Jan. 15, 1924. 1,480,573

F. S. SMITH

APPARATUS FOR TREATING GRAIN, BEANS, ETC., BY DISRUPTIVE CONDUCTION

Filed March 27, 1919 2 Sheets-Sheet 1

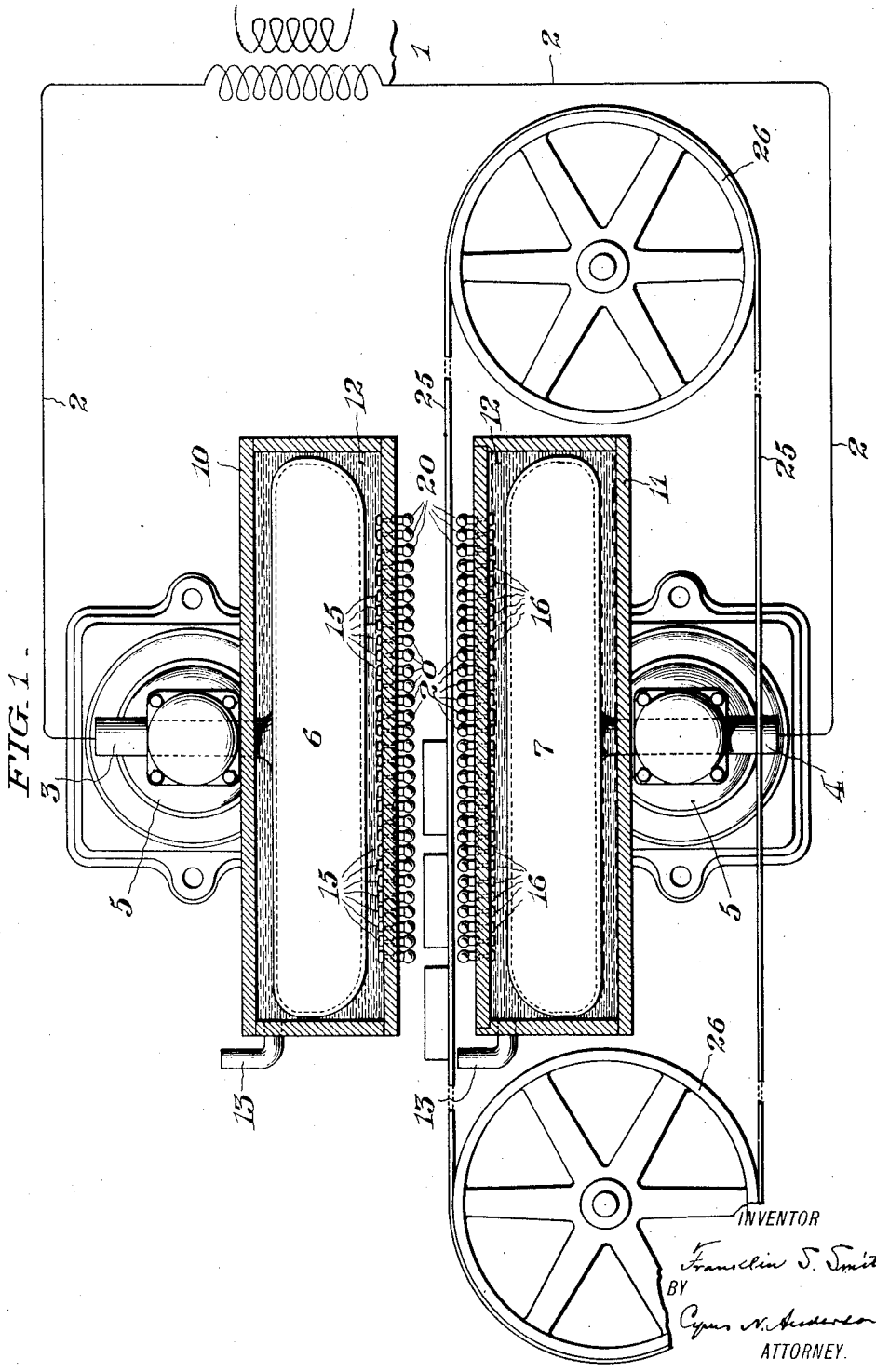



FIG. 1.

