Nov. 30, 1943. F. G. SOMMERVILLE 2,335,462

METHOD AND APPARATUS FOR TREATING FELT

Filed July 27, 1940 2 Sheets-Sheet 1

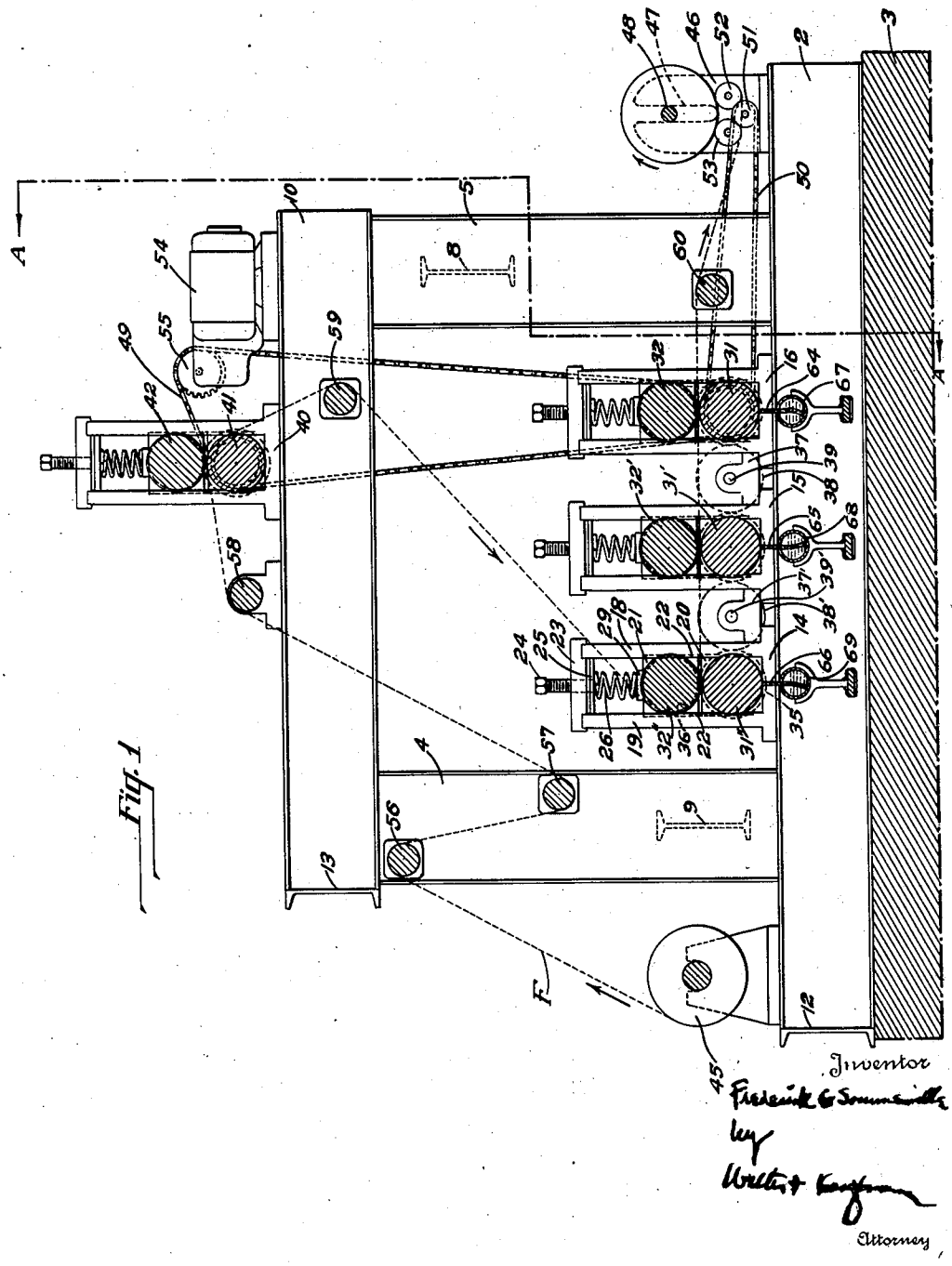


Fig. 1

Inventor
Frederick G. Sommerville
by
Walter & Langsam
Attorney

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Filed July 27, 1940 2 Sheets-Sheet 2

