Aug. 25, 1936. U. PESTALOZZA 2,052,361

MANUFACTURE OF ELASTIC RUBBER THREAD, CORD, STRIP AND THE LIKE

Filed June 2, 1933 2 Sheets-Sheet 1

Fig. 1

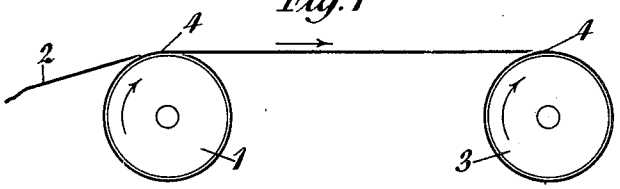
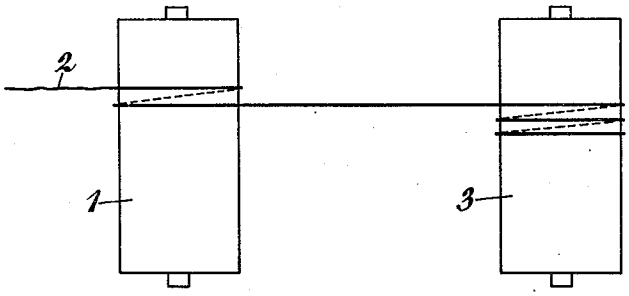


Fig. 2



Ugo Pestalozza, INVENTOR,
By: Smith, Michael & Gardiner,
Attorneys.

Aug. 25, 1936. U. PESTALOZZA 2,052,361

MANUFACTURE OF ELASTIC RUBBER THREAD, CORD, STRIP AND THE LIKE

Filed June 2, 1933 2 Sheets-Sheet 2

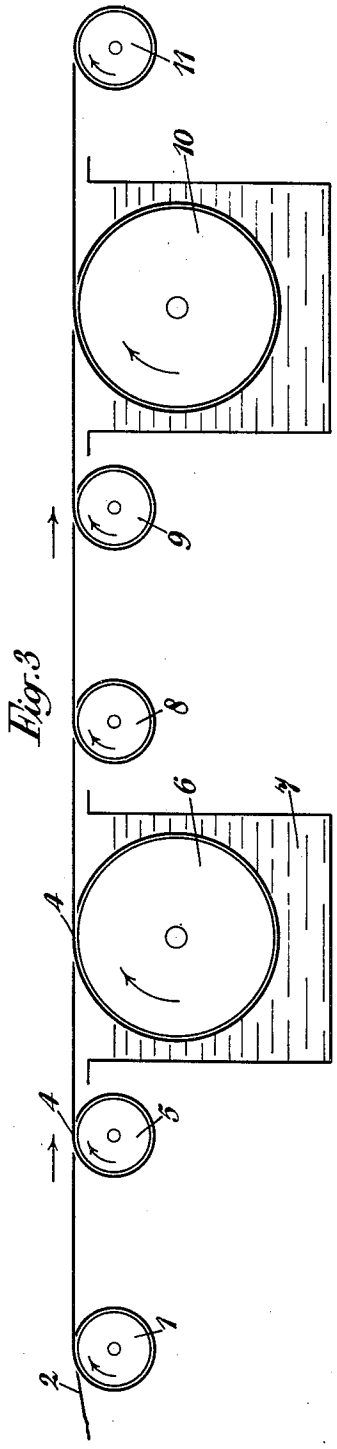


Fig. 3

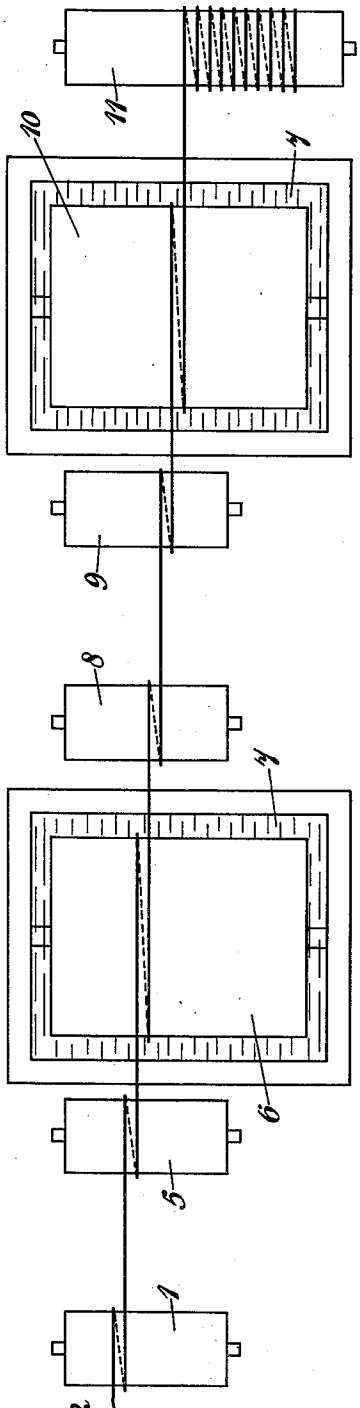


Fig. 4

Ugo Pestalozza, INVENTOR,
By: Smith, Michael & Gardiner,
Attorneys.

Patented Aug. 25, 1936 2,052,361

UNITED STATES PATENT OFFICE

2,052,361

MANUFACTURE OF ELASTIC RUBBER THREAD, CORD, STRIP, AND THE LIKE

Ugo Pestalozza, Milan, Italy, assignor to Società Italiana Pirelli, Milan, Italy

Application June 2, 1933, Serial No. 674,103
In Italy June 4, 1932

4 Claims. (Cl. 18—54)

This invention relates to the production of elastic rubber thread, fine elastic rubber cord and strip and tubular elastic rubber and like elastic rubber filament of small cross-section, by extrusion of coagulatable aqueous rubber dispersions followed by vulcanization of the filament produced.

The object of the invention is to meet a practical difficulty which has been experienced in the attempt to employ the process disclosed in the United States of America Patent No. 1,717,248 in the manufacture by extrusion of such small cross-section material as that above referred to, in particular the finer counts of elastic rubber thread.

It is characteristic of the process of said Patent No. 1,717,248 and of the various modifications of that process covered respectively by the following patents, namely United States of America Patent No. 1,750,540 and British Patents No. 292,964 and No. 351,012, that an aqueous rubber dispersion is employed which contains a coagulating agent of such a kind and in such quantity in the dispersion that the latter is stable against coagulation at normal temperature but is unstable and coagulable to the form of coherent rubber containing a substantial proportion at least of the water of the initial dispersion, at a definite predeterminable raised temperature, and that the necessary heat to raise the dispersion to this temperature is applied to the dispersion from a forming surface in contact with it, the coagulum which forms from the dispersion conforming to the shape of the forming surface.

The practical difficulty referred to which has been experienced in the attempt to employ this process (which, for the sake of brevity, will be referred to hereinafter and in the claims as the nozzle coagulation extrusion process) in the manufacture of the finer counts or sizes of elastic rubber thread or the like is as follows. It has been found that owing to the process of coagulation which proceeds within the bore of the extrusion nozzle, a certain resistance is set up therein to the normal flow of the dispersion through the nozzle, which resistance, moreover, tends to vary in a manner quite uncontrollable with the result that it is almost impossible to produce by this method a fine thread of perfectly uniform cross-section throughout the length of the thread, of accurate predetermined cross-sectional dimensions and of accurate conformity in cross-sectional shape to the bore section of the extrusion nozzle, which three characteristics are, of course, of paramount importance on account of the exacting nature of the market requirements.

According to this invention, a process for the production of small section elastic rubber filamentary material of the nature referred to above by the known method of extruding a heat sensitized aqueous rubber dispersion through a nozzle heated to effect coagulation of the dispersion as it issues through the nozzle, that is to say by the known method disclosed, for example, in the United States of America Patent No. 1,717,248, is characterized by first forming by this method a largely over-size thread or the like of substantially unvulcanized rubber and then reducing this thread or the like without altering its cross-sectional shape by submitting it to a stretching process in which the stretched thread or the like is heated subsequently to stretching and with maintenance both against longitudinal contraction back towards its initial length and also against further extension due to end pull, to eliminate the internal stresses produced in the thread by the stretching, whereafter the fully stretched thread or the like is submitted to vulcanization.

According to a feature of the invention, the stretching of the filament is performed with the filament in a substantially unheated condition and the subsequent heating of the stretched filament to remove the internal stresses therein is performed while the filament is wound upon the periphery of a supporting roller whereon it becomes held against endwise slip relatively to the surface of the roller and thereby relieved of any endwise pull tending further to stretch the filament either evenly and in an aggregate sense (i. e. as a whole) or at localized points along its length.

According to a further feature, the stretching is preferably performed in a succession of stages with interposition between each stage and the next of a rest period during which, as above, the heating of the filament is performed with the filament both preserved against longitudinal contraction and also relieved of any endwise pull tending further to stretch it, by being wound without slip upon the periphery of a supporting roller, the duration of each rest period being such, having regard to the temperature of heating employed, that the whole of the internal stresses are removed from the filament, that is to say before the latter leaves the supporting roller.

It is found that by operating in accordance with the present invention, it is possible very readily and effectively to meet the above practical difficulty experienced with the known extrusion process and therefore to produce, even in the case of the finest counts, thread which is of a high order of accuracy and uniformity of cross-section both as regards dimensions and also in respect of shape. This is the result of two primary factors, which are as follows. Firstly, with a largely over-size nozzle, the aforesaid setting up of resistance in the nozzle due to the normal flow of dispersion therethrough does not take place, or at any rate to any material degree, for the pur-

poses of the present invention, with the result that the extruded thread or the like is of a highly uniform cross-section as it issues from the nozzle, that is initially. Secondly, owing to the avoidance of heating of the thread or the like during the stretching thereof, or in other words, to the confining of the heating of the filament to the steps of annealing thereof (or dissipation of the internal stresses in the thread) following the stretching or each stage of stretching, coupled with the winding of the stretched filament upon the periphery of a supporting roller, with consequent maintenance of the stretched filament during the heating thereof against longitudinal contraction and also at the same time against further stretching due to end pull, any weak spots there may be in the composition of the filament as it leaves the extrusion nozzle (which weak spots it is very difficult to avoid in practice on account of the fact that even slight patchiness or non-uniformity in the composition of the rubber dispersion in course of extrusion through the heated extrusion nozzle will tend to manifest itself in a corresponding non-uniformity of degree of coagulation and therefore strength or tenacity of the issuing filament) will be prevented from forming local thinning or drawing out points or points of possible rupture of the filament, either during the stretching thereof or during the subsequent step or steps of annealing, when as will be appreciated, the thread or the like will be in a heated condition and therefore in a condition in which any local weakness that may exist in the filament will at once manifest itself with the effect referred to.

It should also be remarked in this connection that in the preferred case according to the invention of stage stretching the filament with complete elimination of the internal stresses during the annealing periods, that is after each stage of stretching and before the next, with consequent possibility of accurate predetermination of the eventual cross-sectional size of the filament for a given number of stretches of a given ratio of stretch each, this result is found to be possible only when the filament is wound upon the periphery of a supporting roller during the annealing periods and thereby in the manner referred to prevented from contracting back towards its prestretched length and also from further extension due to end pull. Thus, if the attempt be made to anneal to the point of complete elimination of the internal stresses a stretched filament in an unsupported condition, a point is reached in the progressive dissipation of the increased tenacity conferred upon the rubber of the filament by the stretching thereof, even before completion of elimination of the stresses, when, on account of the loss of this tenacity coupled with the softening effect of the heat treatment upon the rubber and the further effect of reduction of cross-sectional area of the filament consequent upon the stretching thereof, the resistance of the filament to further extension becomes less than the end pull imposed upon it, with the result that further stretching takes place, with consequent prevention of the possibility of accurate predetermination of the ultimate cross-sectional size of the filament, and frequently rupture of the filament.

The requisite degree of extension of the extruded thread or the like will depend, of course, upon the area of its section relatively to the area of the section desired of the thread or the like to be produced. The elongation to which the extruded thread or the like can undergo at one stretching operation will depend upon a variety of factors, including, as will be appreciated, the percentage of water contained in the thread and the temperature at which the stretching is operated.

In the case of rubber thread produced from a dispersion mixing rich in rubber, an elongation of the parent length of rubber from which the thread is produced is readily obtainable at one stretching operation to the extent of 800–900%.

It ought to be added in this connection, that, in the main it has been found more convenient and, generally speaking, more satisfactory, to limit the elongation which is performed at any one stretching operation, to a degree not exceeding one half the elongation at break of the parent length.

In some cases, that is to say, in cases where the rubber thread remains sufficiently firm at the elevated temperature that would be employed in a heating bath for fixing the elongation of the partially stretched thread, not to undergo an appreciable superficial deformation during successive windings and unwindings, it is possible to stretch and heat simultaneously by performing the stretching operation while the thread is immersed in a bath heated to the requisite temperature, in contrast to interposing a separate heating step between successive stages of stretching.

A method of performing the step of stretching the parent length of rubber consists in continuously feeding said parent length on to a feed drum rotating with a peripheral speed equal to the speed of formation and supply of the parent length and operating to wind on to its periphery the parent length supplied to it and, at the same time, to pay off the wound-on length at said speed of formation thereof to a stretching drum rotating with a peripheral speed exceeding that of the feed drum by an amount proportional to the degree of stretch desired of the parent length.

This method of stretching the parent length may be applied, of course, to the simultaneous production of a plurality of lengths, the several parent lengths of rubber being fed to the periphery of a feed drum common to them all and from thence to a stretching drum also common to all of the threads.

Further, the said method of stretching may with convenience be applied, as hereinafter described, to that form of the process in which the stretching operation is performed in stages. Thus, in this case, there would be a succession of stretching drums, the partially stretched lengths of rubber being fed from drum to drum in the succession and the several drums thereof being caused to rotate at progressively increasing peripheral speeds.

The thread or the like is preferably paid off the stretching drum on to the periphery of a heating drum rotating at the same peripheral speed as the stretching drum and serving to support the stretched thread both against longitudinal contraction back towards its initial length and also against further extension due to end pull, in the manner hereinbefore referred to. In the case of stage stretching the partially stretched length, now of fixed elongation, may be paid off the heating drum to the periphery of a second, third or fourth stage, (as the case may be) feed drum, which, in turn, delivers the thread on to the next stretching drum in the succession and so on. Or

the stretched thread or the like, may from the heating drum be fed to a collecting drum or, if vulcanization is to follow, unwound on to a vulcanizing drum, the said collecting or vulcanizing drum being caused to rotate, of course, at the same peripheral speed as the heating drums.

If desired, however, the arrangement may conveniently be one in which the stretching drum or drums themselves constitute the heating drums of the apparatus. For example, the several drums of the apparatus may revolve in partial or complete immersion in a bath of hot water and serve each in turn as a feed drum towards the next stretching drum.

The heating drums may, if desired, be arranged, themselves, through their walls, to impart the necessary heat to the thread or the like wound upon their peripheries, for example, may be hollow and internally heated by steam or a like heating fluid circulated through the drum.

The improved process, according to this invention, will now be further described with reference to the accompanying drawings which diagrammatically illustrate forms of apparatus suitable for carrying the invention into effect, and of which,

Figure 1 is a side elevation of one form of apparatus;

Figure 2 is a corresponding plan view to Figure 1;

Figure 3 is a side elevation of another form of apparatus, being in principle a development of the form shown in Figure 1, and

Figure 4 is a corresponding plan view to Figure 3.

Referring to Figures 1 and 2, the apparatus shown comprises a feed drum 1 receiving on to its periphery a parent length 2 of rubber, which, after being wound once around the periphery of the drum 1, as shown in Figure 2, is fed therefrom to the periphery of a stretching drum 3, around the periphery of which the stretched length becomes wound by the rotation of the drum.

These drums 1, 3 may be composed of any suitable material, for example, iron or aluminium, and they may be of any desired dimensions, according to convenience or to the requirements of the process. For example, in the case of manufacture of rubber thread, the two drums may both be of a diameter of about 5—6 centimetres, the stretching drum 3 may rotate at three times the speed of the feed drum 1 and, therefore, at three times the speed of supply of the parent length 2, and the two drums 1, 3 may be spaced with their axes about 20 centimetres apart.

The parent length 2 is fed slack on to the periphery of the feed drum 1 so as to avoid stretching it up to this point, and the parent length remains in this unstretched condition as long as it is upon the periphery of the feed drum. Owing to the fact, however, that the stretching drum 3 is rotated at a greater peripheral speed than the feed drum 1, the rubber length during its travel from the periphery of drum 1 to that of drum 3 becomes elongated and correspondingly reduced in cross-section to a degree proportional to the ratio of said peripheral speeds. If, as stated, this ratio is 3–1, the elongation of the thread will be 300 percent. and its cross-sectional area will be reduced by ⅔rds, but without, as previously explained, change of cross-sectional form. Therefore, for example, if the gauge of the parent thread be 24, that of the stretched thread will be about 42.

The feed and stretching drums 1, 3 may, if desired, be sheathed with vulcanized rubber coated with lacquer or the like adapted when dry to prevent slipping of the wound-on lengths of rubber, more especially in the neighbourhood of the tangency points 4 on the drum periphery, where the stretched thread is paid off and received on to the peripheries of the drums. Alternatively, the drums, more especially if composed of aluminium, may be wetted with water to provide the anti-slipping effect referred to, or again, the parent rubber length itself may be wetted with water to the same end.

When the stretching drum 3, is full, that is to say, when its periphery is covered with stretched thread, it is removed bodily from its bearings, with the thread upon it, and immersed in boiling water for a short period, to fix substantially the elongation of the thread, as previously explained herein.

The stretching drum 3 may conveniently be provided with means for guiding the thread as it is received on the drum so that it is prevented from building up in layers on the drum periphery.

If desired, or if necessary, the stretched thread, of fixed elongation, may then be subjected to a fresh stretching operation, or a succession of such additional stretching operations. By this means, it is readily possible to obtain from a parent thread, having, say, a gauge of 24, an ultimate finished thread of a gauge up to 72, 124, 216 or even higher. Clearly, moreover, by suitably varying the gauge of the initial parent length or by varying the ratio of the peripheral speeds of the stretching and feed rollers, or by varying both of these factors, practically any desired final gauge may be obtained.

The fully stretched thread has now to be vulcanized, and for this purpose, it may be wound directly from the stretching drum on to a vulcanizing drum and thereon subjected to the necessary heat for vulcanization of the thread.

Referring now to Figures 3 and 4, these figures illustrate a form of apparatus for effectuating the stage of step-wise method of stretching the rubber lengths.

The parent length of rubber 2 is fed, as before, in a slack or unstretched condition, to the periphery of a feed drum 1 rotated at a peripheral speed equal to the speed of the supplying of the material. The parent length is wound once around the periphery of the feed drum 1 and is fed thence to the periphery of a first-stage stretching drum 5, equal in diameter to the feed drum 1 and rotated at, say, three times the speed thereof. The partially stretched rubber length is wound, say, once, upon the periphery of this drum 3, as shown, and from the tangent point 4 thereof is fed to the periphery of a larger immersing or annealing drum 6, which rotates with a peripheral speed equal to that of the first-stage stretching drum 5 and functions to immerse the draw-on length of partially stretched material in a bath 7 of hot water, the effect of the heat of which is substantially to fix the elongation of the partially stretched thread in position upon the periphery of the drum 6. From the tangent point 4 of the drum 6, the elongated rubber length passes to a second-stage feed drum 8, equal in diameter to the first-stage stretching drum 5 and rotating at the same peripheral speed thereas. From the periphery of drum 8 the partially stretched thread is fed to a second stage stretching drum 9 equal again in diameter

to the first stage stretching drum 5 but rotating at, say, three times the peripheral speed thereof. This second stage stretching drum will further elongate the thread therefor and the stretched material thereafter passes to a second-stage heating drum 10 of similar diameter to the drum 6 but rotating with a peripheral speed equal to that of the second-stage stretching drum. Then, assuming there is a further stage or stages to be performed in the stretching operation, the partially stretched thread or the like is paid off the second-stage heating drum 10 to the periphery of a third stage feed drum 11 rotating again at the same peripheral speed as the second-stage stretching drum and from thence to a third stage stretching drum and on, in turn, to a third stage heating drum and either on to a collecting drum from the fully stretched thread or else to a fourth stage feed drum for a further stage or stages of stretching.

The temperature and duration of the heating step to fix the elongation of the unvulcanized thread or the like will, generally speaking, vary with the character of the component rubber. In the case of a normal mixing of high rubber content, a few seconds at the boiling temperature of water will generally suffice to fix, say, a 3–1 stretch of rubber thread. If, however, water of a lower temperature is employed, a correspondingly longer immersion will be required.

In cases where the parent rubber length is formed by extrusion with application of the heat-deposition process referred to, the said length may with certain mixings remain sufficiently plastic as it leaves the extrusion nozzle to be capable of being wound directly onto a stretching drum rotating at a speed higher than the speed of extrusion of the rubber length and then, again directly, without interposition of a heat-settling step, onto a second stretching drum, such a heat-settling step being interposed, however, between this second-stage of stretching and the next and thereafter between each stretch and the one following.

The possibility of operating in this particular manner depends upon the quality of the component rubber of the parent length and the nature and quantity used of the heat-sensitizing agents initially present in the extruded latex mixing.

In order still further to illustrate the invention, the following specific examples will now be given:—

Example I

A parent rubber length produced by extruding a latex mixing of the following composition (in parts by weight):—

	Parts
Rubber (of latex having a 60% dry-rubber content)	120
Magnesium sulphate	3
Ammonium sulphate	3
Accelerator	1.2
Sulphur	7
Zinc oxide	0.7

by application of the aforesaid heat-deposition process described in American Patent No. 1,717,248, was passed through an apparatus of the above description, the said parent length being in an unvulcanized condition and still containing the whole or a substantial proportion of the initial water of the dispersion.

The extrusion nozzle by which the parent length was produced had a circular bore cross-section of such a diameter as to produce a thread which after drying, would have a diameter of 1.5 mm.

After the first three stages of stretching of the parent length, the diameter thereof was reduced to 0.866 mm.; 0.500 mm., and 0.288 mm. (Corresponding in cross sectional area to a square thread of count 100), respectively, and after the following (last) two stages, the diameter of the thread was 0.167 mm. and 0.096 mm. (corresponding to a square thread of count 298), respectively. The diameter of the thread in the case of each measurement referred to was with the rubber in dry condition.

Example II

A parent rubber length similar in composition and method of formation to the parent length of Example I, was stretched after drying to the counts referred to in said Example I by means of apparatus as described and illustrated in the accompanying drawings, but with the stretching and heating of the rubber length being performed simultaneously, the length being stretched while in immersion in a bath of boiling water.

It is to be clearly understood that the accompanying drawings and the foregoing description and the examples are included herein purely by way of illustration of the invention, and the actual sizes and speeds of the various drums of the apparatus and the specific gauge ratios referred to, may be widely varied as desired to suit requirements in any given case.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In the manufacture of fine elastic rubber thread and like filament of small cross-section, by the nozzle coagulation extrusion process as herein defined, forming a largely over-size filament of substantially unvulcanized rubber, reducing the over-size filament to the ultimate desired size without altering its cross-sectional shape by stretching it in a succession of stages with interposition between each stage of the stretching and the next of a rest period in which while the filament is maintained both against longitudinal contraction back towards its initial length and also against further extension due to end pull, it is heated to remove the internal stresses produced in the filament by the stretching, and vulcanizing the fully stretched filament.

2. A process as specified in claim 1 in a form wherein the duration of the rest periods and the temperature employed in the heating of the filament are so controlled that the stresses are removed completely from the filament before the latter is submitted to the next step of stretching.

3. In the manufacture of fine elastic rubber thread and like filament of small cross-section by the nozzle coagulation extrusion process as herein defined, forming a largely over-size filament of substantially unvulcanized rubber, reducing the over-size filament to the ultimate desired size without alteration of its cross-sectional shape by stretching it in a substantially unheated condition and thereafter heating it to dissipate the internal stresses produced in it by the stretching, whilst wound and held against slip upon the periphery of a supporting roller, which thereby serves during the heating of the filament both to prevent the latter from contracting to-

wards its initial length and also to relieve the filament of end pull tending further to stretch it, and finally vulcanizing the fully stretched filament.

4. In the manufacture of fine elastic rubber thread and like filament of small cross-section by the nozzle coagulation extrusion process as herein defined, forming a largely over-size filament of substantially unvulcanized rubber, reducing the over-size filament to the ultimate desired size without alteration of its cross-sectional shape by stretching it in a substantially unheated condition in a succession of stages with interposition between each stage and the next of a rest period in which the partially stretched filament is heated for a sufficient length of time completely to dissipate from it the internal stresses produced in it by the stretching, whilst wound and held against slip upon the periphery of a supporting roller, which thereby serves during the heating of the filament both to prevent the latter from contracting towards its initial length and also to relieve the filament of end pull tending further to stretch it, and finally vulcanizing the fully stretched filament.

UGO PESTALOZZA.

CERTIFICATE OF CORRECTION.

Patent No. 2,052,361. August 25, 1936.

UGO PESTALOZZA

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 70, after the word and period "filament." insert the following paragraph:

> It may be further remarked with regard to the stretching of the thread or the like that it has been found that thread, strip, tube or the like produced from heat sensitized dispersions by extrusion through a heated nozzle in accordance with the known process referred to above is specially amenable to the stretching or reducing process of this invention, that is to say with maintenance, even when stretched to the farthest limits, of the initial cross-section of the thread and of uniformity of cross-sectional dimensions throughout the length thereof.

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of October, A. D. 1937.

Henry Van Arsdale.

(Seal) Acting Commissioner of Patents.