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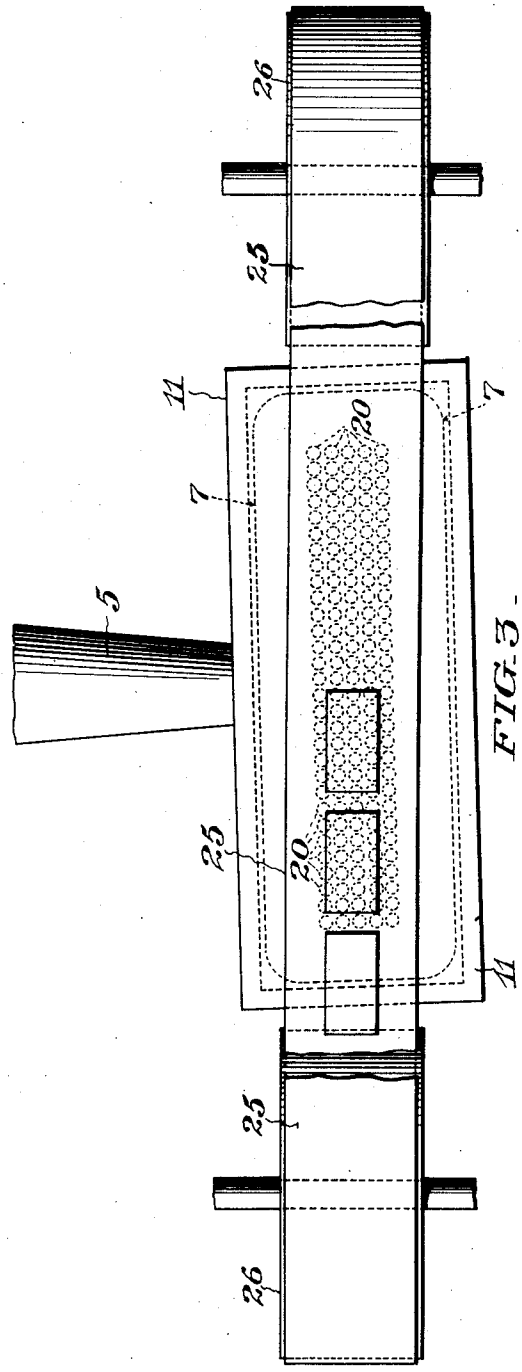



FIG. 2.

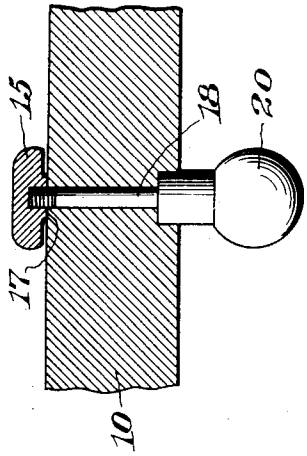



FIG. 3.

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# UNITED STATES PATENT OFFICE.

FRANKLIN S. SMITH, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE PRODUCTS PROTECTION CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

## APPARATUS FOR TREATING GRAIN, BEANS, ETC., BY DISRUPTIVE CONDUCTION.

Application filed March 27, 1919. Serial No. 285,484.

*To all whom it may concern:*

Be it known that I, FRANKLIN S. SMITH, a citizen of the United States, and a resident of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented an Improvement in Apparatus for Treating Grain, Beans, Etc., by Disruptive Conduction, of which the following is a specification.

My invention relates to apparatus for treating certain food and other products by disruptive conduction, and it has for its object broadly to provide means whereby a product, such as milled cereals, dried fruits, drugs, books and papers, leather, etc.; also furs, woolens, and the like, may be efficiently subjected to the action of electrical disruptive conduction, and of a current density sufficient to destroy such insect life as may be present in the article or product treated, and of properly controlled voltage gradients.

A further object of my invention is to provide an apparatus in which articles may be subjected to the action of a disruptive conductive current controlled by a condenser or elastor connected in series with the secondary of a transformer.

