LEWIS G. ROWAND, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE NEW JERSEY ZINC COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

MAGNETIC SEPARATOR.

1,303,397.

Specification of Letters Patent.

Patented May 13, 1919.

Application filed June 21, 1917. Serial No. 176,028.

To all whom it may concern:

Be it known that I, LEWIS G. ROWAND, a citizen of the United States, residing at Sea Gate, in the borough of Brooklyn, in the county of Kings, State of New York, have invented certain new and useful Improvements in Magnetic Separators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to ore separators of the type in which the ore is finely divided, or pulverized condition is carried by a conveyer belt through a magnetic field which is so disposed as to lift the magnetic particles out of the ore and against the bottom of another conveyer belt disposed at right angles to the ore conveyer and operating to divert or convey these lifted magnetic particles laterally with respect to the ore conveyer, finally discharging them into a suitable hopper or receptacle at the side of the ore conveyer belt. In a certain sense, therefore, the present invention may be regarded as a further development of the invention disclosed and claimed in United States Letters Patent No. 596719, issued to me January 4, 1898.

It is an object in the present invention to improve, both mechanically and magnetically, the structures whereby the magnetic fields are established and adjusted, and whereby the ore is transported through those fields, and is there separated, the magnetic material from the non-magnetic.

Improved means are provided for delivering the ore from a hopper to the ore conveying belt in amounts regulated to the capacity of the electro-magnetic units, this delivery mechanism being proportioned and designed to lay the ore particles on the belt with a forward movement of the particles comparable to the speed at which the belt is moving, so that the particles will lie on the belt at the points where they are dropped thereon and will not roll about or become unevenly distributed.

It is an object of the present invention to

provide improved take-up means, whereby the ore-conveying belt is kept under proper tension at all times irrespective of any stretching or wear of the belt and its adjuncts.

The magnetic units of the present invention are of the type to establish a substantially vertical magnetic field, or flux, through which the ore conveying belt passes, and in this regard these magnetic units follow the teachings of the United States Letters Patent 784,502, issued to me March 7, 1905. With such a magnetic unit, the upper and lower electro-magnets, when energized with current, exert a powerful pull one on the other, tending to shorten the air gap between them. Any slight movement of one electromagnet toward the other, resulting from a change in, or interruption of, the magnetizing flux, is detrimental to the operation of such a unit, and it is an object of the present invention to so mount the electromagnets, one with respect to the other, that no inadvertent shortening of the air gap will occur whatever may be the condition or magnitude of the energizing current, while at the same time providing facilities whereby any air gap may be adjusted in width throughout its whole length, or at either end, and without interrupting the operation or functioning of the device. As a part of this adjustability and as a particular feature thereof the transverse or discharging belts are preferably so mounted as to move with their cooperating pole points, and consequently remain at all times in proper working adjustment with respect thereto.

To attain the foregoing objects and advantages and others which will hereinafter appear, or are inherent in the structure disclosed and apparent to those skilled in the art, I mount the upper half of each electro-magnetic unit on four powerful jacks, and I swivel or pivot each upper magnetic pole on the core of its coil, so that any one of the four jacks can be lengthened or shortened independently of the other three, thereby adjusting the width and shape of each air gap as much as may be necessary or desirable to secure most perfect separation of the

ore. Not only does each upper magnetic pole swivel on its magnet's core, but the discharging belt, which coöperates with that pole to convey the magnetic particles laterally beyond the ore-conveying belt, is mounted so that it and its supporting and driving pulleys swing with the magnetic pole about the magnet's core. Hence each discharge belt remains in fixed and proper adjustment with respect to its magnetic pole, whatever alterations may be made in the width or shape of its air gap.

