

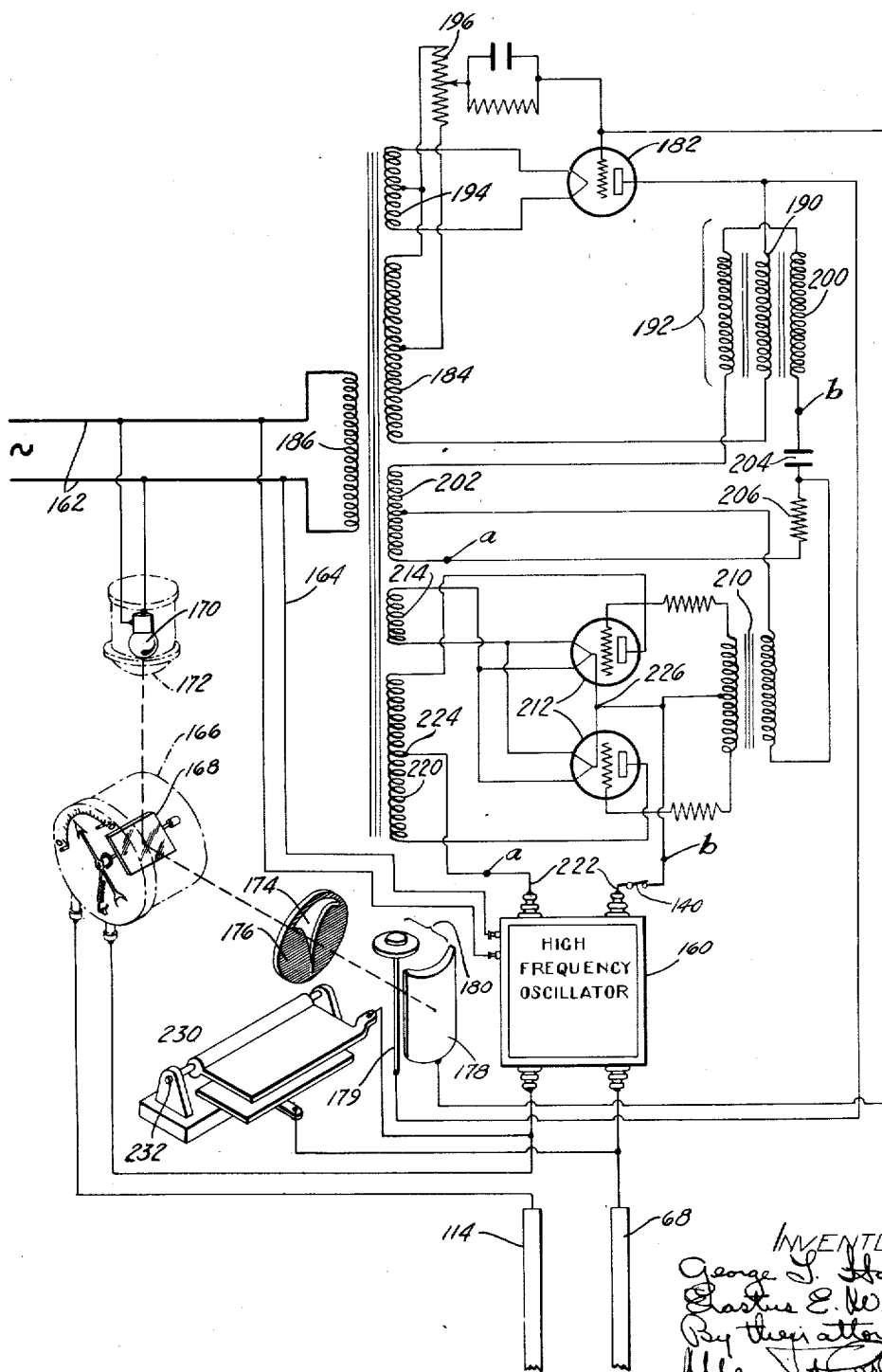
Aug. 5, 1941.

G. T. HART, JR., ET AL

2,251,277

CONTROL APPARATUS FOR ELECTROSTATIC DRYING

Filed Jan. 24, 1939



INVENTORS
George S. Hart
Charles E. Winkley
By their attorney
Merritt C. Cole

UNITED STATES PATENT OFFICE

2,251,277

CONTROL APPARATUS FOR ELECTRO-
STATIC DRYING

George T. Hart, Jr., and Erastus E. Winkley,
Lynn, Mass., assignors to United Shoe Machin-
ery Corporation, Borough of Flemington, N. J.,
a corporation of New Jersey

Application January 24, 1939, Serial No. 252,605

10 Claims. (Cl. 219—47)

This invention relates to the control of an apparatus arranged to produce an electrostatic field for drying or otherwise treating a series of articles, in order that the output of the apparatus which produces the field may be varied in response to changes in the demands of the load.

