Oct. 31, 1950 L. D. DRUGMAND 2,528,428

ELECTROSTATIC HEATING APPARATUS

Filed April 25, 1946

Fig. 1

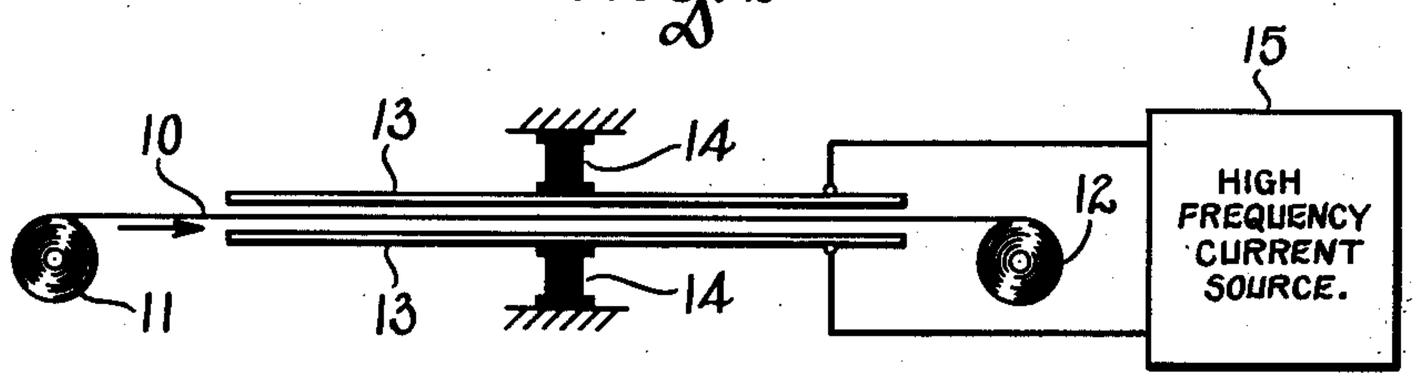


Fig. 2

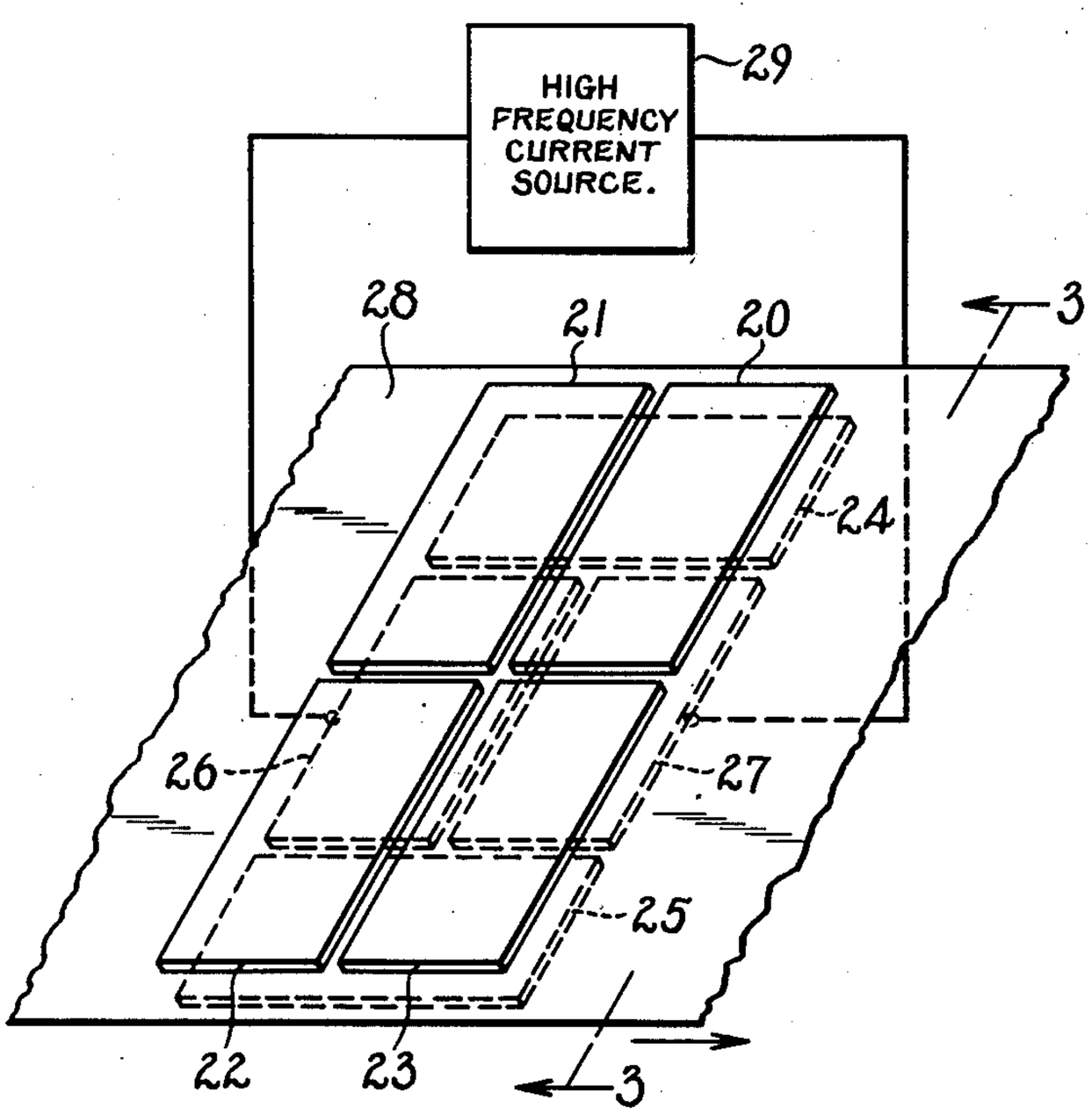
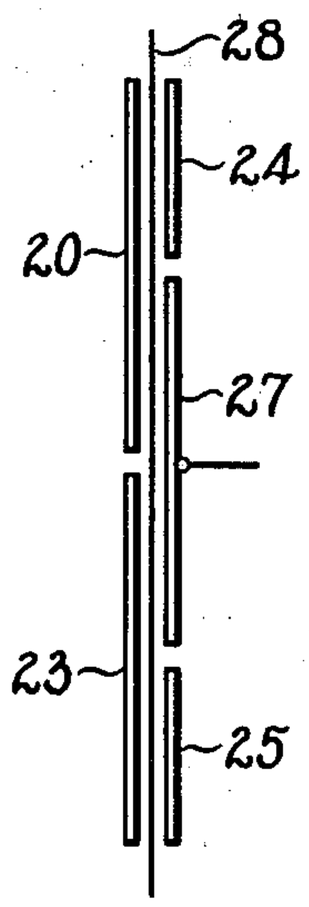


Fig. 3



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ELECTROSTATIC HEATING APPARATUS

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4 Claims. (Cl. 219—47)

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This invention relates to an improvement in electrostatic heating apparatus, and more particularly to means for dielectric heating of a sheet or web of material or of a coating deposited on such sheet or web. The invention is particularly advantageous for the drying of ink deposited on a web or sheet of paper passing through printing machinery.

It has heretofore been a practice in printing to move the printed sheet or web past a blast of hot air or a series of open gas flames for drying the ink. These methods are unsatisfactory, as in many installations the paper passes through the press at a very high speed so that the time of exposure to the drying medium is very short. Consequently extremely high temperatures are required which are likely to cause ignition of the paper should it be slowed down or stopped opposite the heat source. Furthermore, the heat absorption is non-selective, so that both the unprinted paper and the portion covered with ink must be heated.

An object of the present invention is to provide means for drying a stream of material in transit by dielectric means.

Another object is to provide means for heating a sheet or web of material by passing it through an electrostatic field.

Another object is to provide means for drying the ink or color deposited on sheets or webs of paper or the like upon their passage through an electrostatic field.

Another object is to provide means to facilitate the employment of an electrostatic field for drying webs or sheets of dielectric material of relatively great width.

Another object is to provide means to facilitate the employment of an electrostatic field for drying moving webs or sheets of dielectric material as they move through or are discharged from a processing machine.