It has been found in practice that with magnetic poles of the character disclosed in the above mentioned patent, 784502, there is a very considerable wear of the pole point, due to the friction thereon of the discharging belt. It is a further object of the present invention to provide a pole point of suitable magnetizable material and of special shape, whereby as one edge or corner becomes worn, it may be turned in its socket to present a new corner as a working edge. To attain this end, I make each pole point of rectangular cross section preferably square, and I provide means whereby it may be quickly and conveniently detached from its magnetizing pole, and quickly and securely re-attached thereto, as occasion may require. Each edge of this removable pole point has a projecting rounded tip, or nose, as hereinafter described more in detail, the function of which will, in the main, be clear from the disclosures of my above identified prior patents, and the detailed arrangement of which is hereinafter set forth.

In the accompanying drawings

Figure 1— is a side elevation of one embodiment of the present invention.

Fig. 2— is a plan view of the same, on the reference line 2—2 of Fig. 1, a part of the ore conveying belt being broken away to disclose underlying elements.

Fig. 3— is a rear end elevation of the machine.

Fig. 4— is a transverse section on the line 4—4 of Fig. 1.

Fig. 5— is a transverse section on the line 5—5 of Fig. 1.

Fig. 6— is a sectional detail of the ore-feeding hopper, and of the control means whereby the ore is delivered to the conveying belt in regulated quantity and with an appropriate forward movement.

Fig. 7— is a detail of a pair of opposed magnetic poles.

Fig. 8— is a side view of one of the detachable pole points.

Fig. 9— is an end elevation of the same.

Fig. 10— is a transverse section on the line 10—10 of Fig. 8, this line being just at the bottom of the notches which divide the end of the pole into four projecting rounded tips.

Figs. 11—12 are respectively, a side eleva-

tion, and an end elevation, of a pole point on which the four projecting tips are shorter and less rounded than in Fig. 8, and therefore, are better adapted for use where the magnetic field is very strong.

Fig. 13— is a perspective view of one of the pole points, and may be taken as typical in shape, though it is to be understood that when six of these points are used, as disclosed in the preferred embodiment pictured in Fig. 1, the size and curvature of the four projecting tips will, at each magnetic gap, be in conformity with the width of the gap and the intensity of the magnetic field or flux.

In the embodiment illustrated, the machine has for its foundation, two steel girders, each comprising a pair of channels, 1 and 2, arranged back to back and spaced apart by a plurality of metal fittings, 3 and 4, likewise arranged in pairs. The upper portion of each fitting has a projecting shelf 5, which rests upon the upper flange of its supporting channel. Between each pair of fittings a standard, or pedestal, 6, is received and is firmly clamped, not only by the bolts, 7, provided for that purpose, but also by the bolts, 8, which anchor channels 1 and 2, against fittings 3 and 4. These pedestals, 6, are used for supporting certain parts of the apparatus, as hereinafter described more in detail.

At the front end of the machine is a rectangular frame work, 9, and superimposed on this is a smaller framework, 10, whereon is mounted the ore-feeding hopper, 11, as shown in detail, Fig. 6. Four leveling screws, 12, with lock nuts, 13, are provided for adjusting the hopper on the supporting metal framework to keep its delivery mechanism in proper adjustment to the main ore-conveying belt. At the mouth of the hopper is a feed cylinder, 14, rotating in the direction indicated, and serving to deliver the ore in a constant flow through an elongated slot, 15, at the bottom of the hopper, the width of which slot is adjustable by the movement of a gate, 16, actuated by one or more threaded supports, 17, each equipped with a hand wheel, 18. But in addition to the delivery of the ore from the hopper in a broad, thin band it is desirable, as above mentioned, that the ore particles should be deposited on the conveyer belt while traveling forward in the same direction and at about the same speed as said belt, so that they will lie on the points at which they strike the belt, and not roll about, and particularly not roll off or be thrown from the belt. To attain this result I incase the downwardly moving side of cylinder, 14, in a hood of cylindrical shape the upper half, 19, of which is stationary, and the lower half 20, of which has its ends mounted to slide in grooves 21, to thereby vary the location of the front or de-

livery edge, 22, of said element, and so control the point of delivery of the ore after it has slid down the interior of the hood and so attained a direction and speed of movement comparable to that of the underlying ore-conveying belt, 23, to which it is delivered.

