

Oct. 8, 1968

H. G. SCHIRMER

3,405,052

APPARATUS FOR CORONA TREATMENT OF FILM INCLUDING A
POROUS SINTERED METAL ELECTRODE
Original Filed Aug. 26, 1964

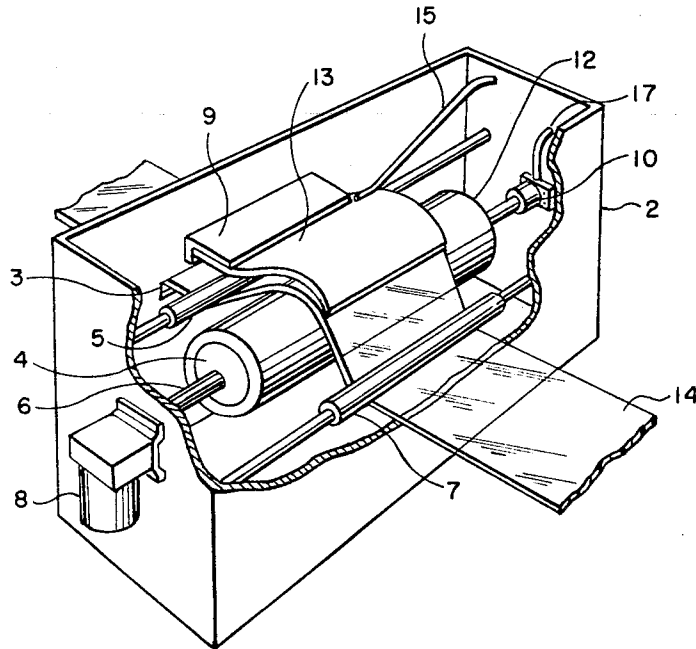


Fig. 1

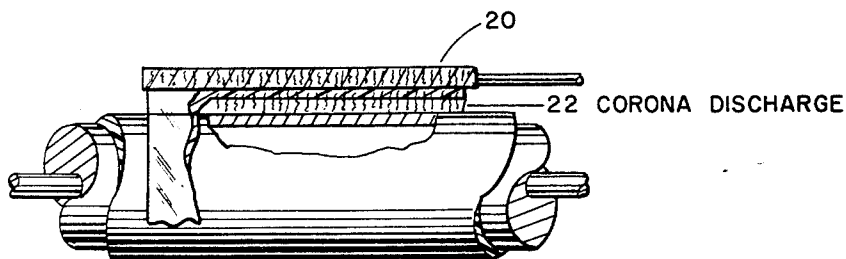


Fig. 2

Inventor

HENRY G. SCHIRMER

By

John J. Toney
ATTORNEY

1

3,405,052

APPARATUS FOR CORONA TREATMENT OF FILM INCLUDING A POROUS SINTERED METAL ELECTRODE

Henry G. Schirmer, Spartanburg, S.C., assignor to W. R. Grace & Co., Duncan, S.C., a corporation of Connecticut

Original application Aug. 26, 1964, Ser. No. 392,147, now Patent No. 3,346,480, dated Oct. 10, 1967. Divided and this application July 12, 1967, Ser. No. 688,629

1 Claim. (Cl. 204—312)

ABSTRACT OF THE DISCLOSURE

An apparatus for treating polymeric film in a corona discharge to improve the printability thereon. One of the electrodes is made from a porous sintered metal electrode having a concave arcuate surface.

This application is a division of my prior copending application Ser. No. 392,147, filed Aug. 26, 1964, now U.S. Patent No. 3,346,480.

This invention relates to apparatus for the corona treatment of film.

It has previously been proposed to improve the printability of polyolefins, such as polyethylene, by subjecting said films to high voltage electrical discharge. In proposed prior processes the film is passed between a pair of electrodes having an extended surface area to which is applied a high value alternating potential sufficient to produce a diffuse corona between the electrodes. The corona is apparently 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 electrode and helps to spread the corona over the entire width of the electrode and causes 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, silicone rubber and the like, and anodized coatings. The elastomers are generally preferred since the only maintenance required is that it be kept free of any surface irregularities to prevent treat-through.

One of the difficulties with a blade or area type electrode has been achieving a uniform corona over the entire film surface. Generally, it is believed that the electrical discharge is effected at sharp edges. If the electrodes has points and peaks which are closer to the discharged electrodes, the discharge will preferentially take place at these points resulting in spotty corona treatment.

It is an object of the invention to provide apparatus for the corona treatment of film.

It is another object of the invention to provide apparatus for the production of an electrical discharge.

Still another object of the invention is to provide apparatus for the formation of a corona.

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

It has now been surprisingly found that a thin, flexible, electrically conductive, area electrode, for example, aluminum foil, in conjunction with a discharging electrode will produce a uniform electrical discharge and corona if a

2

high-value alternating potential is applied across said electrodes. Further, if the flexible electrode is minimally supported so that the remainder of the electrode is unsupported, said electrode will adjust itself to a corona-producing distance from the discharging electrode.

In another embodiment of the invention the charging electrode may comprise an arcuate plate electrode composed of a sintered metal.

FIGURE 1 is a perspective view of a suitable embodiment employing an aluminum foil electrode for the corona treatment of thermoplastic film such as polyethylene or polypropylene.

FIGURE 2 is a cross section of a sintered arcuate plate electrode employed in lieu of the aluminum foil electrode shown in FIGURE 1.

The invention is best described with reference to the drawings. 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 4 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. The film 14 enters the frame 2 through a slot 3, passes under guide roller 5, over electrode 4 and under guide roller 7.