Other objects and advantages will hereinafter appear.

In accordance with the present invention, the generation of heat takes place directly in and is confined to the ink deposit, thus avoiding overheating of the paper, the heat of evaporation of the ink tending to keep the paper underlying the latter cool. Furthermore, as the dielectric losses in the paper are low, the imprinted part of the paper surface also remains cool.

Inks such as used for printing newspapers and the like have dielectric loss factors which are several times those of the paper with which they are used. Hence if such a printed paper is introduced as a dielectric between two parallel condenser plates which have impressed therebetween a high frequency voltage, the dielectric losses appear as heat. As the loss factor of those areas which are covered with wet ink is much greater than that of the unprinted areas, the losses in and the heating of the inked part will be much greater, with the result that the ink is rapidly dried or set without overheating of the paper, even should the web or sheet be slowed down or stopped in its travel between the plates.

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The accompanying drawings are illustrative of an embodiment of the invention.

In the drawing,

Figure 1 is a diagrammatic view of a drying apparatus.

Fig. 2 is a perspective sketch of a modification of the arrangement illustrated in Fig. 1, while

Fig. 3 is a cross section along the line 3—3 of Fig. 2.

Referring for further explanation to Fig. 1, the same diagrammatically illustrates a web 10 which is wound from a roll 11 onto a roll 12, the latter being driven by any appropriate means (not shown). Interposed between the rolls 11 and 12, in parallel with the web 10 and spaced therefrom a short distance on opposite sides thereof are the two conducting plates 13, 13, each suitably supported by an insulator 14, thus forming a capacitor. Each plate is connected to one pole of a source 15 of high frequency current. The electric field, between the plates 13, 13, induces dielectric losses in the paper between the plates but due to the low loss factor of the paper the heat generated therein is not sufficient to overheat it. However, in the areas where the paper is covered with a layer of moist ink, additional dielectric losses occur in the layer of ink due to the higher loss factor of the latter. These losses heat up the ink and dry it rapidly.

Obviously the speed of drying depends upon the resulting dielectric losses in the ink per unit time. These losses in turn are a function of the voltage between the plates. Assuming a fixed speed of the web, the total drying time depends upon the size of the plates 13 in the direction of movement of the web and upon the gradient and frequency of the voltage between the plates. For a given voltage the gradient is also a function of the distance between the plates whose lower limit is dictated by the necessary clearance between the plates and the web. This lower limit is also dependent upon the dielectric strength of the interspace between the two plates, as modified by the web.

Furthermore, if the length of the plates exceeds a certain value for a given frequency, standing voltage waves will exist on these plates and will cause an unequal distribution of the energy conversion in the composite dielectric between the plates. The heat energy is, however, a function of the frequency, hence the maximum frequency also limits the rate of drying.

The present invention avoids this limitation by passing the energy from the source through several smaller series connected capacitors, thereby reducing the relative capacitance of the circuit to permit employment of a sufficiently high frequency at a correspondingly higher total voltage. The reduction of the capacitance also overcomes the serious tuning problem occasioned by the employment of large capacitances at the required high frequency. Furthermore, the dimensions of the individual plates are reduced, thereby not only facilitating the installation and avoiding complicated structural features to prevent bending and buckling of the individual plates which would cause variations in the interspace between the plates, but also eliminating the standing voltage wave mentioned above.

Figs. 2 and 3 show an arrangement of plates in accordance with the foregoing for drying of a web of considerable width. Instead of employing a single plate on each side of the web, each plate is replaced by a number of coplanar plates. Above the web 28 are shown four coplanar rectangular plates 20, 21, 22 and 23. Each plate has a length equal to twice its width, and the width of each plate extends in the direction of movement of the web. A small air gap is provided between adjacent edges of the plates so as to electrically insulate them from one another. The plates are suitably supported and insulated from the machine. Below the web and opposite to the plates 20 to 23, inclusive, are four plates 24 to 27, inclusive. They are of the same proportions as the plates 20 to 23, inclusive. The plates 24 and 25 are arranged with their major axes longitudinal of the web 28 and therefore at right angles to the upper plates. They are located under the respective outer areas of the upper plates. The plates 26 and 27 are arranged with their major axes transverse to the web 28 and thus parallel to the major axes of the upper plates. They are interposed between the longitudinal edges of the plates 24 and 25 so that their own longitudinal axes are parallel to the longitudinal axes of the plates 20 to 23, inclusive. Each plate 26 and 27, respectively, is connected to one pole of a source 29 of high frequency current.