Fig. 2

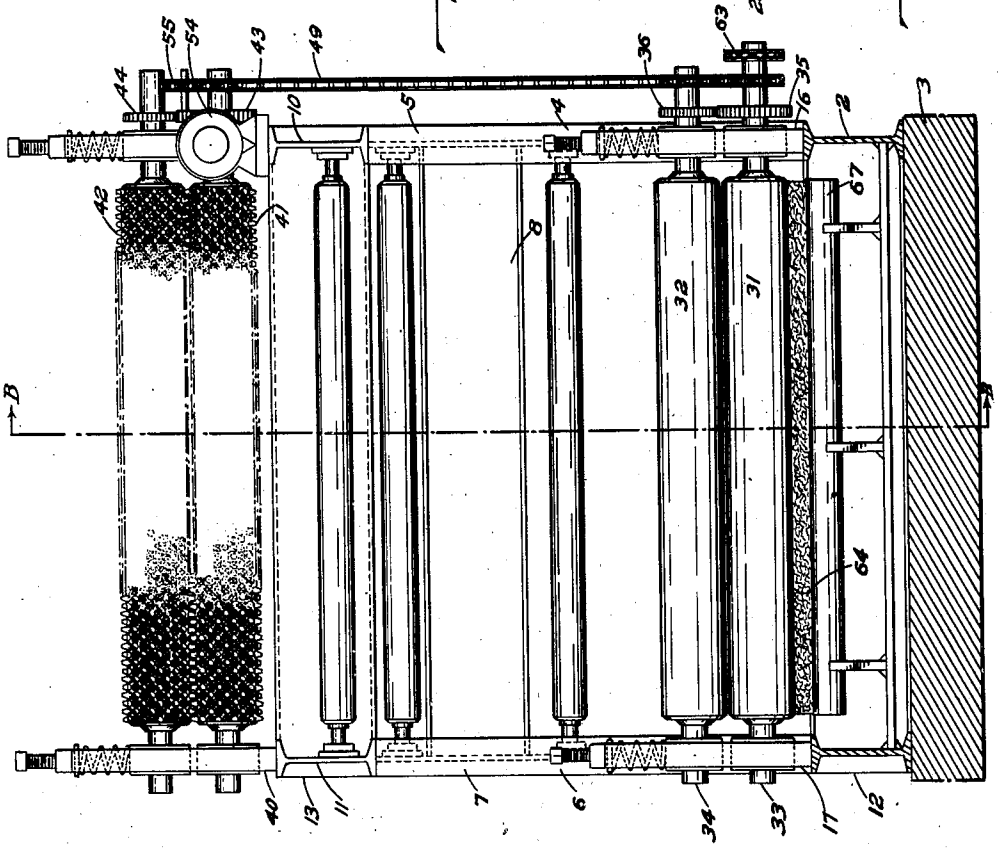


Fig. 5

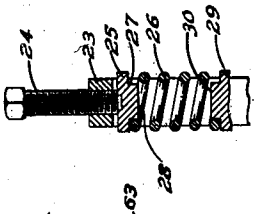


Fig. 3

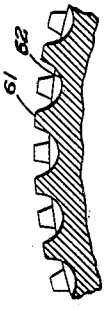
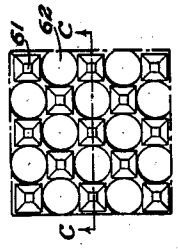


