

111

Nov. 9, 1943.

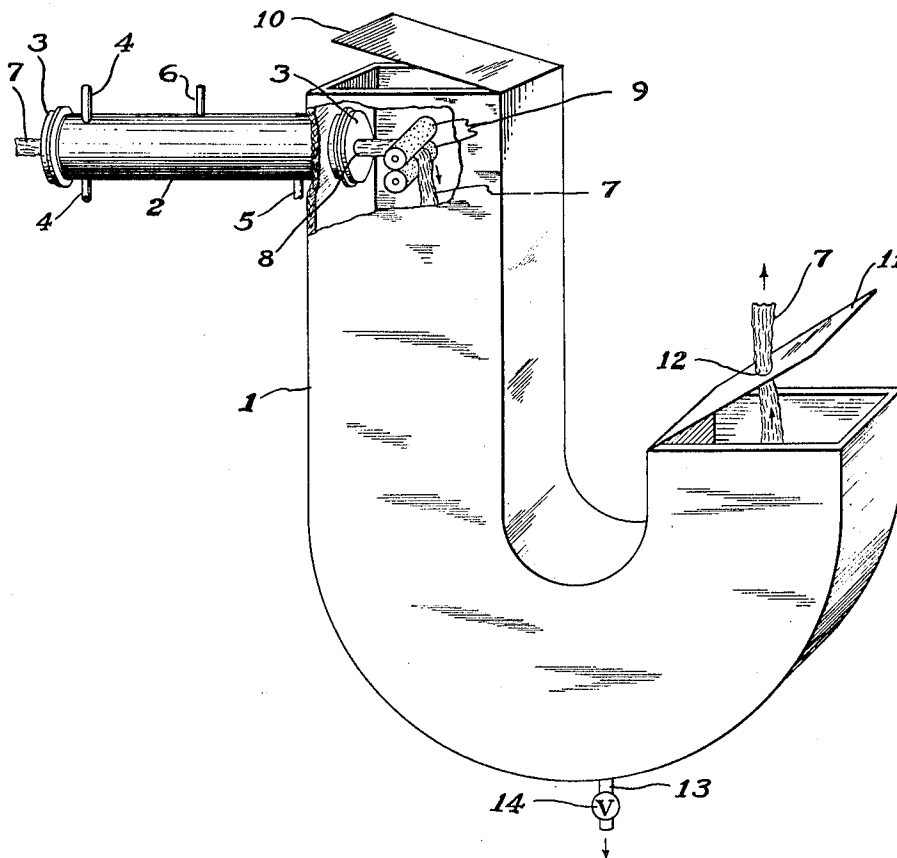
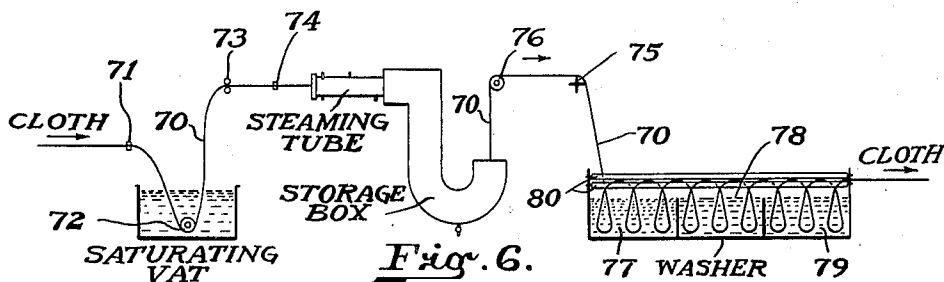
D. J. CAMPBELL ET AL

2,334,066

TEXTILE TREATING PROCESS

Filed Aug. 30, 1940

5 Sheets-Sheet 1



INVENTORS.
 DONALD J. CAMPBELL
 FRANCIS LEROY FENNELL
 BY *E. H. O'Brien*
 ATTORNEY.

111

Nov. 9, 1943.

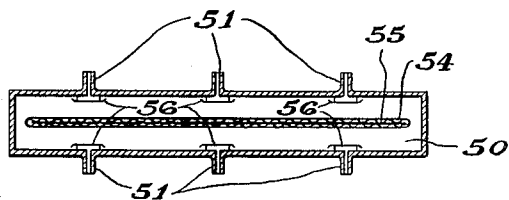
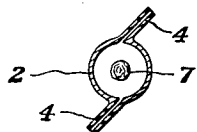
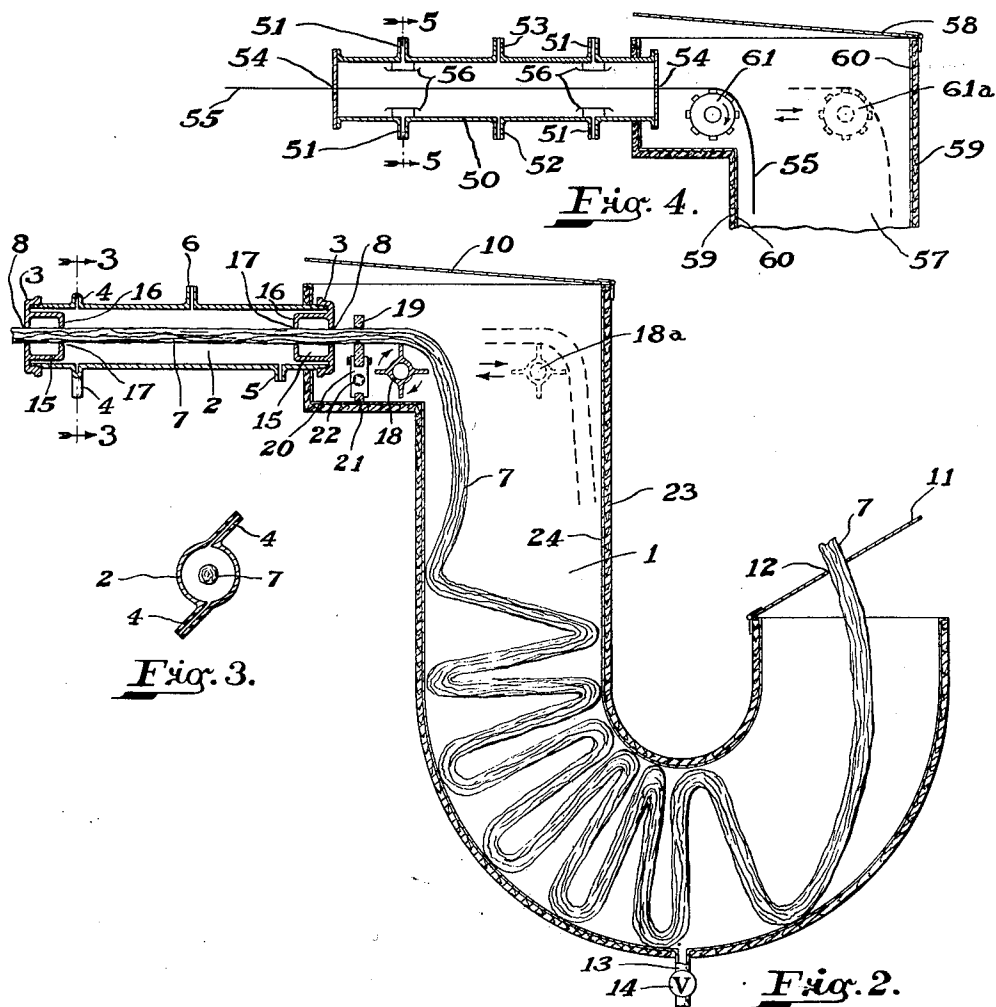
D. J. CAMPBELL ET AL

2,334,066

TEXTILE TREATING PROCESS

Filed Aug. 30, 1940

5 Sheets-Sheet 2



INVENTORS.
DONALD J. CAMPBELL
FRANCIS LEROY FENNELL
BY
C. H. O'Brien
ATTORNEY.

