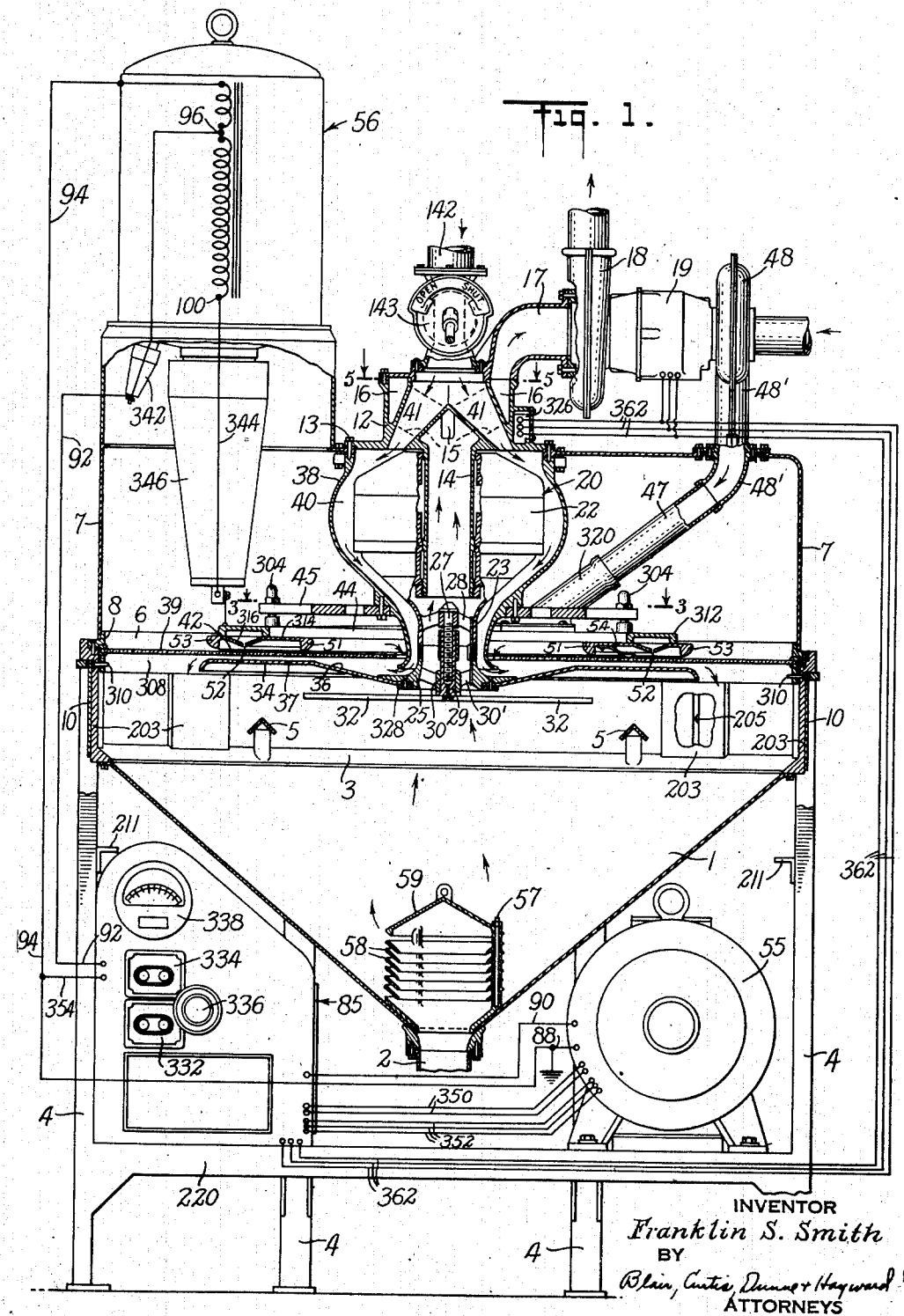
Sept. 30, 1941. F. S. SMITH 2,257,541

APPARATUS AND METHOD OF TREATING BULK MATERIAL

Filed June 26, 1937 4 Sheets-Sheet 1

Fig. 1.

