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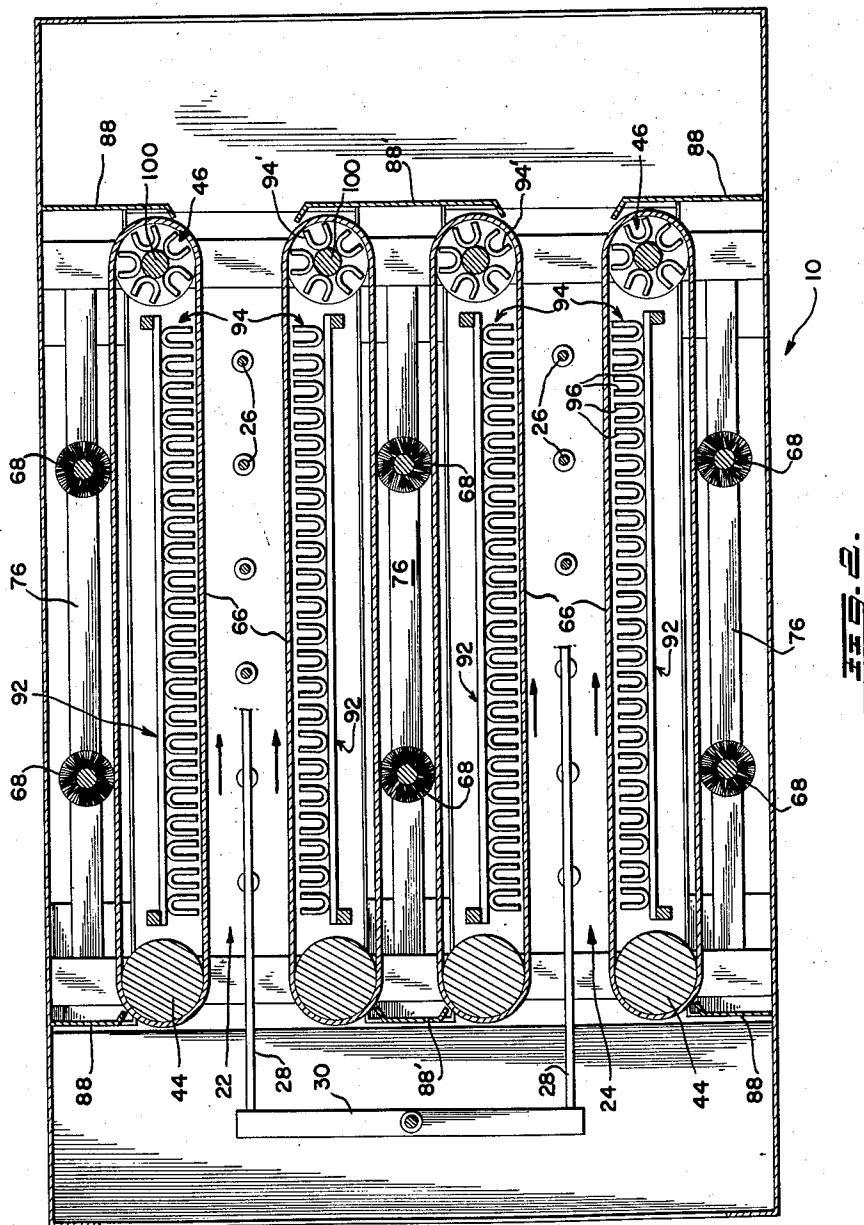
L. M. ROBERTS