The ore-conveying belt, 23, is of rubberized duck, or other suitable material, stretched rather tightly between cylindrical drums, 24 and 25, which are positioned at the front and rear ends, respectively, of the machine. Drum, 25, at the rear end of the machine, is on a shaft provided with a driving pulley, 25', as shown in Fig. 3. At its other end the ore-conveying belt is carried in a pair of bearings, 26, each mounted to slide on a pair of horizontal supporting bars, 27. A counterweight, 28, connected through a flexible tension band, 29, as shown in Fig. 1, serves to keep the ore conveying belt suitably taut under all conditions of operation. In this detail the machine is a very considerable improvement over the prior art, for even in the hands of relatively unskilled labor, a proper working tension can be maintained on the ore-conveyer and without danger of unduly stretching or deforming the fabric of which it is in a large measure composed.

In the embodiment illustrated in Fig. 1, three electro-magnetic units are employed, these being arranged one behind the other to act on the ore in succession, the first unit being the smallest and the least powerful, and the last unit being the largest, most expensive and most powerful, and being intended to take out substantially all of whatever magnetizable ore particles may pass the preceding unit or units. More or less than three of these electro-magnetic units may be used in conjunction with a single ore-conveying belt, it being understood that they should be arranged in sequence in the order of their lifting power, as shown in Fig. 1.

Each of the three magnetic units illustrated in Fig. 1, has a magnetizing coil, positioned above the ore-conveying belt and arranged longitudinally thereof, and a similar magnetizing coil below the ore-conveying belt, and each of these coils is provided with a core having poles which are opposed to corresponding poles of the other coil, whereby there are formed a plurality of magnetic air gaps, through which passes the conveyer with its thin, broad band of supported ore particles. The upper pole face at each air gap is of smaller area than the opposed pole face, and consequently carries a more dense magnetic flux. With such an arrangement as explained in my Patent 784,502, the magnetizable ore particles tend to lift out of the ore on the conveyer belt. By suitable adjustment of the shape and width of the air gap, and the intensity of the magnetic flux, the more magnetic of these particles can be and

are there lifted into contact with the under surface of a transversely moving discharge belt, which conveys them across and ultimately drops them off into a suitable hopper at the side of the ore-conveying belt.

Considering more in detail the electrical and mechanical features of one of the magnetic units of the series, for instance the second unit, shown in Figs. 5 and 7, this being in large measure typical of the others, its salient features may be said to comprise a coil, 30, provided with a magnetizable core, 31, at each end of which is a projecting cylindrical hub, 32, as indicated in dotted lines, Fig. 7. On each of these hubs, and making close magnetic connection with core, 31, is a pole piece, 33, held in position by a bolt-retained end plate, 34. The pole piece is, however, capable of swinging or swiveling on hub, 32, when occasion may require such relative movements to vary the shape of the magnetic air gap between pole piece 33, and the cooperating pole piece beneath the ore belt.

The lower edge of each pole piece, 33, is provided with an elongated right angled two-sided recess, wherein is mounted a pole point of the general character illustrated in Figs. 8 to 13 inclusive. These pole points are preferably made of special steel, thoroughly annealed, and preferably containing not over

Carbon-----	0.060%	
Phosphorus-----	0.025 "	
Sulfur-----	0.025 "	100
Manganese-----	0.300 "	
Silicon-----	0.300 "	

They are finished with a watercut as smooth and true as can be made with tool on lathe or planer, to insure perfect contact and low magnetic reluctance where the pole point fits in the recess of the pole.