The use of a high frequency electrostatic field for the purpose of drying articles is well understood and when such an apparatus is employed commercially it follows that it will be utilized commonly for a large number of articles which frequently are not presented simultaneously to the field but are added one after another. Such an apparatus is employed for drying shoes, for example, and then the load will vary as successive shoes are presented to the field and the resultant changes in the load will depend not only upon the number of articles presented but also on the quantity of moisture in the various articles, which, in the case of shoes being bottomed, is located principally in their outsoles. The quantity of moisture in turn will depend partly upon the sizes of the shoes being treated and partly upon the quality of the material, because of the different absorptive powers of different types of leather, as well as upon the way the shoes are put together and other factors. The demand for power created by these various factors will for convenience be termed the shoe- or work-load. In considering the problem, it will be convenient to think of the various articles as included in a single electrostatic field, that is to say, a field produced merely by one pair of electrodes. The problem is, however, not substantially different where pairs of electrodes are provided for single articles and a plurality of these electrodes are joined in parallel and connected to a single source of supply, such as a high frequency oscillator.

In one physical embodiment of an apparatus for this purpose, cars of a conveyor are provided for supporting pairs of shoes and each car has electrodes associated with the respective shoes, these electrodes being joined to a single oscillator by means of a trolley and live rail arrangement. There will further be no substantial difference in the problem of control of output if the shoe supports are mounted in fixed positions, or, if electrodes are provided for association with shoes positioned upon the ordinary shoe racks so commonly used in shoe factories.

It will be understood that, in designing a conveyor for drying articles, the number of cars provided is more than sufficient to take care of the regular run of work during an interval such as

thirty minutes, for example, required for drying the wettest articles. The articles, such as shoes, will be loaded successively on the cars of the conveyor as they are delivered from the operator performing the last operation prior to the drying period and it will be obvious that the electrical capacity of each article will affect the output of the oscillator so that the power must be varied to meet the changing load, if the drying time of the various articles is to be kept substantially constant so that they may be removed from the cars returning along the lower run of the conveyor as these cars reach the loading station. As moist articles are presented to the system, the load increases; as they dry out, the load is correspondingly reduced. At any particular setting of the oscillator, an electrostatic field of certain intensity is produced and if this field is shared by a plurality of wet articles, the active power in each article will be less than would be the case if a lesser number of articles were within the field and the oscillator must be adjusted to meet the needs of the greater load.

One important object of the invention is to provide a control organization for use with a high frequency source whereby the action of the field on the articles, such as shoes, is substantially unaffected by variations in the load as determined by the various factors mentioned above.

To this end, and in accordance with a feature of the invention, automatic means is provided which is responsive to changes in the demands of the load and is arranged to vary the output of the oscillator to meet its demands.

Other features of the invention reside in employment of apparatus which is responsive to changes of the output current of the oscillator which supplies the electrodes, these changes operating to regulate the voltage applied so that the efficiency of the field will be maintained and the drying time will be substantially uniform.

Still another object of the invention is to devise an improved method of drying articles by means of an electrostatic field in accordance with which the drying time for the various articles is rendered substantially constant by automatically varying the effectiveness of the field as the load changes.

In another aspect, the novel method consists in applying the field to a changing number of articles and in automatically maintaining the effectiveness of the field as the load imposed by the articles changes.

The way in which this method may be carried out and an illustrative apparatus which may be

employed, will now be described in the following specification taken in connection with the drawing.

In the single figure of this drawing, typical control apparatus has been shown diagrammatically.

There, a high frequency oscillator 160 of any well-known construction receives power from wires 162 leading from a source of alternating-current power of ordinary commercial frequency and delivers high frequency current to live rails 68 and 114 typifying the electrodes in association with which the articles are positioned for treatment. It will be assumed, for the sake of illustration, that the oscillator 160 is of the self-excited type and involves vacuum tubes of well-known construction, the filaments of which are supplied with power through leads 164.