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COMBINED ELECTROSTATIC AND MAGNETIC SEPARATOR

Filed Feb. 6, 1957

4 Sheets-Sheet 2



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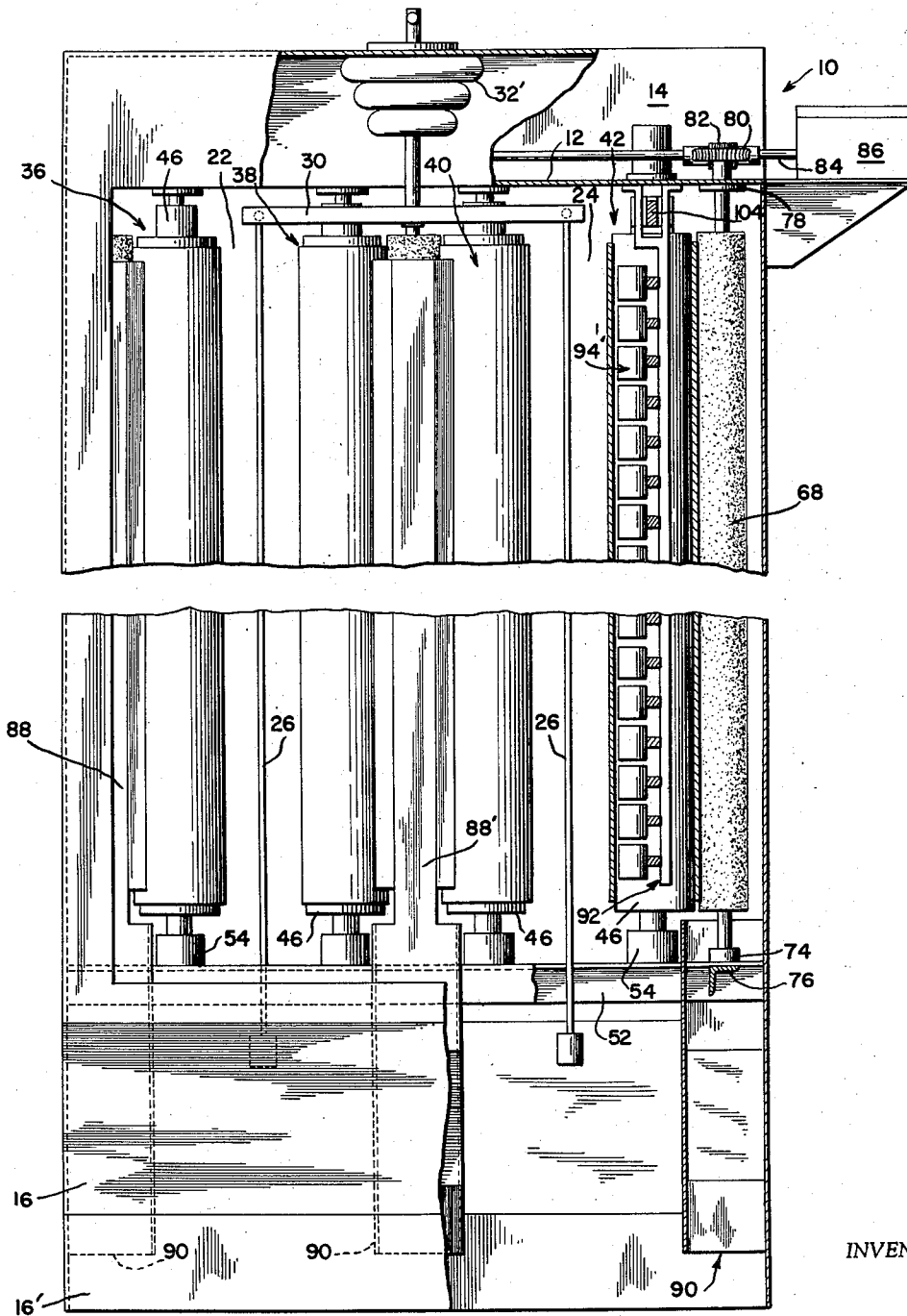
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FIG 4.

