

March 26, 1957

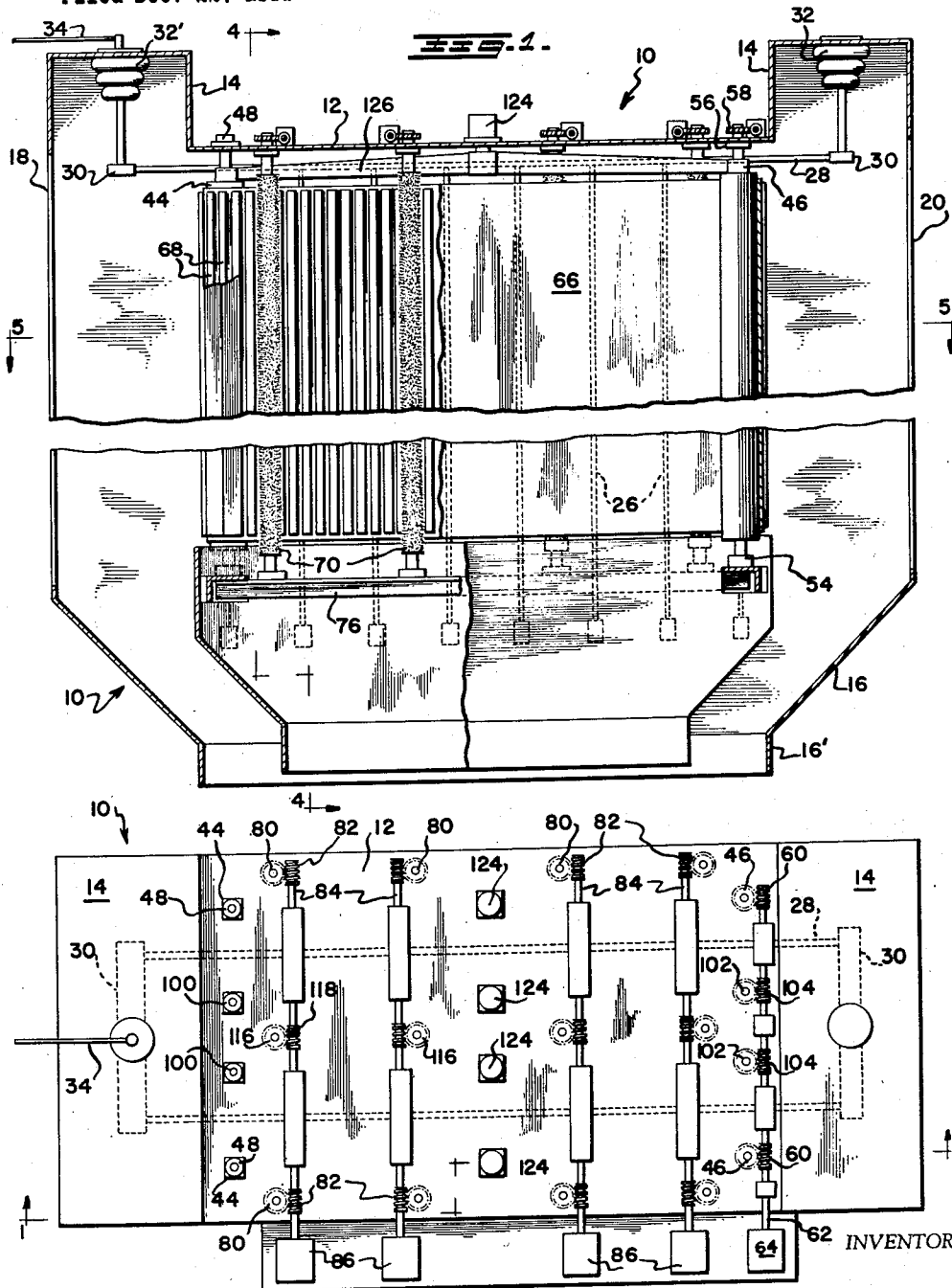
L. M. ROBERTS

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COMBINED ELECTROSTATIC AND MAGNETIC SEPARATOR