Mounted directly above the ground electrode is a thin, flexible, electrically conductive smooth sheet-like material, such as aluminum foil, which may be attached to any suitably supporting means 9 or to a blade electrode (not shown). The aluminum foil may be attached at any suitable location on the foil such as at the middle portion or at any edge, for example, the posterior edge relative to the movement of the film. However, the foil can be supported at only one point or in any plane transverse the moving web. Upon the application of a potential across the electrodes, the aluminum foil is attracted to the grounded electrode but does not contact the same and is self supported at a distance which is conducive to the formation of a corona between the aluminum foil and the grounded electrode. The mechanism for this phenomena is not understood but may be related to electrostatic forces.

Although the invention is discussed herein primarily with reference to the employment of a thin sheet of aluminum foil, it is to be understood that any electrically conductive material may be employed, for example thin flexible sheets of copper, iron, steel, brass, and the like. However, it is also within the scope of the invention to employ a wrinkled sheet of foil. Preferably, the foil electrode has a thickness of from 0.1 to 1.0 mil. However, the foil thickness is not necessarily limitative so long as the sheet is flexible enough to permit the formation of a substantially uniform corona. The mechanism for this phenomenon is not known but apparently is related to the vibration of the sheet. The width of the electrode should be sufficient to cover the film and the length is preferably at least 1 inch, more preferably 1 inch to $\frac{1}{2}$ the electrode circumference. The distance between the aluminum foil and the grounded electrode during treatment is generally less than $\frac{1}{4}$ inch, preferably in the range of from $\frac{1}{32}$ to $\frac{1}{2}$ inch. Prior to treatment the foil should be positioned about $\frac{1}{32}$ to 1 inch from the grounded electrode. The aluminum foil electrode 13 is connected to a power source (not shown) through electrical conduit 15. The grounded electrode is grounded through conduit 17.

The sintered electrode 20 is shown in cross section in FIGURE 2 in lieu of aluminum foil electrode 13 shown in FIGURE 1. The sintered electrode may be supported by

3

any suitable means. However, in contrast to the aluminum foil electrode, the sintered electrode is relatively thick, does not vibrate and does not seek the corona-producing distance. Since the sintered electrode is a porous metallic material, gases may be introduced through the electrode into the space between the electrodes. Apparently the sintered electrode provides for a large number of peaks or points which uniformly distribute the corona 22 throughout the space.

Although the invention has been described with reference to the employment of the aluminum foil and the sintered metal electrodes as the charging electrodes, it is within the scope of the invention to employ these electrodes as the discharging electrodes or to employ them as both electrodes or in any combination thereof.

The invention is not limited to the particular type of product being treated by the corona, however, the invention is particularly applicable to the treatment of film-like materials including all organic thermoplastic 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 may be irradiated and/or molecularly oriented. The film thickness is not critical but is preferably between 0.1 and 20 mils.

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 kc. Suitable currents are in excess of 0.7 amp., preferably 1 to 1.5 amps.

The lower electrode may be covered by any suitable buffer dielectric material as hereinbefore described.

The invention is best described with reference to the following examples:

Example I

Using a high frequency high voltage generator Model HFSG-2 as the power source, an aluminum foil electrode measuring 18¼" wide x 5" long x 0.5 mil thick was separated from a ¼ inch thick rubber covered ground roll by a ½" fiberglass screen*. A .75 mil polypropylene (Profax 6420) film and a .75 mil polyethylene (Alathon 1412)** film passed between the rubber covered ground roll and the fiberglass screen.

Current -----amps-- ¼
Watts -----1100
Film speed -----f.p.m-- 151

Result.—There was no breakdown of film and a uniform oxidation pattern was produced over the surface of electrode indicating a uniform corona (oxidation pattern as left by corona).

*Profax 6420

**Alathon 1412

Example II

Using a high frequency high voltage generator, Model HFSG-2, a sintered stainless steel electrode, measuring

4

18¼" wide x 5" long x ⅛" thick, was spaced approximately ⅛" from the ¼" rubber covered ground roll while the film (see Example I) was passed between the electrodes.

Current -----amps-- 1.3
Watts -----1100
Film speed -----f.p.m-- 150

Results.—No breakdown of film and a uniform oxidation pattern over surface of electrode.

Example III

Using a high frequency high voltage generator, Model HFSG-2, a polished aluminum electrode measuring 18¼" wide x 5" long x ¼" thick was spaced approximately ⅛" from the ¼" rubber covered ground roll while the film (see Example I) was passed between the electrodes.

Current -----amps-- 1.4
Watts -----1100
Film speed -----f.p.m-- 150

Results.—Some scorching of the film and a non-uniform oxidation pattern over the surface of electrode thus indicating that a non-uniform corona was produced.

Example IV

Using a high frequency high voltage generator, Model JFSG-2, a steel blade electrode measuring 18¼" wide x ⅛" thick was spaced ⅛" from a ¼" rubber covered ground roll while the film (see Example I) was passed between the electrodes.

Current -----amps-- .9
Watts -----300
Film speed -----f.p.m-- 150

Results.—There was much scorching of film.

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

I claim:

1. Apparatus for corona treating film comprising in combination:

- (a) a pair of spaced apart electrodes chargeable to opposite polarities;
- (b) means for continuously passing a film between said electrodes;
- (c) means for applying a high value alternating potential across said electrodes sufficient to maintain a corona therebetween;
- (d) the discharging electrode comprising a grounded metal roller; and,
- (e) the charging electrode comprising an arcuate extended plate electrode having a porous sintered metal providing an inner surface at a substantially constant corona producing distance from said discharging electrode.

References Cited

UNITED STATES PATENTS

3,284,331 11/1966 McBride et al. ----- 204—165
3,294,971 12/1966 Von Der Heide ----- 250—49.5

ROBERT K. MIHALEK, *Primary Examiner.*