The removable pole point, 34', is tightly anchored in pole 33 by means of a plurality of bolts, 35, of which four may be used in the staggered holes, 36 (Fig. 8), as indicated in Fig. 7. As it is over the lower and relatively acute corner of this pole point, 34', that the transverse, or discharging belt, runs I find it advantageous, as protecting the point and also the belt against mechanical wear, to fasten to the two lower faces of pole point 34', a pair of rounded, bronze shoes, 37 and 38, the adjacent beveled edges of which approach closely the lower or working edge of pole point, 34', and form therewith a rounded and relatively smooth face, over which the discharging belt, 39, may rub without undue cutting or wear. The mechanical expedient relied on for holding these bronze shoes in position on the pole point comprises short bolts 40, threaded into holes, 41 (Fig. 8) of the pole point.

Each pole point has at the delivery end of

its working edge a tapered tip, 42, through the use of which the magnetic pull on a particle while being conveyed laterally will not release the particle so suddenly as to drop it back on the ore belt or fail in its delivery beyond the point to which non-magnetic particles might be conveyed or thrown because of mechanical entanglements with moving magnetic parts, as explained somewhat generally in my above mentioned patents, 596,719 and 784,502.

With the arrangement above described, any particular pole point after it has become worn along one edge can be taken out quickly and turned to present a new and unworn edge, and thus in succession each of the four working edges of the pole point can be worn out. Thereafter, the pole point can be removed and a new one quickly substituted, and in some instances the worn pole point can be utilized in other electro-magnetic units of the series where a less acute working edge can be tolerated. As a general rule the weaker the flux is at any of the several air gaps, the longer and more rounded should be the tip of the pole point, and this I have endeavored to indicate somewhat diagrammatically in Figs. 8 to 13 where the pole point of Fig. 8 is of suitable shape for use at the first magnetic air gap, and the pole point of Fig. 11, with its shorter and less rounded tips, is suited for use at the last air gap of the series. For intermediate air gaps the length, thickness and curvature of the tips of the pole points may lie intermediate these two extremes, proportionately.

Although when using a plurality of magnetic units as shown on Fig. 1, I prefer that the size and power of the coils shall increase progressively toward the tail of the machine with consequent progressive increase in the cross sectional area of the upper pole pieces from front to rear of the machine I make of a uniform size the right angled recesses of these several pole pieces so that every pole point, so far as concerns its rectangular cross-section and mode of fastening is interchangeable with every other pole point of the series. This gives to the machine as a whole a great flexibility in range of operation and the capacity for quick adjustment from one type of ore to another. In an emergency a pole point can be put in position on a pole where rightfully it does not belong and, by suitable adjustment of the width of gap and the intensity of magnetic flux, can be made to serve temporarily or until a pole point of more correct shape for that particular location can be obtained. I have found in practice that the interchangeability of the pole points and the capacity which each of them has for quick reversal to present a new and unworn edge and for quick removal and replacement as soon as all of the edges have become worn, contribute

materially to continuity of operation of the machine as a whole.

The arrangement for adjusting the several magnetic air gaps, and for maintaining each air gap at its adjusted length and shape, irrespective of such changes as may be found necessary to be made from time to time in the strength of magnetizing current, may be described as follows: Each lower magnetizing coil, 42', and its core, 43, and upstanding, broad top poles, 44, are mounted on a pair of horizontal brackets, 45, through which the standards or pedestals, 6, pass. These brackets are clamped at a proper height between nuts, 46, and 47, threaded to the standard. In general, I aim to have the broad, flat, rectangular top of each of the lower poles at about the level of the lower face of the ore-conveying belt, so that this belt may slide freely thereover and receive support therefrom.

At the top of each standard, 6, and threaded thereto, is a bronze jack, 48, the upper rounded edge of which forms a ball and socket connection with a bracket, 49, rigidly attached to a pole of the upper magnetizing coil and this pole, as above explained, is free to swivel or turn on hub, 32, of the magnet core when retaining plate, 34, has been loosened to permit it. By the construction disclosed, it is possible to raise or lower any one of the four jacks without disturbing the others, or any two or more of the jacks can be adjusted simultaneously. Because of this arrangement, the width of any air gap can be adjusted at will and it is even possible to make the gap wider at one end than at the other if an unequal distribution of ore on the ore conveying belt or the piling up of magnetized particles on the undersurface of the discharging belt should make this desirable. Such is often the case. Furthermore, all of these adjustments can be made while the machine is in operation and this is of great convenience as it enables the operator to determine exactly what current and what length and shape of air gap is best suited to the needs of the moment by watching the results of his adjustments.