A still further object of my invention is to provide an apparatus for treating articles by disruptive conduction including means whereby the current density and the voltage gradient may be controlled.

Another object of my invention is to provide a construction in which the groups of electrodes are so related to the path along which the products or objects to be treated travel that they will be subjected to the practically homogeneous action of or treatment by a disruptive conductive current which is being discharged between the electrodes of the opposing groups of electrodes.

Other objects and advantages of my invention will be specifically referred to and pointed out in the detailed description thereof which follows or will be apparent from such description.

In order that my invention may be more readily understood and its practical advantages fully appreciated reference may be had to the accompanying drawing, in which I have illustrated one form of a convenient embodiment thereof.

In the drawings:

Fig. 1 is a view showing an apparatus embodying my invention and adapted for the treatment of objects for the purpose hereinabove stated;

Fig. 2 is a top plan view of a portion of the apparatus shown in Fig. 1; and

Fig. 3 is a sectional view showing a detail of construction.

Referring to the drawings: 1 designates a step-up transformer, the secondary of which is connected by means of conductors 2 to the shanks or stems 3 and 4 which are supported adjustably upon high tension insulators, a portion of one of which is shown in plan at 5 in Fig. 2. The shanks 3 and 4 respectively are connected with and support condenser plates 6 and 7. These plates, in the construction shown, are in the form of hollow bodies having wide flat surfaces in opposed relation with respect to each other. These plates are rounded at their outer edges so as to prevent too great a flux concentration at such edges. It will be understood, however, that my invention is not limited to condenser plates of the specific construction illustrated and that plates of other forms may be employed which should, however, be provided with rounded outer edge portions. These condenser plates, 6 and 7, are situated respectively in receptacles or containers 10 and 11, consisting of dielectric material, such, for instance, as baekelized fiber. These containers contain and are filled preferably with a liquid dielectric 12, such as transformer oil. The liquid dielectric is introduced into the containers 10 and 11 through pipes 13 which may be closed by stoppers or in any other suitable way. It is obvious that a solid dielectric could be used, preferably a wax, such as ceresin. Cooperating with the respective condenser plates 6 and 7 are a plurality of small condenser plates 15 and 16. These condenser plates are situated within and are supported upon the opposing adjacent sides of the containers or receptacles 10 and 11. In order to prevent possible surface leakage between the small condenser plates 15 and 16 of the respective groups thereof, the said plates are each provided with a small central projection, as indicated at 17 in Fig. 3, which supports the

greater portions of the underneath surfaces of the said plates in spaced relation with respect to the portions of the containers 10 and 11 upon which they are supported. The projections 17 and the spaced relationship between the greater portions of the underneath surfaces of the said plates and the adjacent opposing surfaces of the portions of the containers upon which the said plates are supported are not shown in Fig. 1 of the drawing because of the smallness of the said plates 15 and 16 shown in said figure.

The liquid 12 within the containers 10 and 11 occupies the spaces between the condenser plates 6 and 7 and the respective groups of small condenser plates 15 and 16 and constitutes the dielectric between the said condenser plates 6 and 7 and the respective groups of small condenser plates 15 and 16 and between the small condenser plates themselves.

Each of the small condenser plates 15 and 16 is connected by means of a shank or rod 18, which extends through the adjacent opposing sides of the containers 10 and 11, with a spark gap electrode 20, the said electrodes being situated in opposing relation with respect to each other as is shown in Fig. 1 of the drawings.

In the apparatus as designed and illustrated by me, it will be noted that I have provided two sets of condensers, each set comprising or including a plurality of condenser plates respectively connected in multiple, one of which sets is connected to one side and the other set to the opposite side of the secondary of the transformer 1 and also that the two sets of condensers are in series with the spark gaps formed by the opposing electrodes 20 having connection respectively with the plurality of small condenser plates as hereinbefore described. Obviously this results in three sets of gaps in series or in fact three sets of condensers in series. It will be obvious to those skilled in the art that the desired result may be obtained by the employment of only one set of condensers, resulting in two sets of gaps in series, or in fact, two condensers.

