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APPARATUS FOR MEASURING ELECTROSTATIC BUILD-UP ON STATIC PRODUCING WEB MATERIAL BROUGHT INTO ROLLING CONTACT WITH A STANDARD WEB

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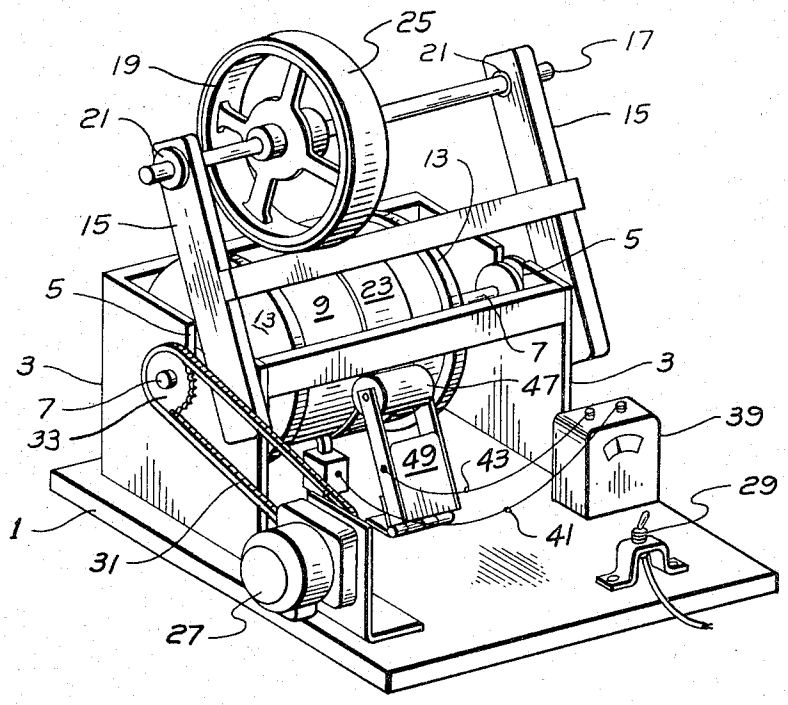


Fig. 1

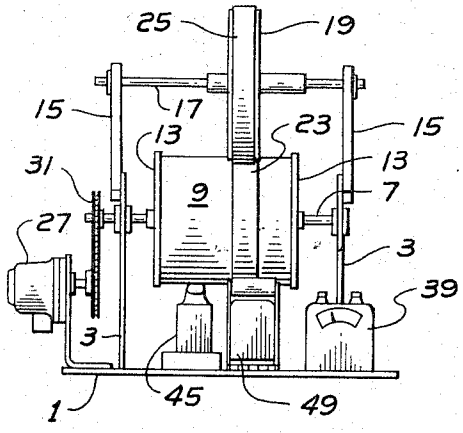


Fig. 2

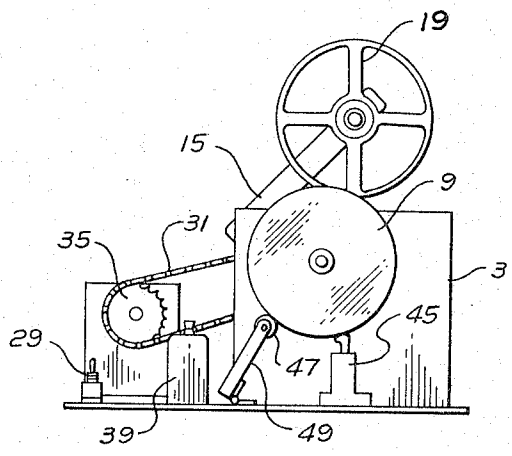


Fig. 3

INVENTOR.
KARL J. MOULTON
BY E. T. McCabe

ATTORNEY.

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APPARATUS FOR MEASURING ELECTROSTATIC BUILD-UP ON STATIC PRODUCING WEB MATERIAL BROUGHT INTO ROLLING CONTACT WITH A STANDARD WEB

Karl J. Moulton, Peoria, Ill., assignor to Swift & Company, Chicago, Ill., a corporation of Illinois

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ABSTRACT OF THE DISCLOSURE

An apparatus for generating and measuring the electrostatic potential of web materials having two bearing surfaces rotating in opposite directions and each mounting a sample of web material which are brought into rolling contact, and an electrical circuit in direct contact with opposite surfaces of the web sample tested for recording the electrostatic charge generated.

This invention relates to the determining of static electricity associated with given materials and more particularly, it relates to apparatus and an improved method for assigning an absolute value for the electrostatic charges on various materials.

Hereafter it is to be understood that the designation of web and sheet type materials is to include all materials both natural, i.e., wool; synthetic, i.e., paper or plastic films, and combinations thereof which are capable of developing static charges. Web material as used herein, generically, designates an endless sheeted material whereas sheet material designates such materials having a defined length.

Webbed and sheeted materials, in general, build up an electrostatic charge as they are being processed, and also during use. This electrostatic build-up is theorized on the basis of the electronic concept of the structure of matter, in which the atom is considered a definite aggregate of electricity. Thus, in the atom, we have the positively charged protons, the negatively charged electrons, and the neutrons which are said to be neutral. In light of this theory, the sheets of film, webs, fibers, etc., either acquire or donate electrons as they pass other substances that can accept or donate the electrons. When they donate electrons they are said to be positively charged, while an acceptor of electrons is said to be negatively charged, but positive or negative designation of the charged particles is an arbitrary selection.

In the manufacture and handling of web type materials, the electrostatic potential may be of major importance. Opposite charges attract each other and may cause sticking, wrinkling, creasing, etc., in the material being handled. Like charges repel each other, and thus webs or sheets of like materials will repel each other when maintaining a sufficient static build-up. Likewise, in the process of making a synthetic fiber and the like, when the static build-up is excessive, the fiber filaments will repel each other and thus cause detrimental effects to the finished product, e.g. loops, etc. Also, in the manufacture of synthetic webs a solvent atmosphere is generally present with an attendant hazardous explosive atmosphere.

Electrostatic potentials of sufficient magnitude to produce spark discharges which may result in explosions, fires, repeated shutdowns of equipment, and injuries to unwarned personnel are frequently generated by continuous moving webs of paper, plastics, cloth and other objects of low conductivity. These and other harmful effects may be effectively reduced or eliminated by proper neutralization of the electrostatic charge. However, effective control

of these undesirable high potentials is dependent on their detection and measurement.

Heretofore available static measuring devices have included two general types; namely, (1) a reciprocating test strip meter to determine static development and (2) an electrostatic induction instrument which picks up the charges developed and registers the value on a meter.

Definite disadvantages are inherent in the use of both of these instruments. The reciprocating test strip generally cannot be used when the test film has a "blocking" property because the film "sticks" when top dead center is reached. If sticking should occur, the use of an additional force necessary to overcome this blocking action is not desirable since such a force would produce a different static reading than that determined from a nonblocking film and thus the values obtained would be erroneous due to the different conditions.

In using the electrostatic induction detector, the film must be moved in a standard manner and the detector placed precisely in the same relative position to that used on comparative film materials. Since the detector is not in contact with the test film, the reading expressed on the meter is a function of the distance the detector is from the test film, the speed of the film, the humidity and the temperature. Thus the problem arises as to the precision of the placement of the instrument to maintain accurate results for comparative static determinations. Also, the area between the film and the detector is subject to variations in temperature and humidity. As the temperature and/or humidity increase, the atmosphere becomes more conductive and thus erroneous variations of the developed static are revealed.

Another method used for testing films is the "pant leg and back-of-the-hand test," where a strip of film is rubbed over the pant leg for a time and then held close to the back of the hand where the attractive forces raise the hairs on the operator's hand. This method is not a quantitative one.

It is accordingly a principal object of the present invention to provide an improved electrostatic measuring method and apparatus that avoids these and other defects and deficiencies of the prior art electrostatic measuring devices.

Another object of this invention is to provide an improved method and apparatus for measuring the electrostatic charge in webbed and sheeted materials from direct contact with said materials.

Still another object of this invention is to provide an improved method and apparatus for measuring the electrostatic potential of web materials by testing individual samples of a given material.

It is a further object of this invention to provide an improved method and apparatus for developing the electrostatic voltage build-up on web materials by subjecting them to frictional and separational forces.

Another object of this invention is to provide an improved method and apparatus for continuously developing the electrostatic charges in web materials being processed or while in use.

Basically the present invention involves the method of bringing two webs of material into rolling contact producing frictional and separational forces to generate an electrostatic potential between two opposite sides of at least one of the webs, said one web being a test sample, and then establishing an electrical circuit between said two opposite sides of the test sample and measuring the potential thereacross as a comparative indication of the electrostatic properties of the sample.

An apparatus for carrying out the foregoing method comprises separate mounting means, for a first web or test sample and for a second web or standardized material, devised for rolling the webs upon one another to produce

constant frictional and separational forces therebetween. An actuating means is connected to drive the mounting means; and electrical contact means is conected for electrical contact with two opposite sides of one web and an indicating means for displaying the magnitude of electrostatic potential across said web.

These and other objects of the present invention not specifically set forth herein will be readily apparent to those skilled in the art from the detailed description set forth hereafter and from the drawings wherein:

FIGURE 1 is a perspective view which is an illustration of a static measuring apparatus according to the present invention; and

FIGURE 2 is a front elevation of the device shown in FIGURE 1; and

FIGURE 3 is a side view of the apparatus shown in FIGURE 1 with certain parts removed.

The improved method of the present invention involves the application of frictional forces to a web or sheet type material whereby an electrostatic potential or charge is built up thereon, and thereafter measuring this static charge by forming an electrical indicating circuit in direct contact with two opposite surfaces of the material tested. The frictional forces are synchronously applied for the duration of each reading or the measurement of the electrostatic build-up. The preferred mode of applying a constant frictional force to a first web, or a test sample of web material, is by rolling, at constant speed, in contact with a second web of standardized material which may be the same as, similar, or dissimilar to the test sample. Where testing relatively small samples on the illustrated device it is preferred, as a uniform test procedure, to obtain comparable data, that both webs be of the same test material. By bringing the two webs of material into rolling contact with one another, both frictional and separational forces are imparted to the test sample; and a constant electrostatic potentil is thereby built up between opposite sides of the test sample which can be accurately measured either continuously or intermittently. In order to permit the development of a comparative value for the electrostatic potential of the test sample without unnecessary variations caused by environmental influences, the two webs of material are insulated from their respective surroundings. In this regard, it has also been found advantageous to bring the electrical terminals of an indicating circuit into direct contact with the respective sides of the test sample. Preferably, where testing small samples, test conditions are normalized by rolling the webs together for a period while the electrical terminals are shorted. Thereafter the terminals are unshorted and static built up for a period after which the potential is visually indicated by connecting the electrical terminals with a meter or other suitable measuring means which indicates a value for the electrostatic potential of the sample that may then be compared with known standards and/or with other test data.

Referring to FIGURE 1, a preferred embodiment of the present invention for testing relatively small samples is shown to comprise a base 1 with a pair of vertical sidewalls 3 upstanding thereon. Each of the sidewalls 3 contains a notch 5 which houses a bearing in which the axle is rotatably supported. Mounted on axle 7 is a hollow brass drum 9 which has a pair of end plates 13 constructed of non-conductive material so as to insulate drum surface from the axle and sidewalls. A pair of vertical support arms 15 are pivotally attached at their lower ends to the exterior of sidewalls 3 respectively, and have a shaft 17 extending through the upper ends thereof. An idler wheel 19 is mounted on shaft 17 and is positioned directly over, and is rollingly engaged with brass drum 9. Preferably non-conductive bearings 21 rotatably support shaft 17 at each arm 15 to insulate the idler wheel 19 from the rest of the device. Alternately arms 15 may be constructed of a non-conductive material. A band of a first material or test sample 23 is mounted on the brass drum 9; and a band of a second or standard material 25 is mounted on idler wheel 19, both bands being rollingly engaged with one another. A synchronous motor 27 is mounted on base 1 and is energized through a toggle switch 29 from a source of electric power. Motor 27 is connected with brass drum 9 through a drive chain 31, which is trained around a sprocket 33 fixed to axle 7 and sprocket 35 fixed to the motor shaft.

A vacuum tube volt meter 39 is positioned on or adjacent base 1 and has a first lead wire 41 and a second lead wire 43 attached thereto. Lead wire 41 is connected to a carbon brush 45 which is positioned on base 1 beneath one side of brass drum 9 so as to directly contact the brass surface thereof and to serve as an electrical contact for the under surface of the test sample 23. Lead wire 43 is electrically connected to an insulated brass roller 47 centrally mounted, with respect to drum 9, on a frame 49 which is hingedly connected to base 1 and biased, by a spring or the like, to engage the exposed surface of the test sample 23.

In operation the motor 27 is energized to rotate drum 9 and idler wheel 19. The test sample 23 acts as a condenser for the electrostatic potential built up as a result of the frictional and separational forces produced by the rolling contact between the test sample 23, mounted on the brass drum 9, and the standard material 25 mounted on the idler wheel 19. An electrical circuit is established between the respective surfaces of the test sample 23 by means of the brass roller 47 contacting the exposed surface thereof and the carbon brush 45 contacting the brass drum 9 on which the opposite surface of the test sample 23 is mounted. As the electrostatic potential builds up on the test sample 23, it flows from one surface to the other over the path of least resistance through the vacuum tube volt meter 39 which indicates the magnitude of electrostatic potential build-up on the sample.

As an example of an application of the foregoing method and apparatus the electrostatic properties of ten different plasticized polyvinylchloride films were measured. Strips of the same film were secured to each of the drum 9 and idler wheel 19 for each test. The motor 27 was energized and the device operated at a constant drum speed of 40 r.p.m. The electrical leads 40, 43 were initially shorted for a period of about 3 minutes and then unshorted for static build-up for a period of about 5 minutes whereupon meter 39 was connected and an e.s.v. value recorded. Each film was thus tested repeatedly and the indicated value was uniformly reproduced. Observation of these films as packaging materials led to the conclusion that a value of 4 e.s.v. in the foregoing test represented a maximum for satisfactory handling properties.

Similar results were obtained upon testing the same films with a standard material secured to idler wheel 19 in all tests.

While the preferred apparatus above described is primarily suitable for determining the electrostatic voltage build-up in relatively small samples of synthetic or plastic webs or sheeted films, it will be apparent that modifications can readily be provided by those skilled in the art to include other substances, materials and objects. For example, the present invention may readily be applied to continuous production lines wherein one or both of the aforementioned bands 23 and 25 may be replaced by continuous webs of material which are confined to arcuate paths so as to provide for rolling contact, one with the other, and where the electrostatic potential is measured across one continuous web at a location closely beyond, in the direction of movement, the area of contact.

Obviously many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A device for measuring electrostatic build-up on static producing web material, comprising: two electrically

insulated rotatable mounting means for bringing two webs of said material into rolling contact whereby constant rotational and separational forces are produced between the two webs as each rotates in an opposite direction, one said mounting means having an electrically conductive bearing surface for mounting the web of material to be tested; a first electrical contact means positioned for bearing against the exposed surface of the web material to be tested; a second electrical contact means positioned for electrical connection with said conductive bearing surface; and an electrical indicating means connected between the first and second contact means for recording the flow of static charge passing between said contact means.

2. A device for measuring electrostatic build-up on static producing web material, comprising: an insulated driving drum having a conductive surface for mounting a first web of said material; an insulated idler-wheel for mounting a second web of said material and positioned adjacent said drum to bring the second web into rolling contact with the first web of material on said drum; a synchronous actuating means connected to rotate said driving drum whereby the first and second webs are rotated in opposite directions and are subjected to constant frictional and separational forces for producng an electrostatic build-up on the opposite surfaces of the first web of material; a first electrical contact means contacting the exposed surface of the first web; a second electrical contact means directly contacting the conductive surface of the driving drum; and an indicating means electrically connected between the first and second electrical contact means for indicating the electrostatic flow on opposite sides of the first web of material.

3. A device for measuring the electrostatic build-up on static producing web material, comprising: a base; a rotatable drum having a conductive surface and insulatably mounted for rotation above said base, said drum being adapted to for mounting the first web of said material thereon; an actuating means mounted on said base and operatively connected to rotate said drum; an idler-wheel insulatably mounted on the base and positioned to ride atop and to be rotated in an opposite direction by the drum, said wheel being adapted to receive a second web of said material thereon, and positioned to bring the second web into rotating contact with the first web whereby continuous frictional and separational forces are produced for developing a static build-up on opposite surfaces of the first web; a brush electrical contact positioned against a conductive surface of the drum; a roller electrical contact positioned against the exposed surface of the first web; and an indicating means electrically connected between the electrical contacts for measuring the electrostatic build-up produced by said frictional separational forces.

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RUDOLPH V. ROLINEC, *Primary Examiner.*

E. L. STOLARUN, *Assistant Examiner.*