It is another and very important characteristic of the embodiment illustrated, that each discharging belt, 39, is so mounted as to follow the adjusting movements of its magnet pole and in its workings thereon is not in any way disturbed because of adjustments of one or more of the supporting jacks. To this end each discharging belt, 39, is carried on two drums, 50 and 51, and an idler, 52, the bearings for the drums being mounted to move with the adjacent pole piece. Belt 39, is driven by a pulley, 53, on the same shaft as drum 50. The bearings for drums 50 and 51, are adjustable along horizontal studs, 54, and 55, to com-

pensate for stretching of the belt and the like.

As a means for controlling the flow of current to the two coils of each magnetic unit, I provide each unit with a rheostat, 56, having hand wheels, 57 and 58, on the respective sides of the machine, these wheels being connected together by a horizontal shaft, 59, (Fig. 5) so that the operator may adjust the current strength while standing on either side of the apparatus.

With the machine arranged and constructed, as above described, the thin uniform layer of ore particles on the ore-conveying belt, 23, passes first into the air gap of the first, or weakest, magnetic unit. The first gap of that unit is relatively wide, and the magnetic flux is relatively weak and consequently at this point only the more easily magnetizable particles are lifted out of the layer of ore, and into contact with the transverse delivering belt. This belt carries the particles laterally out of the range of the magnetic field and drops them off into a hopper, 60, (Fig. 2) arranged to receive them. A small amount of the ore, because of mechanical entanglement, with these magnetic particles, may also be lifted or dragged laterally and dropped just beyond the edge of ore-conveyer 23. I therefore provide at this point a small auxiliary hopper 61, into which these tangles are received and from which they can be dropped down through a conduit, 62, into a trough, 63, which extends lengthwise of the machine and is provided with a flight conveyer, 64, (Fig. 5) suitably driven from the main drive shaft at the tail of the machine. This conveyer, 64, also acts as the driving means for feed roller, 14, at the base of hopper, 11, being connected thereto through a driving chain, 65, and suitable gearing 66.

In practice I find that it is best to have this air gap wider at the discharge end than at the other end, or in other words, flaring toward the receiving hopper, 60, because the layer of magnetic material on the discharging belt is thickest near the hopper side of the belt, and consequently needs more space, if the true, or effective air gap for the layer of ore is to be of the same magnitude from one side to the other of the ore carrying belt. Even with an air gap thus flaring, I find that there is a tendency for the ore body to be shifted over on the face of the ore supporting belt, 23, so that as the layer leaves the first air gap it will no longer be in an equally distributed layer. I therefore arrange the next air gap and its discharging belt so that the next delivery of magnetic material will be to the other side of the machine, as into a hopper, 67, (Fig. 2).

With certain classes of ore, as for instance the zinc ore found at and near Franklin, New Jersey, I find it advantageous, at

the second air gap, to provide, in addition to hopper, 67, two intermediate hoppers, 68 and 69, the latter for the tangles and the former for intermediate products which I may designate as middlings. This second air gap can be, and preferably is, shorter and therefore more powerful than its predecessor, and so will lift and remove particles that have escaped effective magnetization at the first air gap. The third air gap may be of still closer adjustment and still greater strength, and preferably delivers to the same side of the machine as the first air gap and, like the second air gap, may have a small hopper, 70, for the tangles and an intermediate hopper, 80, for the middlings, and a main hopper, 81, for the truly magnetic particles lifted from the ore bed under the magnetic conditions prevailing at this gap. Hopper 81, (Fig. 5) like the others of its kind, is provided with a pivotally mounted hood, 82, which can be swung about its pivots, 83, into close relation with the discharging belt, 39, where it passes over drum, 50, and so can serve to catch particles which might otherwise overshoot the hopper. Wing nuts on the pivot studs, 83, hold this hood in adjusted position.