Fig. 4



Inventor
Frederick G Sommerville
by
Walter J Kaufman
Attorney

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UNITED STATES PATENT OFFICE

2,335,462

METHOD AND APPARATUS FOR TREATING FELT

Frederick G. Sommerville, Fulton, N. Y., assignor to Armstrong Cork Company, Lancaster, Pa., a corporation of Pennsylvania

Application July 27, 1940, Serial No. 347,942

8 Claims. (Cl. 154—27)

This invention relates to a method and apparatus for treating felted fibrous webs and finds particular usefulness in the manufacture of vibration damping and sound absorbing materials. The treated web will, of course, be useful for other purposes where the characteristics imparted to the web by my treatment may be found desirable.

Felt and felted products, with or without waterproofing or binders, have been used as sound damping and sound absorbing agents in connection with vibratile metal sound producing and transmitting surfaces, such as file cabinets, office furniture, vehicular and automobile bodies, machinery pads, partition and wall constructions, and generally wherever a relatively cheap, easily applied material may advantageously be employed to reduce or inhibit the production or transmission of sound. Felt as produced by the usual water laying methods has not been entirely satisfactory for such uses in that the fibers of the water-laid sheet tend to be predominantly oriented along the length of the sheet as produced on the machine, resulting in a polarizing of the flexibility characteristics of the material, in which state, the material customarily produced exhibits its best flexing characteristics in a direction along the length of the sheet, and its poorest flexing characteristics in a direction normal to the length of the sheet. This non-uniform property is undesirable in the formation of vibration and sound damping and absorbing materials intended to be conformed or applied to surfaces other than planar.

According to my invention, a felted product, suitable for use as a vibration and sound damping and absorbing material, is produced with a high degree of uniformity with respect to its flexing properties and in a much softer, less "boardy" condition than is customarily available in unindented sheets.

An object of the invention is to provide a method whereby felt or felted sheets, before or after impregnation with waterproofing or binders, are subjected to a combination of treatments comprising working the fibers by a deformation of alternate areas transverse of the sheets and another working of the fibers by longitudinal pulling and stroking of the surfaces of the sheets.

A further object of the invention is to provide apparatus adapted to effectively carry out this method. The drawings illustrate an apparatus for treating felt in accordance with my invention.

Figure 1 is a side sectional view of the apparatus taken on line B—B of Figure 2;

Figure 2 is an end elevation of the apparatus partially in section taken on line A—A of Figure 1;

Figure 3 shows a detail sectional view of the surface of the corrugated roll taken on line C—C of Figure 4;

Figure 4 is a developed view of the corrugated surface shown in Figure 3; and

Figure 5 is an enlarged detail view of the roller pressure adjusting means.

To obtain the material to be used in my invention, I may produce a felted fibrous sheet which is preferably predominantly rag fiber, on a paper machine, which felt when dried and finished the usual way is in the neighborhood of $\frac{3}{32}$'' thick and of the order of $1\frac{1}{8}$ pounds per square yard, being somewhat less dense than roofing felt. This sheet is rendered water resistant by the addition of asphalt or flux oil in such amounts that the voids of the sheet are not completely filled, as, for example, is commonly done in flooring felts. Alternatively, I may take any felted fibrous sheet which has been made in any suitable way and subject it to the following process, which process constitutes my invention.

According to my invention, the felt, saturated or not, is subjected to a loosening treatment by means of corrugating rolls in conjunction with further loosening accompanied with a smoothing of the sheet into a level-surfaced material by means of differentially driven rolls.