111

Nov. 9, 1943.

D. J. CAMPBELL ET AL

2,334,066

TEXTILE TREATING PROCESS

Filed Aug. 30, 1940

5 Sheets-Sheet 3

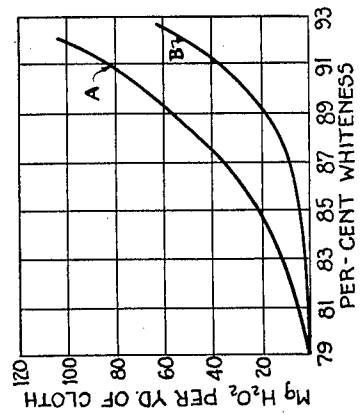


Fig. 8

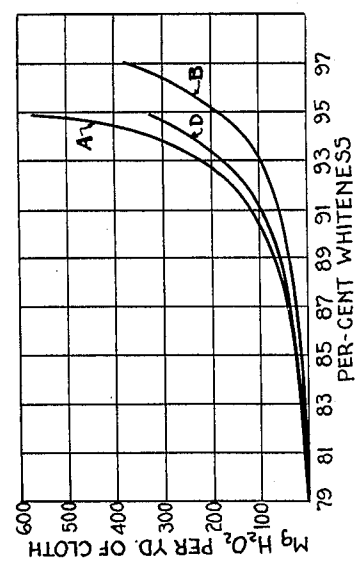


Fig. 10

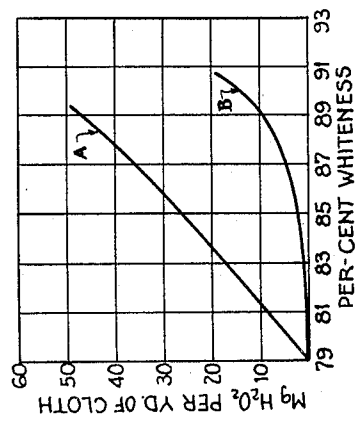


Fig. 7

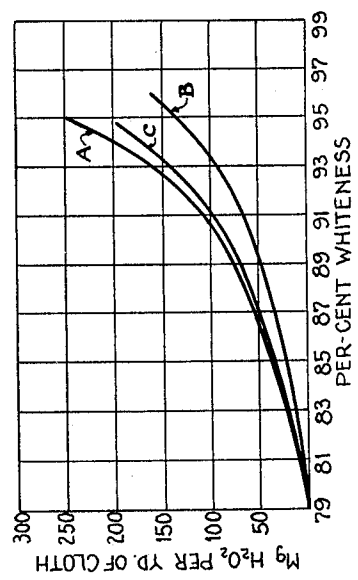


Fig. 9

INVENTORS.
DONALD J. CAMPBELL
FRANCIS LEROY FENNELL
BY
C. N. O'Brien
ATTORNEY.

111

Nov. 9, 1943.

D. J. CAMPBELL ET AL

2,334,066

TEXTILE TREATING PROCESS

Filed Aug. 30, 1940

5 Sheets-Sheet 4

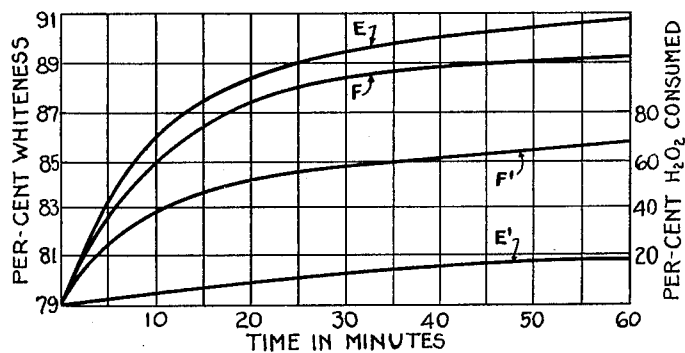


Fig. 11

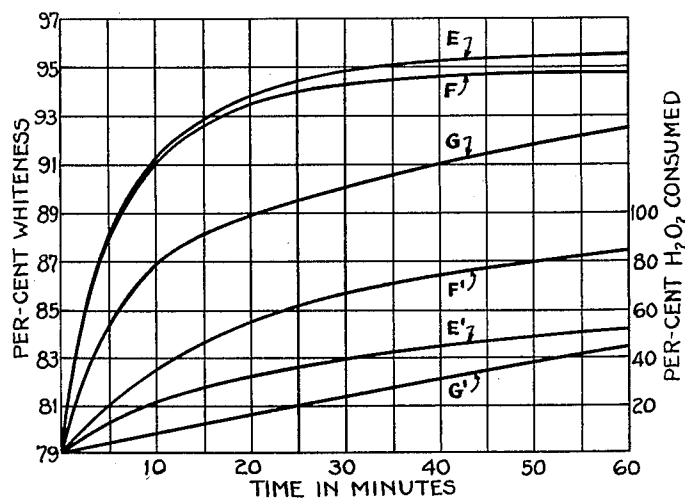


Fig. 12

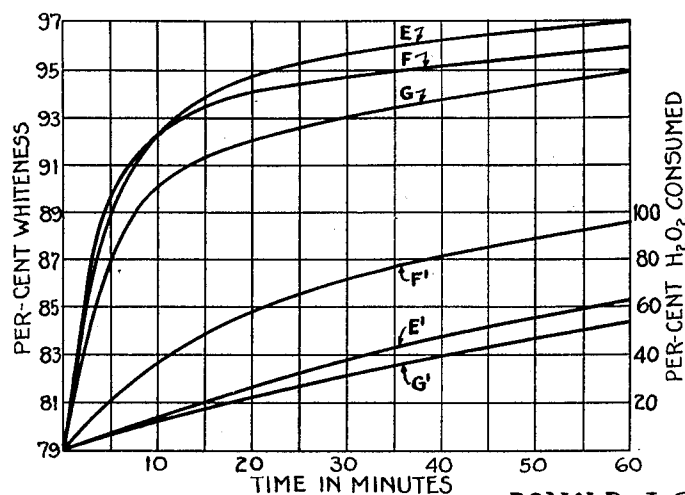


Fig. 13

INVENTORS.
DONALD J. CAMPBELL
FRANCIS LEROY FENNELL
BY
E. H. O'Brien
ATTORNEY.

111

Nov. 9, 1943.

