

April 15, 1924.

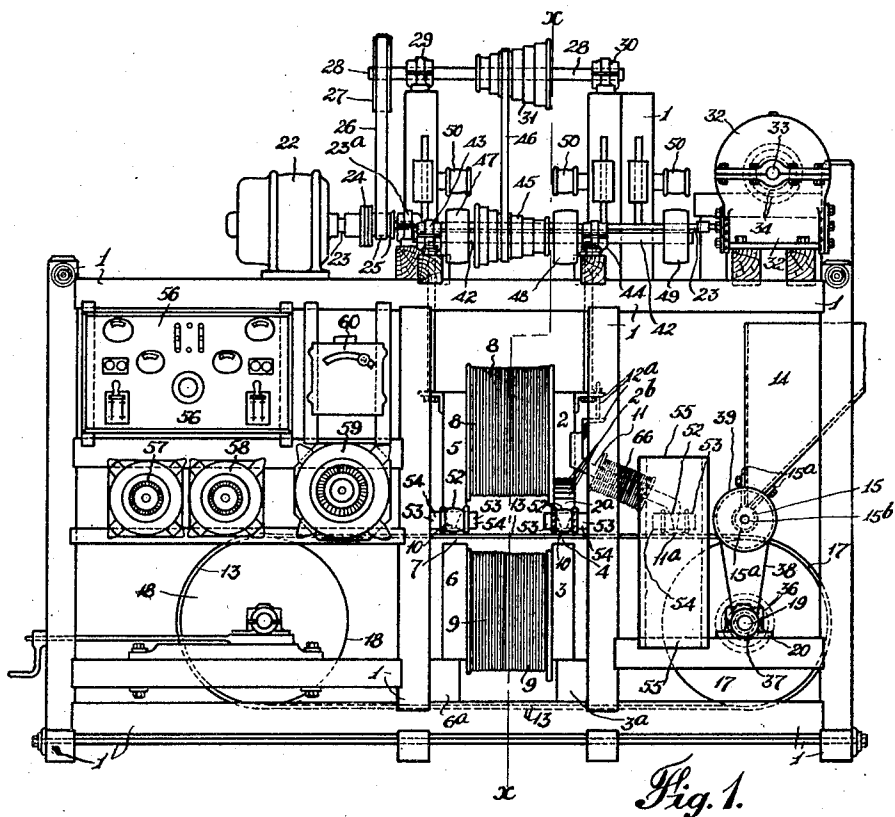
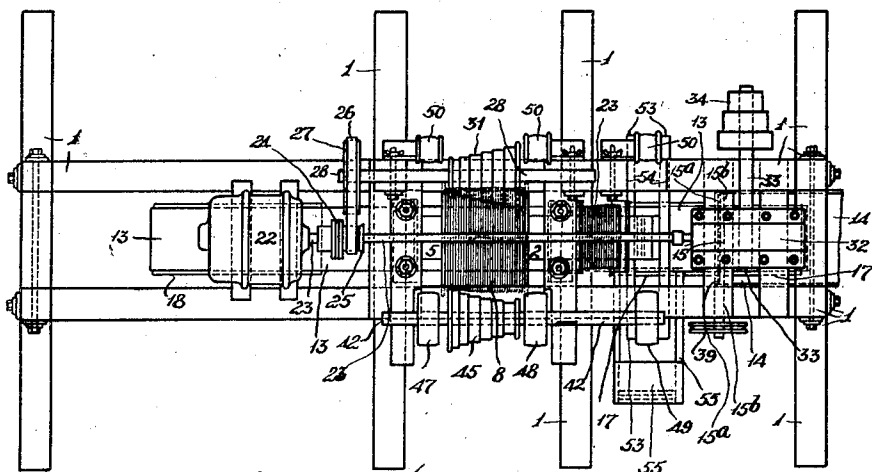
L. B. WOODWORTH ET AL

1,490,792

MAGNETIC SEPARATOR

Filed May 11, 1921

3 Sheets-Sheet 1



Witness:
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Fig. 2.