Thus a dielectric current passes from the source 29 successively to plates 26, 21, 24, 20, 27 back to the source 29; a second and parallel path for the dielectric current is from the source 29 to plates 26, 22, 25, 23, 27 back to the source 29.

It will be apparent that this arrangement provides two groups of four series-connected dielectric fields, the two groups being connected in parallel. Thus the effective capacitance of each group for the same vertical spacing of the plates is substantially one quarter of the capacitance of a single capacitor of the same total plate area, while with the same voltage gradient in the interspace the arrangement of Figs. 2 and 3 enables the employment of four times the voltage for the same total energy dissipation over a given area as that of the arrangement illustrated in Fig. 1.

By connecting two sets of series-connected capacitors in parallel as shown in Fig. 2 the total

energy dissipation is doubled over that afforded by a single set. It is obvious that the plate areas representing one of the parallel branches may be omitted, the remaining areas cooperating with one-half of the width of the web 28. It is also obvious that the arrangement of Fig. 2 may be further modified by increasing or decreasing the number of capacitor sections which are connected in series across the source of energy.

While the invention has been described as applied to the drying of a printed paper web, it may also be applied generally to the drying of a succession of individual printed sheets as they leave a press or other processing machine. Furthermore, the invention is applicable to the heating for drying or curing of any dielectric material in web, ribbon, or sheet form which may be passed in a substantially continuous or intermittent stream through the apparatus described.

The apparatus is capable of various modifications which will be apparent to those skilled in the art as coming within the scope of this invention.

I claim:

1. Apparatus for dielectric heating of sheet material, comprising, a source of high frequency energy, a first group and a cooperating second group, exceeding two in number, of coplanar conducting plates, the plates of the respective groups being spaced in parallel relation to each other to provide a corresponding number of dielectric fields, the interspace between each pair of corresponding plates affording a passage for a material to be heated while moving through said dielectric fields, and circuit connections for connecting said dielectric fields in series with one another across said source.

2. Apparatus for dielectric heating of sheet material while in transit between given points over a given path, comprising, a source of high frequency energy, a first group and a cooperating second group, exceeding two in number, of coplanar conducting plates, the plates of the respective groups being spaced in parallel relation to said path on opposite sides thereof, said plates providing a plurality, exceeding two in number, of dielectric fields affording a passage for the material to be heated across said dielectric fields, and circuit connections for connecting said dielectric fields in series with one another across said source.

3. Apparatus for dielectric heating of sheet material while in transit between given points over a given path, comprising, a single source of high frequency current, two groups of conducting plates, each group exceeding two in number, the plates of one group being so arranged in spaced parallel relationship to the plates of the other group as to provide a number of dielectric fields exactly corresponding to the total number of plates in both groups, the space between said groups of plates affording a passage for sheet material to be heated while moving through said dielectric fields, circuit connections arranged to divide said dielectric fields into two groups, the dielectric fields of each group being connected in series across said source, and the two groups of fields being connected in parallel with each other.

4. Apparatus for dielectric heating of sheet material while in transit between given points over a given path, comprising, a single source of high frequency current, at least eight like conducting plates of rectangular contour, each plate having a length equal to twice its width, one

group of four of said plates being symmetrically arranged in the form of a rectangle with one corner of each adjacent a common point, the other group of four of said plates being arranged in the form of a rectangle of corresponding contour but in a relationship to respectively overlap each of the four lines of division between the plates of said group first mentioned, the space between said groups of plates affording a passage for sheet material to be heated while moving therethrough, means for respectively connecting two plates of said second mentioned group with said source of high frequency current, said connections and the arrangement of the plates of both groups being such as to provide eight dielectric fields, each four of said dielectric fields being connected in series with each other, and the two groups of four series connected dielectric fields being connected in parallel with each other.

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