D. J. CAMPBELL ET AL

2,334,066

TEXTILE TREATING PROCESS

Filed Aug. 30, 1940

5 Sheets-Sheet 5

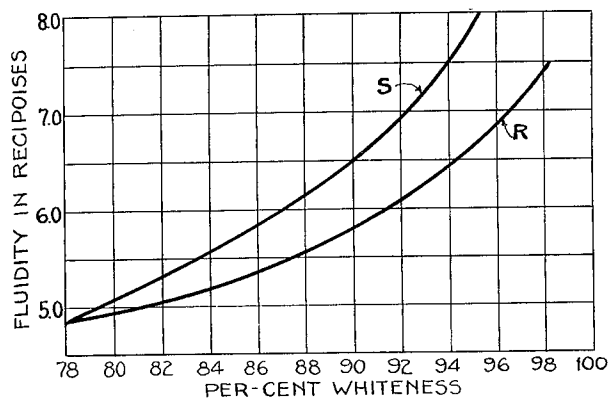


Fig. 14

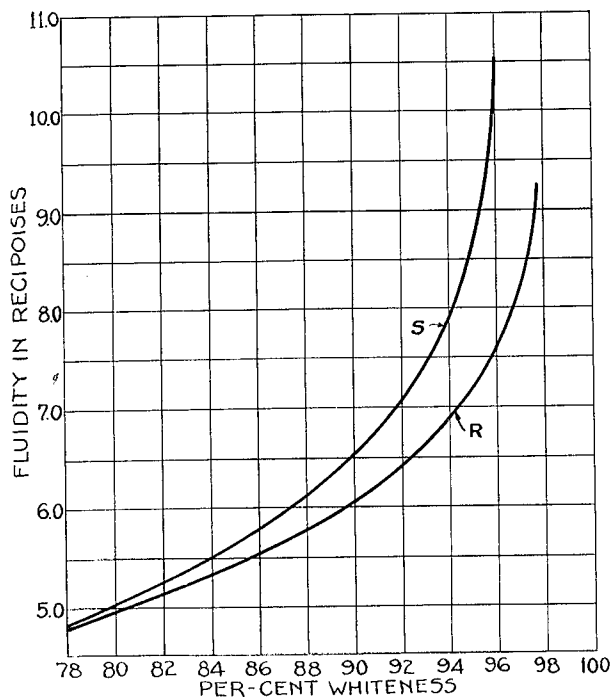


Fig. 15

INVENTORS.
DONALD J. CAMPBELL
FRANCIS LEROY FENNELL
BY
G. H. O'Brien
ATTORNEY.

Patented Nov. 9, 1943

2,334,066

UNITED STATES PATENT OFFICE

2,334,066

TEXTILE TREATING PROCESS

Donald J. Campbell, Niagara Falls, N. Y., and
Francis Le Roy Fennell, Rumford, R. I., as-
signors to E. I. du Pont de Nemours & Company,
Wilmington, Del., a corporation of Delaware

Application August 30, 1940, Serial No. 354,866

8 Claims. (Cl. 8—111)

This invention relates to the treatment of textile goods and is a continuation-in-part of our copending application Serial No. 264,872, filed March 29, 1939, now Patent No. 2,267,718, issued December 30, 1941.

This invention relates more particularly to the bleaching of textile fibres and fabrics, herein generally referred to as goods, utilizing as the bleaching agent a peroxide such as an alkaline solution of hydrogen peroxide or a solution of an alkali metal peroxide.

Textile goods such as those of vegetable origin, especially such textile materials as cotton or those consisting largely or predominantly of cotton, are commonly bleached with alkaline solutions of peroxides. Alkaline or acid solutions of peroxides, more particularly solutions of hydrogen peroxide or of an alkali metal peroxide such as sodium peroxide, are also customarily employed in the textile bleaching industries to a large extent for bleaching other textile fibres such as those fabricated from regenerated cellulose, acetate rayon, silk, linen, wool, and other fibres of animal or vegetable origin. Our invention relates to a new and improved process utilizing solutions of peroxides such as an alkaline solution of hydrogen peroxide for the bleaching of textile fibres, more especially those of vegetable origin.

Our process has for its primary aim the bleaching of such textile fibres under conditions wherein there is less degradation of the chemical nature of the textile fibre, more constant and uniform bleaching, and less unevenness in the bleaching action. In addition to these advantages, which result in the securing of a bleached textile fabric having superior dyeing qualities, our method possesses the important characteristic of insuring the production of a higher degree of whiteness in the bleached textile fabric for equal quantities of peroxide than was ever before attainable in commercial bleaching methods. This aim or advantage may also be expressed by stating that by the use of our improved bleaching process it is possible to produce a given degree of whiteness in bleached textile fabrics with the consumption of a lesser quantity of peroxide.

Various methods for bleaching textile goods by the use of the peroxides are now known and employed to a greater or less extent in commercial bleaching operations. Among these methods the kier bleaching method has, in the past, been utilized to perhaps a greater extent than other methods.

In the kier bleaching method wherein textile fabrics are bleached with alkaline solutions of

hydrogen peroxide, the fabric is packed in a kier and the lid is securely closed. A solution of caustic soda is then circulated through the cloth for eight to twelve hours. The temperature is ordinarily about 250° F. and the gauge pressure 15 lbs. At the end of this period the goods are washed with fresh water. This washing may be conducted in the kier or the cloth may be withdrawn and washed in separate equipment and reloaded into the kier. After washing the fabrics are treated for 4 to 6 hours with an alkaline peroxide solution at a temperature of 180° to 200° F.

While kier bleaching methods have generally produced satisfactory bleaching results, they possess certain disadvantages. Since a relatively long time is required for the treatment, expensive pressure-sustaining equipment must of course be used. But perhaps the most important disadvantage of kier bleaching methods is that the comparatively rigorous treatment necessary to effect satisfactory bleaching of the textile fabrics results in considerable degradation.

The chief advantage of employing a high temperature during bleaching operations wherein alkaline solutions of peroxides are employed is the rapidity of bleaching action secured with the elevated temperature. But while high temperature bleaching is rapid, there is a distinct tendency to unevenness in bleaching unless a comparatively even temperature is quickly secured. Moreover, textile fibres are extremely sensitive to the action of alkaline agents at high temperatures and if the treatment is continued too long at the elevated temperature, serious degradation of the textile fibres occurs.

In kier bleaching operations the necessity for prolonging the bleaching treatment to periods ranging from eight to twelve hours, in some cases even overnight treatments, is occasioned by the difficulty of bringing all the goods in the kier up to the bleaching temperature and treating the fabrics therein evenly with the bleach liquor. While most of the bleaching in a kier employing alkaline solutions of hydrogen peroxide as the bleaching agent may be accomplished in a period of as short duration as two hours, in order to secure evenness of bleach the treatment must be continued for a total bleaching period which may be twelve hours or more. This continuance of the heat input after the goods have been packed into the kier and after the major portion of the bleaching has been completed, necessary to secure thorough penetration and bleaching of all parts of the fabrics, results in an uneven treatment insofar as those portions of the fabric which have

been bleached to a substantially complete whiteness are concerned. The necessity for continuing the heat input for some six to ten hours after most of the bleaching has taken place overtreats or degrades those portions of the fabrics first bleached, i. e., those receiving the treatment with the alkaline agents at the elevated temperature over the longer period. This unevenness of action is characteristic of kier bleaching, and the resulting degradation of the fibre not only causes variations in the degree of whiteness but causes unevenness of dyeing in that one part of the bleached cloth has a more uniform and greater affinity for dyestuffs than have other portions of the fabric.

In the past these disadvantages of kier bleaching have been recognized and various processes have been proposed in an effort to avoid the difficulties of this bleaching method. Among such processes are those wherein the textile fabric to be bleached is first impregnated with the bleaching solution and then stored, in contact with a source of heat but out of contact with the bleach liquor, for a period of time sufficient to effect bleaching. While possessing advantages over kier bleaching in several particulars, chief among which are perhaps the possibility of avoiding the circulation of large quantities of alkaline bleach liquor through the kier and the resulting superiority of the bleached fabric because it has not been brought into repeated contact with the boiling highly alkaline bleach liquor, such methods have not completely avoided the disadvantages previously enumerated.