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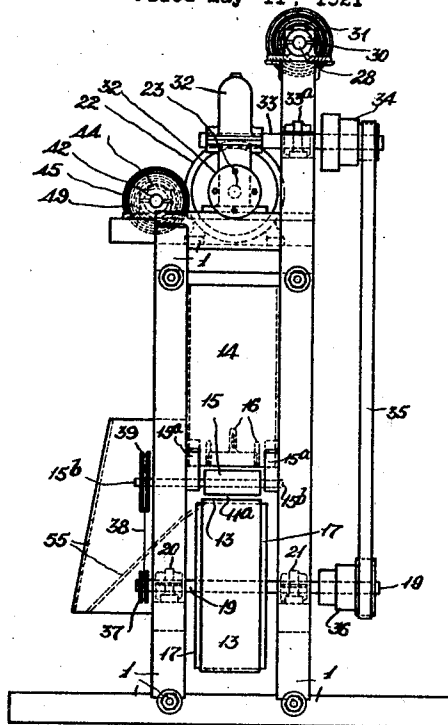


Fig. 4.

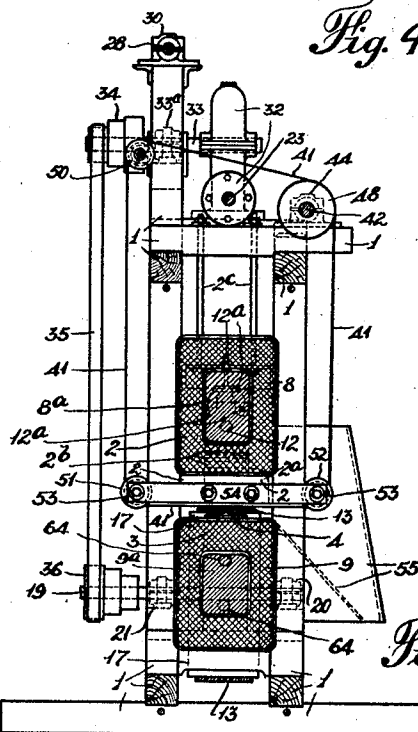


Fig. 3.

Inventors:

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3 Sheets-Sheet 3

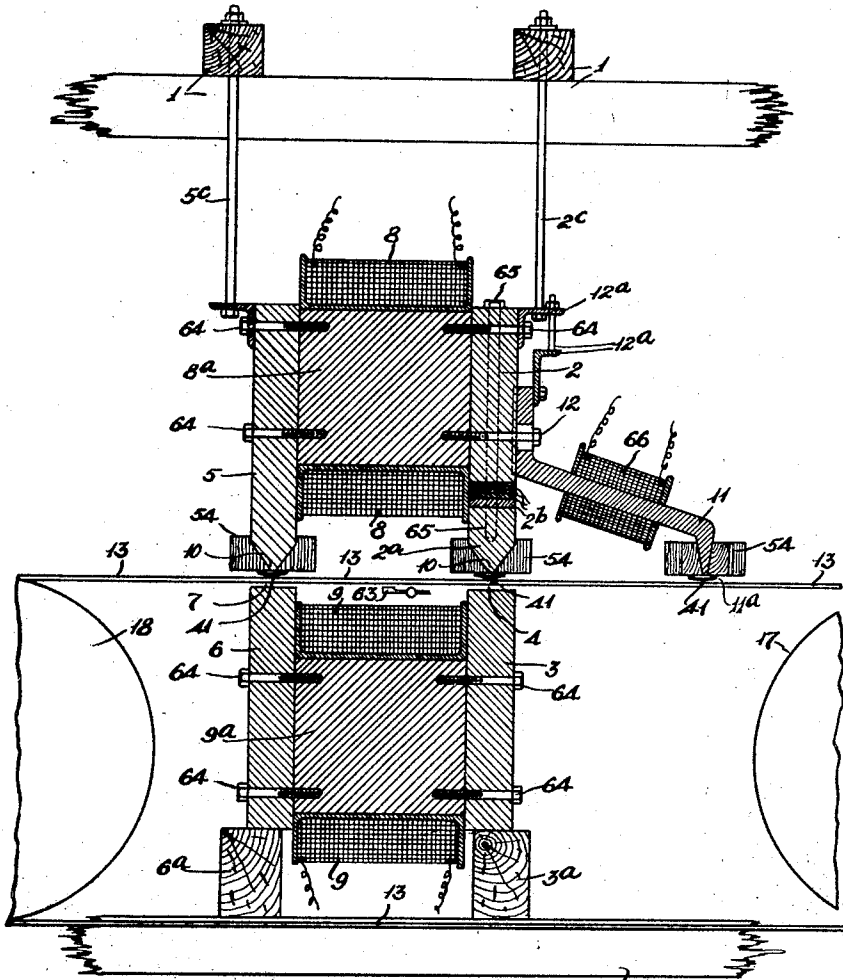


Fig. 5.

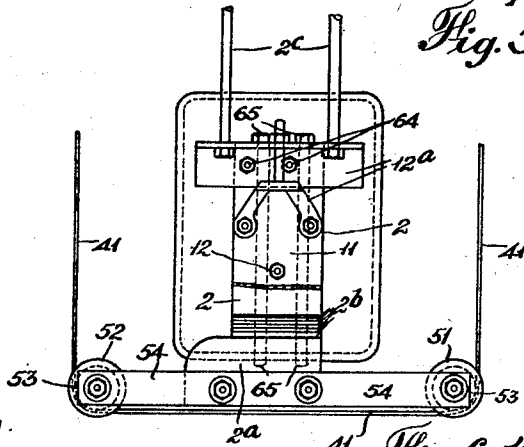


Fig. 6.

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Inventors:

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UNITED STATES PATENT OFFICE.

LEON BYRON WOODWORTH AND SAMUEL THOMAS TREGASKIS, OF JOHANNESBURG,
TRANSVAAL, SOUTH AFRICA.

MAGNETIC SEPARATOR.

Application filed May 11, 1921. Serial No. 468,644.

To all whom it may concern:

Be it known that we, LEON BYRON WOODWORTH, a citizen of the United States, and SAMUEL THOMAS TREGASKIS, a subject of the King of Great Britain, both residents of Johannesburg, in the Transvaal Province of the Union of South Africa, have invented certain new and useful Improvements in Magnetic Separators, of which the following is a specification.

This invention relates to magnetic separators for ore and other substances or materials.

It consists of various constructional features designed to increase the efficiency of such apparatus.

In the usual two zone magnetic separator, whereby the ore to be separated is fed from the hopper on to a main conveyor belt, the magnet systems are energized by direct current, and the transverse or cross belts provided at each separating zone move at right angles to the main conveyor belt.

In operation particles of materials capable of receiving or being acted upon magnetically are drawn by the concentrated magnetic field up against the underside of the transverse or cross belts and are held to the belt for the length of the magnetic pole width and then, being taken out of the magnetic influence, the particles fall or are thrown off into their respective receiving chutes or receptacles.

By adjusting the speed of the main conveyor belt and transverse or cross belts, by increasing or decreasing the magnetic gap at the separating zone, or, by increasing or decreasing the field strengths of the magnet systems, various separations of ore constituents may be obtained and feebly magnetic material as well as strongly magnetic material may be acted upon in various stages. This is in general the main principle of the belt type of magnetic separator.

According to this invention an auxiliary or additional pole is provided, which is co-operatively combined with or taken off one of the ordinary main poles of the separator, with or without an energizing coil.

By a construction including, for example, two pairs of main poles and a single auxiliary pole there is obtained a pole system providing the two zones of the main poles and a third zone applicable for the separation of magnetic substances of varying per-

meabilities. By such an arrangement it is possible to separate the material under treatment into four classes or kinds.

