

## UNITED STATES PATENT OFFICE.

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## MANUFACTURE OF BOOTS AND SHOES.

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This invention relates to the treatment in the manufacture of boots and shoes of stiffeners the stiffening substance of which is a colloid, and is herein described in connection with the treatment of a particular stiffener made of fabric impregnated with precipitated celluloid.

during which the blank remains soft, the blank impregnated with the colloidal material could be softened by treatment with any one of several solvents for the colloid; but, as will presently appear, all of the conditions and possibilities referred to above must be considered.

It has been proposed to use in the manufacture of boots and shoes a box toe blank made in the following manner. A sheet of suitable fabric such as canton flannel is passed first through a solution of celluloid and then through a water bath, the water acting to displace the solvent and precipitate the celluloid in colloidal form in the interstices of the fabric. The sheet is then dried and the box toe blanks died out of it. Celluloid in its colloidal form is weak and porous and consequently unsuitable for the stiffening substance of a finished box toe. It is necessary, therefore, to convert the celluloid into its normal elastic impervious form and in the meantime to render the blank soft and pliable so that it may be shaped to the toe portion of the last. To this end the blank is dipped in a solvent for celluloid and thereby rendered limp and pliable. The softened blank is placed in the upper of a shoe and shaped during the pulling over and lasting operations. The solvent is then allowed to evaporate, and the celluloid, if the conditions are right, returns to its normal, elastic, impervious form. A box toe of this kind possesses two very desirable qualities. In its weak form, the colloidal celluloid is so porous that softening of the blank takes place almost instantly and in its finished form the box toe has all the desirable qualities of a leather box toe and is in addition perfectly impervious to water.

A shoe during the course of its manufacture is subjected to a large number of operations performed in sequence each by specially trained operators. In order, therefore, to secure efficiency, the shoes in process of manufacture must pass from operator to operator without delay. Aside from this reason for a carefully planned time schedule, there are others quite as compelling of which attention is here directed to one which has a particular bearing upon the qualities necessary in a box toe. Practically all shoes are made upon lasts; and it is desirable to withdraw the lasts from the shoes at the end of a given interval so that the lasts may be used again and thus obviate the necessity which would otherwise exist of keeping on hand an unnecessarily large and expensive supply. Hence, not only should the box toe blank soften quickly and remain soft through the pulling over and lasting operations but it should harden in a comparatively short interval sufficiently to permit the last to be withdrawn from the shoe. This interval is somewhat different according to the type of shoe which is being made but in general should not exceed seventy-two hours. That the solvent must not injure the materials of the shoe nor endanger the life or health of the operator is obvious, but the matter of atmospheric conditions needs further explanation.

The present invention is concerned with the treatment of a blank impregnated with colloidal material so as to render it soft and pliable and to ensure that upon evaporation of the solvent the colloid shall take with substantial completeness its normal elastic, impervious form.

When celluloid, either in normal or in precipitated colloidal form, is dissolved in a solvent (for example methyl alcohol) and the methyl alcohol caused to evaporate, the celluloid will come out of the solution in its normal, elastic and impervious form, if no water, or at least, no considerable amount of water, is present in the solution during the evaporation. If, however, water is present, more or less of the solvent will be displaced by the water and consequently more or less of the celluloid, which is left after the evap-

Assuming that the atmospheric conditions are suitable and that no attention need be paid to danger to human life and safety, to possible injury to the materials of which the shoe is made or to the length of the period

oration of the methyl alcohol, will be in precipitated colloidal form in which, as has been explained, it does not have the desired qualities of imperviousness and elasticity.