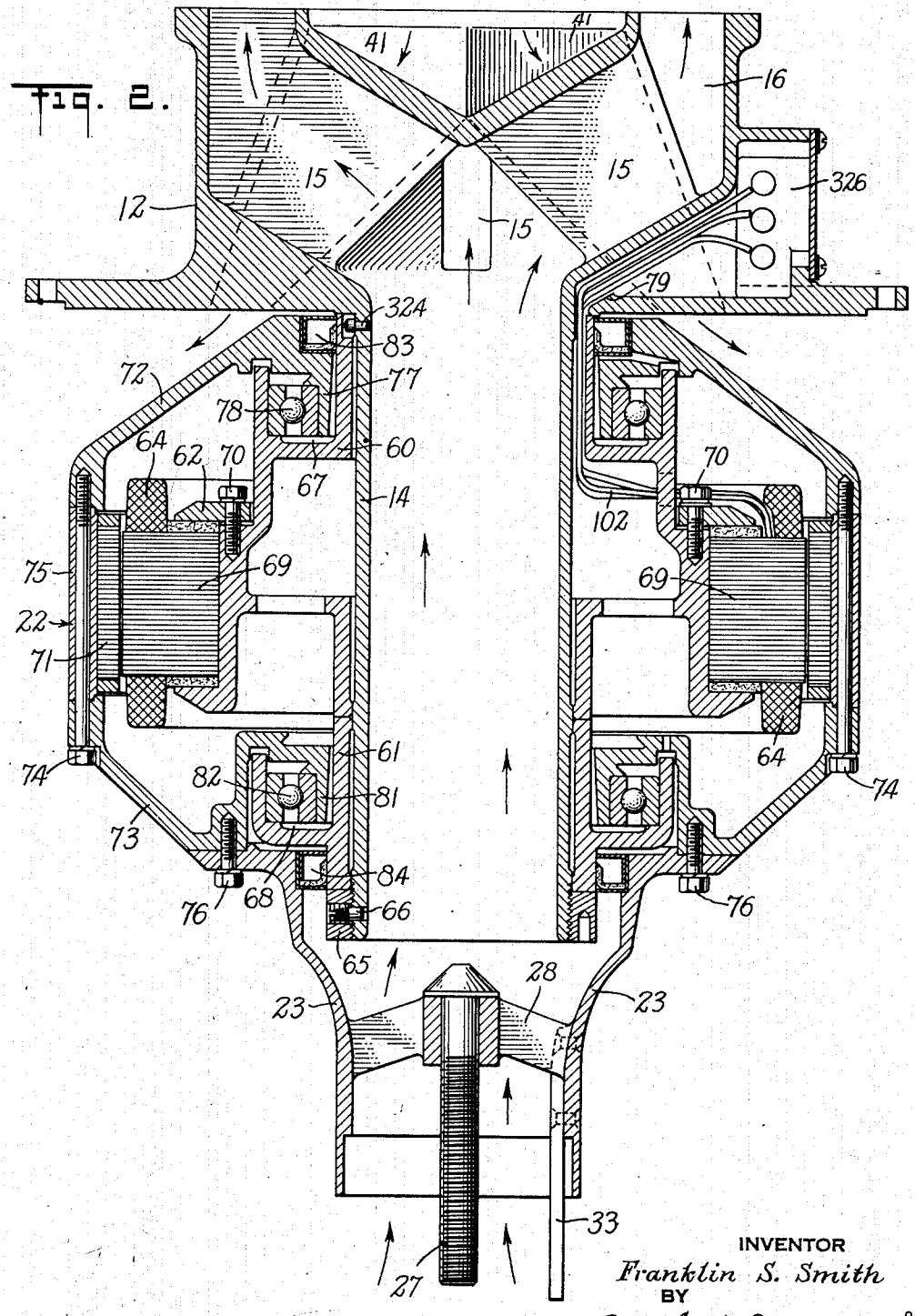


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APPARATUS AND METHOD OF TREATING BULK MATERIAL

Filed June 26, 1937 4 Sheets-Sheet 2

Fig. 2.



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APPARATUS AND METHOD OF TREATING BULK MATERIAL

Filed June 26, 1937 4 Sheets-Sheet 3

Fig. 3.

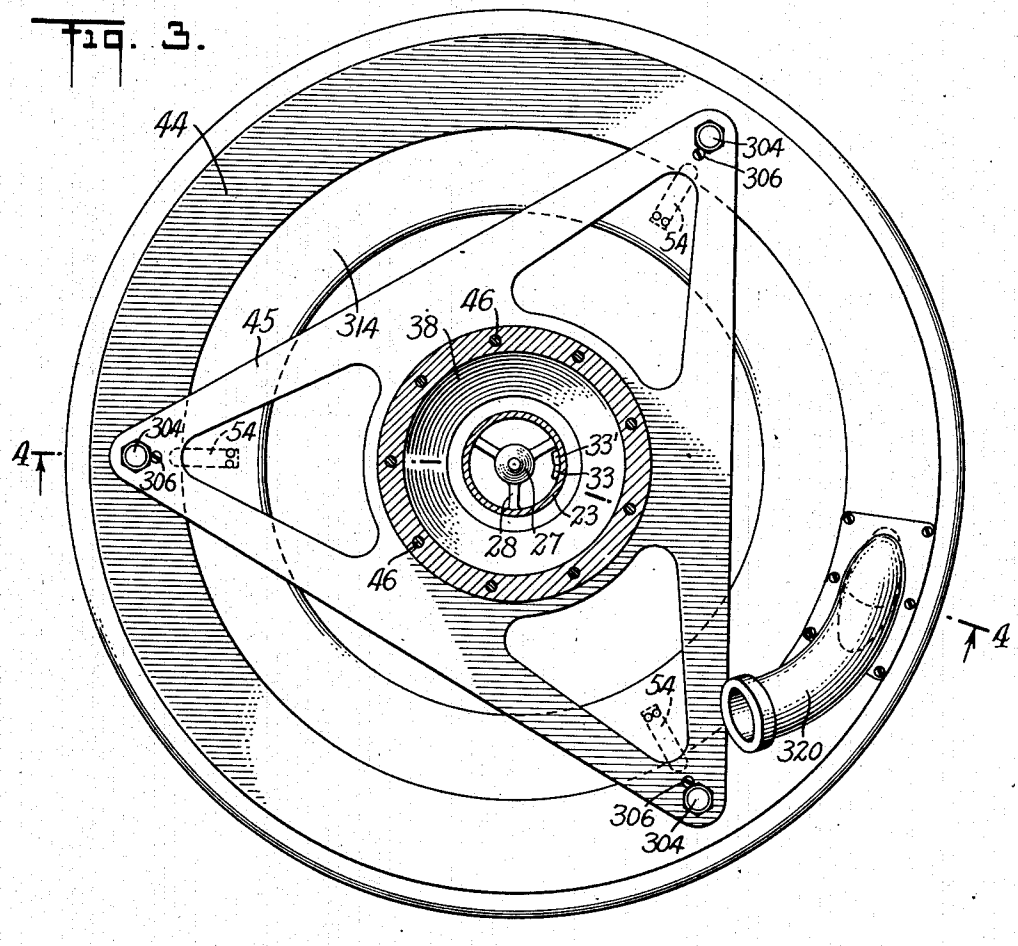
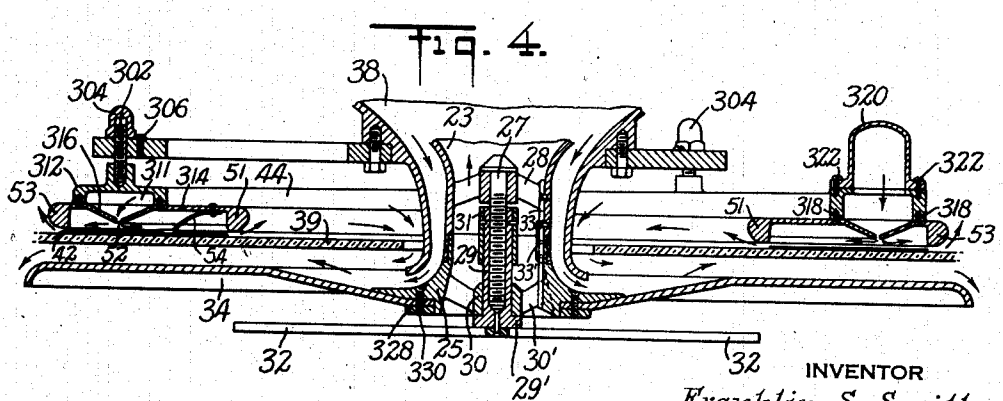


Fig. 4.