The auxiliary pole is adjustable as to gap independently of the main poles. The main pole or poles may also be provided with adjusting means independently of the ordinary screw adjustment, and such additional adjusting means may conveniently consist of distance pieces or plates of any suitable thicknesses or proportions. Such plates constitute a ready means for adjusting the gap without disturbing the magnetic stability of the pole system.

The pole pieces may be provided with one or a plurality of edges, and the magnets may be adapted to be placed either in series or parallel.

The driving arrangement for the separator is characterized by the employment of straight as opposed to cross drives.

The bottom guide pulleys for the transverse or cross belts are carried by extensions of the wooden guards or housings for the pole pieces whereby a rapid adjustment of the cross belt is made possible when the field system is altered; alternatively said pulleys may be supported by parts or members suitably secured to the guards or housings instead of to extensions thereof.

A device or tapper may be provided for striking or tapping the main belt intermediate the main poles, (or otherwise) so that particles of ore after passing through the first separating zone of the main poles will be re-arranged so that cohered particles are "de-cohered" for treatment at the second zone of the said poles. Such device or tapper may be arranged to be operated either mechanically or electrically.

The invention will be more fully described with the aid of the accompanying drawings, wherein—

Fig. 1 is a front elevation of a separator incorporating certain features of the invention.

Fig. 2 is a plan of Fig. 1.

Fig. 3 is a section of Fig. 1, on line $x-x$.

Fig. 4 is an end elevation of the separator as seen from the inlet or feeding end.

Fig. 5 is a sectional elevation of the main poles and the auxiliary pole showing certain further features of the invention, and

Fig. 6 is a view illustrating the construction of the guards or housings with the ex-

tensions to carry the bottom guide pulleys for the transverse or cross belts.

Referring to the general arrangement of the separator as illustrated in Figs. 1 to 4, the numeral 1 denotes the frame for the various parts of the separator. 2 is one of the upper main poles which is adjustable, and 3 its opposing lower pole, providing one zone 4. 5 and 6 are the upper and lower poles providing a second zone 7; and 8, 9, the coils of the said poles. The pole pieces 2, 5, are each shown provided, in Fig. 1, with two edges 10.

11 is the auxiliary pole which may, as shown, be co-operatively combined with or taken off the main pole 2, so that it is magnetized by contact with said main pole 2, to which it is preferably adjustably attached, as indicated at 12; the parts 12^a constituting the independent adjusting means for regulating the height of said auxiliary pole 11. This pole provides a third zone 11^a. The auxiliary pole 11 is shown with an energizing coil 66, which may or may not be provided, as desired.

13 is the main conveyor belt on to which the material which is to be separated is delivered in regulated quantity from a hopper 14, by means of a feed roller 15; 15^a are members providing bearings for the shaft 15^b of feed roller 15; 16 in Fig. 4 representing the means for adjusting the feed to the roller 15.

17 is the driving pulley for the main conveyor belt 13, and 18 the adjustable pulley for the other end of said belt. 19 is the shaft on which the driving pulley 17 is mounted and 20, 21, the bearings.

22 is the electric motor, 23 the motor shaft, 23^a one of the bearings therefor, 24 a coupling and 25 a pulley which, through belt 26, and pulley 27, drives a second motion shaft 28 which runs in bearings 29, 30; 31 being a stepped pulley or speed cone on shaft 28, and hereinafter referred to. The main shaft 23 enters a reduction gear case 32. 33 is the reduction gear shaft mounted in bearings 33^a, on the outer end of which shaft is mounted a stepped pulley or speed cone 34 off which the motion is taken for driving the main conveyor belt 13 and feed roller 15 through belt 35, speed cone 36 on the pulley shaft 19, and grooved pulley 37, on the other end of shaft 19, rope 38 and grooved pulley 39 on the shaft 15^b of the feed roller 15.

