March 24, 1970 H. G. SCHIRMER 3,502,845

APPARATUS FOR PERFORATING FILM BY ELECTRICAL DISCHARGE

Original Filed Oct. 26, 1964

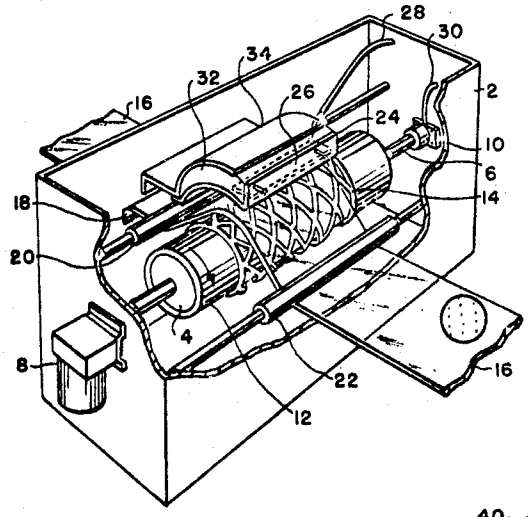


Fig. 1

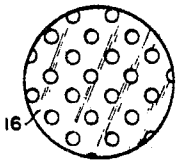


Fig. 2

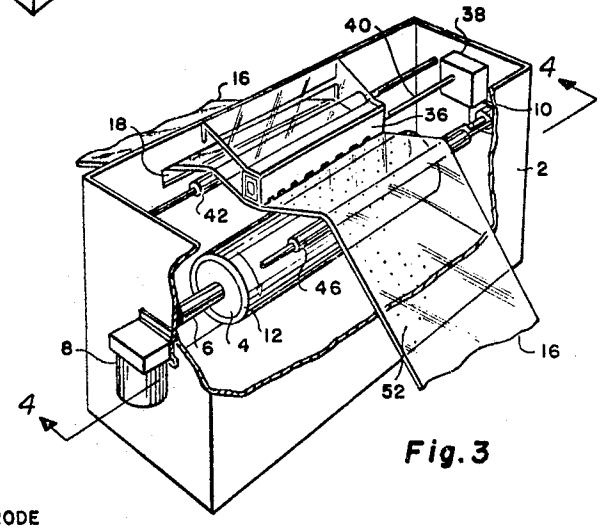


Fig. 3

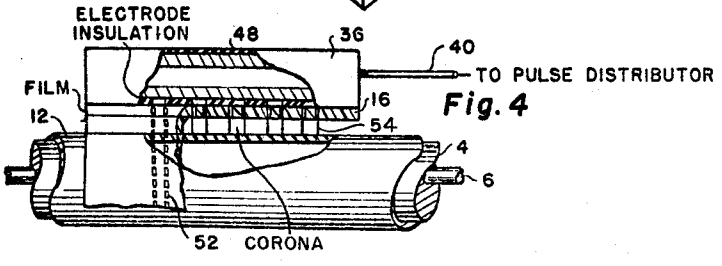


Fig. 4

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APPARATUS FOR PERFORATING FILM BY ELECTRICAL DISCHARGE

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Application June 27, 1967, Ser. No. 662,229, now Patent No. 3,435,190, dated Mar. 25, 1969, which in turn was a division of application Ser. No. 392,168, Aug. 26, 1964. Divided and this application June 11, 1968, Ser. No. 766,339

Int. Cl. H05b 7/18

U.S. Cl. 219—384 2 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus for perforating a film of dielectric material which comprises a fixed charging electrode and a rotatable grounded electrode spaced apart each from the other, a source of current sufficient to produce a corona between said electrodes, and means for passing the film through the corona. A discontinuous dielectric material about the grounded electrode and means for rotating said grounded electrode.

This invention relates to method and apparatus for perforating film by electrical discharge.

This application is a division of my prior co-pending application, Ser. No. 662,229 now U.S. Patent No. 3,435,-190. Ser. No. 662,229, filed June 27, 1969 was, in turn, a division of Ser. No. 392,168 which is now U.S. Patent No. 3,348,022, filed Aug. 26, 1964.