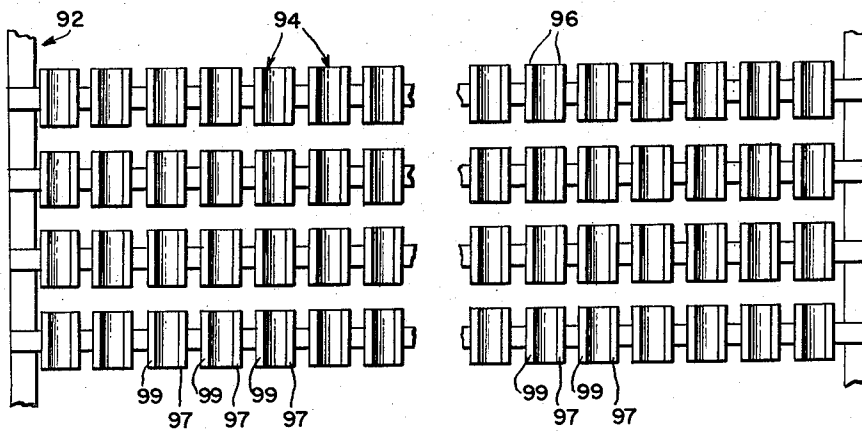
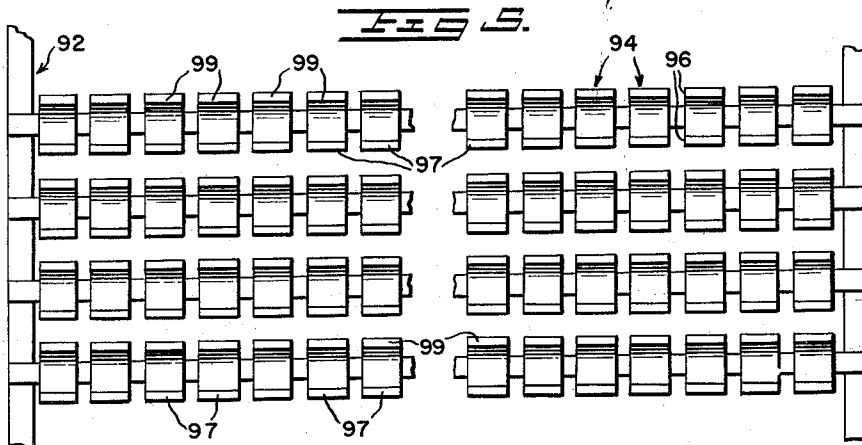


FIG 5.



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COMBINED ELECTROSTATIC AND MAGNETIC SEPARATOR

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4 Claims. (Cl. 209—12)

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 in 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 gas cleaning apparatus including a housing having a gas treating zone therein, a dirty gas inlet and 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 extended surface element having one face positioned in parallel spaced relationship to its complementary discharge electrode, a plurality of magnet elements positioned adjacent the other face of said extended surface element, and means for moving said extended

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surface element relative to the magnet elements through the gas treating zone.

The present invention will be more particularly described with reference to the accompanying drawings 5 wherein:

Fig. 1 is a vertical, section through one form of gas treating apparatus constructed in accordance with the teachings of this invention;

Fig. 2 is a section substantially on line 2—2 of Fig. 1;

Fig. 3 is an end view in partial section of the gas treating apparatus shown in Fig. 1;

Fig. 4 is an enlarged sectional view showing the arrangement of permanent magnets of one collecting unit;

Fig. 5 is a view similar to that shown in Fig. 4 of a modified form of the present invention.

Referring to Figs. 1 through 4 of 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, 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, (Fig. 3).

Each collecting electrode unit generally comprises a pair of rollers 44 and 46 positioned respectively at the inlet and outlet ends of the gas treating passages 22 and 24 with the axis of the rollers 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, carried by support members 52 suitably secured to the housing structure. The lower ends of rollers 46 are rotatably supported in bearings 54 while the upper ends are supported in bearings 56 and are provided with gears 58 which mesh with worm gears 60 connected to drive shaft 62 driven by a suitable motor, as shown in detail in my copending application, Serial No. 554,763, filed December 22, 1955, now Patent No. 2,786,575, issued March 26, 1957.

An endless belt 66 is supported between 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 non-magnetic material.

Associated with each of the collecting electrode units are a plurality of substantially cylindrical brushes 68 positioned with their axis of rotation parallel to the axis of rotation of the rollers 44 and 46. The brushes are positioned within the casing 10 to contact the outer run of the endless belts 66 remote from the discharge electrodes 26. Each of the brushes 68 are rotatably supported at their lower ends in bearings 74 carried by frame members 76. The upper ends of the brushes 68 pass through bearings 78 and are provided with a gear 80 which gear meshes with worm gear 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 68 are rotated to aid in the removal of magnetic susceptible materials from the belts 66 as to be more fully described hereinafter.