The driving means for the three cross belts 41—one of which is shown in Fig. 3—comprises the third motion shaft 42 which runs in bearings 43, 44, and has fixed on it the speed cone 45 which is driven by belt 46 off the speed cone 31 on the second motion shaft 28. 47, 48, 49, are the three driving pulleys, on shaft 42, for the three cross belts 41. 50 are adjustable guide pulleys for

the transverse belts 41, in the upper portion of the frame at the back, 51 the pulleys at the back and 52 the pulleys at the front, which pulleys 51, 52, are mounted in the extensions 53, of the wooden guards 54 for the pole piece edges—see also Fig. 6. The several belts 41—see Fig. 2—run transversely of and above the main conveyor belt 13. 55, in Fig. 4, represents the receiver or discharge hopper for the material which is separated in the zone 11^a of the auxiliary pole 11. Discharge hoppers similar to 55 will be provided for the other two transverse belts 41.

56 is the switch board which is provided with the requisite equipment for the separator; 57, 58 the rheostats for increasing or decreasing the current supply to the poles; 59 the main speed rheostat and 60 the motor starter. It will, of course, be understood that the construction and arrangement of the various parts 56—60 will be designed according to the particular requirements of the separator.

In Fig. 5, which illustrates the preferred arrangement of, and adjusting means for, the separating zones 4, 7, and 11^a, to a larger scale, the principal parts shown are the auxiliary pole 11, the main upper and lower poles 2, 5, and 3, 6, respectively, the coils 8, 9, for energizing the said poles, the cores 8^a 9^a, of the said poles, the main conveyor belt 13, and three cross belts 41, for the respective poles, the wooden guards 54 at the pole piece edges 10 (the pole pieces in this construction have single edges) the adjusting bolts 2^c, 5^c, suspending the upper pole system, timbers 3^a, 6^a, supporting the lower pole system, the main conveyor belt pulleys 17, 18, the tapper 63, mechanically or electrically operated, bolts 64 holding the pole pieces 2, 3, 5, 6, to the cores 8^a, 9^a, and the soft iron distance pieces 2^b, of various thicknesses, and held in place by bolts 65 passing through them into the lower pole piece 2^a.

The auxiliary pole 11, in this arrangement, is adapted to be energized by the separate coil 66, disposed around it, the pole forming the core therefor. 11^a, 4 and 7 indicate the three separating zones.

The several coils 66, 8 and 9 are energized by dynamic current.

The coil 66 is so controlled by means of a reversing switch, adjustable rheostat and terminal panel that the current passing through the coil can be reversed, and raised or lowered in value, thus changing the polarity of pole 11, and increasing or decreasing its magnetic strength the effect being to produce a "bucking," neutral or "boosting" action as regards magnetic action.

The coils 8, 9, have their connections so arranged by means of a terminal panel and suitable rheostats that they can be operated

in parallel or series with various current values, as desired; or by means of the terminal panel the coil 8 can be energized only; or if required the coil 9 can be energized only, thus permitting various combinations of magnetic strengths to be obtained in the separating zones.

As will be seen the lower magnetic pole system is fixed, the upper pole faces being underneath and in contact with the main conveyor belt.

The upper pole system is adjustable as to height, pole 11 being adjustable separately to poles 2, 5, and the one pole 2 is so constructed or combined with its detachable pole shoe 2^a that by means of the distance pieces or plates 2^b, the separating zone at this point can be adjusted independently of the other separating zone poles by either adding or subtracting magnetic plates; or, when desirable, substituting in place of the magnetic plates a type of non-magnetic plate or plates which will introduce a predetermined reluctance gap in the magnetic circuit. This construction of the pole 2 permits of any desired adjustment at the separating zone, without disturbing the alignment of the poles 2, 3.

As will be understood, an ore passing along the conveyor belt may be subjected at will to magnetic influence with varying combinations of magnetic strength, so controlled that various re-acting separating zones are established, thus dealing with a large variety of minerals and the like.