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APPARATUS AND METHOD OF TREATING BULK MATERIAL

Filed June 26, 1937 4 Sheets-Sheet 4

Fig. 5.

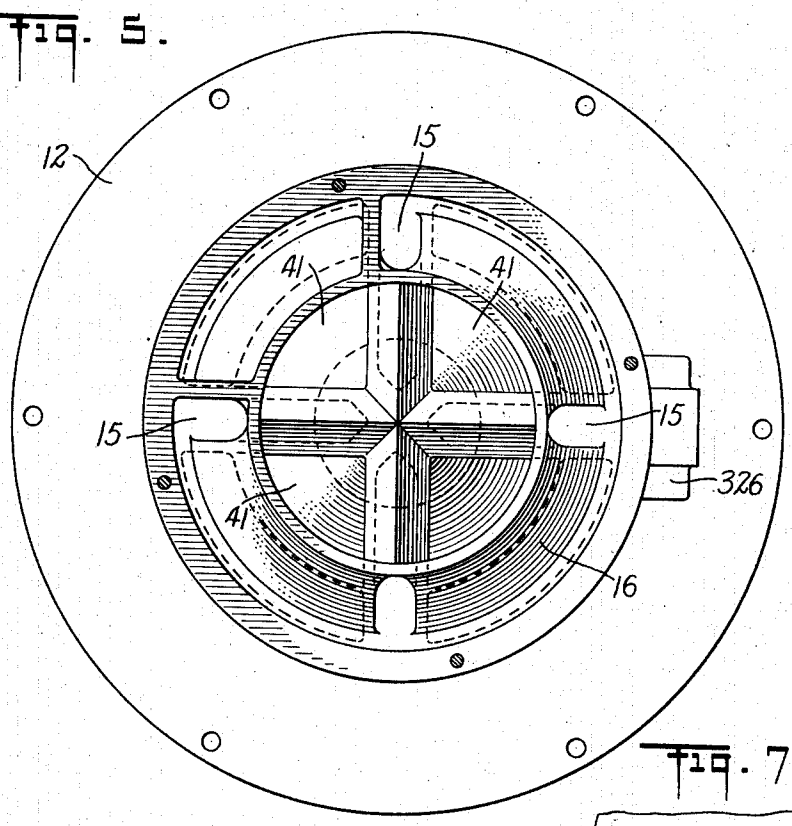


Fig. 7.

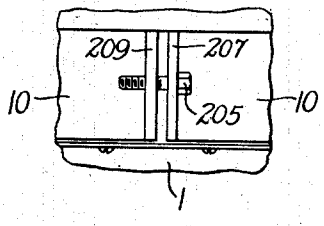
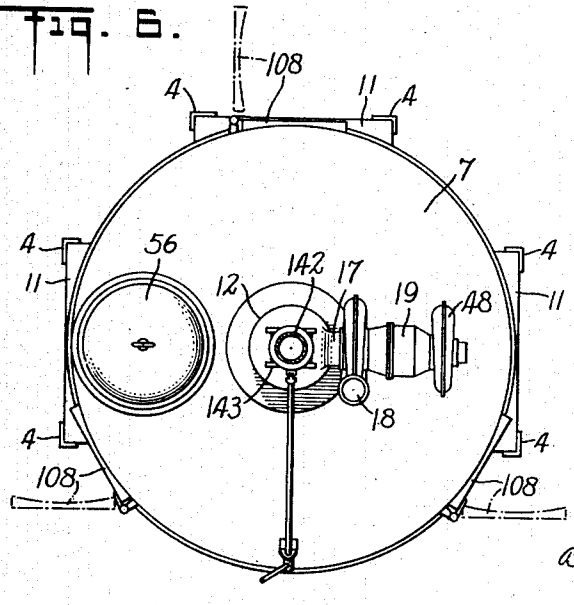


Fig. 6.



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UNITED STATES PATENT OFFICE

2,257,541

APPARATUS AND METHOD OF TREATING BULK MATERIAL

Franklin S. Smith, New Haven, Conn.

Application June 26, 1937, Serial No. 150,522

19 Claims. (Cl. 21—54)

This invention relates to the treatment of materials and more in particular to the art of and apparatus for the electrical treatment of materials for purposes such as the destruction of "insect life," which term as herein used includes the egg, larva, pupa, and adult states of insects.

Among the objects of this invention is the provision of practical apparatus of simple and durable construction and efficient and dependable action. Further objects are to provide apparatus of the above nature for avoiding an explosive mixture of air and dust, for providing and regulating a desired electrical potential, for removing ozone and the like from the finished product, and for the prevention of excessive heat at certain points.

Other objects are to provide practical methods or arts for achieving the above aims which may be readily carried on and shall be characterized by certainty of the desired results.

Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the drawings:

Figure 1 is a view partly in elevation and partly broken away, disclosing the general assembly of the apparatus;

Figure 2 is a vertical sectional view of the motor and certain of its associated parts;

Figure 3 is a horizontal sectional view on the line 3—3 of Figure 1;

Figure 4 is a vertical sectional view on the line 4—4 of Figure 3;

Figure 5 is a horizontal sectional view on the line 5—5 of Figure 1;

Figure 6 is a plan view of the assembled machine; and

Figure 7 is an enlarged view of means for holding band 10 in place.