5 Considering now a specific example, let it be supposed that a box toe blank impregnated with precipitated colloidal celluloid is softened with methyl alcohol, placed in the upper of a shoe, and the shoe pulled over, 10 lasted and allowed to stand. Whether the dry, finished box toe which finally results will be stiff and elastic, as it should be, or weak and useless will depend upon the dew point of the atmosphere in the factory, that 15 is upon the temperature at which the moisture in the atmosphere will condense into water. If the dew point is comparatively low, as it will usually be when the temperature outside is at or below freezing, no difficulty will be experienced; but, if the dew 20 point is sufficiently high, condensation of moisture with the deleterious results referred to above will result. Assuming a typical and frequently occurring condition in which 25 the dew point is not more than ten or twelve degrees below the temperature of the air in the factory, as the box toe cools by reason of the evaporation of the methyl alcohol, water condenses upon it and mixes with the 30 methyl alcohol. During the course of the drying of the blank both the water and the methyl alcohol evaporate but at different rates, the methyl alcohol evaporating much more rapidly so that the proportion of water 35 to methyl alcohol present in the blank increases. Presently a point is reached at which the water predominates, and during the later stages of the evaporation only a small proportion of the mixture is methyl 40 alcohol. In the course then of the evaporation, the water displaces the methyl alcohol and precipitates more or less of the celluloid with the result that, when the box toe is dry, it has more or less the same lack of stiffness 45 and elasticity that it had before it was softened. In other words it has returned more or less, depending upon the amount of water which has condensed upon it and displaced the solvent, to its original condition, and the 50 finished shoe is injured or ruined.

The atmospheric condition referred to above in which the dew point is sufficiently high to cause this disadvantageous result to the box toe occurs frequently in ordinary 55 clear weather. The result is, of course, relative, and it may happen that for one part of a given day the box toes may come out all right and for another part they may come out in various degrees of undesirable weakness. 60 Moreover, aside from these clear days there occur frequently days of fog in which minute globules of water are present in the atmosphere; and in such an atmospheric condition it is perfectly impossible to manufacture any 65 shoes at all if methyl alcohol is the solvent.

used. The particular property of methyl alcohol which militates against its use, so far as condensation of moisture from the atmosphere is concerned, is that its boiling point is much below that of water, in consequence 70 of which the condensed water persists in the softened box toe and predominates in the later stages of the evaporation.

From a consideration of all the circumstances which surround the manufacture of 75 shoes it becomes clear that the softener with which the box toe blank is treated must fulfill the following conditions:—

(1) It must not injure the leather or other materials of the shoe. 80

(2) It must have no offensive odor in the factory and must leave none in the finished shoe.

(3) It must give off no toxic fumes.

(4) It must not be highly inflammable and, 85 in this connection, it should be miscible with water so that in case it does become ignited, the fire may be quenched by water.

(5) It must on the one hand maintain the stiffener blank soft and pliable for an interval sufficient to permit the blank to be con- 90 formed to the last during the course of the usual pulling-over and lasting operations and, on the other hand, evaporate in a time sufficiently short so as not to require any 95 change in the regular time schedule of usual operations employed in shoemaking.

(6) It must render the softened stiffener capable of being used in an atmosphere in which water may condense upon it; that is, 100 it must have a higher boiling point than that of water.

In order to fulfill all of these conditions, as well as to provide a softener which will permit the time interval of its soft, pliable 105 condition—that is, the period during which it may be worked—to be controlled, I make use of a mixture of liquids one of which fulfills all of the conditions except that of the time interval and another of which has a 110 lower boiling point than that of water. For example, a mixture of diacetone alcohol and ethyl alcohol in proper proportions will fulfill all of the conditions and permit the time interval of the soft and pliable condition of 115 the box toe blank to be varied, the larger the proportion of the diacetone alcohol in the mixture the longer the period. Neither of these substances is highly inflammable, has an offensive odor, gives off toxic fumes, or is 120 injurious to the materials of the shoe, and both of them are miscible with water. Diacetone alcohol boils at 182° C. and ethyl alcohol at 78° C. With regard to the degree of inflammability of any substance this quality 125 is always a relative one dependent upon the conditions which regularly obtain in the industry in which it is to be used. In shoe factories naphtha is used in large quantities 130 as a solvent for the rubber in rubber cement;