In such methods the textile fabric to be bleached is ordinarily wet out in the bleach liquor and the fabric then stored in a closed chamber wherein it is brought into contact with the source of heat, usually steam at atmospheric pressure or at a pressure above atmospheric. During this period the goods are heated by the heating medium and a high temperature is sustained by the constant and continued heat input for the period necessary to effect the desired bleaching. Unfortunately, this continued heat input, necessary in such processes to secure satisfactory action of the bleach liquor on the goods, results in certain objectionable disadvantages. Thus, the continued heating subjects certain portions of the fabric to more heat than other portions and so results in unevenness of treatment. This uneven characteristic is particularly pronounced where the goods are stacked by means of some form of stacking device in the heat chamber in the form of folds, those portions of fabric adjacent the folds and in contact with the stacking device through which heat is continuously supplied being subjected to more rigorous heat treatment than portions intermediate to the edge portions and positioned more centrally in the folds of the stacked fabric. This unevenness, due to continued heat input and irregular heat treatment, not only results in certain portions of the fabric being bleached to whiteness percentages different from those of other portions of the fabric, but also results in increased fibre degradation which shows up as uneven dyeing when the bleached goods are subsequently subjected to the dyeing operation.

In such processes the cloth wet out with the bleaching liquor loses weight during the heat treatment, i. e. there is evaporation or loss of moisture or bleaching liquor from the textile fabric. We have found that this drying out action is objectionable, and gives rise to a tendency

to bring about scorching or incipient scorching of the fabric. In our process no such loss in weight occurs, the goods having a greater weight at the end of the process than after having been impregnated with bleach liquor at the start, due to condensation of steam thereon during our brief heating step.

Accordingly, it is one of the objects of this invention to provide an improved method for bleaching textile fabrics with alkaline solutions of peroxides whereby the necessity for providing a continued heat input throughout the bleaching period is avoided. The attainment of this object results in more even bleaching, lower degradation of the bleached fibre, and a more uniform affinity of the fabric to dyestuffs where the fabric is to be subsequently subjected to a dyeing operation.

Another object of this invention is to secure a given degree of whiteness with lower peroxide consumption and therefore lower cost for the bleaching agent required than necessary when employing those methods requiring continued heat input characteristic of the prior art. This object may also be expressed by stating that it is our aim to secure with equal amounts of peroxide a higher degree of bleaching than previously possible with methods wherein the fabric is contacted with a source of heat such as boiling bleach liquor or steam throughout the bleaching period. These and still further objects of our invention will be apparent from the ensuing disclosure of certain improved embodiments thereof.

In our process the goods to be bleached are saturated or padded with an alkaline bleach solution such as an alkaline solution of hydrogen peroxide having a pH value falling within the range 8.0 to 12.0. Generally the alkaline peroxide solution employed will contain one or more alkaline agents such as caustic soda, soda ash, caustic potash, tri-sodium phosphate, borax, or water-glass (sodium silicate). Since most of the peroxide bleach baths commercially utilized contain sodium silicate, the pH of such solutions usually falls within the somewhat narrower pH range 10.0 to 11.0.

The goods to be bleached may be readily impregnated with the bleach liquor by running the fabric, which ordinarily will have been previously subjected to the usual preliminary boil-out or alkaline scour treatment, through the alkaline solution of hydrogen peroxide or other peroxide solution selected and then through squeeze rolls to squeeze out excess solution. The scouring of the goods with alkaline agents may have been previously carried out in accordance with the process of our copending patent application, or other usual boil-out or scouring processes may be employed. Under certain circumstances certain types of goods may be bleached without preliminary caustic treatment.

The impregnated goods, which may contain an amount of bleach liquor approximately equal in amount to their own weight, are then contacted with a source of heat such as steam by being passed through a steam tube for a brief period of time. Here the wetted cloth is heated rapidly to an elevated temperature which, when steam at the atmospheric boiling point is employed, will be substantially 212° F. or some temperature close thereto, ordinarily 200° F. or higher. The heated material is now stored in a compartment under conditions wherein loss of heat from the heated fabric is hindered by providing suitable heat in-

111

2,334,066

3

sulation around the compartment. However, no continued heating is carried out, and there is no heated medium of any sort provided for continuing the heat input to the fabrics. Under the usual conditions of insulation and where the goods have been heated to a temperature of close to 212° F. by momentary passage through the steam chamber before storage in the bleaching compartment, the temperature of the fabrics will ordinarily fall from a temperature of approximately 200° F. to one in the neighborhood of 170° F. during the ensuing bleaching period of approximately sixty minutes' duration.

Accordingly, our process may be most simply described as involving the steps of first thoroughly impregnating the goods to be bleached with the bleach liquor, generally an alkaline solution of a peroxide such as hydrogen peroxide. The excess bleach liquor is then removed and the goods passed rapidly through a chamber filled with steam, where they are rapidly brought up to a temperature substantially in the neighborhood of 212° F. The goods are then stored in a storage apparatus which in textile mills may most conveniently be in the form of a J-box. This J-box is generally provided with stacking means at its upper portion and the web of fabric is stacked by the stacking means in order to fold it compactly into the storage space. At the conclusion of the stacking operation the temperature of the fabric web will ordinarily be very close to 200° F. Owing to the fact that the storage compartment is insulated, the temperature will be maintained to a substantial extent during the ensuing period but will nevertheless slowly and regularly decrease to a temperature of approximately 170° F. at the end of a bleaching period of one hour.

Our process does not require the provision of a heated medium during the storage period, and the addition of heat to the stored goods by means of a heated medium is definitely to be avoided, as we have discovered that such continued heat input is objectionable, and in fact constituted one of the major difficulties in the bleaching methods as now known to the art.

Preferably our process is carried out in a continuous manner, the textile fabric to be bleached being treated either in the form of rope or web and, preferably, in continuous lengths. The goods in continuous lengths may therefore be passed through a saturating vessel containing the alkaline solution of the bleaching agent and then continuously passed through a squeeze roll or a wringer for removing the excess bleach liquor. The web is then passed through the steaming compartment wherein it is subjected to the action of steam at substantially the atmospheric boiling point of water (212° F.). After this rapid heating to a temperature closely approximating that of the steam, the length of goods is passed into the storage compartment through which the rate of travel is adjusted to provide adequate time to permit action of the alkaline bleach bath to effect the desired bleaching action on the goods. As generally carried out, we prefer that this period of time be in the neighborhood of one hour, although under some circumstances periods longer than this may be employed. It is also within the scope of our invention to utilize storage periods of less than one hour, storage periods as brief as thirty minutes having been found satisfactory under certain circumstances.

The stacked goods in the storage compartment

are readily and continuously withdrawn from that compartment after having remained therein the desired length of time. As previously pointed out, the storage compartment should preferably be insulated against excessive heat loss so that the temperature of the goods which at the beginning of the bleaching period is 200° F. or close thereto should be at a temperature within the neighborhood of 170° F. at the time of their removal from the storage compartment at the end of our preferred storage period of approximately one hour. After removal from the storage compartment the fabrics may be washed and are then ready for subsequent utilization for textile purposes. Washing may, of course, be followed by or include scouring or any other treatment applied to textiles subsequent to bleaching.

Our invention and the advantages resident therein over the bleaching procedures as now known to the art may perhaps be better understood from the annexed drawings. In the drawings Figs. 1 through 6 represent diagrammatically and in detail one form of apparatus adapted for carrying out the herein-described process of bleaching textile fabrics. Figs. 7 through 15 are graphs illustrating the theoretical considerations involved in our process wherein heat input, after initial heating, is avoided during the period wherein the goods are allowed to stand in contact with the bleach liquor.