However, the construction as shown is preferred, for one reason because if only one set of condensers were employed it would be necessary that the thickness of the di-electric between the large condenser plate and the plurality of small condenser plates would be required to be more than twice as great as the thickness of the dielectric between either of the condenser plates 6 or 7 and the groups of small condenser plates 15 or 16. In other words, if only a single set of condensers were employed the thickness of the dielectric between the large condenser plate and the opposing group of small condenser plates would be more than the combined thickness of the dielectric material between the large and small condenser plates in the two sets of condensers in order to properly control the current density and the voltage gradient.

In order to convey the products or articles to be treated through the space between the opposing electrodes, I have provided means consisting of a conveyer belt 25 of dielectric material, supported upon revolving drums or pulleys 26 of well known form and construction, driven in any suitable manner from any suitable source of power, not shown. Other means of causing the product, whatever it may be, to pass between the electrodes, may be employed, such as gravity feed, etc., if desired.

Upon reference to Fig. 2 of the drawings in which the top spanning portion of the belt is shown and in which the lower container 11 and the lower group of electrodes 20 carried thereby are shown in top plan view, it will be observed that the arrangement is such that the conveyer belt extends diagonally over or angularly with respect to the group of electrodes 20. One purpose of this arrangement is to cause the products or articles being treated to travel diagonally across the rectangular shaped group of electrodes so that every particle of and point within the product or article will be subjected to the current discharged across the space between the electrodes 20,—thereby obtaining and insuring an approximately or substantially homogeneous treatment of the product or article as it travels between the electrodes.

In the apparatus as illustrated there are five rows of electrodes and thirty electrodes in each row. Let it be assumed that these electrodes are one and one-half inches apart in each horizontal direction and that the apparatus is connected with an alternating supply current of sixty cycles. Such a current will produce or cause one hundred and twenty group discharges per second across the spark gap between the electrodes 20.

The conveyer belt 25 as has been already stated conveys the products or articles to be treated at an angle to or diagonally with respect to the rows of electrodes as is shown in Fig. 2. The number of electrodes between which each inch transversely of the product or article being treated passes may be ascertained by dividing the number (30) of electrodes in each row by the distance, one and one-half inches, between the electrodes, which, under the assumption, will give 20 as the number of electrodes between which each transverse inch of the product or article will pass; which in operation, amounts to twenty group discharges per transverse inch through the product or article. To ascertain the speed at which the belt shall travel in order to secure the number of dis-

charges desired through the product or article being treated (400 per square inch), the number, 120, of group discharges should be divided by the number (20) of discharges per transverse inch of the product or article being treated, which gives 6, the latter being the number of inches per second traveled by the product or article under the conditions stated.

It is not necessary that the speed of travel of the belt and consequently of the products and articles carried thereby to be treated shall be mathematically correct or in exact accordance with the figures as above indicated, but preferably in practice the speed of travel of the belt should be somewhat slower than it is indicated mathematically, usually about sixty per cent of the theoretical speed.

The distance apart of the discharges through the product or article being treated, or in other words, the number of the discharges required through any unit of area of the products or articles being treated varies with the material. In general, the distance apart of the discharges through various products varies from one-fifth to one-tenth of an inch.

After considerable use the electrode material disintegrates leaving the surface rough. Obviously the larger the sphere the less the roughness will alter the spark gradient at the surface of the electrodes.

The electrodes of each group, that is, electrodes of the same side, positive or negative, should be separated from each other a distance equal to about one-third of the length of the spark gap in order to avoid discharges between the same.

The condensers preferably should be of such capacity that about 3 watts per inch of spark gap length is expended for milled cereals in general and about two watts for certain other products or objects, such for example as furs. The larger the particles of the product being treated the greater amount of energy is required to effect efficient treatment. Preferably also the electrodes should be spaced such distance from the product being treated that disruption occurs on or about the peak of the wave.

The voltage gradient across the spark gap should be a few kilo-volts in excess of the actual voltage required to break down, or rupture, the air. The dielectric strength of the condenser dielectric must be high enough to prevent corona or rupture, otherwise the product will be damaged.