A suitable apparatus for performing these treatments is illustrated in the figures of the drawings in which Figures 1 and 2 show the general form of the entire apparatus. The apparatus comprises a framework comprising a bed 2 supported on a foundation 3 of any suitable nature and joined by any suitable means to the upright beams 4, 5, 6, and 7, and on this supporting structure there are fixed longitudinal beams 10 and 11. This structure is braced by any suitable means, such as by the cross beams 8 and 9 and the channels 12 and 13 shown on the drawings. The bed 2 carries bearing blocks 14, 15, and 16 at one side and corresponding blocks on the other side of which 17 is shown in Figure 2. These blocks carry suitable means for rotatably supporting the several pairs of calendering rolls 31 and 32, 31' and 32', and 31'' and 32'' therein and means for adjusting the pressure exerted by the rolls upon the web of felt F passing between them. As herein shown, these blocks each have a pair of uprights 18 and 19 (as illustrated with respect to block 14 in Figure 1) to which is fixed a cross member 23, and the slide

bearings 20 and 21 have grooves 22 which are complementary to the upright pieces 18 and 19 for relative movement vertically with respect thereto. The uppermost slide bearing 21 has a bearing plate 29 upon it against which a spring 26 is pressed by means of the plate 25. The pressure exerted by the spring upon the upper slide bearing 21 is adjusted by means of screw 24 which engages a screw thread in cross piece 23 and has a shoulder 27 which bears against the vertically movable plate 25. See the detail view in Figure 5. The spring bearing plate 29 is provided with a cylindrical projection 30 to maintain the spring in place. The projection 28 on plate 25 performs the corresponding function at the top portion of the spring.

Rolls 31 and 32 are supported by means of their trunnions 33 and 34 in their slide bearings 20 and 21 respectively for rotation therein, and the trunnions carry gears 35 and 36 respectively at one end thereof. Rolls 31', 32', 31'' and 32'' are similarly arranged. Between the pairs of blocks 14, 15 and 15, 16 respectively, are placed bearings 37 and 37' which carry shafts 39 and 39' and gears 38 and 38', said gears being of the same diameter and pitch as gears 31, 31', and 31'' with which they mesh.

On the upper platform, bearing blocks 40 similar to blocks 14 to 17 already described are provided with corrugating rolls 41 and 42, the trunnions of which each carry at one end thereof gears of identical pitch and diameter, 43 and 44. The bed at one end has suitable supports for the core of a supply roll 45 and at the other end has supports 46 provided with slot guides 47 therein for permitting the core 48 of the wind-up roll to be vertically displaced.

The lower corrugating roll 41 and the lower calendering roll 31 have their trunnions provided with sprockets by means of which all the corrugating and calendering rolls are driven, power being taken off the motor 54 from sprocket 55 through chain 49. The trunnion 33 in block 16 has an additional sprocket 63 which drives chain 50 and roll 51 of the friction type, said roll 51 operating the wind-up roll through the agency of friction rolls 52 and 53 with which it engages.

The whole mechanism is driven by means of the motor 54 through the sprocket 55 and the interconnecting chains 49 and 50. Suitable idle rolls 56, 57, 58, 59 and 60 are positioned as shown to facilitate passage of the web F of felt successively through the series of paired rolls.

Figures 3 and 4 show detail views, the former in cross section and the latter in elevation, of one suitable form of corrugating roll. In the embodiment shown, projections 61 are generally pyramidal and are separated by depressions 62 so that the complementary projections of one roll will be aligned with the depressions of the complementary roll, the distance between the outermost faces of the projections of one roll and the depth of the depressions in the complementary roll at the point of their nearest approach being such that the thickness of the felt is not greatly altered during the passage through such rolls.