and compared with naptha, the use of which is authorized by the fire underwriters, neither diacetone alcohol nor ethyl alcohol is readily inflammable. With regard to the boiling point of the mixture of liquids, this boiling point, in the earlier stages of evaporation, may be somewhat lower than that of water but in the later stages it is higher than that of water. As to the manner in which the evaporation takes place, it might seem that the ethyl alcohol would all evaporate before any of the diacetone alcohol evaporated with the result that the box toe would remain soft for too long a period; but, owing to entrainment or some similar phenomenon of liquid mixtures the time taken for the mixture to evaporate is less than would be required by an amount of diacetone alcohol equal to that in the mixture. The miscibility of diacetone alcohol with water has been mentioned above. This miscibility is extremely desirable in the manufacture of shoes since it ensures that there shall be a firm bond between the box tone blank and the leather and lining of the shoe. Both the leather and the lining are commonly filled with hygroscopic substances, the leather, for example with yolk of egg and glucose, the fabric with sizing which may be dextrin or starch and glue. Both leather and lining, therefore, contain a considerable amount of water which may constitute as much as eight or ten per cent of their weights. When, now, a box toe blank has been rendered soft and sticky by treatment with a solvent which is not miscible with water, the water in the fabric and the leather forms a barrier more or less impermeable to the dissolved colloid, with the result that the dissolved colloid does not surround the fibers of the fabric or enter freely into the pores of the leather. On the other hand, if the solvent is miscible with water, the fibers are surrounded by and the pores filled with the dissolved colloid, so that, upon evaporation of the high boiling point solvent, a firm bond results between the box toe blank and the leather and lining of the shoe.

With regard to the effect of a high dew point, and assuming for conciseness that the box toe blank has been softened by immersion in a liquid which is a mixture of one part of diacetone alcohol to three parts of ethyl alcohol, moisture will condense on the blank as soon as evaporation of the softener has lowered the temperature of the blank to the dew point, and this moisture will mix with the softening liquid; but inasmuch as the boiling point of the liquid is or presently becomes much higher than that of water, the proportion of the liquid to the water will increase as the evaporation progresses, and, during the latter part of the evaporation, practically no water will be present. Consequently, even though the water may at

some time displace some of the softening liquid and convert the celluloid into a form which upon complete evaporation would otherwise result in the undesirable colloidal form, such a final result cannot occur since the softening liquid (or at least the diacetone alcohol constituent) in its steadily increasing proportion will redissolve the colloidal form before the evaporation has reached completion. Whether any such changing of the celluloid from one form to the other and back again to the first form really takes place under the conditions is not known to applicant, the statement made above being presented merely as a plausible explanation of what may occur. The fact remains, however, that long before the box toe becomes dry practically no water is contained in it.

The proportions of the two solvents of which the mixture is made will be varied according to the type of shoe which is being manufactured. For example, a mixture of 24% of diacetone alcohol to 76% of ethyl alcohol has proved suitable for women's welt shoes and a mixture of 37% of diacetone alcohol and 63% of ethyl alcohol for men's welt shoes. In general, the proportions to be used will depend upon the process of manufacture of the shoe according to whether it is a welt, McKay or turn,—that is according to the length of time during which the box toe must be maintained in a soft and pliable condition.

Having described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:—

1. The method of treating a shoe stiffener composed of sheet material containing a cellulose ester, said method comprising softening the stiffener by wetting it with a mixture of liquids containing two solvents for the cellulose ester, one of which is diacetone alcohol and the other of which has a boiling point below that of water, and then causing the mixture to evaporate, whereby the cellulose ester will take on a strong, impervious, elastic form regardless of moisture in the air.

2. The method of treating a shoe stiffener containing a cellulose ester, said method comprising softening the stiffener by wetting it with a mixture of diacetone alcohol and a monohydroxyl alcohol the boiling point of the latter of which is lower than the boiling point of water, and then causing the liquids to evaporate by exposure to air whereby the cellulose ester will take on a strong, impervious, elastic form regardless of moisture in the air.

3. The method of treating a shoe stiffener containing a cellulose ester, said method comprising softening the stiffener by wetting it with a mixture of diacetone alcohol and ethyl alcohol, and then causing the liquids to evaporate by exposure to air whereby the cel-

lulose ester will take on a strong, impervious elastic form regardless of moisture in the air.

4. The method of treating a shoe stiffener containing celluloid, said method comprising  
5 softening the stiffener by wetting it with a mixture of diacetone alcohol and ethyl alcohol, and then causing the liquids to evaporate

by exposure to air whereby the celluloid will take on a strong, impervious, elastic form regardless of moisture in the air.

In testimony whereof I have signed my  
name to this specification.

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STANLEY P. LOVELL.