Referring particularly to Figs. 1 through 6, Fig. 1 is an elevational view, certain parts being cut away so as to show various internal details, of one form of apparatus adapted for use in practicing our process. Fig. 2 is a vertical sectional view of the apparatus of Fig. 1 with a few modifications which are pointed out fully in the following description. Fig. 3 is a cross-sectional view of the steaming tube of Figs. 1 and 2, taken on the line 3—3 of Fig. 2. Fig. 4 is a vertical cross-sectional view of a modification of the apparatus shown in Fig. 2, only the upper part of the apparatus being shown. Fig. 5 is a vertical cross-sectional view of the steaming compartment of Fig. 4, taken along the line 5—5 of Fig. 4. Fig. 6 shows diagrammatically the various pieces of equipment including a saturating vat and a washer, for carrying out our improved process of bleaching including the step of washing the treated goods after they emerge from the storage compartment.

Referring to Figs. 1 and 3, 1 is a box constructed in the shape of a J and which will be referred to hereinafter as a J-box. This J-box is provided at its upper end with a steaming or heating tube 2 having apertured end caps 3. Tube 2 is also provided with steam inlets 4 through which jets of steam are introduced into tube 2. The manner of attachment of steam inlets 4 to tube 2 so as to provide tangential jets of steam will be more apparent from the arrangement of inlets 4 with respect to tube 2 as shown in Figure 3. Tube 2 is further provided with drain tube 5 for the escape of steam and condensate and also with a thermometer well 6. The cloth rope which passes through steam tube 2 and into the J-box is indicated generally by the numeral 7. Caps 3 are provided with apertures 8 through which cloth rope 7 passes. After emergence of cloth rope 7 from steam tube 2 it passes through draw rolls 9 which serve as means for drawing the cloth through the steam tube. The J-box is provided with a lower hinged cover 11 having opening 12 therein through which the cloth is withdrawn from the J-box by

means not shown in the drawings and also with an upper hinged cover 10. The lowest portion of the J-box is provided with a drain tube 13 having valve 14 therein.

The apparatus of Figure 2 differs slightly from that of Figure 1 in that in place of squeeze rolls 9 there is provided a stacking means for stacking the cloth rope in a loose and orderly manner in the J-box. This stacking means consists of a winch 18 which cooperates with travelling eye guide 19, so as to stack the cloth rope in a manner conforming roughly to the cross-sectional shape of the vertical portion of the box. Winch 18 is caused to travel back and forth across the top of the J-box as indicated generally by the arrows and the numerals 18 and 18a. Eye guide 19 travels backward and forward horizontally in a direction at right angles to the direction of travel of winch 18. Any suitable means commonly employed for such purpose may be used for effecting the desired movement of winch 18, no such means being shown in the drawing. Eye guide 19 is supported on travelling support 20, the latter being caused to travel back and forth upon track 21 by means of worm 22. It is evident that by coordinating the movements of eye guide 19 and winch 18 the cloth rope, as it emerges from steam tube 2, may be stacked in a loose and orderly manner in the J-box. Aside from its function in stacking the material in the J-box, winch 18 serves to draw the cloth rope through steam tube 2 and thus functions in the same manner as does the pair of squeeze rolls 9 in the apparatus of Figure 1.

The apparatus of Figure 2 also differs from that of Figure 1 in that each cap member 3 is provided with an inwardly extending annular portion 15 whose inner end 16 is flanged centrally with respect to annular portion 15 so as to provide openings 17. In this modification each cap member 3 provides two openings, indicated by the numerals 8 and 17, through which the cloth rope passes, which arrangement provides better assurance against excessive loss of steam through the openings provided for the travel of the cloth. It should be remarked, however, that in neither of the modifications shown in Figure 1 and Figure 2 do the openings in the end caps 3 provide an absolute seal against passage of steam therethrough. However, in normal operation of the apparatus but little steam will pass from steam tube 2 into the top of J-box 1.

The apparatus illustrated in Figures 1 and 2 functions to heat the cloth in rope form rapidly to a temperature approximating that of the temperature of steam at atmospheric pressure and then permits the storage of the heated material initially saturated with the alkaline bleach liquor solution in a storage compartment for a predetermined length of time. Since an interval of only a fraction of a second, or at most no more than a few seconds, is required to heat the cloth by means of steam in accordance with our invention, it is apparent that the time required for the bleaching will correspond substantially to the time the cloth is maintained in the storage compartment, which time may be regulated as desired.

Since storage of the saturated and heated textile fabrics in the storage compartment should be carried out under circumstances wherein the temperature of the cloth varies from substantially 200° F. to 170° F. during the one hour period wherein the goods are in the storage compartment, the J-box 1 is preferably insulated in

order that the temperature may be thus regulated. However, as previously emphasized, no source of heat is supplied to the J-box, nor are any portions of the fabric subjected to the action of any heating medium at any time during the storage. We have found that a J-box consisting of a wooden shell, shown as element 23 in Figure 2, provides adequate insulation against heat losses so that the temperature does not drop below about 170° F. in the cloth leaving the J-box through opening 12 at the end of the one hour storage period. However, other insulating media may of course be supplied. In its preferred form the J-box may be provided with an inner metal lining 24, which exposes a smooth surface to the cloth and which is preferably made of a corrosion-resistant metal such as stainless steel.

Instead of a cylindrical steaming tube such as element 2 of Figures 1 and 2, a steaming tube of rectangular shape may be employed as shown in Figures 4 and 5. In the latter figures a rectangular shaped steam box 50 is provided with a plurality of steam inlets 51 and with steam and condensate outlet 52. Steam inlets 51 are preferably provided with baffle plates 56 adapted to prevent direct impingement of the incoming steam upon the cloth. Numeral 53 indicates a thermometer well. The ends of steam box 50 are provided with slots 54 through which cloth strips 55 may be passed in open width. Steam box 50 is preferably built integral with the upper part of a J-box 57 or other suitable storage compartment. Only the upper part of the storage compartment 57 is shown, which part is provided with a hinged cover 58 and consists of an outer wooden shell 59 having an inner metal lining 60, as is the case in the apparatus of Figure 2. The length of open width cloth 55 is drawn through steam chamber 50 by means of winch 61 which is provided with means not shown for moving the winch back and forth across the top of the box, e. g., between the positions 61 and 61a as indicated by the arrows. It is seen that winch 61 has two functions, i. e., to draw the cloth through the steaming compartment and also to stack the cloth in the storage compartment.

Whether or not the apparatus of Figures 1 and 2 or that of Figures 4 and 5 should be employed will depend upon the cloth being treated and also upon the uniformity of the results desired. The apparatus of Figures 4 and 5 permits the passage of cloth in open width form through the apparatus which facilitates a more rapid and uniform heating of the goods. This may be desirable in some circumstances. In general, however, excellent and uniform heating may be obtained using the cylindrical steaming tube of Figures 1 and 2. Results of practical trials have indicated that with cloth rope of 1½ inches in diameter substantially instantaneous and uniform heating to the desired temperature is readily obtained.

A schematic diagram of assembled apparatus for use in carrying out our process as described is illustrated in Figure 6. As shown in the drawings, the textile fabric in continuous length is caused to travel through a saturating bath containing the alkaline bleaching liquor. The cloth is then passed through the steaming tube into the J-box, after which it is passed through a washer. The washer may be of any type conventionally utilized in textile treating processes. Prior to passage through the saturating bath the cloth strip may be drawn through guide eye 71, which shapes the strip into the form of rope 70. However, as previously indicated, the bleaching may

be carried out in open width, in which case suitable rollers (not shown) will take the place of the guide eye. The cloth passes into the saturating solution and under guide rolls 12 located therein. Squeeze rolls 13 express excess bleaching liquor from the saturated goods and the guide 14 serves to direct the cloth rope into the steaming chamber through which it then passes into the storage compartment. The treated fabric may be withdrawn from the J-box storage compartment by means of winch 15 after having passed over guide rolls 16. From winch 15 the cloth passes through the washer, which may consist of the three washing compartments indicated by the numerals 17, 18, and 19. Washing compartment 17 may contain a soap compound, washing compartment 18 a hot water rinse, and washing compartment 19 a cold water rinse. The washer is indicated generally as including two long squeeze rolls 20, through which the cloth rope 21 is threaded so as to cause loops of rope to dip a number of times into each washing compartment prior to emergence from the washer. Other types of washers may be employed, and instead of the particular washing solutions indicated, other solutions such as a souring solution, may be used in one or more of the washing compartments.