Filed Dec. 22, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

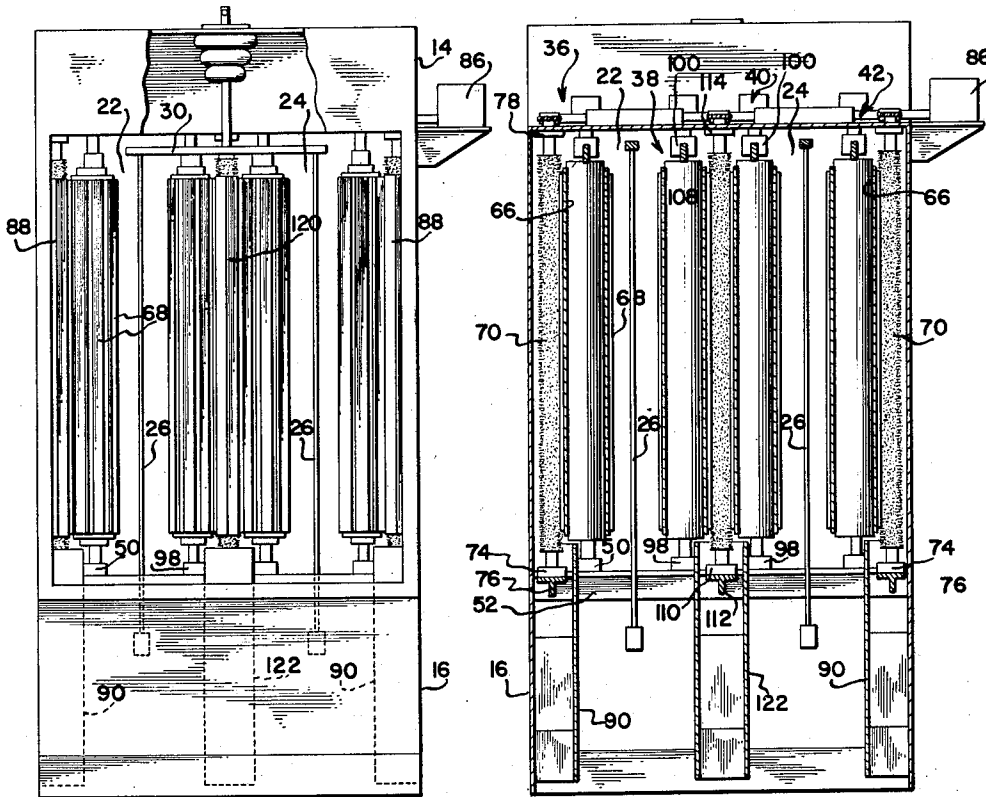


Fig. 3.

Fig. 4.

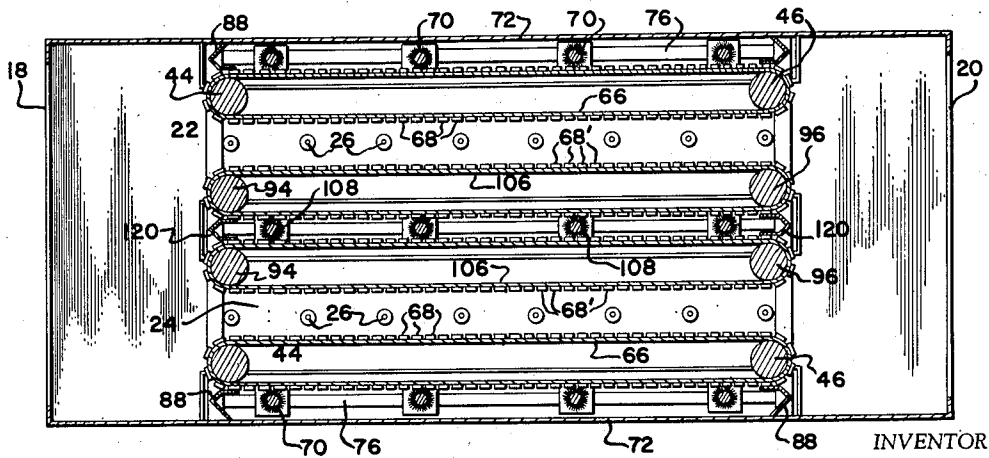


Fig. 5.