In the operation of the machine, the felt web travels in the direction indicated by the arrows and is taken from the supply roll 45 over the idle rolls 56, 57 and 58 between the corrugating rolls 41 and 42 where it is deformed by the projections of the rolls and is thereby worked, after which the web passes over idle roll 59 and then through the series of pairs of differentially driven rolls. The differential effect is the result of the difference in size of gears 36 and 35 on rolls 31 and 32 (identical pairs of gears on the rolls 31', 32', 31'', and 32'' imparting differential speeds thereto) said gear 36 being smaller in diameter and having fewer gear teeth than said gear 35, with which it meshes, thereby causing roll 32 to have a higher surface speed than roll 31 and causing further working of the fibers and leveling of the surfaces of the sheet passing between the rolls. The treatment in these calendering rolls may be facilitated by means of lubricating oil, such as kerosene, which is supplied by the wicks 64, 65, 66 dipping into the tanks 67, 68, 69 beneath the lower rolls 31, 31', and 31'' respectively. The lubricant may be applied to only one or two of the pairs of calendering rolls, but preferably it is applied to all pairs of differentially driven rolls. After passage through the differential calendering rolls, the web goes over idle roll 60 and under friction rolls 52 and 53, back over rolls 53 and 52, and then on the wind-up roll on core 48. The application of the lubricant to the rolls prevents sticking and tearing of the felt and assists the dissipation of heat generated by the slip of the felt web upon the faster moving rolls. A similar lubricating arrangement may be applied to one of the corrugating rolls but this is not essential.

I have found that with a series of three pairs of differentially driven rolls, as illustrated, the difference between the surface speed of the rolls in each set may be from 10% to 15% of the speed of the fastest roll of the pair, and yield a satisfactory commercial product. The manipulation of the sheet with the corrugating and calendering rolls is preferably done after partial saturation of the sheet by the waterproofing ingredient, such as asphalt or flux oil, for the effect of such partial saturation is to bind the fibers at their points of contact, to generally stiffen and strengthen the sheet. Furthermore, if the waterproofing ingredient is first put into the sheet, the softening effected by the corrugating and differential working treatment permanently characterizes the sheet after such treatment. If the sheet is treated with the corrugating and the differential working prior to saturation, or partial saturation, the softening effect is not as great and subsequent saturation or partial saturation locks the fibers to a relatively stiffer structure. Where the sheet is to be used as a base or body for floor coverings or the like, a lesser degree of softening is generally satisfactory, but, as with vibration damping and sound absorbing felts, the preferred procedure is to effect a softening after the waterproofing agent has been incorporated into the web.

As illustrated by the drawings, the web F is first engaged by the corrugating rolls and then one surface of the web is engaged by the high speed rolls to effect the final working. Thus the web is subjected simultaneously at spaced points along its length to distinct types of mechanical working. The effect of the corrugating rolls which are complementary in surface configuration and have projections spaced at regular intervals and of any suitable shape, such as truncated pyramids or cones, is to deform the sheet by offsetting outwardly from one side of the sheet spaced areas corresponding to the projections on the corrugating rolls and offsetting

outwardly from the other side of the sheet other areas spaced between the first mentioned areas and corresponding to the projections on the other rolls. Such displacement results in loosening the fibers and, by increasing the effective thickness of the sheet, makes the subsequent treatment by differential rolls correspondingly more effective to thereby thoroughly soften the sheet. The differential rolls remove the indentations and projections in the sheet so that a sheet having substantially flat faces results.

Other forms and arrangements of projections and depressions may be used on the corrugating rolls instead of those shown in the drawings. For example, pyramidal projections having three or six or any other number of sides may be used and the depressions may have other shapes, and the projections may be arranged at the corners of triangles, hexagons, and so forth, instead of at the corners of squares as shown. Of course, the projections of one roll should, in this instance, be arranged to mesh properly with the projections of the other. Alternatively, one of the corrugating rolls may be replaced by a smooth-faced roll so that the working of the felt web produces indentations on only one side of the web. Or this treatment may be followed by a second treatment between such a combination of smooth and corrugated rolls so arranged that the opposite side of the felt web is also worked by indentation.