Cloth rope 1, while passing through apertures 8 in end plate 3 of Figure 1 or apertures 8 and 17 of Figure 2 functions as a seal to prevent excessive escape of steam from the ends of the steam tube. Cloth rope 55 acts in a similar manner in preventing escape of steam from slots 54 in the end walls of steam chamber 50 of Figures 4 and 5. It should be noted that the steam chamber in all of the modifications of the apparatus illustrated in the drawings is at all times open to the atmosphere so that the steam in contact with the goods is never at a temperature higher than substantially the atmospheric boiling point of water. This means that the cloth is never heated to a temperature above that temperature. We have discovered that the cloth may be heated rapidly and substantially uniformly in this manner when a steam tube of sufficient length is utilized. For fabrics of normal weight a cloth rope of about 1.5 inches in diameter may be effectively heated to substantially the temperature of steam at atmospheric pressure during passage through a steam tube approximately 6 inches in diameter and 6 feet long when passage through the tube is at a rate of 100 to 150 yards per minute. In general adequate heating of the continuous length of cloth will be accomplished if the rate of travel of the goods through the steam tube is such that a given point of the strip will be contacted with the steam for a period of time on the order of one second. This time interval obviously may vary considerably depending upon the type of goods being treated and other obvious factors, but rarely will a period longer than about 1 to 10 seconds be required.

Apertured end cap members 3 of Figures 1 and 2 constitute in effect constrictions of the steaming tube 2. Instead of the structure shown consisting of these end caps, the steaming tube of our apparatus may be constricted in any desired manner so as to provide openings therein corresponding to apertures 8 and 17 through which the continuous length of goods passes so as to provide an effective seal against excessive loss of steam at the points of constriction. Constriction at the desired point may be accomplished merely by shrinking the diameter of the tube, by insert-

ing apertured plugs into the tube, or by any other equivalent manner. Instead of a simple steaming tube with steam inlets and outlets as shown in the drawings, the walls of the tube may be perforated and provided with an outer jacket into which the steam is initially passed. Obviously the number of steam inlets and/or steam outlets employed may be varied as desired. Still other modifications of the apparatus will be obvious to those skilled in the use of apparatus for treating textile materials.

Our process is capable of utilization with bleaching liquors of varying strengths and containing varying amounts of peroxygen compounds or other bleaching agents. Generally we prefer to use an alkaline solution of hydrogen peroxide, although other peroxygen compounds such as sodium peroxide or sodium perborate may be effectively utilized under certain circumstances. The concentration of peroxide in the bleach bath may range from 1 volume or even below 1 volume to concentrations of 2 volumes or greater. The volume concentration of a solution of hydrogen peroxide or other peroxygen compound is defined as the number of volumes of oxygen gas measured at 0° C. and 760 mm. of mercury pressure that will be released from one volume of the solution at 20° C. Commercial solutions of hydrogen peroxide such as those sold under the trade-mark name "Albone" are of 100 volume concentration and contain substantially 27.6% H_2O_2 by weight and approximately 30% H_2O_2 by volume. Such solutions are ordinarily diluted by the addition of water in order to give the desired concentration. They are also usually rendered alkaline by the addition of various alkalizing agents, such as caustic soda, caustic potash, soda ash, sodium peroxide, etc. Usually, a stabilizing agent is present in the commercial solution of hydrogen peroxide used to prepare the bleach bath, and under some circumstances one may be added to the bleach bath itself. Usually commercial bleach baths contain sodium silicate, which operates both as a buffering agent to maintain the pH within a desired range and also as an alkalizing agent. Our preferred bleach baths may therefore be described as alkaline solutions of peroxide which may contain from 1 to 6% and preferably from 1 to 4% of caustic soda or its equivalent. Peroxygen salts, such as sodium perborate, may also be utilized. The bath will preferably have a pH falling within the range 10 to 12 and will contain hydrogen peroxide or equivalent peroxygen compound in amount corresponding to 0.3% to 0.6% by weight. The use of such baths will produce, when utilized in accordance with our process wherein heat input during the storage period is carefully avoided, highly uniform whiteness in the bleached fibre, as well as a fabric with a high degree of absorbency. Under some circumstances the bleach bath may contain a wetting agent in order to facilitate rapid wetting of the fabric with the treating solution, although such an agent is ordinarily not necessary. After the goods are wetted out in the bleach bath and excess bleach liquor expressed therefrom, they will normally contain an amount of bleach liquor corresponding roughly to from 100% to 150% by weight based on the weight of the fabric itself. However, greater or lesser quantities of the treating liquor may be retained in the goods, depending upon the particular quality of bleaching desired and upon the strength of the bleaching liquor.

It will also be evident that our method is not

restricted to a method of operation wherein the goods are passed but once through the saturating bath and storage compartment, as it may be desirable in certain instances to subject the goods to a plurality of treatments in which successive treatments may be the same or may vary somewhat as to the concentration and character of the bleach bath applied. The goods before their subjection to bleaching may have been previously boiled out in accordance with standard scouring operations, either those previously in use by commercial bleachers, or in accordance with that described in our previously referred to copending patent application. Thus the advantages of both procedures may be secured. Under certain circumstances prior scouring or treatment with alkaline agents may of course be eliminated, and the use of our process for bleaching textile goods which have not been previously subjected to the action of such alkaline agents is of course within the contemplation of this invention.

The advantages of our process wherein heat input is avoided during the period wherein the goods to be bleached are maintained in contact with the bleaching liquor may be particularly illustrated with reference to the graphs shown in Figures 7 through 15 inclusive. These graphs show, in particular, the advantages of carrying out our process so that the cloth to be bleached is quickly brought to the necessary high temperature, one of substantially 212° F. or one somewhat below this temperature, and then stored under conditions such that the temperature of the cloth varies from substantially 200° F. to 170° F. during the storage period. These graphs show the superiority as a bleaching process of our process over those wherein heat is supplied by contacting a heated medium, usually steam, with the impregnated cloth in order that the cloth may be maintained at a substantially constant temperature during its period of storage. Specifically, the curves show the advantages of rapidly heating the cloth in the steaming tube by contacting it with steam at substantially atmospheric pressure and then storing it out of contact with any heating medium, over processes wherein a heating medium such as steam is continuously present to maintain the temperature of the fabric at 212° F., or at temperatures lower than 212° F., such as 170° F., during the storage period. In all cases the storage period is substantially one hour, which is the preferred storage period in our process, and this may be defined as the period during which the cloth is in contact with the bleach liquor under conditions wherein bleaching can take place.

Specifically, the graphs of Figures 7 through 10 show that it is possible to secure a higher percentage of whiteness at the same peroxide consumption, or to secure the same percentage of whiteness with a lower peroxide consumption, when no heating medium is supplied and the temperature is allowed to drop from 200 to 170° F. throughout the storage period than when a heating medium such as steam is supplied and the temperature maintained at 212° F. or some temperature below 212° F. such as one of 170° F. throughout the entire storage period.