It has previously been proposed to improve the printability of polyolefins, such as polyethylene, by subjecting said films to high voltage electrical discharge. In a preferred prior process, the film is passed between a pair of electrodes having an extended surface area to which is applied a high alternating potential sufficient to produce a diffuse corona between the electrodes. The corona is caused by partial breakdown or ionization of the atmosphere around an electrode. The electrodes must be so spaced that the film surface is exposed to the corona. The electrodes may comprise a pair of flat plates positioned parallel to one another. The electrodes may also comprise a drum having a stator spaced apart and concentric therewith. There may also be positioned between the electrodes a sheet of dielectric material to prevent an arc-over and damage to the film being treated in the event that said film has pin holes or other weak spots therein. The dielectric covering also prevents pitting of the electrodes and helps to spread the corona over the entire width of the electrode and cause the film to be a minor portion of the total dielectric in the gap. Suitable dielectrics for ground roll coverings are glass, Mylar, epoxy resins and elastomers, such as chlorosulfonated polyethylene, silicon rubber and the like, and anodized coating. The elastomers are generally preferred since the only maintenance required is that it be kept free of any surface irregularities to prevent treat-through. This is a particularly vexatious problem when it is desired to surface treat only one side of the film. It has been found that any space between the film and the dielectric cover will allow corona to form on the back to the film thus treating both surfaces.

It has now been found that this problem can become an advantage when certain conditions are applied so that a pattern of perforations is produced in the film.

Although polyolefins such as polyethylene have numerous uses as a packaging material, one of its assets, gas impermeability, is a detriment when packaging commodities which must "breathe" or which releases a gas which must be removed from the container.

Numerous methods have been proposed for perforating film such as described in the patent to C. M. Schaar, U.S. 3,012,918 and U.S. 3,038,198. The methods involve passing the film over and in direct contact with a cooled perforated roll while subjecting the opposite film surface to a hot flame bath.

It is an object of the invention to provide method and apparatus for perforating film.

Yet another object is to simultaneously perforate and corona treat film.

These and other objects of the invention will be readily apparent to those skilled in the art from the disclosure, drawings and claims.

These objects are broadly accomplished by passing film through a corona formed by an electrode which is transverse of said film, providing a substantially uniform space between the opposite side of said film and a second discharging electrode, applying an alternating high value electrical current across said electrodes, providing for areas of concentrated electrical energy along said electrode which are transverse said film, said areas having sufficient energy to perforate said film with little or no corona in between said areas, thus providing transverse spacing for said perforations and periodically disrupting the electrical energy thus providing the longitudinal spacing for said perforations.

The invention in its various embodiments is illustrated in the drawings in which:

FIGURE 1 is a perspective view of a typical apparatus for perforating film by corona treatment;

FIGURE 2 is an exaggerated enlargement of a section of perforated film;

FIGURE 3 is an apparatus essentially the same as that shown in FIGURE 1 except for the use of a partially insulated blade electrode; and,

FIGURE 4 is an elevated view along section lines 4—4 of FIGURE 3.

In one embodiment a uniform longitudinal spacing is provided by a foraminous dielectric material having transverse members which move longitudinally through the space between the film and the discharging or ground electrode thus periodically disrupting the discharge of electrons.

In another embodiment the longitudinal spacing of the perforations is provided by pulsing the electrical current supplied to the charging electrode.

In another embodiment the transverse spacing of the perforations is provided by electrically insulating portions of the charging electrode, the areas of concentrated corona, thus the concentrated flow of electrons, being at the perimeter of the non-insulated portions of said electrode.

It has now been surprisingly found that a discontinuous insulative dielectric material placed between the film and the discharging electrode permits perforation of the film. Particularly suitable materials are a fiber glass screen and a polyethylene netting. The size and shape of the openings in the spacer are not limitative and must only be sufficient to provide support for the film and to provide a substantially uniform distance between the film and the discharging or grounded electrode. Preferably the spacing material is a dielectric netlike structure which periodically disrupts the flow of electrons. This distance is preferably between 0.01 and 0.2 inch. It has also been found that by varying this distance the pattern of the perforations is variable along the charging electrode or transverse to the moving film. In general, the transverse spacing of the perforations is proportional to the gap distance between the film and discharging electrode. For example, under certain known conditions a 1/32 inch thick screen results in a 1/8 inch spacing, two 1/32 inch screens on top

of each other result in a ¼ inch spacing, and three 1/32 inch screens result in approximately ⅜ inch spacing.

It is also possible to obtain transverse spacing of the perforations by simply employing an electrode having "peaks" from which the electrons are emitted. The tarnsverse pattern will thus depend on the arrangement of the peaks. For example, a sintered electrode is satisfactory although there will not necessarily be a hole corresponding to each peak.