While the drawings show the application of the corrugating rolls before treatment with the differential calendering rolls, it is obvious that the corrugating treatment may be applied between any two pairs of the differential calendering rolls. Also, a greater or lesser number of pairs of differential rolls from that shown in the drawings may be applied, the larger the number of rolls, the more softening that will result. It is preferred to subject the sheet to the corrugating rolls first because this makes the operation of the differential rolls more effectice in producing a given degree of pliability and softness in the product. While the drawings also show that the faster rolls of the differential pairs are above the felt web, they may be underneath instead, or they may alternate from above to below the sheet. My combination of corrugating and differential working treatment results in opening of the sheet, and the formation of pores (as well as the further opening of the pores already present in an unsaturated sheet when such a sheet is subjected to the treatment) so that the finished treated material presents a surface requiring a minimum amount of adhesive to secure it to another surface, possesses pores for the escape of solvents of such adhesive, if the adhesive be of the solvent type, and, although water-repellant, is nevertheless substantially symmetrically flexible and possessed of enhanced vibration and sound absorbing qualities.

It will be apparent that with other types of felts and other calipers and densities of sheets, other degrees of differential working in combination with the corrugating may be employed with good results, but in no event should the treatment be carried to the point where the homogeneity and essential strength of the sheet are destroyed.

My invention is particularly useful in connection with the treatment of vehicular bodies in which the application must be convenient and rapid and the treating material must be possessed of a high degree of flexibility to conform to angular and rounded surfaces. The flexibilizing effect of the combination of corrugating and differential stretching and working, results in a superior vibratile damping and sound absorbing material requiring a minimum of adhesive for complete bonding to the surface to be treated.

The reason for the softening effect obtained by the treatment I have described is not entirely clear. I have found that the sheet is not materially increased in length or width, so that the effect is apparently not due to a permanent stretching of the sheet as a whole. I believe that the effect may be attributed mainly to loosening of the fibers of the web by the combination of treatments. I have also found that the flexibilizing effect is enhanced by increased pressure between the differential rolls, although high pressure alone does not give the desired effect, and has the undesirable effect of permanently reducing the thickness of the sheet resulting in a more dense product with decreased vibration damping and sound absorbing properties. The degree of pressure which I prefer maintained between the differential rolls is such that the felt is firmly pressed in the nip of the rolls but the thickness of the sheet is not permanently decreased more than in the neighborhood of 5% or 6% of its thickness before treatment. I believe that the softening effect of the differential rolls is due to a crowding of the felt by each of the higher speed rolls into a nip through which it can travel only at the speed of the complementary slower speed roll, resulting in an intense working of the felt to loosen the fibers thereof. I do not wish to be limited to any particular theory of operation, for whatever action takes places in my treatment, the result is a surprising increase in the flexibility and conformability of the product, together with a material increase in the vibration damping and sound absorbing properties. Tests have also indicated that the susceptibility of the sheet to expand and contract upon absorption and release of moisture is materially reduced by this treatment. Reduction of this tendency is desirable in surface coverings where dimensional changes will cause buckling.

The combination of the corrugating rolls with the differential calendering rolls is a distinct improvement over the method described in the application of E. A. Worm, Jr., Serial No. 325,059, filed March 20, 1940, now Patent No. 2,229,401, only differential calendering rolls are used, in that the material produced by the new process is more flexible and porous than that of the prior mentioned application, such increase in flexibility permitting the felt to conform more readily to the complex contours of automobile bodies and other pressed steel bodies, and the increase in porosity permitting a more rapid escape of the solvent present in the adhesive used to adhere the belt to the metal body.

While I have illustrated and described the present preferred embodiment of my invention, it will be understood that it may be otherwise practiced and embedded within the scope of the following claims.

I claim:

1. In an apparatus for treating a felt web, the combination of means comprising a pair of rotatable rolls having intermeshing projections thereon for deforming said web transverse to its plane at numerous small areas, rotatable bearing means spaced from said deforming means and means for simultaneously pressing said web against said bearing means and for driving said

pressing means tangentially of the web at the point of pressing at a linear speed greater than that of the web to effect a pulling and stroking of the fibers in the web to a condition wherein the two web faces lie substantially in parallel flat planes.