The graphs of Figures 11 through 13 inclusive show the greater rapidity of the bleaching action when the temperature varies from 200 to 170° F. during the storage period, as contrasted with those methods wherein a heating medium is supplied to keep the temperature constant during

the storage period. This greater rapidity of bleaching results in a higher degree of whiteness after a given time interval with the process herein described as compared with those wherein heating media are continuously supplied. These curves also show the amounts of hydrogen peroxide consumed, in the two methods, plotted against the duration of the bleaching period.

The curves of Figures 14 and 15 are designed to show the lessened degradation in the textile fibres characteristic of our improved method wherein the temperature of the fabric during storage varies from 200° F. to 170° F. as contrasted with the fibre degradation where a heated medium is supplied to maintain the fabric at a constant temperature. All of these curves will now be discussed in detail.

In the graphs of Figures 7 through 10, percentage whiteness is plotted against peroxide consumption in milligrams of H_2O_2 per yard of cloth bleached. The whiteness determinations were made with a standard whiteness comparator. The graph of Figure 7 shows the results utilizing a peroxide bath of $\frac{1}{4}$ volume concentration; that of Figure 8 a peroxide bath of $\frac{1}{2}$ volume concentration; that of Figure 9 a bath of 1 volume concentration; and that of Figure 10 a bath of 2 volume concentration. In Figures 7 and 8 the curve marked "A" represents the curve obtained, plotting whiteness against peroxide consumption, for a process in which a heating medium, steam under atmospheric pressure, was supplied during the storage period in order to maintain the temperature of the goods constantly at substantially 212° F. Curve B represents the curve resulting, plotting peroxide consumption against percentage whiteness, when the goods are treated in accordance with our improved process, no heating medium being supplied during the storage period, the temperature falling from 200° F. to 170° F. during the one hour storage period. It is evident in the cases of both the $\frac{1}{4}$ volume bleach bath and the $\frac{1}{2}$ volume bleach bath that the method of curve B gives a higher percentage of whiteness for a given peroxide consumption than the method of curve A. Conversely, for a given percentage whiteness the method of curve B uses up less peroxide.

In the graphs of Figures 9 and 10 there are plotted, in addition to curves corresponding to curves A and B, curves C and D. Curve C constitutes a graph of percentage whiteness against hydrogen peroxide consumed in milligrams per yard of cloth when the temperature of the impregnated cloth during the storage period is maintained at substantially 190° F. by contacting it with steam under a pressure lower than atmospheric as a heat source. In Fig. 10, curve D is a graph of percent whiteness against peroxide consumption in milligrams of H_2O_2 per yard of cloth when the cloth after impregnation, is maintained during the storage period at a temperature of 170° F. by continuously contacting it with steam under reduced pressure as a heat source. On each graph, that of Figure 9 and that of Figure 10, the curves A and B are the same as those of Figures 7 and 8, i. e. percentage whiteness is plotted against peroxide consumption for a process wherein the temperature is continuously maintained during the storage period by steam at a temperature of 212° F., and a process wherein no heating medium is supplied and the temperature during the storage period varies from 200 to 170° F. The latter, as shown by curve B

111

2,334,066

7

in all of these graphs, is the improved process described herein.

It will be apparent that in all cases the method of curve B gave a higher percentage whiteness for equal peroxide consumption than either the method of curve A or the method of curve C. For equal percentage whiteness the method of curve B required a lower peroxide consumption than either the method of graph A or the method of graph C. These curves conclusively show that the process wherein no heating medium is supplied and the temperature is permitted to drop from 200 to 170° F. during the period of storage is considerably more economical and produces better bleaching results at lower peroxide consumption than do those methods wherein a heating medium is supplied in order to maintain the temperature of the impregnated cloth substantially constant over the entire storage period.

Referring now to the graphs of Figures 11, 12 and 13, these graphs show the curves resulting when whiteness and peroxide consumption are each plotted against bleaching time. The graph of Figure 11 shows the results obtained with a bleaching bath comprising hydrogen peroxide of substantially $\frac{1}{4}$ volume concentration. The graph of Figure 12 shows the results secured with a bleach bath of 1 volume concentration, while the graph of Figure 13 constitutes a plot of the results secured with a hydrogen peroxide solution of 2 volume concentration.

In each case curve E on the percentage whiteness curve and curve E' on the hydrogen peroxide consumption curve represent the graphs resulting when the process carried out is that described in this application, no heating medium being supplied to keep the impregnated goods at a constant temperature during the storage period, which temperature therefore drops from substantially 200° F. to 170° F.

Curve F on the percentage whiteness graph and curve F' on the hydrogen peroxide consumption graph are the curves resulting when a constant source of heat is supplied to the stored goods, steam at atmospheric pressure, in order during the bleaching period continuously to maintain the temperature at substantially 212° F. Finally, curve G on the percentage whiteness curve and curve G' on the hydrogen peroxide consumption curve also show the results secured when a constant source of heat is supplied to the impregnated goods during the storage period. However, in this case the temperature maintained by the use of steam at reduced pressure during the entire storage period was 170° F. It will be noted that in the case of the graph of Figure 11 no curves corresponding to G or G' were plotted.

The graphs of Figures 11 through 13, particularly curves E, F, and G, show conclusively the higher percentage whiteness attained for a bleaching period of any specified duration when practicing the process herein described, as contrasted with processes wherein heat sources are supplied to maintain the temperature substantially constant throughout the storage period. For all practical bleaching periods, i. e. bleaching periods ranging from ten minutes to sixty minutes, the superiority of the process wherein the temperature drops from 200° F. to 170° F. during the storage period is evident.

Referring particularly to the peroxide consumption curves on the graphs of Figures 11, 12 and 13, curves E', F', and G', it will be noted that the amount of peroxide consumed in a given time was always greatest when the temperature was

continuously maintained during the storage period by means of a heating medium at substantially 212° F. While the amount of peroxide consumption during a specified time interval of bleaching period was somewhat greater when the temperature fell from 200° to 170° F., as in our improved process, than it was when the temperature was continuously maintained at 170° F. during the bleaching period, it is evident that the difference between these two curves, curves E' and G', was indeed very slight. When contrasted with the percentage of whiteness secured (compare curves E and G), the superiority of the process herein described, even though it does consume slightly more hydrogen peroxide in a given bleaching period, will become immediately evident.

That less degradation occurs when, after initial heating, no further heat input is supplied and the temperature of the stacked goods during the storage period is allowed to drop from substantially 200° F. to 170° F., is illustrated by the results plotted in Figures 14 and 15. In these figures, the curves resulting from plotting the data obtained from tests on cotton fabrics bleached in accordance with the method of our invention are represented by the letter R. The letter S, in each graph, represents the plots of the corresponding results obtained in a process wherein the cotton goods, impregnated with the bleaching solution, were maintained at a temperature of substantially 212° F. by constantly supplying to the stacked goods a heating medium in the form of steam at atmospheric pressure.

Figures 14 and 15 constitute a plot of fluidity in recipioles against percentage of whiteness. Samples of cloths bleached to various percentages of whiteness by the two processes were taken and the fluidity of each sample determined. Then the fluidity of each sample was plotted against percentage whiteness to give the curves shown in Figures 14 and 15. In the case of Figure 14, the samples were bleached with a hydrogen peroxide solution of 1 volume concentration, while in the case of the curve shown in Figure 15 the bleach bath was of 2 volume concentration.

In determining the fluidity, the viscosity of a cuprammonium solution of the sample was determined in accordance with standard methods usual in the textile bleaching industry. The fluidity, in reciprocal poises or recipioles, is the reciprocal of the viscosity, which is normally expressed in poises or centipoises. Samples having lower fluidity were less degraded and the fibre had undergone less chemical change than in the case of those samples having higher fluidities.