Longitudinal spacing of the perforations in moving film is readily attained by periodically disrupting the corona of the areas of concentrated electrical energy causing the perforations. Although the invention is not limited to any theory of this surprising phenomenon, it is believed that the use of a dielectric spacing member having transverse members which periodically pass between the discharging the electrode and the film causes a disruption in the corona. It is believed that the discharging electrons must also "follow" the hole for a brief distance until the resistance is such that it is easier for the electrons to form a new hole than to cover the extending distance through the air to follow the hole. This disruption can also be achieved by simply pulsing the electric current such as by use of a distributor. In this case the spacing means need not have the transverse members but need only provide open space between the film and the discharging electrode to permit perforation.

Preferably the frequency is in the range of 10 to 1000 kc., more preferably 100 to 300 kc. The voltage and current are variable over a wide range and are sufficient to provide a corona discharge for the gap employed between the film and the charging electrode. Suitable voltages are in excess of 100, preferably 500 to 10,000 kv. Suitable currents are in excess of .7 amp, preferably 1 to 1.5 amps. The space between the two electrodes is generally less than ¼", preferably 1/32 to 3/32 inch, although this depends primarily on the voltage.

Numerous shapes and types of electrodes have been employed for corona treatment. Any electrode shape or size may be employed herein which will produce a corona betwen the electrodes over the transverse portion of the film desired to be perforated. A suitable charging electrode is a simple piece of 18 gauge black iron about 2 inches wide and of the required length. The discharge end should be cut in a good sheet metal shear and sanded to remove burrs. Using nylon bolts to prevent stray corona, the strip is preferably bolted to a piece of electrical grade micarta and mounted at a proper distance from the grounded electrode roll. The grounded treating roll is connected to the ground on the generator terminal.

The invention is best described with reference to the drawings. FIGURE 1 represents the perspective view of a typical apparatus for perforating film by corona treatment of thermoplastic film such as polyethylene or polypropylene. In this type of apparatus, which is shown as enclosed within a framework **2**, but which may employ any suitable frame structure, is a grounded steel cylindrical electrode **1**, mounted on a shaft **6** driven by any suitable driving means such as motor **8**. The opposite end may be mounted onto the framework by any suitable means such as a journal box **10**. The exterior surface of the grounded electrode **4** is preferably, but not necessarily, covered with an insulating substance **12**, such as rubber. Although the direction of rotation is not important, the grounded electrode is shown as rotating in the clockwise position looking from the motor end of the shaft. Immediately surrounding and in direct contact with the insulated grounded electrode is a spacing member **14** which preferably has transverse members at least as wide as the film and more preferably is a foraminous or net-like material, such as polyethylene netting having a substantially uniform thickness. This discontinuous material provides a uniform air space between the insulated grounded electrode and the film **16** which passes over the netting and in direct contact therewith. The film may enter the corona treating area by any suitable means such as by passing through a slot **18** in frame **2**, then under a guide roller **20** mounted by any suitable means (not shown), then over the netting and under a second guide roller **22** so as to provide uniform and intimate contact between the film and the netting. Mounted directly above the grounded electrode is an area electrode, such as aluminum foil **24**, which may be attached to a blade electrode shown by dotted line **26**. If the aluminum foil electrode is placed at a very small distance from the film such as less than ¼ inch, a corona will be formed in the space between the foil and the film. The aluminum foil electrode **24**, of blade electrode which is attached thereto, is connected to a power source (not shown) through electrical conduit **28**. The grounded electrode is grounded through conduit **30**. A rubber weighting material **32** is positioned on top of the foil with an insulative plate **34** thereabove although neither of these are required since the foil is attracted to the ground roll by electrostatic forces. The passage of the film through the corona results in perforations being formed therein. This results in a uniform spacing or pattern of perforations as shown in FIGURE 2 which is an exaggerated enlargement of a section of perforated film **16**. FIGURE 3 employs essentially the same equipment as shown in FIGURE 2, except for the use of a partially insulated blade electrode **36**. Where there is no difference in functionality identical reference numbers have been employed for all the figures. In this illustration, the disruption of the discharging electrodes is produced by pulsing of the current by passing the current from a source of power (not shown) through a distributor **38** and an electrical conduit **40** to an elongated blade electrode **36**. The film **16** enters through slot **18** as hereinbefore shown but since direct contact with the partially insulated blade electrode **36** is desired in this instance there is virtually no clearance between the electrode **36** and film **16**. The spacing between the film and the charging electrode, whether blade or area, is not limitative. The guide roll **42** is below the film and guide roll **46** is above the film. As best shown in FIGURE 4, which is an elevated view through 4—4 of FIGURE 3, the blade electrode **36** preferably comprises a rectangular elongated member enclosed in insulative material **48**, such as electrician's tape with portions of the under side, that is the side in direct contact with the film, having no insulation in specified areas to provide the desired spacing. The film **16** passes directly through the discharging electrons emanating from electrode **36** resulting in perforation of the film to cause orifices **52**. The corona appears to concentrate at the edge of the non-insulated portions and thus makes two perforations for each of said portions. "Towers" of corona **54** result in the uniform space between the insulation **12** of the grounded electrode **4** and the film **16**.