Certain broad features of this invention contemplate the continuous treatment of materials by high-potential electrical discharges through a gaseous dielectric and the provision of a method and apparatus for carrying on this treatment with safety in a thoroughly efficient and practical manner. An object of this invention is to provide for the treatment, in the above-mentioned manner, of materials such as cereals, seeds, grains, corn, beans, etc.

This treatment is especially effective in completely destroying the insect life of all of the various insects of the type which infest products of relatively small particle sizes, such as coursely milled cereals, semolina, farina, grits, etc. However, in the treatment of products, it has been found that the desirable characteristics, such as viability of seeds, color and baking properties of flour, etc., are unimpaired.

Treatment such as that contemplated in the present invention is particularly important in milling or similar operations where insect life is continually being introduced into the milling machinery by infested grain. Under such circumstances, certain eggs and small larvae are not destroyed during the milling process, but often lodge within the equipment and form foci of infestation where they propagate and spread to the finished material. However, if the grain, or other material, entering the milling equipment is treated in accordance with the teachings of this invention, this insect life will be destroyed and infestation within the equipment will be substantially lessened if it is not completely eliminated.

In the present embodiment, means is provided to pass the grain or other material between two electrodes through an area which is termed the "treatment zone." A relatively high-frequency, high electrical potential is maintained across the electrodes with the result that when the material passes through the zone, an electrical discharge occurs between the electrodes. It has been found that this discharge seeks out and destroys insect life of the nature referred to above.

Very satisfactory results have been obtained with the use of a pair of annular, horizontally positioned, electrodes, the upper electrode being stationary, and the lower electrode being rotatable. During operation, the grain or other material is passed upon the upper surface of the rotatable electrode near its center and moves outwardly due to centrifugal force so that it is thrown through the treatment zone.

Under certain conditions, dust accompanying or forming part of the material being treated, might be so distributed in the oxygen present to form an explosive mixture. However, when desirable, an additional quantity of air, or other gaseous dielectric, such as carbon dioxide, is mixed with the material being treated immediately prior to its passage through the treatment zone; thus, the dust concentration is brought

down below that necessary to form an explosive mixture.

When the material being treated is surrounded by air, the corona-like discharges produce ozone and certain oxides, such as oxides of nitrogen, all of which shall be referred to as "air-ionization products." By providing means for blowing air through the treatment zone with the grain and then providing means for removing air from the machine, the air-ionization products are effectively removed from the treatment zone, and the machine, and, at the same time, heat produced incident to the treatment process is removed from the machine.

The general construction of the illustrative embodiment herein set forth is shown in Figures 1 and 6 where it will be seen that the apparatus is mounted upon a frame of rectangular tubing which includes three pairs of vertical posts 4 (Figure 6), the tops of the posts of each pair being connected by a crossbar 11. Mounted upon crossbars 11 is the upper housing-ring 6 (Figure 1) of a casing-supporting frame. The casing-supporting frame provides mounting means for the entire casing and also includes four downwardly-extending arcuate brace plates 203, supporting a lower housing-ring 3 across which extend two horizontal rails 5. Attached to the under side of lower housing-ring 3 is a funnel-like hopper 1 which receives the treated grain and directs it into an outlet conduit 2.

Mounted in a shoulder on the top inner edge of upper housing-ring 6 is a cover rim 8 which carries cover 7. The flat top of cover 7 supports the electrode structures, the air blower means, the grain inlet means, and other elements including the high voltage transformer, all in a manner that will fully appear below.

Brace plates 203 of the casing-supporting frame are positioned as shown in Figure 1, there being one on each side of the apparatus (shown in section) and two in the back. These plates 203 divide the space between housing-rings 3 and 6 into four arcuate openings through which access may be had to the interior of the machine. One of these arcuate openings extends around the entire front (the bottom of Figure 6) of the machine.

Normally closing these arcuate openings, and overlapping housing-rings 3 and 6, is a removable band 10 which is tightened and thus held in place by structure best shown in Figure 7. Band 10 is provided at its ends with flanges 207 and 209 and extending through a hole in flange 207, is a cap screw 205, which is threadably received in a hole in flange 209. When band 10 is being positioned, its ends are placed along the side of one of the brace plates 203, as shown at the right of Figure 1, so that when cap screw 205 is turned to tighten band 10, a substantially sealed casing is formed of cover 7, hopper 1, and band 10. Band 10 may be removed by loosening cap screw 205 and then slipping it down where it may be rested upon lugs 211 on posts 4.

Cover 7 is provided with three sealed doors 106 (Figure 6) through which access may be had to the upper portion of the interior of the housing. It is also provided with windows (not shown) through which the corona-like discharge and the operation of the machine within the housing may be observed.

Mounted on the top of casing cover 7 are two blowers, an air supply blower 48, and an air exhaust blower 18, both driven by a high-speed motor 19 mounted therebetween. Blowers 18 and 48 and motor 19 are mounted as a unit, one end being supported by an air supply conduit 48' and the other end being supported through an L conduit 17 by a casing-head 12 which is centrally positioned on casing cover 7 and is held in place by cap screws 13. Casing-head 12 has integral therewith a downwardly-extending hollow dead shaft 14 upon which is mounted the stator of an electrode motor 20 (see also Figure 2), the rotor of which is within and carried by a motor casing 22 supported as later described. Extending downwardly from casing 22 is a neck 23 which supports the rotatable lower electrode 34 through a releasable telescopic connection with hub 25 (Figure 4), electrode 34 being held in place on hub 25 by means of a ring 328 and suitable screws 330.

Casing-head 12 (Figure 1) receives the grain from above through a grain supply conduit 142 and a valve 143 and is provided with a central web structure. This structure forms four downwardly and outwardly-extending grain passageways 41 and four upwardly and outwardly-extending air exhaust passageways 15 (see Figures 2 and 5) opening into an annular air exhaust manifold 16. Manifold 16 communicates with ell conduit 17 of exhaust blower 18 and thus completes an air exhaust circuit which is from hopper 1, up through the center of hub 25, through neck 23, through dead shaft 14, through passageways 15, annular manifold 16, conduit 17, and blower 18 to a suitable exhaust conduit.