Thus in succession the layer of ore passes through one gap after another, at each gap losing a magnetized increment, the magnetic units being of progressively increasing size and power as the ore approaches the tail of the machine, with the result that by proper adjustment of the air gap and of the magnetizing current, due consideration being given to the shape of the removable pole points, the ore bed, when it leaves the last air gap, has in it practically nothing of magnetizable character.

I am aware that various changes in details of the apparatus and various changes in the grouping and arrangement of the several parts may be made without departing from the spirit of the present invention as defined by the appended claims.

I claim:

1. In a magnetic separator, the combination of an ore carrying belt, magnetic poles beneath the belt, poles complementary thereto and positioned above the belt, a pole point of substantially rectangular cross-section detachably secured to each of said upper poles with two of its faces in contact with the pole, and a discharging belt for each pole point arranged to pass thereunder through the air gap formed between that point and its opposing pole.

2. In a magnetic ore separator, the combination of a substantially horizontal ore conveying belt, a magnetic pole beneath said belt, an opposed magnetic pole above said belt, said upper pole being provided with a right angled two-sided recess, a pole point of substantially square cross section

adapted to be detachably secured in said recess with any two of its adjacent faces in contact with the sides of the recess so that each of the four edges of said pole point may serve in succession as the working face of said upper pole and a discharging belt arranged to pass beneath said removable pole point closely adjacent the lowermost edge thereof to laterally convey magnetized particles picked up from said ore conveying belt at said pole point.

3. In a magnetic ore separator, the combination of an ore conveying belt, opposed magnetic poles, one above and one below said belt to form an air gap through which the ore is carried on said belt, said upper pole having a right angled recess and a pole point of substantially square cross-section detachably secured in said recess, a plurality of the edges of said pole point being adapted to serve in succession as the working pole face, said pole point having a rounded tip at one end of each of said working edges, and a discharging belt mounted to pass beneath said pole point transversely of said ore conveyor to convey laterally the magnetized particles lifted from said ore conveying belt at said air gap.

4. In a magnetic separator of the character described, an ore conveying belt, opposed magnetic poles, one above and one below said belt, a right angled two-sided recess in said upper pole, a pole point of rectangular cross section adapted to be secured in said recess with any two adjacent faces in contact with the sides of the recess so that any one of its edges may be presented in opposition to the lower pole, and a discharging belt traveling beneath the lowermost edge of the pole point to convey laterally of said ore conveying belt the magnetic particles lifted at the air gap between the poles.

5. In a magnetic separator the combination of an ore conveying belt, opposed magnetic poles, one above and one below said belt, a right angled two-sided recess in said upper pole, a pole point of rectangular cross-section detachably secured in said recess and presenting one of its edges in opposition to said lower pole, a discharging belt traveling beneath the lower edge of said pole point, and shoes of non-magnetic material positioned adjacent to the lower working edge of said pole point to form a relatively smooth surface over which said discharging belt may pass without undue wear.

6. In a magnetic separator, the combination of an ore conveying belt, a magnetic unit located partly above and partly below said belt to form air gaps through which the ore is carried, a plurality of jacks adjustably holding the upper part of said unit in spaced relation to the lower part, discharging belts running through said gaps trans-

versely of said ore conveying belt to carry away the magnetic material separated at said gaps, and pulleys for said belts mounted directly on the upper part of the unit so that said discharging belts may remain at all times in adjusted relation with the upper part of said unit when the latter is moved by said jacks; substantially as described.