The invention is broadly applicable to perforating any film including all organic theremoplastic and thermosetting resins such as but not limited to polyolefins, including polyethylene, polypropylene, polybutene-1 and the like, polyvinyls, vinylchloride copolymers, polyamides including nylon and the like. The term polymer as employed herein includes homopolymers, copolymers, terpolymers, block copolymers, laminates and the like. The film can be molecularly oriented. Film thickness which can be perforated depends on the voltage, distance, etc., but is preferably between 0.1 and 20 mils.

The invention is best illustrated by the following examples.

EXAMPLE I

Holes were produced in several different types of film by means of a concentrated high frequency-high voltage current pulsed by a distributor. The electrical energy was first concentrated by alternately masking the blade elec-

trode of a Lepel model MFSO–2 treater with electrician's tape. Taped sections were ½ inch in length and untaped sections were ¼ inch in length along the blade. When a piece of polypropylene film was held against the prepared electrode to provide as air gap of 1/16 inch between the film and the rubber insulated ground roll, the concentrated electrical energy burned two holes into the film at each unmasked section of the blade. The two holes were formed in the film at the end of each unmasked section of the blade where the insulation tape provided a distinct border. Therefore, the two holes were spaced ¼ inch apart from each other every ½ inch across the film.

EXAMPLE II

The blade electrode of Example I was replaced by an area electrode 5 inches long and 18 inches wide consisting of aluminum foil. The rubber insulated ground roll was wrapped with a polyethylene netting 3/32 inch thick in order to provide an air gap between the foil electrode, the contacted film and the ground roll. After conforming both the electrode and film to the shape of the wound insulated ground roll, the roll was rotated at 50 f.p.m. and the film was passed between the netting and the area electrode and through a visible purple corona. The resulting film was punctured with a myriad of tiny holes spaced approximately every ½ inch along the width of the film. The gap distance was found to affect the hole spacing. Moving the electrode nearer to the ground roll caused the holes to be spaced closer together and moving the electrode away from the ground roll caused the holes to be spaced further apart. The size of the hole produced in the film was also found to vary inversely to the speed of film passage through the treating area.

The table below illustrates the power settings used to produce holes in various types of film using the area electrode.

Material	Thickness (mil)	Watts power	Speed (f.p.m.)	Amps
Saran	1	350	50	0.7
Polypropylene	0.75	1,300	50	1.3
Nylon	3	1,300	20	1.3
Polyvinyl chloride	0.75	600	50	1.0

While certain examples, structures, composition and process steps have been described for purposes of illustration, the invention is not limited to these. Variations and modification within the scopt of the disclosure and the claims can readily be effected by those skilled in the art.

I claim:

1. Apparatus for perforating a film of dielectric material comprising:

(a) a fixed, elongated charging electrode transverse said film;

(b) a rotatable, elongated grounded electrode spaced apart from said charging electrode and being transverse said film, said grounded electrode having a cover of discontinuous dielectric material;

(c) a source of alternating high value electrical current in communication with said electrodes thus producing a corona between said electrodes;

(d) driving means for continuously passing a film through said corona;

(e) control means for adjusting the current so as to provide for areas of concentrated electrical energy along said electrodes sufficient to perforate said film; and,

(f) rotatable means for rotating said grounded electrode.

2. The apparatus of claim **1** wherein the discontinuous dielectric material is a net-like dielectric material wrapped about said covered, grounded electrode.

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VOLODYMYR Y. MAYEWSKY, Primary Examiner

U.S. Cl. X.R.

204—323; 264—154

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,502,845 Dated March 24, 1970

Henry G. Schirmer

It is certified that error appears in the above-identified patent and that Said Letters Patent are hereby corrected as shown below:

In the specification, Column 3, Line 6, "tarnsverse" should read --transverse--. Column 3, Line 61, "electrode 1" should read --electrode 4--. Column 4, Line 29, "FIGURE 2" should read --FIGURE 1--. Column 4, Line 43, "above" should read --below--. Column 5, Line 1, "MFSO-2" should read --HFSG-2--. Column 5, Line 5, "as" should read --an--. Column 6, Line 2, "scopt" should read -- scope--.

SIGNED AND
SEALED
AUG 18 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

UNITED STATES PATENT OFFICE
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