Also attached to casing cover 7 by cap screws 13 is a downwardly-extending shell 38 which surrounds electrode motor 20 and casing 22, but is spaced throughout so as to form a grain passageway 40 between its inner surface and the outer surfaces of casing 22, neck 23, and hub 25. Electrode 34 is depressed at its center to form a bowl-like portion 36 and shell 38 flares outwardly at its lower end and cooperates with hub 25 in directing the grain outwardly through this bowl-like portion. The outer portion of electrode 34 is provided with a radially extending discharge surface 37 which forms the lower wall of the treatment zone. The grain thus passes from bowl 36 across discharge surface 37, and falls into hopper 1.

Directly above rotatable electrode 34, so as to form the upper wall of the treatment zone, is a disc 39 of a vitreous dielectrical material, such as low power factor glass or quartz. Disc 39 is supported by upper housing-ring 6 and is held against the lower surface of cover rim 8 by a disc-retaining ring 308. Disc-retaining ring 308 is held in place by a plurality of headed pins 310 which extend inwardly through holes in upper housing-ring 6, and are limited in their inward movement by their heads and held from outward movement by removable band 10. Glued to the periphery of disc 39, where it is contacted by cover rim 8 and disc-retaining ring 308, are two rings of vibration-damping material, such as felt.

Directly above the discharge surface 37 and upon the upper surface of disc 39, is stationary electrode 42 which is of a few mils thickness. In this embodiment, stationary electrode 42 is formed by sand-blasting an annular portion of the upper surface of disc 39, then covering the sand-blasted portion with a thin layer of lead and covering this with a thin layer of aluminum, the lead and the aluminum being applied by means of a metal spray. Stationary electrode 42 is thus in intimate contact with disc 39 and is of

sufficient conductivity and dimensions to function as an electrode, but is thin enough to permit the rapid transfer of heat from disc 39 to the surrounding air.

Carried near the lower end of shell 38 is a triangular insulator 45 (see also Figure 3) which is held in place by a plurality of cap screws 46 (see Figure 4). Extending through the corners of insulator 45 are three studs 302 which cooperate to carry upon their lower ends an annular manifold 44. Each stud 302 is held in place by an acorn nut 304 which is locked by a set screw 306. Manifold 44 is provided with an annular air passageway 311 which is shaped in cross-section as shown, and is formed by channel member 312, a lower inner ring member 314, and a lower outer ring member 316, which are held together by suitable screws 318. The adjacent edges of lower ring members 314 and 316 extend downwardly and are separated by an annular air slot 52.

Attached to the upper side of channel member 312 is a manifold coupling 320 which is held in place by screws 322 and which receives air from air supply blower 48 and conduit 49' through a conduit 47 of dielectric material. Channel member 312 is so shaped that passageway 311 is enlarged at the point of its attachment to manifold coupling 320 so that air delivered to manifold 44 escapes throughout slot 52 in an evenly distributed stream.

Manifold 44 is effectively insulated from the grounded frame of the machine by members 45 and 47 and at the same time air is delivered through it to the upper surface of the upper electrode 42.

Manifold 44 is provided at its inner and outer edges with enlarged rims 51 and 53, respectively, which extend beyond and thus shield stationary electrode 42 from physical and electrical damage. During operation, manifold 44 is maintained at a high potential and the presence of rounded rims 51 and 53 lessens flux concentration on these edges and thus eliminates the danger of sparking. The spacing of rims 51 and 53 from disc 39 is such that, in escaping, air passing from slot 52 moves in intimate contact with electrode 42 and disc 39 to effect cooling thereof.

In addition to its functions of distributing the air and shielding stationary electrode 42, manifold 44 also provides the high potential electrical connection with the stationary electrode 42, and thus, in effect, is a "feeder." The electrical connection between manifold 44 and stationary electrode 42 is formed by three leaf springs 54 which are equally spaced as shown in dotted lines in Figure 3, and which are riveted to lower inner ring member 314 as shown in Figure 4. Leaf springs 54 are so shaped that they are under tension when the elements are positioned as shown, and intimate contact is thus maintained between leaf springs 54 and stationary electrode 42.

The structure of the electrode motor 20 together with its mounting means, is best shown in Figure 2. Rigidly mounted upon the upper end of dead shaft 14 and held in alignment by a stud 324 is upper frame 60; in a like manner, on the lower end of dead shaft 14 is lower frame 61. These two frames are held in place by a spanner nut 65 which is locked in place on the lower end of dead shaft 14 by set screw 66. Frames 60 and 61 provide a support for the electrode motor, casing 22, and the elements supported thereby. Casing 22 includes an upper casing cover 72, a center cylindrical portion 75, a lower casing cover 73, and neck 23. Casing covers 72 and 73 are held in place on the opposite ends of cylindrical portion 75 by a suitable number of cap screws 74. Neck 23 is held in place on the lower end of casing cover 73 by cap screws 76. The upper end of casing cover 72 is provided with a downwardly extending center flange 77 which extends into an annular recess 67 in frame 60, where it is supported by a ball bearing unit 78, mounted on this frame. In a like manner, lower casing cover 73 is provided with a flange 81 which extends downwardly into recess 68 and is supported by a ball bearing unit 82. The juncture of casing cover 72 and frame 60 is sealed by a dust seal 83 of leather or other suitable material, and the juncture of neck 23 and frame 61 is sealed with a similar dust seal 84.

Rigidly held in place upon upper frame 60 by clamping ring 62 and a suitable number of cap screws 70, is stator-core 69 which carries stator-winding 64. Surrounding stator-core 69 and rigidly clamped between casing covers 72 and 73, is rotor-core 71 which is provided with a suitable squirrel cage winding. In this embodiment, a three-phase motor has been used and it has been provided with 48 poles so as to obtain a relatively slow speed at 60 cycles. The conductors 102 from stator-winding 64 extend inwardly through a recess (not shown), upwardly along dead shaft 14, through a hole 79, and into a junction box 326. Within box 326, conductors 102 are attached to power supply conductors 362 (Figure 1) which extend from the source of power as will be explained below.