By means of magnetic effects, as hereinbefore stated, a large number of separating zone values are obtainable, some of which are as follows:—

(1) the coil 66 only being energized by direct current; or (2) the coils 66 and 8 being energized by direct current; or (3) the coils 8 and 9 being energized by direct current; or (4) the coils 66, 8 and 9 being energized by direct current; or (5) 1, 2, 3, and 4 occurring with various current values due to rheostatic control; or (6) 1, 2 and 4 occurring but with coil 66 receiving reversed current to that previously sent through the coil; or (7) the above combination being used, but the separating zone 4 being varied by altering the number of magnetic plates 2^b or introducing non-magnetic plates in their stead.

The above and other combinations are possible, each of course, dependent upon circuit connections, rheostatic control, current direction, potential and magnetic gap values and moments of magnetic forces acting at the same moment.

The device or tapper 63, previously described, serves the function that the particles of ore on the belt 13, after passing through the separating zone 4 will be rearranged for treatment at zone 7.

In Fig. 6, a side view of the pole 2 is illustrated showing the wooden guards 54 lengthened to carry the pulleys 51, 52, for the cross belt 41, thus ensuring an exact alignment of the cross belt 41 so that in raising or lowering the pole 2 the cross belt 41 is automatically placed in correct register. This figure also illustrates the details of the parts 12^a which serve for regulating the height of the auxiliary pole, 11.

In some separators it is the practice to cant the upper pole system to obtain various magnetic gaps at the separating zones 4, 7, and by so doing the pole shoe centers of the zones are out of alignment in respect to the lower poles; thus creating a magnetic un-balance. By the arrangement of plates 2^b, however, the pole system is raised vertically without cant, and the pole gap varied by the detachable plates 2^b as desired; thus this adjustment is secured and the magnetic alignment maintained without undue magnetic strains being imposed or magnetic leakage increased.

The arrangement of detachable adjusting plates 2^b is not restricted to any particular pole, as it may be convenient to place the arrangement on several poles.

It may be found advantageous to employ a main conveyor belt made of a suitable non-magnetic metal such as brass or other suitable alloy. This would allow of the construction and employment of a strong but very thin conveyor belt, which would reduce the distance the materials or concentrates under separation are from the faces of the lower pole pieces, thereby effecting better separation of the material.

What we claim as our invention and desire to protect by Letters Patent is:—

1. A magnetic separator comprising an upper adjustable pole system and a lower opposing fixed pole system, certain of the pole pieces of the upper pole system being constructed in parts and having means consisting of detachable distance pieces interposed between said parts for varying the pole gap independently of the adjusting means of said upper pole system.

2. A magnetic separator comprising an upper adjustable pole system and a lower opposing fixed pole system, certain of the pole pieces of the upper pole system being adjustable to vary the pole gap independently of the adjusting means of said upper pole system, an auxiliary pole, means for adjusting said auxiliary pole independently of the main pole system, and a separate coil disposed around said auxiliary pole.

3. A magnetic separator comprising upper and lower pole systems, a main conveyor belt, pulleys therefor, a cross belt for each zone of the pole systems, pulleys for said cross belts, and guards for the edges of the pole pieces, said guards having extending

parts to carry the pulleys for the cross belts, as set forth.

4. A magnetic separator comprising an upper pole system and a lower pole system
5 providing a plurality of separating zones, a main conveyor belt for conveying the material through said separating zones, a cross belt for each separating zone and a device positioned intermediate the separating zones
10 for re-arranging the particles of the material on the main belt in its passage between the zones.

5. A magnetic separator comprising an upper pole system and a lower pole system,

a main conveyor belt, pulleys therefor, a 15 cross belt for each zone of the pole systems, pulleys for said cross belts, and driving means for said belts including straight belts, as set forth.

In testimony whereof we have signed our 20 names to this specification in the presence of the two subscribing witnesses on this 6th day of April, 1921.

LEON BYRON WOODWORTH.
SAMUEL THOMAS TREGASKIS.

Witnesses:

L. A. GINSBERG,
CHAS. OVENDALE.