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COMBINED ELECTROSTATIC AND MAGNETIC SEPARATOR

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Application December 22, 1955, Serial No. 554,763

9 Claims. (Cl. 209—127)

This invention relates to electrical precipitation apparatus and particularly and specifically to apparatus for combining magnetic and electrostatic fields for collection of gas born particulate materials.

In the beneficiation of the magnetic type iron ores such as the magnetic taconites, it is necessary to separate the magnetic portion of the ore from the gangue or tailings. In general, this is accomplished by pulverizing the ore and subjecting the pulverized mixture of magnetic material and gangue to a source of magnetism whereby the magnetic portion is removed. Through the use of magnetic concentration of the ores an ore containing from about 15 to 20 percent iron may be beneficiated to the extent that the treated material will contain as much as 65 percent iron.

Before the ore can be subjected to magnetic separation it must be pulverized to a relatively small size by means of mills or grinders. In the case of dry mills where the ore is comminuted in a dry form, the mills are vented through dust collection equipment for removal of the milled ore from the venting gas stream. The dust collected in the dust collectors is then passed to hoppers for storage purposes from which the collected dust is later passed to magnetic separators within which the magnetic portion is removed from the tailings.

It is a primary object of the present invention to provide apparatus for combining magnetic and electrostatic fields for the separate collection of magnetic and non-magnetic materials whereby the beneficiation of iron ores of the magnetic type may be efficiently and economically carried out.

It is a further object of the present invention to provide apparatus for use in mills where the beneficiation of iron ores of the magnetic type is carried out, which will substantially reduce the danger from silicosis.

A further object of the present invention is to provide apparatus of relatively simple construction which will readily separate and individually collect materials of the magnetic and the non-magnetic type.

Another object of the present invention is the provision of a new and improved electrostatic precipitator apparatus including permanent magnetic structures associated with the collecting electrodes of the precipitator to provide magnetic fields across the paths of gas flow in the precipitator.

These and other objects and advantages are provided by the electrical precipitation apparatus which generally includes a shell or housing, a gas inlet and a gas outlet in the housing, spaced discharge and collecting electrodes within the housing establishing electrostatic fields in the path of gas flow between the inlet and the outlet, means associated with the collecting electrodes establishing magnetic fields thereon, and between the surfaces of opposed collecting electrodes, across the path of gas flow through the precipitator, and means for separately removing magnetic and non-magnetic materials collected upon the collecting electrodes.

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The present invention will be more particularly described with reference to the accompanying drawings wherein:

Fig. 1 is a vertical, sectional view of a precipitator embodying one form of the construction constituting the present invention substantially on line 1—1 of Fig. 2;

Fig. 2 is a top plane view of the apparatus shown in Fig. 1;

Fig. 3 is a side elevational view of the precipitator shown in Fig. 1;

Fig. 4 is a sectional view substantially on line 4—4 of Fig. 1; and

Fig. 5 is a section substantially on line 5—5 of Fig. 1.

Referring to the drawings 10 generally designates a housing or shell for the dust collecting apparatus of the present invention. The housing is provided with a top portion 12 having associated therewith a pair of insulator housings 14, a hopper bottom 16 provided with an outlet for collected non-magnetic material 16', a gas inlet 18, 20 and a gas outlet 20.

Within the housing 10 and extending between the gas inlet 18 and the gas outlet 20 are a pair of parallel gas passages 22 and 24. Centrally disposed in each of the gas passages 22 and 24 are a plurality of vertically extending discharge electrodes 26. The discharge electrodes are suspended from their upper ends by a high tension frame comprising bus bars 28 and end cross members 30, which end cross members are secured to insulators 32 and 32' carried within the insulator housings 14. The insulator 32' is provided with a conductor 34 for directing high voltage electricity to the discharge electrodes 26 from a source not shown in the drawings.

