Jan. 4, 1966 M. O. SCHUR 3,227,019

METHOD FOR INCREASING AIR PERMEABILITY OF FILMS OR SHEETS

Filed Jan. 24, 1964 2 Sheets-Sheet 1

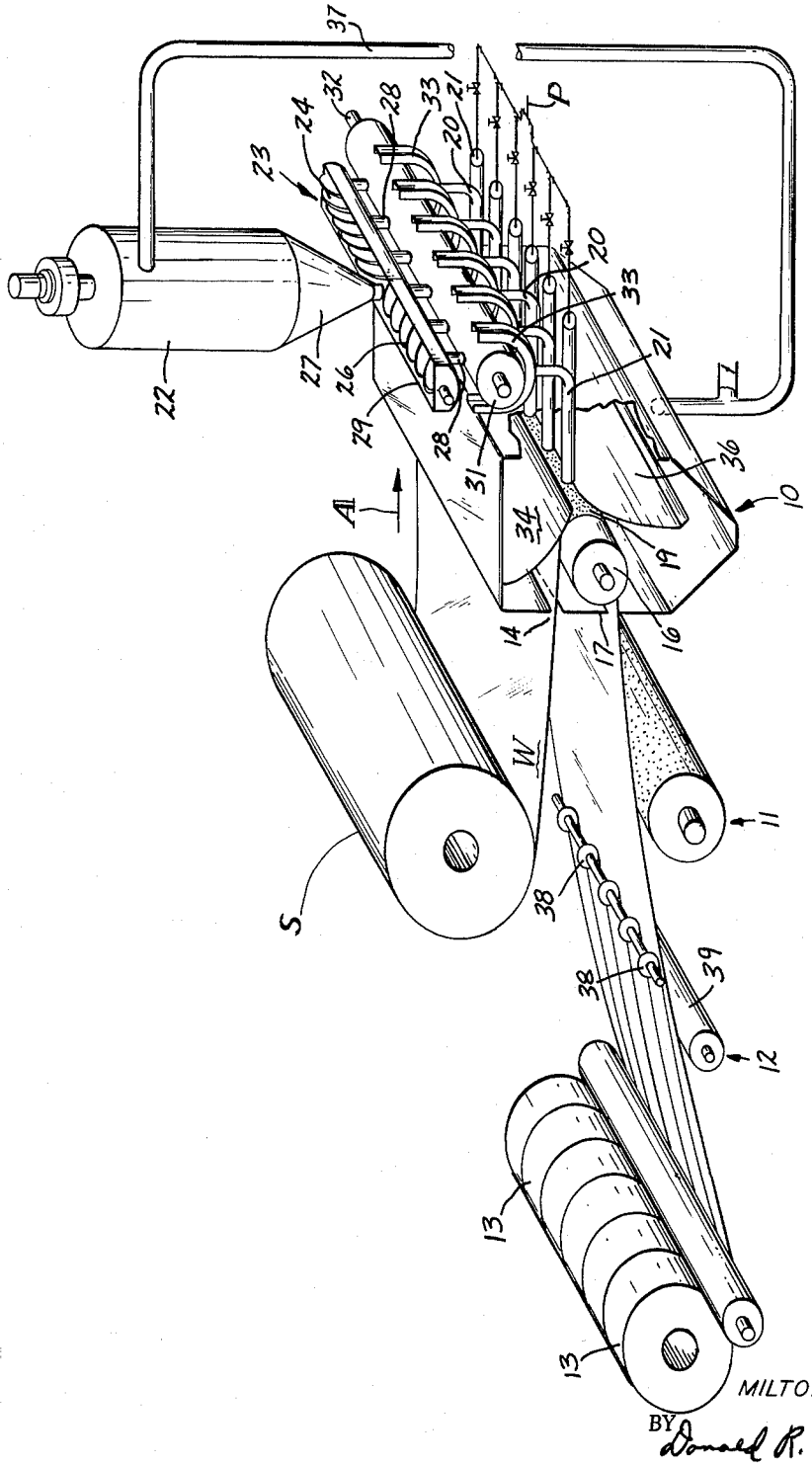


FIG - 1

INVENTOR.
MILTON O. SCHUR

BY Donald R. Mahler

ATTORNEY

Jan. 4, 1966 M. O. SCHUR 3,227,019

METHOD FOR INCREASING AIR PERMEABILITY OF FILMS OR SHEETS

Filed Jan. 24, 1964 2 Sheets-Sheet 2

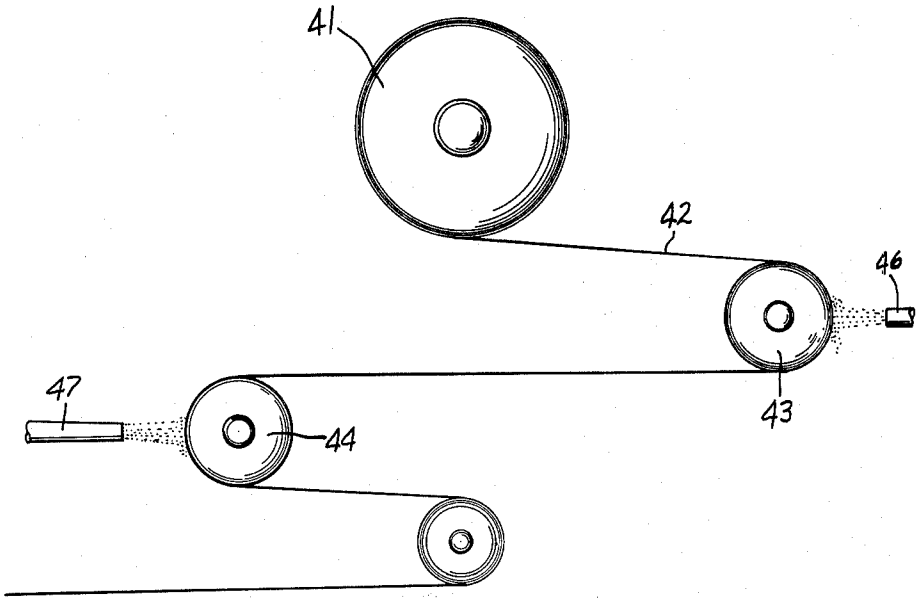


FIG - 2

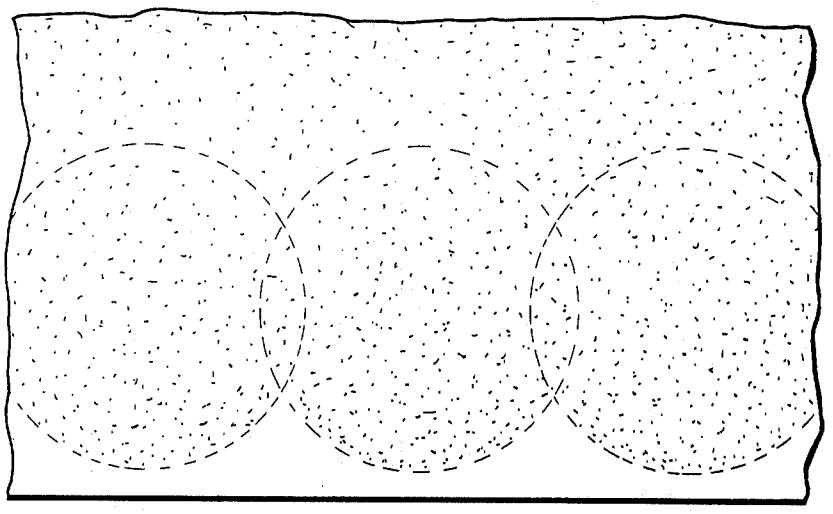


FIG - 3

INVENTOR.
MILTON O SCHUR
BY Donald R. Mahaffey
ATTORNEY

United States Patent Office

3,227,019

Patented Jan. 4, 1966

3,227,019

METHOD FOR INCREASING AIR PERMEABILITY OF FILMS OR SHEETS

Milton O. Schur, New Haven, Conn., assignor to Olin Mathieson Chemical Corporation, a corporation of Virginia

Filed Jan. 24, 1964, Ser. No. 339,944
13 Claims. (Cl. 83—30)

This application is a continuation-in-part of my co-pending application, Serial Number 35,256, filed June 10, 1960, now abandoned.

This invention relates to an improved method for increasing the air permeability of paper, particularly conventional cigarette paper, as well as other sheet materials such as plastic film or the like.

Frequently, the characteristic of paper sheets or plastic film which allows fluids to be transferred through the sheets or film is referred to as porosity. In the prior art, porosity has been heretofore fabricated into a paper sheet or web by regulating fibrillation in the paper mill, or by perforating, slitting or renting by mechanical means subsequent to the manufacture of paper.

Conventional cigarette paper is considered to be a relatively non-porous paper and is characterized by a porosity index of about 35–50 seconds as measured with the Greiner porosity tester, an instrument long used in the industry. The index is the time in seconds required for 50 cc. of air to be drawn through a test area of cigarette paper one inch in diameter under the influence of a varying suction head equivalent to a column of water averaging about 4.5 inches in height. Since the measurements are reported in seconds, the higher the numerical value of the test, the less porous is the paper. It has been found that certain desirable characteristics can be imparted to a cigarette if the cigarette paper can be made to have a porosity index in the range of 5–20 seconds. Such a cigarette paper would be desirable, however, only if the range of 5–20 seconds can be attained without substantially affecting the tensile strength or burning rate of the paper.

In certain prior art schemes for rendering cigarette paper more permeable to air, the means for increasing the porosity of the paper has had undesirable effects upon the tensile strength and burning rate of the paper.

For example, in fine papers, such as cigarette paper, increasing the porosity of the paper by regulation of fibrillation in the paper mill during manufacture has resulted in a substantial decrease in tensile strength and a substantial increase in burning rate of the paper.

Both these occurrences are undesirable in the cigarette art.

Consequently, it is a prime feature of the present invention to provide a method for increasing the air permeability of conventional cigarette paper to develop a porosity index in the range of 5–20 without altering substantially the tensile strength or the burning rate of the paper.

Another feature of this invention is to provide a method capable of obtaining a greater degree of porosity in a sheet of fine paper such as cigarette paper with smaller holes than can be conveniently obtained by any other known methods and apparatus.

Another feature of the present invention is the provision of a novel process for forming microscopic openings such as rents or the like in a continuously advancing web of sheet material such as paper, plastic or the like.

Another feature of the present invention is the provision of a novel apparatus for forming microscopic openings in a continuously advancing web of sheet material.

Another feature of the present invention is the provision of a simple, inexpensive process for treating cigarette paper so as to increase the air permeability of the paper without altering in a substantial way the tensile strength or burning rate of the paper.

A method of accomplishing increased air permeability of a web of paper or plastic material according to this invention may comprise the steps of continuously advancing the web over an anvil and bombarding the web backed by said anvil with a fluid jet including a dispersion of solid particles moving with a force effective to cause substantially each of said particles to form spaced microscopic rents or openings in the web.

An apparatus embracing certain principles of the present invention and utilized to practice the process steps thereof may comprise a supply roll and a take-up roll, a cylindrical anvil for supporting the web as it passes from the supply roll to the take-up roll, jet means for guiding and directing solid particles toward the web while backed by the anvil, conveyor means including a distributor cooperating with the jet means for introducing solid particles to the jet means and controlling the number and rate at which said particles are introduced into the jet stream, and abrading roll in contact with the paper for removing fibrous projections and imbedded solid particles, and slitting means for cutting the sheet longitudinally to convert the sheet into bobbins.

The apparatus and method described briefly above and in detail below, has certain distinct advantages not found in any of the known prior art devices for perforating paper sheets and the like to obtain increased air permeability. One such distinct advantage is that the porosity being imparted to a web of sheet material by my apparatus can be continuously measured and regulated within a rather close range by control of the number of particles being directed at a unit area of sheet material thereby regulating the openings per unit area being made in the sheet material. Such convenience and ease of regulation and control is not possible with other known apparatus such as the pin roll type of perforating apparatus. In order to vary the porosity being imparted to a sheet which is being acted upon by a pin roll, for example, the machine must be stopped and a new roll substituted having a different number of perforating pins. In the alternative, it may be possible to add or remove pins from a given roll; however, this is a cumbersome and time-consuming job.

The ability to measure, regulate, and control the porosity being imparted to a given sheet of material is extremely important when one considers the fact that even in a given roll of paper or other sheet material the inherent porosity of the sheet can vary from one given area to another. This is due to differences in sheet thickness and compaction of the fibers. It may therefore be necessary to continuously increase or decrease the number of rents or openings per unit area imparted to different portions of a given sheet by the perforating apparatus in order to obtain a sheet having a generally constant porosity index over its entire area.

Another distinct advantage of this invention is that the air permeability of the paper is increased to the desired porosity index number by the provision of a plurality of very small openings per unit area in the sheet material. The openings made by the apparatus and method of this invention are smaller in size than the openings which can be conveniently made by other known prior art devices. The tensile strength of the sheet is therefore not substantially reduced as it would be if a plurality of larger openings per unit area were

made in the sheet material. By the use of the apparatus and method of this invention, the average opening size can be easily maintained at less than 1500 square microns. The openings or pores made by the practice of this invention are not normally visible to the naked eye, but can be readily discerned when the sheet material is held up against a strong light. The number of pores per unit area made in the sheet material can be regulated so as to give the desired porosity index. For example, it has been found that, in cigarette paper, the porosity index will be about 7 seconds when there are 48 openings per square centimeter. At a porosity index of 10 seconds, there will be about 37 openings per square centimeter of sheet material.

Before proceeding further with a detailed description of my invention, I consider it important to note that the method of this invention is dependent on the piercing action of solid particles being directed against a web of sheet material. This is to be clearly distinguished from an abrasive effect wherein the thickness of a sheet is diminished, or the surface finish of the sheet material is worn away, or wherein relatively large holes are formed in the sheet by the constant abrasive effect of many particles striking and wearing the sheet away in a given unit area. Theoretically, my apparatus functions to drive each particle at a given area of sheet material with a force sufficient to cause the particle to penetrate the sheet and form spaced microscopic openings. In actual practice, not every particle will be properly disbursed or have sufficient acceleration to pierce the sheet; but the apparatus can be regulated and controlled to provide the required number of microscopic openings per unit area to give the desired porosity.

Other features and advantages of the present invention will become more apparent from the succeeding specification when read in conjunction with the appended drawings, in which:

FIGURE 1 is a schematic view of an apparatus operable to practice the process steps of the present invention.

FIGURE 2 is a schematic view of an additional embodiment of the invention showing apparatus operable to treat a continuously advancing web upon both sides.

FIGURE 3 is an enlarged view of a portion of treated web showing the dispersion pattern developed by the process of the present invention.

Referring now to the drawings, there is shown in FIGURE 1 a supply roll of paper S which for purposes of describing an exemplary embodiment of the present invention is identified as a roll of cigarette paper.

The roll S is mounted in appropriate spindles (not shown) and is operative to pay off in the direction shown by the arrow labelled A and is led through a chamber, indicated generally by the reference numeral **10**, and thence to an abrading roll **11**.

Thereafter, the web passes between slitting rolls, indicated generally at **12**, and is ultimately wound into a plurality of bobbins **13**.

More specifically, the paper web W passes from the supply roll S through an elongated slot **14** formed in the chamber **10**, thence around anvil roll **16** and emerges through an elongated slot **17**. The end wall of the chamber **10** facing a viewer of FIGURE 1 has been removed for clarity.

While the web is in contact with the anvil **16**, the surface **19** of the web is exposed to a jet or blast of solid particles driven by fluid under pressure from a plurality of guide or jet tubes **21—21**.

In the disclosed embodiment of the invention, the solid particle matter utilized is sand having a particle size such that the granules pass through a 50 mesh screen but are retained upon an 80 mesh screen.

The above description of the solid particles are described primarily to explain an illustrative embodiment of the invention and the description is not intended to limit the invention because it is anticipated that other solid particles of different particle size and of different material may achieve the desired increase in air permeability depending upon the particular web treated.

Obviously, any suitable gas or fluid under pressure may be utilized to create a jet. It is anticipated that the apparatus and process of the present invention will be useful in treating web material generally, including polyolefin and cellophane films, paper and other fibrous or plastic sheet or webs.

The sand particles are stored in collector **22** and drop downwardly onto a distributor means indicated generally by the reference numeral **23**, the disclosed embodiment thereof comprising a conveyor screw having a section **24** and a section **25** fabricated with leads of opposite hand. This arrangement is effective to distribute the sand laterally from the funnel **27** to the various outlets **28—28** depending from a trough-like structure **29** within which the screw is rotatably mounted and housed. Disposed below the outlets **28—28** is a distributor roll **31** which is rotated by means (not shown) about axis **32** to distribute the sand circumferentially about roll **31**.

Disposed below the roll **31** are a plurality of generally U-shaped collectors or traps **33—33**. Each trap **33** is positioned in alignment with a corresponding outlet **28** and is formed with a dimension across its width which is wider than the opening of its mating outet **28** so that the sand discharged from a particular outlet **28** is caught or trapped in its entirety in the mating trap **33**. The number of grains of sand supplied to the guide tubes **21—21** is controlled by regulation of the speed at which distributor roll **31** rotates.

Each jet or guide tube **21—21** is connected to a source of air pressure indicated generally by the reference numeral P so that a Venturi effect is created by the introduction of air under pressure into the tubes **21—21** with the result that as the air passes through the tubes **21—21**, a vacuum is created in nipples **20—20** and sand particles are drawn from the traps **33—33** and propelled towards the paper in contact with the anvil roll **16** with a force effective to pierce the paper and form microscopic rents therein.

Since the sheet is continuously moving and the jet tubes **21—21** are laterally spaced, the dispersion of particles contacting the sheet is such that the openings formed in the sheet are individually spaced in a random pattern. A reference to the illustration of FIGURE 3, particularly the pattern disposed within the region bounded by the intersecting dotted circles, shows generally the instantaneous dispersion pattern achieved by bombarding the continuously advancing web W with sand particles propelled by air pressure in the manner just described. A random distribution is achieved.

Obviously, the porosity of a web of sheet material can be controlled by regulation of the number of particles striking and piercing a given unit area of material. The control of porosity can be accomplished by adjustment of the displacement of the jet tube **21—21** relative to the anvil roll, by change of the air pressure, by change of the particle size or composition of particles, by change of the rate at which the particles are fed into the jet tubes, by change of the rate at which the paper is moved past the anvil roll, or by any combination or permutation of all of these and other considerations as well. The porosity of the sheet material may be continuously measured or samples may be taken, and measured to determine that the desired porosity is achieved. Apparatus for random or continuous testing of the porosity of the sheet material is commercially available and as such forms no part of this invention.

Baffles **34** and **36** are utilized within the chamber **10** to deflect the sand and air downwardly after the occurrence of bombarding to the bottom of the chamber **10** whereupon, in well-known fashion, the collector **22** is operative

to draw the sand through the conduit 37 back to the collector 22 from which the sand may be recycled.

In some instances, it is desirably gently to brush or otherwise to clean the paper after bombardment to eliminate superficially adherent particles.

In these instance, roll 11, carrying an abrasive material on its surface, is rotated against the continuously advancing web effective to remove by abrasion the undedesirable fibrous projections. Where the web being treated is cigarette paper, as in the exemplary embodiment, it is found desirable to package the treated paper in bobbins of relatively narrow widths. Consequently, a series of slitting knives 38 are arranged over an anvil roll 39 effective to slit the paper longitudinally in continuous fashion.

Referring now the the FIGURE 2 embodiment of the invention, there is disclosed schematically a modification of the apparatus of FIGURE 1 wherein a supply roll 41 paying off a web 42 is continuously passed around anvil rolls 43 and 44 so that both surfaces of the web 42 may be bombarded in sequential fashion by the action of two groups of guide tubes referenced 46 and 47, respectively.

In effect, then, the method of the present invention embraces the continuous advance of a web of sheet material, such as paper or plastic film, over an anvil roll and the bombardment of the sheet or film in the region of the roll and while backed by the roll with a continuous stream of solid particles, such as sand, effective to create a random dispersion of spaced microscopic rents in the paper.

The method also embraces the concept of bombarding both sides of a continuously advancing web in sequential fashion.

It is anticipated that a wide variety of embodiments of the present invention may be devised without departing from the spirit and scope thereof.

I claim:

1. A method of increasing the porosity of cigarette paper by forming spaced microscopic openings in said paper while substantially maintaining the initial tensile strength and burning rate of said paper including the steps of:

continuously advancing a web of cigarette paper over and into engagement with a backing member,

feeding solid particles into a pulrality of jet tubes,

propelling said solid particles through said jet tubes by means of a fluid under pressure against the backed portion of said paper with a force sufficient to cause said particles to penetrate said web and form spaced microscopic openings through said paper,

and regulating the number of said particles piercing said sheet thereby controlling the number of openings formed per unit area of said web to produce paper of desired porosity.

2. The method of claim 1 in which the regulating of said particles piercing said sheet is accomplished by adjusting the rate at which the particles are fed into the jet tubes.

3. The method of claim 1 in which the regulating of said particles piercing said sheet is accomplished by controlling the pressure of the fluid propelling said particles.

4. A method of increasing the air permeability of sheet material to a Greiner porosity of less than about 20 seconds without substantially affecting the tensile strength or burning rate of said sheet material comprising the steps of:

advancing sheet material into engagement with a backing member,

propelling solid particles at said sheet material while engaging said backing member with a force sufficient to cause said particles to pierce said sheet in a random dispersed pattern to form a plurality of spaced microscopic rents in said sheet material,

and regulating the number of particles contacting a given unit area of said sheet material to control the porosity imparted to said sheet material.

5. The method of claim 4 in which said solid particles are directed at both sides of said sheet material in sequential fashion.

6. The method of claim 4 including the step of measuring the porosity of said sheet to properly regulate the number of particles per unit area piercing said sheet material.

7. The method of claim 6 in which said measuring is continuously performed as the sheet is advanced beyond said backing member.

8. A method of making microporous cigarette paper having a Greiner porosity of less than 20 seconds comprising the steps of:

moving a continuous strip of cigarette paper from an unwinding roll to a winding roll,

passing said moving strip over a backing member,

propelling solid particles suspended in a gaseous medium against said strips while in engagement with said backing member with a force sufficient to cause said particles to penetrate and pierce said strip thereby forming individual microscopic openings therein described in a random pattern,

and regulating the number of particles piercing a unit area of said strip to control the porosity imparted to said strip.

9. The method of claim 8 in which the average size of said microscopic openings formed by said particles is maintained at about 1500 square microns.

10. A method for increasing the air permeability of a web of paper such as cigarette paper to develop a Greiner porosity index within a range of 5–20 seconds comprising the steps of:

continuously advancing a web of said paper against a backing member,

feeding solid particles at a controlled rate into a plurality of jet tubes directed toward said backing member,

accelerating said particles through said jet tubes toward said backing member with a force sufficient to cause said particles to penetrate said web and form microscopic rents therein and regulating the number of particles piercing a given unit area of said web to control the porosity imparted to said web.

11. A method for increasing the air permeability of a strip of sheet material including the steps of continuously advancing said strip over a backing member, continuously bombarding the strip backed by said member with a jet stream including a dispersion of solid particles moving in said stream with a force sufficient to penetrate said strip and form microscopic rents in said sheet, and regulating the number of said particles impinging upon the backed portion of said strip so as to control the number of rents formed in the sheet and increase the air permeability of said strip to the required degree.

12. A method of uniformly increasing the porosity and air permeability of a paper strip including the steps of passing the paper strip over a backing member, directing solid particles suspended in a gaseous medium against said strip while backed by said member with a piercing force so that said particles form individual microscopic rents in said paper, and controlling the number of said solid particles impinging upon said strip so that a given number of individual microscopic rents are formed in the paper to give the desired porosity and air permeability.

13. The method of uniformly increasing the air permeability of a strip of sheet material including the steps of providing a backing member, continuously advancing said strip of material so that a portion of said strip is backed by said backing member as the strip is advanced, directing a plurality of solid particles against the backed portion of said strip with a force sufficient to penetrate and form individual microscopic rents in said strip and

regulating the dispersion of said particles so as to control the number of rents per unit area of paper to impart the desired permeability to said strip.

References Cited by the Examiner

UNITED STATES PATENTS

767,104	8/1904	Denison	51—8
767,363	8/1904	Phillips	51—8

2,385,246	9/1945	Wilsey et al.	131—15
2,666,282	1/1954	Peterson	51—318

FOREIGN PATENTS

683,748	4/1964	Canada.

WILLIAM W. DYER, JR., *Primary Examiner.*

WILLIAM S. LAWSON, *Assistant Examiner.*