In our arrangement for automatically controlling the output of the oscillator in accordance with the shoe or work-load present between the electrodes, an ammeter 166 is inserted in the circuit between the oscillator and one of the live rails and, hence, is responsive to the varying load. This ammeter 166, indicating changes in output current, is provided with a mirror 168 mounted to be tilted as the needle of the ammeter moves, thereby to vary the angle of reflection of a beam of light received from a lamp 170 focused by a lens system 172 on a small area of the mirror and reflected therefrom through a V-slot 174 in a plate 176 for reception by the cathode 178 of a photoelectric tube 180 having the usual anode 179. It will be seen that the slot 174 is wider at the top than at the bottom and as the current in the ammeter decreases, the mirror will be tilted counterclockwise to pass the beam of light through the upper part of the slot thereby throwing more light on the cathode and causing a greater current to flow through the tube 180. Current passing through the photoelectric tube 180 is amplified by a thermionic tube 182 in the usual manner. The plate currents for the photoelectric tube 180 and the amplifier tube 182 are supplied from the transformer secondary winding 184, one end of which is connected to the direct current winding 190 of the saturable reactance 192 and thence to the anodes of the tubes 180 and 182, the other end being connected to the mid point of the filament transformer 194 and to one end of the potentiometer 196. The other end of the potentiometer is connected back to a tap in the transformer winding 184. Adjustment of the potentiometer determines the voltage impressed on the anode of the photoelectric tube 180. Because of the rectifying action of the tubes, it is obvious that pulsating direct current flows in the winding 190 of the saturable reactance 192.

The alternating current coil 200 of the saturable reactance is supplied with power from another transformer secondary 202. A condenser 204 and a non-inductive resistance 206 are in series with the reactance coil 200 and the primary of a grid transformer 210 is connected between a mid point of the secondary coil 202 and a point between the condenser 204 and the resistance 206 in the circuit of the coil 200 of the saturable reactance. It will be understood that the saturable reactance 192, in a well understood fashion, responds to small changes in the current flowing through the direct current coil 190, thereby producing large changes in the current delivered to the grid transformer 210. The secondary of the grid transformer 210 is connected to the grids

of a pair of thyatron tubes 212, the filaments of which are supplied from a transformer secondary 214. These tubes act to supply more or less current from a transformer secondary 220 to the input circuit 222 of the oscillator 160. To this end, the terminals of the secondary 220 are connected to the plates of the thyatron tubes 212 and the input circuit 222 derives its power in a well-understood fashion by reason of connections to a mid point 224 in the secondary 220 and a point 226 in a lead connecting the filaments of the thyatron tubes. A switch 140 is in series with this input circuit of the oscillator.

It will be understood, however, that the particular control circuits herein shown by way of illustration are not the only ones which may be used and that other well-known arrangements may be substituted for enabling variations in load to control the output of the oscillator. For example, in oscillators where the load imposed requires a smaller output, the thyatron tubes together with their transformers could be dispensed with and the alternating current windings 200 of the saturable reactance 192 be connected directly to the input terminals 222 of the oscillator 160 by connecting together the points *a, a* and also connecting the points *b, b*, thus accomplishing the same result in the smaller power range. Any preferred arrangement which provides for automatically increasing the output power of the oscillator as the work load increases and correspondingly decreasing the output power as the work load decreases, comes within the scope of this invention.

It is found that, where the greater part of the electrical capacity in the output circuit of the oscillator is formed by the electrical capacities of the articles, then the frequency of the current delivered by the oscillator will be continually upset because of the change in the electrical capacities of the articles as they dry. It has been found desirable, therefore, especially in the case of a self-excited oscillator, to provide a stabilizing condenser 230 bridged across the output side of the oscillator which will have a sufficient capacity so that the capacity provided by the articles, such as shoes, is a small part of the total of the electrical capacity of the output circuit of the oscillator. As a consequence, changes in the capacities provided by the articles as they dry will not unbalance the oscillator and cause it to operate inefficiently. The stabilizing condenser 230 is shown diagrammatically as comprising a pair of plates, one of which may be moved with respect to the other by rotating it about a supporting pin 232. This adjustment is required chiefly during the setting up of the apparatus.

The action of the control apparatus will now be explained. As articles, such as shoes, are inserted between the electrodes, the effect on an oscillator circuit having a fixed input power is to increase the output voltage drop and consequently to reduce the output amperage. This would lengthen the drying time since there would be less power per article. In the illustrated method of regulating the output power so that drying is accomplished in a uniform time regardless of changes in the work load, it is elected to adjust the power supplied to the input circuit of the oscillator. The ammeter 166, responding to changes of current in the output circuit, reflects more light to the photoelectric tube 180 as the work-load increases by adding wet articles, thus temporarily causing a decreased output current or less light as the load

decreases during the progress of the drying-out process. The electrical response of the photoelectric tube 180 to the changing values of impinging light, amplified by the tube 182, will cause a controlled, pulsating, direct current to flow in the coil 190 of the saturable reactance, 192.