The means for removably attaching hub 25 and rotatable electrode 34 to neck 23 is best shown in Figure 4. Neck 23 is provided with a spider 28, and depending from spider 28 is a screw threaded stud 27. In a like manner, hub 25 is provided with a spider 30' having a central collar 30 through which extends a sleeve-like nut 29. The lower end of nut 29 is flanged at 29' and carries four radial handles 32 for manual rotation. Surrounding the upper end of nut 29 is a collar 31 which acts as a stop to prevent the movement of nut 29 downwardly through collar 30. Attached to the inner surface of neck 23 and extending downwardly is a key 33, and attached to hub 25 is a lug 33'. Key 33 and lug 33' cooperate to limit relative rotary movement between neck 23 and hub 25.

Referring to Figure 1, to install rotatable electrode 34 in position, band 10 is loosened and rested upon lugs 211 on posts 4. The electrode, with its hub 25 and with nut 29 hanging in collar 30, is slid in from the side (the bottom of Figure 6) on rails 5 (Figure 1) until hub 25 is directly below neck 23, and nut 29 is directly below stud 27. Nut 29 is then raised by means of handles 32 until it engages stud 27 and is rotated while electrode 34 is manually held at its periphery so that it cannot rotate. As nut 29 rotates and progresses upwardly on stud 27, the flanged portion 29' engages the lower surface of collar 30 and lifts electrode 34.

During this engagement of nut 29 with stud 27, stud 27 may tend to rotate due to the fact that it is rotatably supported through spider 28 and neck 23 upon the rotatable motor casing 22. If such rotation occurs, neck 23 will carry key 33 with it until it engages lug 33'; at which time rotation of stud 27 will stop because electrode 34 is manually held from rotation. Continued rotation of nut 29 carries electrode 34 and hub

25 upwardly until the upper end of hub 25 telescopically engages the lower end of neck 23; nut 29 is then tightened and electrode 34 is securely supported so that it will be rotated by motor 20.

Referring again to Figure 1, mounted in the bottom of hopper 1 is a grating for the purpose of permitting the grain to flow from the hopper, and for preventing, nevertheless, the passage of foreign material, such as pieces of disc 39 if it should break. This grating consists of a series of posts 57 supporting superimposed louvers 58 through which the grain passes. These posts support a cap 59 which directs the grain through the louvers.

Extending between vertical posts 4 are two cross-frame members 220 which provide mounting means for a high-frequency, low-voltage alternator 55 at the right, and control apparatus 85 at the left. Control apparatus 85 includes a control switch 332 which operates switching means to control alternator 55 and the connection of its output, a control switch 334 which operates switching means to start and stop the electrode motor 20 and blower motor 19 which are connected in parallel, an alternator field control rheostat 336, and a wattmeter 338. Mounted on the top of casing cover 7 is a high-frequency, high-voltage auto-transformer 56 which receives the low-voltage, high-frequency output of alternator 55 and raises the voltage so that a high-voltage, high-frequency output is produced and this output is impressed across the electrodes.

The three-phase motor circuit of alternator 55 is connected to the control apparatus 85 through conductors 352, and the alternator field of alternator 55 is connected to its rheostat 336 by a pair of conductors 350. As indicated above, electrode motor 20 and blower motor 19 operate in parallel and are connected to the switching means controlled by the control switch 334 through conductors 362. One side of the current coil of wattmeter 338 is connected to conductor 92 and the other side is connected to conductor 90; one side of its potential coil is connected to conductor 92, and the other side is connected through potential lead 354 to conductor 94. One side of the output of alternator 55 is connnected directly by conductor 94 to the low side of the winding of auto-transformer 56, and this conductor is connected directly at 88 to the grounded frame of the machine. The other side of the output voltage of alternator 55 is connected through switching means (not shown) and conductors 90 and 92 and thence through low-voltage insulator 342 to the tap 96 of the auto-transformer winding. The high side 100 of the auto-transformer is connected by a conductor 344 through a high-voltage insulator 346 to manifold 44.

Rotatable electrode 34 is effectively grounded through its supporting means to the frame of the machine and thus, the high-frequency, high-voltage output of auto-transformer 56 is connected directly across the electrodes. This potential is of such a value that suitable discharges, preferably of disruptive corona-like form, occur in the treatment zone, which is between the lower surface of disc 39 and discharge surface 37 of the rotatable electrode 34. At the same time rims 51 and 53 on manifold 44 and the downwardly turned periphery of rotatable electrode 34 effectively prevent undesirable concentration of flux which might result in sparking.

The switching mechanism controlled by switch 334 is so arranged that alternator 55 cannot be started except when the circuit of blower motor 19 and electrode motor 20 is closed; likewise, alternator 55 will be stopped at any time that the blower and electrode motors are stopped.

During operation, the grain or other material moves down from grain supply pipe 142 through grain valve 143 through passageways 41. From passageways 41 it passes into passageway 40, where it contacts casing 22 and is given a swirling motion and is conveyed to the upper surface of the rotatable electrode 34. It then passes outwardly through the treatment zone to hopper 1 from which it passes by an outlet conduit 2. During the movement of the grain through the treatment zone, it follows turbulent curvilinear paths so that it is effectively treated and any insect life which is entrained with the grain is sought out by the discharges and destroyed.

During movement of the grain through the treatment zone, air is delivered by blower 48 through conduits 48' and 47 and conduit connection 320 to manifold 44. In passing from manifold 44 through slot 52, the air impinges downwardly upon the surface of stationary electrode 42 and divides, one stream moving beneath each of rims 51 and 53. These two streams then combine and flow outwardly from between the inner edge of disc 39 and the lower end of shell 38. At this point, the air is thoroughly mixed with the grain moving outwardly through the treatment zone, and, thus, as the grain passes through the treatment zone, it is accompanied by an additional quantity of air which is made sufficient to bring the dust concentration in the air below that necessary to form an explosive mixture. In movement past electrode 42 and through the treatment zone, the air is given sufficient turbulent effect to cause it to carry away the heat incident to the treatment process, including the heat caused by dielectric losses in disc 39. When air is present in the treatment zone, air-ionization products, including ozone and certain oxides of nitrogen, are formed and these are continually removed by this rapid movement of the air through the zone. The removal of these air-ionization products effectively assists in obtaining a high potential gradient within the treatment zone at all times.