The lateral walls of the gas passages 22 and 24 are formed by the novel collecting electrode systems of the present invention generally designated 36, 38, 40 and 42. The outermost pair of collecting electrode units 36 and 42 are identical in form and the inner pair of collecting electrode units 38 and 40 are identical.

The outer pair of collecting electrode units 36 and 42 generally comprise a pair of rollers 44 and 46 positioned one at each end of the gas treating passages 22 or 24 with the axis of the roller extending in a vertical direction. The upper ends of rollers 44 are rotatably supported in bearings 48 secured to the top 12 of the casing 10, while the lower ends thereof are supported in bearings 50, Figs. 3 and 4, carried by support members 52 suitably secured to the housing structure. The lower ends of rollers 46 are rotatably supported in bearings 54 also carried by frame 52, however, the upper ends of rollers 46 pass through bearings 56 and are provided with gears 58 which mesh with worm gears 60 connected to drive shaft 62 driven by a suitable motor generally designated 64.

An endless belt 66 is carried by each pair of rollers 44 and 46 to travel thereabout and extend the entire height of the gas treating zone. The bands or belts 66 may be constructed of thin brass, conductive synthetic or natural rubber or other suitable material. Secured to the outer run of the belts 66 in spaced relationship are a plurality of vertically extending bars 68 constructed of magnetic material. The bars 68 are of the permanent magnetic type with the direction of magnetization parallel to the thickness thereof so that a substantially uniform magnetic field is provided throughout their length. Good results are obtained when the bars are secured to the belts 66 so that the polarity of each of the plurality of magnetic bars 68 on a belt is in the same direction. Square bar, round, semi-circular, horseshoes or other standard shape magnets may be employed in association with the endless belts and the endless belts may be positioned with the belt axis at right angles to the direction of gas flow instead of parallel thereto as shown in the drawings.

Also associated with each of the collecting electrode units 36 and 42 are a plurality of substantially cylindrical brushes positioned with their axis of rotation parallel to the axis of rotation of the rollers 44 and 46. The brushes are positioned between the side walls 72 of the casing 10 and the outer run of the endless belts 66 remote from the discharge electrodes 26. Each of the brushes 70 are rotatably supported at their lower ends in bearings 74 carried by frame members 76. The upper ends of the brushes 70 pass through bearings 78 and are provided with gear wheels 80 which gear wheels mesh with worm gears 82. The worm gears 82 are secured to shafts 84 extending transversely across the top 12 of the casing 10. Each of the plurality of shafts 84 is drivably connected to a motor generally designated 86 whereby the brushes 70 are rotated to remove magnetic susceptible materials from the permanent magnetic bars 68 as to be more fully described hereinafter.

As more clearly shown in Fig. 5 of the drawings the space between the outermost surface of each of the endless belts 68 and the sidewalls of the casing 72 between which the cylindrical brushes 70 are mounted is separated from the main gas passage by end plates or baffles 88 positioned at the leading and trailing edge of the gas treating zone to provide a quiescent zone to prevent resuspension of the magnetic materials removed from the magnetic bars by the brushes 70. Projecting upwardly from the lower hopper bottom 16 of the casing 10 are dust chutes 90 for each of the collector electrode units 36 and 42 which terminate at their upper ends in the zone, defined by the baffles 88, the outer pass of the endless belt 68 and the walls 72 of the casing 10 whereby the magnetic susceptible material removed by the brushes may be separately collected and removed from the casing.

The collecting electrode units 38 and 40 providing the inner boundaries of the gas treating passages 22 and 24 are similar in form and construction to the collecting units 36 and 42 hereinabove described. Collecting units 38 and 40 comprise vertically extending rollers 94 and 96. Rollers 94 are rotatably supported at their upper and lower ends in bearings 98 and 100 respectively while the rollers 36 are supported in bearings at their lower ends and pass through bearings at their upper ends to receive gears 102 which intermesh with worm gears 104. The worm gears 104 are connected to shaft 62 and are driven by motor 64 as previously described with reference to worm gears 60 for the outermost rollers 46.

Between each pair of rollers 94 and 96 of collector electrode units 38 and 40 is an endless belt 106 carrying on the outer face thereof a plurality of spaced, vertically extending permanent magnetic bars 68' which bars have their direction of magnetization parallel to the thickness thereof as described with reference to permanent magnets 68.

Interposed between the opposed faces of endless belts 106 are a plurality of cylindrical, vertically extending brushes 108 similar in shape and construction to the outer rows of brushes 70. The lower ends of brushes 108 are rotatably supported in bearings 110 carried by frame members 112 while the upper ends of the brushes pass through bearings 114 and receive on their ends gears 116 which mesh with worm gears 118 secured to shafts 84, driven from motor 86 as previously described with reference to brushes 70. As more clearly shown in Figs. 4 and 5 of the application drawings, while brushes 70 remove magnetic susceptible material from only one endless belt, the brushes 108 are positioned to remove collected magnetic susceptible materials from both of the endless belts of collector electrode units 38 and 40.

Baffle members 120 are provided between the endless belts 106 to provide a quiescent zone therebetween. A dust chute 122 extends from below the lower extension of the collecting electrodes 38 and 40 to receive magnetic material removed by brushes 108 from the magnets 68'

and convey the collected material through the hopper 16 for separate collection.

In order to remove the non-magnetic susceptible material from the collecting electrode units 36, 38, 40 and 42 each of the units is provided with a rapper device generally designated 124 of conventional electrical or pneumatic type. The rappers 124 are positioned to strike vibration transmitting bars 126 which extend between each pair of rollers 44 and 46, and 94 and 96, whereby the collecting electrode units are vibrated upon actuation of the vibrator or rapper devices 124.

In operation of the apparatus of the present invention, motors 64 and 86 are energized so that the brushes 70 and 108 are rotated and the endless belts 66 and 106 carrying the permanent magnets are actuated to continuously pass the permanent magnetic bars 68 and 68' into the gas treating passages 22 and 24 and then into the cleaning passages past the rotating brushes 70 and 108. The high tension discharge electrodes 26 are energized and a stream of gas carrying both magnetic susceptible and non-magnetic materials is passed through the housing from the inlet 18 to the outlet 20 through the gas treating passages 22 and 24. As the gases carrying the suspended magnetic and non-magnetic materials pass through the treating zones the suspended particulate materials are precipitated and collected upon the collecting electrode units 36, 38, 40 and 42. The magnetic portions of the suspended material are held by the magnetic bars 68 and 68' so that upon operation of the rapper devices 124 the non-magnetic precipitated particulate material is vibrated from the bars and the spaces therebetween to fall into the hopper structure 16 for collection and disposal as well known in the art. Due to the magnetic attraction between the permanent magnets 68 and 68' and the magnet susceptible material the vibrating or rapping shocks imparted to the collecting electrodes by rappers 124 do not remove these particles. The magnetic particles, however, are removed by the rotating brushes 70 and 108 as the plates or bars 68 and 68' pass into the quiescent zones between the baffles 88 and 120. The magnetic susceptible material removed by the brushes 70 and 108 fall through dust chutes 90 and 122 for separate collection.

The gas stream issuing from the outlet 20 of the collecting apparatus is free of both suspended non-magnetic and suspended magnetic susceptible materials and may be discharged to atmosphere or recirculated through conventional ore grinding apparatus to pick up further finely ground particles to be separated in the novel apparatus of the present invention.