It is apparent from the graphs of Figures 14 and 15 that curves R, in both figures, represent lower fluidities for given percentages of whiteness than do curves S. This means that for a given percentage of whiteness the cotton fabric is less degraded and less changed in chemical composition, i. e. less damaged, by utilizing for bleaching it the process described herein, than it is by utilizing a constant temperature process wherein heat is continuously supplied during the storage period to maintain substantially constant the temperature of the stacked fabrics. Conversely, for equal fluidities, representing equal amounts of degradation and chemical change in fibre structure, i. e., equal amounts of textile injury, the percentage whiteness is greater with samples bleached in accordance with the method herein described than when those samples are bleached

with the constant temperature heat input methods.

Since the percentage whiteness to which any given fabric may be safely bleached in commercial bleaching operations depends entirely upon the permissive degradation or loss in tensile strength, it is significant that by utilizing the method herein described it is possible to bleach the fabric to a higher degree without carrying degradation and chemical change beyond permissive limits. This advantage of our method, wherein the temperature is permitted to drop from 200° F. to 170° F., renders the method much more attractive for commercial bleaching than constant temperature methods such as those previously used in the prior art which are, in all cases, characterized by greater amounts of fibre degradation if an equal degree of whiteness is to be secured.

It may be advantageous in some instances to utilize for padding, wetting, or saturating the goods to be bleached a bleaching solution at temperatures somewhat above room temperature. However, for most purposes the bleaching solution in which the goods to be bleached are wet out or impregnated will have a temperature of room temperature or even below room temperature, at which temperatures the bath is more stable than at elevated temperatures. This is of course an added advantage of our method, for instead of having to heat the entire body of bleaching liquor to an elevated temperature as in former bleaching methods, the major portion of the bleach liquor may be maintained at a temperature at which it is relatively stable, and only that portion actually in contact with the goods and serving to effect bleaching need be heated to an elevated temperature. This heating to an elevated temperature is readily accomplished by passing the goods through a steaming tube for a short period prior to stacking the goods under conditions wherein the temperature drops from substantially 200° F. to 170° F. during the ensuing storage period of approximately one hour.

It will be evident to those skilled in the art of treating textile materials that various modifications of our process and apparatus as described above may be devised without departing from the spirit and scope of our invention. Thus, various means may be employed for removing excess treating liquor from the saturated goods, and various means may be used for zig-zagging the cloth rope in the J-box during the stacking operation. Further, many modifications may be devised in the details of the process described as our preferred embodiment which would nevertheless come within the purview of our invention.

It may be pointed out that the apparatus including the steaming chamber is not restricted to apparatus of any particular shape or size. As far as the steaming tube is concerned, all that is necessary is that the goods be heated rapidly with steam at substantially atmospheric pressure to a temperature of 212° F. or slightly below that temperature. Thus, any steaming tube suitable for accomplishing this purpose is satisfactory, and the apertured end caps and other details of construction described in connection with our improved apparatus may be considerably modified, or omitted, without departing from the scope of our invention. In brief, the scope of our invention is not to be restricted to procedural details and features set forth as illustrative of a preferred embodiment of our improved bleaching

process, but it is to be construed in accordance with the appended claims and prior art.

We claim:

1. A process of bleaching textile goods which comprises impregnating said goods with an aqueous alkaline solution of a peroxygen compound, rapidly heating said impregnated goods to a temperature within the range 200 to 212° F. by passing them in contact with steam, and then storing said goods both out of contact with the main body of alkaline solution and substantially out of contact with steam under conditions wherein heat losses are reduced but no further heat input occurs for a period of at least thirty minutes.

2. A process of bleaching textile goods which comprises impregnating said goods with an aqueous alkaline solution of hydrogen peroxide, passing said goods rapidly through a chamber filled with steam so that said goods are rapidly heated to a temperature falling within the range 200 to 212° F., and then storing said goods, both out of contact with the main body of alkaline solution and substantially out of contact with steam, under conditions wherein heat losses are reduced but no further heat input occurs for a period of at least thirty minutes.

3. A process of bleaching textile goods which comprises thoroughly wetting said goods with an aqueous alkaline solution of a peroxygen compound, rapidly passing said wetted goods through a chamber filled with steam under conditions wherein the temperature of the wetted textile goods is elevated to one falling within the range 200 to 212° F., and then storing said goods in an insulated storage chamber, both out of contact with the main body of alkaline solution and substantially out of contact with steam, so that the temperature thereof falls from substantially 200° F. to substantially 170° F. during the ensuing storage period of at least thirty minutes.

4. A process of bleaching textile goods which comprises wetting said goods with an aqueous alkaline solution of hydrogen peroxide, heating said goods rapidly so that the temperature is rapidly elevated to a temperature within the range 200 to 212° F. by passing said goods in contact with steam, and then storing said goods both out of contact with the main body of alkaline solution and substantially out of contact with steam under conditions wherein the temperature drops to substantially 170° F., for a period of time sufficient to secure satisfactory bleaching of said textile goods.

5. A process of bleaching textile goods which comprises thoroughly wetting said goods in an aqueous solution of a peroxygen compound, rapidly passing said goods through a chamber filled with steam at atmospheric pressure so that said wetted goods are heated to a temperature approximating 212° F., and then storing said goods, both out of contact with the main body of aqueous solution and substantially out of contact with steam, under conditions wherein heat losses are avoided but no further heat input occurs for a period of time of at least thirty minutes during which period bleaching occurs, the temperature of said goods during said bleaching period progressively falling from one in the neighborhood of 200° F. to one of substantially 170° F.

6. A process of bleaching textile goods which comprises thoroughly wetting said goods in an aqueous alkaline solution of hydrogen peroxide, rapidly passing said impregnated goods through a chamber filled with steam at atmospheric pres-

1 1 1

2,334,066

9

sure, and then storing said goods, both out of
contact with the main body of alkaline solution
and substantially out of contact with steam,
under conditions wherein heat losses are reduced
but no further heat input occurs for a period of
time ranging from thirty minutes to sixty min-
utes, during which period the temperature of said
impregnated goods falls from one in the neigh-
borhood of 200° F. to one in the neighborhood of
170° F. and said hydrogen peroxide acts upon
said textile goods to bring about bleaching
thereof.

7. A continuous method for bleaching textile
goods which comprises continuously passing a
web of textile goods through an aqueous solution
of a peroxygen compound, then continuously
passing said web through a chamber filled with
steam, said web being in contact with said steam
only for a very short period of time, during which
time the temperature of said web is raised to one
falling within the range 200 to 212° F., and then
continuously passing said web into an insulated
compartment wherein said web is stored both out
of contact with the main body of aqueous solu-
tion and substantially out of contact with steam

so that the temperature of said web drops from
one of substantially 200° F. to one in the neigh-
borhood of 170° F., and said textile goods are
bleached by the action of said peroxygen
compound.

8. A method of bleaching textile goods which
comprises the steps of subjecting said goods to
preliminary treatment with an aqueous alkaline
solution at an elevated temperature, impregnating
said goods with a bleach liquor comprising
an aqueous solution of a peroxygen compound,
squeezing out excess bleach liquor, passing the
goods in heat contact with steam so that said
goods are rapidly heated to a temperature within
the range 200 to 212° F., and then storing said
goods both out of contact with the main body
of aqueous solution and substantially out of con-
tact with steam under conditions wherein the
temperature is progressively reduced from one
approximating 200° F. to one approximating
170° F., said stored goods being stored during
said period under conditions wherein no heat
input thereto occurs.

DONALD J. CAMPBELL.
FRANCIS LE ROY FENNELL.