After leaving the treatment zone, the air passes downwardly and is withdrawn from the machine by exhaust blower 18, through the center of hub 25, neck 23, dead shaft 14, passageways 15, manifold 16, and L conduit 17. Exhaust blower 18 delivers substantially more air than does air supply blower 48, with the result that a partial-vacuum or subatmospheric pressure condition is maintained in the lower part of the housing and air is continually being drawn upwardly through grain outlet conduit 2. This air-washes the grain and effectively removes any air-ionization products might might otherwise be trapped and carried downwardly with the grain. At the same time, it has been found that dust forming part of or accompanying the materials being treated is not removed by blower 18, but remains with the materials.

This partial-vacuum condition also tends to draw air into the housing through any leaks that might be present. Thus, the air-ionization products and dust accompanying or forming part of the material being treated do not escape. In one embodiment, it was found that very satisfactory results could be obtained by delivering 400 cubic

feet of air per minute from blower 48 and by exhausting 600 cubic feet of air per minute from blower 18.

While the length of discharge gap, which is, in effect, the thickness of the treatment zone, varies with the materials being treated, the voltage, frequency, etc., it has been found that a gap of 3/8 inch to 5/8 inch with a disc 39 of 1/8 inch thickness, and with a corresponding voltage which ranges from 20,000 volts to 30,000 volts, gives satisfactory results. A gap of 3/8 inch has been used with semolina and a gap of 5/8 inch has been used with corn; other lengths of gap have been used with other materials. The length of gap may be varied by changing the length of hub 25. A high-frequency of 500 cycles per second has been used with excellent results but lower and higher frequencies may be used. A frequency of 60 cycles has been found satisfactory except that the quantity of material being treated is less; frequencies substantially higher than 500 cycles tend to result in higher dielectric losses and thus excessive heating of disc 39.

When a material such as spring wheat is being treated, and with a flow of 10 bushels per minute, the watt input is on the order of 6400. With a rise in moisture content, this wattage increases and with lower moisture content this wattage is correspondingly less.

Thus it is seen that the above-mentioned objects are obtained and that a highly efficient and thoroughly practical method and apparatus is provided for treating materials without injury thereto.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In electrical apparatus in which a product is subjected to an electrical discharge, the combination of, a pair of electrodes, a dielectric plate between said electrodes and spaced from one of said electrodes so as to form a treatment zone, an air manifold having a jet adjacent one of said electrodes, means to deliver air from said manifold through said jet into heat-conducting relationship with said dielectric plate and through said treatment zone.

2. In an electrical apparatus in which a product is treated in a treatment zone by subjecting it to the electrical discharge resulting from impressing a high potential across a pair of electrodes, the combination of, a rotatable plate having an electrode discharge area, a motor for rotating said plate, means to conduct the product to be treated to said plate around said motor, and means to conduct air through said motor in a direction opposite to that of the travel of the product around the motor.

3. In an electrical apparatus in which a product is treated in a treatment zone by subjecting it to the electrical discharge resulting from impressing a high potential across a pair of electrodes, the combination of, a rotatable plate having an electrode discharge area, a motor for rotating said plate, means to conduct the product to be treated to said plate around said motor, means to conduct air through said motor in a direction opposite to that of the travel of the product around the motor, and an electrode to cooperate with said electrode discharge area.

4. In an electrical apparatus in which a product is treated in a treatment zone by subjecting it to the electrical discharge resulting from impressing a high potential across a pair of electrodes, the combination of, a rotatable plate having an electrode discharge area, a motor for rotating said plate, means to conduct the product to be treated to said plate around said motor, means to conduct air through said motor in a direction opposite to that of the travel of the product around said motor, an electrode to cooperate with said electrode discharge area, and means for adding a gas to the product on said rotatable plate.

5. In treating apparatus, the combination of, a supporting structure, a dead shaft depending from said supporting structure and having an opening therethrough, a frame structure surrounding and rigidly carried by said dead shaft, a rotatably mounted casing surrounding said frame structure, a motor having its stator rigidly carried by said frame structure and its rotor rigidly carried by said casing, a shell enclosing said casing and forming an annular passageway between its inner wall and the outer wall of said casing, an electrode structure having a central opening in alignment with the opening through said dead shaft and having an annular discharge surface, and means rigidly attaching said electrode structure to the lower end of said casing.

6. In electrical treating apparatus, the combination of, a plate of dielectric material, an electrode structure having an annular discharge surface spaced from one side of said plate to form an annular treatment zone therebetween, a cooperating electrode positioned upon the other side of said plate in intimate contact therewith, said plate being roughened along its surface where it is contacted by said cooperating electrode and said cooperating electrode being formed by a thin layer of lead covered by a thin layer of aluminum.

7. In electrical treating apparatus, the combination of, a plate of dielectric material, a first electrode structure positioned upon one side of said plate, and a second electrode structure positioned upon the other side of said plate and spaced therefrom to form a material directing and confining passageway comprising an annular treatment zone one wall of which is formed by the surface of said second electrode structure and the other wall of which is formed by the surface of said plate.

8. In electrical treating apparatus of the type wherein a dry material being treated is subjected to electrical discharges, the combination of, a settling chamber to receive the treated material, a material discharge connected to the bottom of said settling chamber through an opening which may be substantially sealed by the treated material, a gas discharge connected to the top of said settling chamber to remove gas from said settling chamber substantially free of particles of the treated material and to draw gas in through said material discharge, whereby the material is treated and the fine particles are permitted to settle and the gas accompanying the material during treatment is removed and discharged through the gas discharge.