2. In an apparatus for treating a felt web, the combination of means comprising a pair of rotatable rolls having intermeshing projections thereon for deforming said web transverse to its plane at numerous small areas, rotatable bearing means spaced from said deforming means, a roller adjacent said bearing means, means for passing said web between the roller and bearing means, means for adjusting the space between the roller and bearing means, and means for rotating the roller at a tangential speed greater than the speed of the feb between the roller and bearing means to effect a pulling and stroking of the fibers in the web to a condition wherein the two web faces lie substantially in parallel flat planes.

3. In an apparatus for treating a felt web, the combination of a pair of corrugating rolls for deforming said web and forming projections and depressions in the two web faces, a pair of opposed pressure rolls for calendering said web, means for driving one roll of said pair of pressure rolls at a speed greater than that of the opposed roll to effect a pulling and stroking of the fibers in the web, and means for conveying the web between the rolls of each pair.

4. In the method of producing a vibration-damping felt web having improved flexibility and pliability characteristics, the steps of deforming the web while in a substantially dry condition by offsetting alternate areas along lines transverse of the web to opposite sides thereof and differentially calendering at least one surface of the web with a force parallel to the plane of the web to effect a pulling and stroking of the fibers in the web and expanding of the web to a condition wherein the two faces lie substantially in parallel flat planes with no noticeable decrease in thickness of the deformed web.

5. In the method of producing a vibration-damping felt web having improved flexibility and pliability characteristics, the steps of deforming the web while in a substantially dry condition by offsetting alternate areas along lines transverse of the web to opposite sides thereof, and then differentially calendering at least one surface of the web at each of several spaced points therealong with a force parallel to the plane of said web to effect a pulling and stroking of the fibers in the web and an expanding of the web to a condition wherein the two surfaces lie substantially in parallel flat planes with no noticeable decrease in thickness of the deformed web.

6. In the method of producing a vibration-damping felt web having improved flexibility and pliability characteristics, the steps of deforming the web while in a substantially dry condition by offsetting alternate areas along lines transverse of the web to opposite sides thereof and then differentially calendering at least one surface of the web with a force parallel to the plane of said web to effect a pulling and stroking of the fibers in the web and an expanding of the web and then differentially calendering the opposite surface of the web with a force parallel to the plane of said web to effect further pulling and stroking of the fibers in the web and an expanding of the web to a condition wherein the two surfaces lie substantially in parallel flat planes with no noticeable decrease in thickness of the deformed web.

7. In the method of producing a vibration-damping felt web having improved flexibility and pliability characteristics, the steps of stretching the body of the web while in a substantially dry condition by displacing alternate areas thereof in the form of projections to opposite sides of the web whereby substantially no increase in average width or length of the sheet results and simultaneously differentially calendering and working the fibers in the web, at a point spaced from a point where the projection displacement is applied, by passing the web between two pressure-applying surfaces which have different speeds tangential to the surface of the web and which exert a force parallel to the plane of the web, whereby such working of the fibers is accompanied by substantially no increase in the overall dimensions of the web.

8. In the method of producing a vibration-damping, asphalt-impregnated felt web having improved flexibility and pliability characteristics, the steps of deforming the impregnated web while in a substantially dry condition by offsetting alternate areas along lines transverse of the web to opposite sides thereof and differentially calendering at least one surface of the web with a force parallel to the plane of the web to effect a pulling and stroking of the fibers in the web and expanding of the web to a condition wherein the two faces lie substantially in parallel flat planes with no noticeable decrease in thickness of the deformed web.

FREDERICK G. SOMMERVILLE

CERTIFICATE OF CORRECTION.

Patent No. 2,335,462. November 30, 1943.

FREDERICK G. SOMMERVILLE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 42, for "effectice" read --effective--; and second column, line 51, after "Patent No. 2,229,401" insert --in which--; line 61, for "belt" read --felt--; page 4, first column, line 18, for "feb" read --web--; 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 25th day of January, A. D. 1944.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.