7. In a magnetic separator, the combination of an ore conveying belt, a magnetic unit located partly above and partly below said belt to form air gaps through which the ore is carried, a plurality of jacks adjustably holding the upper part of the said unit in spaced relation to the lower part, discharging belts running through said gaps transversely of said ore conveying belt to carry away the magnetic material separated at said gaps, horizontal brackets upon the upper part of the unit, pulleys adjustably mounted on the brackets and over which the discharging belts pass whereby said discharging belts may remain at all times in adjusted relation with the upper part of said unit when the latter is moved by said jacks; substantially as described.

8. In a magnetic ore separator, the combination of an ore conveying belt, a magnetic unit having a pair of air gaps through which said conveyor belt passes, four jacks upon which the magnetic unit is supported, said jacks being independently adjustable to vary the magnitude of the air gaps of the said unit and delivering belts passing through each of said air gaps and above said ore conveying belt to convey laterally the magnetic particles of ore lifted at said gaps; substantially as described.

9. In a magnetic separator the combination of a substantially horizontal ore conveying belt, a magnetic unit therefor, part of which is beneath said belt and part of which is above the belt to form a plurality of air gaps through which the ore on said belt is carried, four jacks supporting the upper part of said unit and each having a universal connection therewith, said jacks and the parts supported thereby being adapted for independent adjustment to vary the shape and magnitude of said air gaps as occasion may require; substantially as described.

10. In a magnetic separator the combination of a substantially horizontal ore conveying belt, a magnetic unit therefor, comprising an electro-magnet and magnetized poles beneath the belt, and a winding with a magnetic core and poles positioned above the belt, said poles being mounted to swing with respect to said coil and independently of one another, a pair of jacks at the end of each air gap, said jacks being adjustable independently of one another to vary the character of the adjacent air gap, and a

discharging belt mounted to travel through each air gap transversely of said ore conveying belt.

11. An electromagnetic ore separating unit comprising opposed upper and lower magnetic poles forming an air gap, and a pole point of substantially rectangular cross section detachably secured to the pole with two of its faces in contact with the pole.

12. An electromagnetic ore separating unit comprising opposed upper and lower magnetic poles forming an air gap, said upper pole being provided with a right angled two sided recess and a pole point of substantially square cross section adapted to be detachably secured in said recess with any two of its adjacent faces in contact with the sides of the recess, so that each of the four edges of said pole point may serve in succession as the working face of said upper pole.

13. An electromagnetic ore separating unit comprising opposed upper and lower magnetic poles forming an air gap, said upper pole having a right angled recess, and a pole point of substantially square cross section detachably secured in said recess, so that a plurality of the edges of said pole point may serve in succession as the working pole face, said pole point having a rounded tip at one end of each of said working edges.

14. An electromagnetic ore separating unit comprising opposed upper and lower magnetic poles forming an air gap, said upper pole being provided with a right angled two sided recess, and a pole point of rectangular cross section adapted to be secured in said recess with any two adjacent faces in

contact with the sides of the recess so that any one of its edges may be presented in opposition to the lower pole.

15. An electromagnetic ore separating unit comprising opposed upper and lower magnetic poles forming an air gap, said upper pole being provided with a right angled two sided recess, a pole point of rectangular cross section detachably secured in said recess and presenting one of its edges in opposition to said lower pole, and shoes of non-magnetic material positioned adjacent to the lower working edge of said pole point to form a relatively smooth surface over which an ore discharging belt may pass without undue wear.

16. An electromagnetic ore separating unit comprising upper and lower parts between which is a plurality of air gaps, four jacks supporting the upper part of said unit and each having a universal connection therewith, said jacks and the parts supported thereby being adapted for independent adjustment to vary the shape and magnitude of said air gaps as occasion may require; substantially as described.

17. An electromagnetic ore separating unit comprising a lower electromagnet and magnetized poles, an upper winding with a magnetic core and poles, said poles being mounted to swing with respect to said winding and independently of one another and a pair of jacks at the end of each air gap, said jacks being adjustable independently of one another to vary the character of the adjacent air gap.

In testimony whereof I affix my signature.

LEWIS G. ROWAND.