As more clearly shown in Fig. 2 of the drawings the space between the outermost surface of each of the endless belts 66 and the sidewalls of the casing 10, between which the cylindrical brushes 68 are mounted, is separated from the main gas passage by end plates or baffles 88 positioned at the leading and trailing ends of the gas treating zone to provide a quiescent zone to prevent resuspension of the magnetic materials falling from the belts in said zones.

The space between the inner pair of endless belts, housing brushes 68, is similarly separated from the main gas passage by end plates 88' positioned at the leading and trailing end of the gas treating zone to prevent resuspension of magnetic materials removed from the inner run of said belts.

Projecting upwardly from the lower hopper bottom 16 of the casing 10 are dust chutes 90, for each of the collecting electrode units, which terminate at their upper ends in the zone, defined by the baffles 88 and 88' whereby the magnetic susceptible material removed from the belts may be separately collected and removed from the casing.

Associated with each of the plurality of endless belt type extended surface collecting electrodes is a frame 92. The frames are supported at their upper ends to the top 12 of the collector housing as shown in Fig. 3 of the drawings. Each of the frames 92 supports a plurality of permanent magnets 94.

Referring specifically to Fig. 4 of the application drawings there is shown an enlarged fragmentary view of one of the stationary grids of magnetic elements which includes the frame 92 supporting the individual magnets 94 which are shown by way of example as horseshoe or U-shaped magnets having spaced legs 96. The magnets 94 are positioned upon the frame to provide an array of magnets with the pole faces 97 and 99 thereof arranged in a plurality of parallel rows with each row aligned in the direction of travel of the endless belts 66 of the extended surface collecting elements. In the preferred embodiment of the present invention pole faces 97 and 99 are dissimilar whereby any particle of magnetic material collected upon the surface of the travelling belts 66 is caused to reverse polarity as the particle is moved across the face of the array of magnets by movement of the endless belts. The relative change in polarity of the pole faces of the magnets acting upon the particles on the surface of the moving belt causes the magnetic particles to constantly move which movement aids in the release of non-magnetic particles which may be entrapped in a cluster of magnetic particles.

These improved results have been found to be particularly apparent when the materials to be collected and separated are finely ground. With finely ground materials of mixed magnetic and non-magnetic properties applicant has found that clusters of magnetic susceptible materials trap non-magnetic particles therein. The changing polarity of the magnetic fields acting upon the belt carried particles results in movement of the magnetic susceptible particles on the endless belts permitting a large portion of the non-magnetic particles trapped in clusters to be released.

While the horizontal parallel rows of U-shaped permanent magnets 94 are effective in maintaining magnetic susceptible particles upon the surface of the endless belts 66 as the belts pass through the gas treating zones 22 and 24 it is necessary to carry the magnetic particles about the rollers 42 adjacent the gas outlet end of the housing in order to conduct said particles into the area above collecting troughs 90. This is accomplished by construct-

ing the rollers 46, positioned at the outlet end of the gas cleaning apparatus, of a plurality of vertical rows of U-shaped magnets designated 94' with the base of each magnet secured by bolts or welding to a vertically extending shaft 100.

The upper and lower ends of the shaft, as hereinbefore described, are journaled in bearings 54 and 56. The magnets 94' secured to the rotatable shaft 100 of each roller 46 are also arranged as more clearly shown in Fig. 1 in rows corresponding to the rows of U-shaped magnets 94 supported on frames 92.

With this arrangement of U-shaped magnets rotatable with the shafts 100 of each of the pulleys 46 the magnetic susceptible particles maintained in contact with the belts 66 by magnets 94 are carried about the pulleys into the magnetic susceptible particle discharge areas above the troughs 90.

In order to insure the removal of non-magnetic susceptible material from the surfaces of the endless belt collecting electrodes 66, each of the collecting electrode units may be provided with a rapper device generally designated 102 of conventional electrical or pneumatic type. The rappers 102 are positioned to strike vibration transmitting bars 104 which extend between each pair of rollers 44 and 46 whereby the collecting electrode units are vibrated upon actuation of the vibrators 102.