In this reactance 192, the construction is such that with no direct current flowing in coils 190, the large amount of iron in the core offers a high impedance to the alternating current in coils 200 and so but little current can flow. As direct current is admitted to coils 190, a flux will be created that tends to saturate the iron, decreasing the impedance of the alternating current coils 200 and, since the impedance drop is inversely proportional to the total saturation of the iron, more alternating current will flow. As the direct current required is only a fraction of one per cent of the alternating current controlled, the necessary amount is readily supplied by the small currents in the photoelectric tube 180 stepped up by the amplifier tube 182. Utilizing a well-understood principle of phase shifting, changes in the amount of current in the circuit which includes the inductance 200, the capacitance 204, the resistance 206, the primary of the grid transformer 210 and the transformer secondary 202, are effective to change the phase of the grid currents with respect to the plate currents in the thyatron tubes 212. As the phase of the grid current in the thyatrons aids or opposes the electron emission in those tubes, they will act as a rheostat and more or less power will be supplied to the input circuit 222 of the oscillator 160. This will result in energy at higher terminal voltages being impressed on the live rails 68 and 114 as wet articles are added to the field and in a reduction of that voltage as the drying process proceeds toward completion. Inasmuch as the change in the alternating current flowing through the coil 200 of the saturable reactance is not a straight-line change, the sides of the slot 174 in the plate 176 are not straight but have been curved arbitrarily to compensate for the characteristics of the saturable reactance 192.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In an apparatus for treating articles, electrodes between which such articles may be positioned, an oscillator for supplying high frequency current to said electrodes to produce an electrostatic field passing through the articles, and automatic means responsive to changes in the demands of the load and arranged to vary the output of the oscillator to meet those demands.

2. In an apparatus for treating articles, electrodes in association with which articles may be positioned, an oscillator for supplying high frequency current to said electrodes to produce an electrostatic field passing through the articles, means for indicating changes in the output of the oscillator, means for supplying current to the oscillator, and means, including a photoelectric cell, responsive to changes in said

indicating device and arranged to control the input to the oscillator.

3. In an apparatus for treating articles electrically, means for producing an electrostatic field within which a plurality of articles may be positioned, and a device, responsive to a current which is proportional to the output of said field-producing means, for regulating the amount of power delivered by said field-producing means.

4. In an apparatus for treating articles, electrodes in association with which articles may be positioned, means including an oscillator for delivering high frequency current to said electrodes, a device responsive to changes in the output current of the oscillator as the load changes, means for delivering power to the oscillator, and means controlled by said device for varying the amount of power delivered to said electrodes as the output current is varied, thereby to keep the effectiveness of the electrostatic field substantially constant.

5. That method of drying articles by means of an electrostatic field which consists in treating a plurality of articles in such a field, and in rendering the drying time for the various articles substantially constant by automatically increasing the effectiveness of the field as the load increases.

6. That method of drying articles by means of an electrostatic field which consists in treating a plurality of articles in such a field, indicating changes in a current flow as the article load changes, and automatically adjusting the power supplied to the electrostatic field to maintain that current substantially constant.

7. That method of drying articles by means of an electrostatic field, which consists in applying the field to a changing number of articles and automatically maintaining the effectiveness of the field as the load imposed by the articles changes.

8. That method of drying articles by means of an electrostatic field, which consists in treating a plurality of articles in such a field and in automatically adjusting the field in response to the changing load provided by the articles to dry the various articles in a substantially uniform time.

9. That method of drying articles by means of an electrostatic field, which consists in applying the field successively to a plurality of articles which are wet and removing some of the articles which have become dry, and automatically adjusting the field in response to the changing load provided by the articles to keep the efficiency of the field substantially constant independent of the number of articles under treatment.

10. That method of drying articles by means of an electrostatic field, the power for which is supplied by an oscillator, which consists in progressively applying the field to additional articles which are wet, removing articles which have become dry, and automatically varying the output of the oscillator in response to the changing load provided by the articles.

GEORGE T. HART, JR.
ERASTUS E. WINKLEY.

CERTIFICATE OF CORRECTION.

Patent No. 2,251,277.

August 5, 1941.

GEORGE T. HART, JR., ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, lines 54 and 55, claim 9, strike out the words "in response to the changing load provided by the articles"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of October, A. D. 1941.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents