To all whom it may concern:

Be it known that we, JOHN HOWARD WAY and ALBEN WARREN WAY, both of St. Davids, in the county of Delaware and State of Pennsylvania, have jointly invented a certain new and useful Process for Sterilizing Packaged Textile Articles, whereof the following is a specification.

Our process is especially directed toward the sterilization of articles intended for human wear, such as underwear, hosiery, mufflers, sweaters, gloves and articles of clothing generally, which are liable to carry germs injurious to health. Thus, the yarn or other material from which they are made, may be initially impregnated with germs, or during the actual course of manufacture of the articles therefrom, they may become thus impregnated. Furthermore, even though the articles be disinfected individually, or in bulk, after they have been completed, it is quite possible that during the packaging they may become infected with germs carried by the atmosphere, or derived from contact with the persons of those who handle and pack them. We have found that after an article of this character has been completely inclosed in an ultimate package, suitable for commercial handling, and of such character as to be practically impervious to the passage of germs, whether carried by the air or derived from contact with persons or objects, the said article may be sterilized within such final package itself, so that it shall come to the purchaser in an absolutely safe condition, notwithstanding exposure to disease germs down to the time when the package was finally closed. For practical purposes, it is in the highest degree desirable that the envelop or inclosing medium for a package of this character should be composed in whole or in part of paper, not only because of the relative cheapness and adaptability of that material, but because of the characteristics which we have found certain kinds of paper to possess of being practically impervious to the passage of disease germs, of any character, to which the package is liable to be exposed under normal circumstances.

In an application heretofore filed by us under date of April 4, 1914, Serial No. 829,497, we have described a process for sterilizing packaged articles in which the sterilization is effected by a chemical reagent, preferably formaldehyde vapor, one great advantage of which process is that it is available in connection with paper packaged articles. We have also found by careful experiments that steam can be employed under certain conditions of control, notwithstanding its apparent incompatibility with packages composed in whole or in part of paper. While it is well known that steam at sufficiently high temperature is an effective sterilizing agent, its use for packages of the character described would be expected to have disadvantages practically prohibitory. Thus, we have found that in order to insure penetration of a paper inclosed article by the steam, it is necessary that the air should be exhausted from the interior of the package to a substantial extent, and practically this requires exposure of the package within a chamber in which a partial vacuum can be produced. The admission of steam however, to an exhausted chamber of this character, or to the interior of a package from which the air has been exhausted, is liable to be attended by condensation, which would deteriorate the paper and indeed might injure the appearance of the textile article itself inclosed within the package. On the other hand, if the temperature of the steam be high, the paper becomes brittle and the package is unfit for commercial use. We have devised an organized method of treatment, whereby the conditions may be so controlled as to practically eliminate these disadvantages, and we can thus effect the sterilizing of a paper-packaged article, by means of steam, without impairing the integrity or appearance of the envelop.

We will now describe our process in its most highly organized form, and as employed in connection with a paper package of a simple type, without, however, meaning to restrict our claim to the details of the preferred process in their entirety, or to the structural character of the package, other than that it shall be composed wholly or in part of paper, penetrable by the steam under the conditions set forth and substantially impervious to the passage of disease germs. After the article has been finished and is ready for packing, it is inclosed in an envelop suitable for commercial use, such for instance, as a sack of paper having no open joints or exposed apertures of any substan-
tial size. We prefer to use paper of the kind commercially known as "glazed parchment"; or "Pezzo tissue", which we have found to be penetrable by the steam under the conditions of treatment hereinafter set forth, and which is substantially impervious to the subsequent passage of germs, into the interior of the package. The package may be sealed by the use of a paste not liable to be destroyed by the temperature to which it is subjected in the subsequent treatment, or the closure may be accomplished by effective inter-folding and pinching of the edges of the opening. The article thus packaged is inserted in a closed chamber, preferably large enough to receive a considerable number of packages. We prefer to employ a chamber and adjunctive devices of the general character set forth in Letters Patent of the United States No. 704,182, dated July 8, 1902, although we do not limit ourselves to any details of the apparatus, provided it be of a character adapted to carry out the process about to be described. The temperature of the interior of the chamber is raised to about 240° F., and the air is gently exhausted therefrom, until a vacuum of about fifteen inches of mercury is obtained within the chamber. We employ the term "gently" to indicate such a moderate rate of withdrawal as not to burst the envelop through excess of internal pressure. Dry steam, having an initial temperature of preferably about 240° F., is then allowed to enter the chamber slowly, until a pressure slightly above that of the atmosphere is attained in the interior, care being taken to maintain the general temperature within the chamber at a point above that at which the steam would condense under the conditions existing at any given moment. Thus, if the steam were allowed to enter the chamber rapidly, its sudden expansion within the exhausted chamber would result in substantial condensation unless the general temperature were maintained at a point too high to be consistent with preserving the integrity of the paper package. By properly controlling the rate of ingress of the steam we are enabled to prevent any substantial condensation by maintaining a temperature in correspondence with the conditions of internal pressure, but without attaining any such high degree as would injure the paper. After the desired internal pressure has been attained, as above indicated, the steam is shut off and the chamber is again gently exhausted until a vacuum of about fifteen inches is reached, the internal temperature being maintained during this process at a point sufficient to prevent substantial condensation of the steam, under the conditions of diminishing pressure existing from time to time during the withdrawal. Thereupon dry steam of a temperature of about 240° F., is again allowed to slowly enter the chamber under the same conditions of maintenance of temperature as that above set forth. We use the term "slowly" to indicate such a moderate rate of admission of the steam as shall avoid any substantial condensation thereof. The controlled ingress of the steam is continued until an internal pressure has been attained, preferably of about ten pounds to the square inch in excess of atmospheric pressure. This pressure is maintained within the chamber for a period of about thirty-five minutes, the temperature being also maintained at a point sufficient to prevent substantial condensation of the steam, and thereafter the chamber is again gently exhausted, to a vacuum of about fifteen inches of mercury, (the temperature being so controlled as to avoid substantial condensation) and dry air is slowly admitted until atmospheric pressure is attained, the air being preferably heated before its admission. The chamber is again gently exhausted to a pressure of about fifteen inches of mercury and this condition is maintained for from eight to ten minutes. Dry atmospheric air is then slowly admitted and the packages are removed. During all this time, the temperature within the chamber is carefully controlled in a downward direction, so that it shall not at any time fall to the condensing point of the steam corresponding with the degree of internal pressure at any given period. On the other hand, the temperature is so controlled in an upward direction as to prevent impairment of the paper itself. In practice we have found that such impairment is liable to occur if the temperature rises to three hundred degrees F., and we prefer to keep it as much below that point as is consistent with preventing the steam from condensing to any substantial extent within the chamber, either during the period of its admission, its retention or its exhaustion.

We have found that by the careful maintenance of the described conditions of pressure, temperature, and gentleness or slowness of ingress and egress, steam at a sterilizing temperature can be made to penetrate a package of the character referred to and to so permeate the enclosed article as to thoroughly sterilize it, while the integrity of the package is preserved in proper condition for commercial shipment and use, notwithstanding its exposure to a treatment, which, under ordinary conditions, would be practically destructive of its utility.

In the foregoing description, we have given an illustration of our process in its most highly organized form, in which it will be observed that the package is twice subjected to exhaustion for the admission of the steam, and twice for the subsequent admission of air to entirely displace all mois-
ture. While this elaboration of the process may be desirable for articles whose bulk or character renders their permeation by the steam and the subsequent displacement thereof difficult, we do not consider such repetitions of the steps to be essential, or indeed desirable, under ordinary conditions, where the nature of the packaged article is such that the steam can permeate it with readiness and be readily withdrawn.

As above stated, we recognize that steam has heretofore been used for disinfecting purposes, and we do not claim its use either broadly, or in connection with exhaustion of air from the steam chamber.

Our invention is based upon the discovery that an article finally packaged in an envelop composed wholly or in part of paper having the desired qualities, may be thoroughly sterilized within such envelop and that although the latter is readily susceptible to injury by steam, the process may be conducted by an organized control of the conditions of temperature, pressure, and rate of ingress and egress of the steam.

We use the term “envelop” as broadly comprehending any suitable inclosing package, such as a box, carton, or other structure adapted for commercial use and formed in whole or in part of paper.

Having thus described our invention, we claim:

The hereinbefore described process of sterilizing packaged textile articles, which consists in enclosing the article in an envelop comprising paper of a character permeable to steam, under the conditions set forth, but substantially impervious to the passage of disease germs; gently withdrawing air from the interior of such envelop; slowly introducing dry steam into the interior of the package; substantially withdrawing the steam from the interior of the package by gentle exhaustion; admitting air to the interior of the package; and maintaining the temperature throughout at a point sufficient to prevent condensation of the steam under the conditions of pressure which exist at the several periods of treatment, but substantially below the point of impairment of the paper comprised in the inclosing envelop.

In testimony whereof, we have hereunto signed our names at Philadelphia, Pennsylvania, this sixteenth day of April, 1914.

JOHN HOWARD WAY.
ALBEN WARREN WAY.

Witnesses:
JAMES H. BELL,
E. L. FULLERTON.