9. In electrical treating apparatus, the combination of: treating apparatus including means defining an annular treatment zone, an annular rotatable member to move the material through the treatment zone, and a motor concentrically mounted with respect to said treatment zone

and connected to rotate said rotatable member; a settling chamber to receive the treated material from the treatment zone and providing means to effectively stop the movement of the treated material and the accompanying gas with the result that the material collects at the bottom of the settling chamber; a first passageway connected to the bottom of said settling chamber to permit the removal of treated material; and a second passageway opening through said motor to the center of the top of said settling chamber to permit the removal of gas discharged from the treatment zone.

10. In electrical treating apparatus, the combination of: treating apparatus including means defining an annular treatment zone, an annular rotatable member to move the material through the treatment zone, and a motor concentrically mounted with respect to said treatment zone and connected to rotate said rotatable member; a settling chamber to receive the treated material from the treatment zone and providing means to effectively stop the movement of the treated material and the accompanying gas with the result that the material collects at the bottom of the settling chamber; a first passageway connected to the bottom of said settling chamber to permit the removal of treated material; a second passageway opening through said motor to the center of the top of said settling chamber to permit the removal of gas discharged from the treatment zone; and means to withdraw gas from said settling chamber through said second passageway in sufficient quantity to cause gas to flow into said first passageway and thereby wash the treated material as it is being discharged.

11. In electrical treating apparatus of the type wherein a dry material being treated is subjected to electrical discharges, the combination of: a settling chamber to receive the treated material and having a bottom wall the shape of an inverted cone with a material discharge opening at its lowest point; a louver means mounted at the bottom of said settling chamber and surrounding said material discharge opening comprising, a plurality of annular louvers mounted one above the other in spaced relationship to provide annular passageways therebetween through which the treated material may move radially into the center of said louver means and to said material discharge opening.

12. In treating apparatus, the combination of: a supporting structure; a dead shaft depending from said supporting structure and having an opening therethrough; a frame structure surrounding and rigidly carried by said dead shaft; a shell construction enclosing said frame structure and the adjacent portion of said dead shaft and defining an annular passageway extending along said dead shaft; a duct means rigidly carried at the upper end of said dead shaft comprising an upper central chamber, an upper ring-like chamber substantially surrounding said upper central chamber, a lower central chamber open to the opening through said dead shaft, and walls define two sets of interfitting passageways one set of which connects said lower central chamber to said upper ring-like chamber and the other set of which connects said upper central chamber with said annular passageway extending along said dead shaft; and an electrode structure having a central opening in alignment with the opening through said dead shaft and having an annular discharge surface open to the lower end of said passageway extending along said dead shaft.

13. In electrical treating apparatus, the combination of, a plate of dielectric material, an electrode structure having an annular discharge surface spaced from one side of said plate to form an annular treatment zone therebetween, a cooperating electrode positioned upon the other side of said plate in intimate contact therewith comprising a thin metallic sheet, a rigid conductor positioned adjacent said cooperating electrode, and a spring-pressed contactor carried by said conductor and resiliently held against said cooperating electrode to provide an electrical connection therewith.

14. In electrical treating apparatus, the combination of, a plate of dielectric material, an electrode structure having an annular discharge surface spaced from one side of said plate to form an annular treatment zone therebetween, a cooperating electrode positioned upon the other side of said plate in intimate contact therewith comprising a thin metallic sheet, and an elongated jet means positioned adjacent said cooperating electrode to direct a cooling fluid thereon.

15. In electrical treating apparatus, the combination of: a plate of dielectric material; an electrode structure having an annular discharge surface spaced from one side of said plate to form an annular treatment zone therebetween; a cooperating electrode positioned upon the other side of said plate in intimate contact therewith comprising a thin metallic sheet; an elongated metallic jet means positioned adjacent said cooperating electrode to direct a stream of gas thereon, said metallic jet means forming a rigid electrical conductor; and a plurality of spring pressed contactors carried by said metallic jet means and resiliently held against said cooperating electrode to provide an electrical connection therewith.

16. In electrical treating apparatus of the type wherein a product is treated by subjecting it to discharges resulting from producing a high potential gradient within the treatment zone, the combination of: a dielectric plate having a central opening therein; a rotatable structure mounted concentrically with respect to said central opening and including a concentrically mounted annular electrode positioned beneath said plate and spaced therefrom to define an annular treatment zone between the upper surface of said electrode and the adjacent lower surface of said plate; and means to deliver material to be treated to the central portion of said rotatable structure through said central opening and to deliver an excess quantity of gas to the treatment zone with the material to be treated.

17. In electrical treating apparatus of the type wherein a product is treated by subjecting it to discharges resulting from producing a high potential gradient within the treatment zone, the combination of: a dielectric plate having a central opening therein; a rotatable structure mounted concentrically with respect to said central opening and including a concentrically mounted annular electrode positioned beneath said plate and spaced therefrom to define an annular treatment zone between the upper surface of said electrode and the adjacent lower surface of said plate, said rotatable structure having a central dished portion; and means to deliver material to be treated to said central dished portion of said rotatable structure through said central opening and to deliver an excess

quantity of gas to the treatment zone with the material to be treated.

18. In the art of treating dry bulk materials where the materials are subjected to discharges resulting from producing a high potential gradient, the steps of, producing a high potential gradient within a treatment zone to thereby cause corona-like discharges, passing the material through the treatment zone and into a settling chamber to permit the material to settle and assume its normal condition, withdrawing the treated material from the bottom of the settling chamber, and withdrawing gas from the top of the settling chamber in sufficient quantity to cause a counterflow of gas through the treated material being withdrawn but without disturbing the settling process.

19. In the art of treating dry bulk materials where the materials are subjected to discharges resulting from producing a high potential gradient, the steps of, producing a high potential gradient within a treatment zone to thereby cause corona-like discharges, passing the material being treated together with an excess of gas through the treatment zone and into a settling chamber, removing excess gas from the top of the settling chamber substantially free of the material being treated, and removing the treated material from the bottom of the settling chamber.

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