In designing apparatus, embodying my invention, the designer must have in mind the product to be treated and must provide condensers of such characteristics that the product or its container, if there be a container, is not over stressed. Special consideration should be given the dielectric of the condenser, particularly as to its permittivity and dielectric strength.

In the employment and operation of the apparatus embodying my invention, voltage of the secondary of the transformer 1 is applied across the same, that is, thru the sets of condensers as hereinbefore described, or thru a single set if only one set be employed. When the voltage reaches the disruptive value, the permittivity of the dielectric in the condenser being higher than the permittivity of the air in the spark gaps between the electrodes 20, the latter breaks down so that current exists. Upon the breaking down of the air it becomes conducting so that most of the applied voltage is placed on the dielectrics of the condensers with a proportional part on the conveyer belt and on the pasteboard carton, assuming that the product or article being treated in inclosed within such carton. The apparatus as designed and as above described is so constructed and operated that the voltage gradients across the condenser dielectrics are below their rupturing values so that said dielectrics do not break down, in consequence of which neither does the carton or belt, because the voltage gradients across them are below their rupture gradients.

In the operation of the apparatus embodying my invention either high tension alternating oscillating or unidirectional current may be employed.

I claim:

1. In an apparatus for treating products electrically, the combination of a transformer, a plurality of condensers, and a plurality of electrodes connected with the respective condensers, the electrodes having connection with one condenser being situated in opposed spaced relation with respect to those connected with the other condenser, and the said condensers and electrodes being arranged in series with the secondary of said transformer.

2. In an apparatus for treating products electrically, the combination of a transformer, a plurality of groups of electrodes, and means interposed between said transformer and said electrodes and in series with the secondary of said transformer and with said electrodes for controlling the current density of the disruptive current between said electrodes and also for controlling the voltage gradients.

3. In an apparatus for treating products electrically, the combination of a transformer, a plurality of sets of condensers, and a plurality of groups of spark-gap electrodes having connection with the respective sets of condensers, the said sets of condensers being arranged in series relation with the spark-gaps.

4. In an apparatus for treating products electrically, the combination of a trans-

former, two sets of condensers, each set including a plurality of condensers, means for connecting one set of said condensers to one side of said transformer and the other set to the other side thereof, and a plurality of groups of electrodes connected to the said condensers, the said electrodes being separated and forming spark gaps, and being in series with the said two sets of condensers and with the secondary of the said transformer.

5. In an apparatus for treating products electrically, the combination of a plurality of condenser plates in multiple relation and a condenser plate common to said plurality of plates, a dielectric separating the said plurality of condenser plates from each other and from said common plate, and electrodes having connection respectively with the said condenser plates which are arranged in multiple relation, the said condenser plates and condenser plate, the electrodes and the secondary of the said transformer being arranged in series relation.

6. In an apparatus for treating products electrically, the combination of a transformer, a plurality of sets of condensers, the condenser plates of said condensers being relatively adjustable, and a plurality of electrodes connected with said sets of condensers, the said sets of condensers, electrodes and the secondary of said transformer being arranged in series relation.

7. In an apparatus for treating products electrically, the combination of a transformer, a plurality of condenser plates in multiple relation, an adjustable condenser plate common to the said plurality of condenser plates and to which one side of the secondary of the transformed is connected, and a plurality of electrodes connected with said plates, the said condenser plates and condenser plate, electrodes and secondary of said transformer being arranged in series relation.

8. An electrical apparatus for subjecting products to the action of disruptive conductive current, comprising a circuit which includes gaps which are adapted to receive the products for treatment, and means in series with said gaps for controlling the current density and voltage gradients across the said gaps.

9. An electrical apparatus for subjecting products to the action of disruptive conductive current, comprising a circuit which includes a source of high tension current, gaps which are adapted to receive the products for treatment, and means in series with said gaps for controlling the current density and voltage gradients across said gaps and the product under treatment.

10. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit including a gap adapted to receive the products for treatment, and electrical capacity in series with said gap.

11. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit including a plurality of sets of gaps in series, one of said sets of gaps being adapted to receive the products for treatment, said last mentioned set of gaps having therein a dielectric of lower permittivity than that of the dielectric in the other gap or gaps.

12. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit adapted to be charged with a high tension current, said circuit including a plurality of sets of gaps, one of the said sets of gaps being adapted to receive the products for treatment, said last mentioned set of gaps having therein a dielectric of lower permittivity than that of the dielectric of the other set or sets of gaps.

13. An electrical apparatus for treating products by disruptive conduction comprising a circuit including a plurality of gaps in series, and a source of high voltage current, one of said gaps being adapted to receive products for treatment and being of such dielectric strength that disruption occurs, and the other gap or gaps being of such dielectric strength that disruption does not take place.

14. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit including gaps adapted to receive said products for treatment, and one or more sets of electrical condensers in series with said gaps.

15. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit including a source of high tension current, gap adapted to receive said products for treatment, one or more sets of electrical condensers in series with said gap, and electrodes projecting from said condensers from which disruptive conductive current is discharged across said gaps.

16. An apparatus for treating products in cartons by disruptive conduction comprising a circuit including gaps adapted to receive said products in cartons for treatment, and means in series with said gaps for proportioning the voltage across the walls of said cartons and across said means.

17. An apparatus for treating products in cartons by disruptive conduction comprising a circuit including a source of high tension current, gaps adapted to receive said products in cartons for treatment, and means for proportioning the voltage gradients along the entire circuit.

18. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit including gaps adapted to receive said products for treatment, electrical condensers on opposite sides of said gaps and in series therewith, and electrodes projecting from said condensers between which disruptive conductive current is adapted to be discharged across said gaps.

19. An electrical apparatus for treating cartoned products, which comprises a circuit including a plurality of gaps in series, one of which is rupturable and adapted to receive the said products for treatment, and the other gap or gaps being unrupturable by the maximum voltage impressed upon said apparatus.

20. An electrical apparatus for treating cartoned products, which comprises a circuit including a plurality of sets of gaps in series, one of which sets is rupturable and adapted to receive the said products for treatment and the other set or sets of gaps being unrupturable by the maximum voltage impressed upon said apparatus.

21. An electrical apparatus for treating cartoned products comprising a circuit including in combination a source of high tension current, a gap within which said products are treated and means in series with said gap for preventing the potential difference of said source of current from being impressed upon the material of said carton.

22. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit having connection with a source of high tension current, the said circuit including a plurality of gaps in multiple in said circuit adapted to receive the products for treatment, a set of condensers in said circuit situated on one side of said gaps and in series therewith, and a plurality of electrodes having connection with said condensers and from which disruptive conductive current is discharged across said gaps.

23. An electrical apparatus for treating products electrically to destroy insect life which may be present therein, comprising a circuit including gaps in multiple, a plurality of electrodes arranged in rows in a group, means for causing the discharge of electric current from said electrodes across said gaps, and means for conveying the said products through said gaps in paths extending at a slight angle with respect to said rows, whereby, as the said products travel through said gaps past said electrodes, the different parts thereof are brought into such relation to one or more of the electrodes of the group that they are respectively subjected to the action of current discharged therefrom.

24. An electrical apparatus for subjecting products to disruptive conduction comprising a circuit including a plurality of gaps in series only one of which may be overstressed by the maximum voltage impressed on said apparatus.

25. An electrical apparatus for treating articles by disruptive conduction comprising a plurality of condensers in series, only one of which is adapted to become ruptured.

26. An electrical apparatus for treating products in cartons which comprises a circuit including a gap in which said products are treated and across which disruptive conduction occurs, and means for preventing the potential difference of the gap from equaling the sum of the potential differences across the two walls of the carton.

27. An electrical apparatus for subjecting products to disruptive conduction, comprising a circuit which includes a gap in which products contained in cartons are placed for treatment and across which disruptive conduction takes place, and means for preventing the maximum potential difference of the gap from being impressed upon the walls of the carton.

In testimony that I claim the foregoing as my invention I have hereunto set my hand this 25th day of March A. D., 1919.

FRANKLIN S. SMITH.