From the foregoing description it will be seen that the present invention fully accomplishes the aims and objects hereinbefore set forth. It will be further evident that various modifications may be made in the form of the apparatus without departing from the principles of the invention. For example, the rotating brushes 70 and 108 for removing the magnetic susceptible particles from the permanent magnetic bars carried by the endless belts could be replaced by streams of compressed gases or by streams of liquid directed against the magnetic bars where it is desired to collect the magnetic susceptible particles in a slurry form.

Having described my invention and its uses in a preferred embodiment, what is claimed as my invention is:

1. Gas cleaning apparatus comprising a housing having a dirty gas inlet and a clean gas outlet, extended surface collecting electrodes and complementary discharge electrodes positioned in said housing between the gas inlet and gas outlet, said collecting electrodes comprising a non-magnetic base member and a plurality of magnet elements secured to the non-magnetic base member.

2. Gas cleaning apparatus comprising a housing having a gas treating zone therein, a dirty gas inlet and a clean gas outlet for the gas treating zone, extended surface

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collecting electrodes and complementary discharge electrodes positioned in said housing between the gas inlet and the gas outlet, said collecting electrode comprising a non-magnetic base member and a plurality of magnet elements secured to the non-magnetic base members, and means connected to the collecting electrode for moving the magnet elements into and out of the gas treating zone.

3. Gas cleaning apparatus comprising a housing having a gas treating zone therein, a dirty gas inlet and a clean gas outlet for the gas treating zone, extended surface collecting electrodes and complementary discharge electrodes positioned in said housing between the gas inlet and the gas outlet, said collecting electrode comprising a non-magnetic base member and a plurality of magnet elements secured to the non-magnetic base member, means connected to the collecting electrodes for moving the magnet elements into and out of the gas treating zone, means for removing collected non-magnetic materials from the collecting electrodes in the gas treating zone and means for removing collected magnetic materials from the collecting electrodes outside of the gas treating zone.

4. Gas cleaning apparatus comprising a housing having a gas treating zone therein, a dirty gas inlet and a clean gas outlet for the gas treating zone, extended surface collecting electrodes and complementary discharge electrodes positioned in said housing between the gas inlet and the gas outlet, said collecting electrodes comprising a non-magnetic base member and a plurality of magnet elements secured to the non-magnetic base member, means connected to the collecting electrodes for moving the magnet elements into and out of the gas treating zone, means for removing collected non-magnetic materials from the collecting electrodes in the gas treating zone, means for removing collected magnetic materials from the collecting electrodes outside of the treating zone and means for separately conveying from the housing the removed magnetic and non-magnetic materials.

5. Gas cleaning apparatus comprising a housing having a gas treating zone therein, a dirty gas inlet and a clean

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gas outlet for the gas treating zone, vertically extending discharge electrodes positioned in said gas treating zone, an endless belt, spaced means mounting said endless belt to position a portion of the surface thereof in spaced parallel relation to the discharge electrodes and means for moving said belt about said mounting means whereby the face of said belt is progressively passed adjacent the gas treating zone and thereafter adjacent a zone spaced from the gas treating zone and a plurality of magnet elements secured to the endless belt.

6. The invention defined in claim 5 wherein the magnet elements comprise elongated permanent magnet bars.

7. The invention defined in claim 6 wherein the direction of magnetization of the bars is parallel to the thickness thereof.

8. Gas cleaning apparatus comprising a housing having a gas treating zone therein, a dirty gas inlet and a clean gas outlet for the gas treating zone, vertically extending discharge electrodes positioned in said gas treating zone, an endless belt, spaced means mounting said endless belt to position a portion of the surface thereof in spaced parallel relation to the discharge electrodes and means for moving said belt about said mounting means whereby the face of said belt is progressively passed adjacent the gas treating zone and thereafter adjacent a zone spaced from the gas treating zone, a plurality of magnet elements secured to the endless belt, means for removing collected non-magnetic materials from the collecting electrodes in the gas treating zone and means for removing collected magnetic material from the collecting electrodes in the zone spaced from the gas treating zone.

9. The invention in claim 8 wherein the means for removing collected magnetic material comprises brush means mounted in the zone spaced from the gas treating zone.

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