In operation of the apparatus shown in Figs. 1 through 4 of the drawings, the motors for driving the plurality of rollers 46 and the plurality of brushes 68 are energized so that the brushes 68 are rotated and the endless belts 66 are actuated to continuously pass in the direction of the arrows shown in Fig. 2 through the gas treating passages 22 and 24 and then into the cleaning passages in contact with the rotating brushes. The high tension discharge electrodes 26 are energized and a stream of gas carrying finely ground 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 gas stream carrying the magnetic and non-magnetic particles pass through the treating zones the suspended particulate materials are precipitated and collected upon the surface of the endless belts 66. The magnetic portions of the suspended materials are prevented from falling from the surface of the belts 66 in the gas treating zones 22 and 24 by the plurality of rows of permanent magnets 94. The magnetic particles, with a portion of the non-magnetic particles, held to the surface of the belts 66 by permanent magnets 94 are continuously caused to move about the surface of the belts as the belts carry the particles past the faces of the alternately positioned north and south poles of the magnets. The constant movement of the magnetic particles coupled with the vibration of the belt 66 by vibrators 102 brings about a very effective separation of the magnetic from the non-magnetic particles.

As the magnetic particles collected in the gas treating zones 22 and 24 approach the end of the zones the plurality of permanent magnets secured to the shafts 100 of rollers 46 carry the particles into the quiescent zones of each collecting electrode unit. A large portion of the magnetic particles carried into the quiescent zones fall into the troughs or hoppers 90 as the magnetic fields created by the plurality of permanent magnets 94 and 94' cease to effect the magnetic particles. The magnetic particles which do not fall from the endless belt 66 upon entering the quiescent zones between the baffles 88 and 88' are removed by the brushes 68 and collected in troughs 90.

Referring specifically to Fig. 5 a further embodiment of the present invention is shown wherein the frame 92 has secured thereto a plurality of U-shaped permanent magnets 92 with the pole faces arranged in a plurality of parallel rows aligned in the direction of movement of the endless belt 66. In this form of construction similar poles 99 of each magnet 94 are aligned in rows.

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Magnetic susceptible materials deposited upon the surface of the travelling belts in this form of the invention do not constantly change polarity as the belts carry the particle through the gas treating zones 22 or 24.

When the magnetic array, shown in Fig. 5, is employed in the gas collecting and material separating apparatus of the present invention the discharge rollers 46, as shown in Figs. 1 through 3, are also provided with magnet elements adapted to carry the magnetic susceptible material out of the gas treating zones. Preferably the magnet elements 94' secured to the rotating shafts 100 of the rollers 46 would have their pole faces aligned in a plurality of rings with the polarity of the pole faces similar to and aligned with those in the grids formed by frames 92.

As specifically shown in the illustrated embodiments of the present invention the array of magnetic elements are constructed from U-shaped permanent magnets. However, the magnetic elements may comprise short sections of bars, rods, discs or the like, each of which is secured to a portion of the frame 92 to form the plurality of parallel rows aligned substantially in the direction of movement of the endless belts.

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 68 for removing the magnetic susceptible particles from the travelling belt 66 could be replaced by streams of compressed air or by streams of liquid directed against the travelling belts where it is desired to collect the magnetic susceptible particles in a slurry or suspended form.

Having described my invention and its uses in several embodiments, what is claimed as my invention is:

1. Gas cleaning apparatus including a housing having a gas treating zone therein, a dirty gas inlet and a clean gas outlet for the gas treating zone, extended surface col-

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lecting electrodes and complementary electrodes positioned in said gas treating zone, said collecting electrodes comprising a non-magnetic extended surface element having one face positioned in parallel spaced relation to its complementary discharge electrodes, a plurality of magnet elements positioned adjacent the other face of said extended surface element and means for moving said extended surface element relative to the magnet elements through the gas treating zone.

2. The invention defined in claim 1 wherein the magnet elements comprise an array of magnets having the pole faces thereof arranged in a plurality of parallel rows aligned in the direction of movement of the extended surface element.

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, 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 a 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 positioned adjacent the other face of the endless belt.

4. The invention defined in claim 3 wherein the magnet elements comprise an array of magnets having the pole faces thereof arranged in a plurality of parallel rows aligned in the direction of movement of the extended surface of the endless belt.

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