Dec. 3, 1935. J. J. GALLIGAN ET AL. 2,022,851

CRINKLING APPARATUS

Filed July 1, 1935 3 Sheets-Sheet 1

Fig. 1.

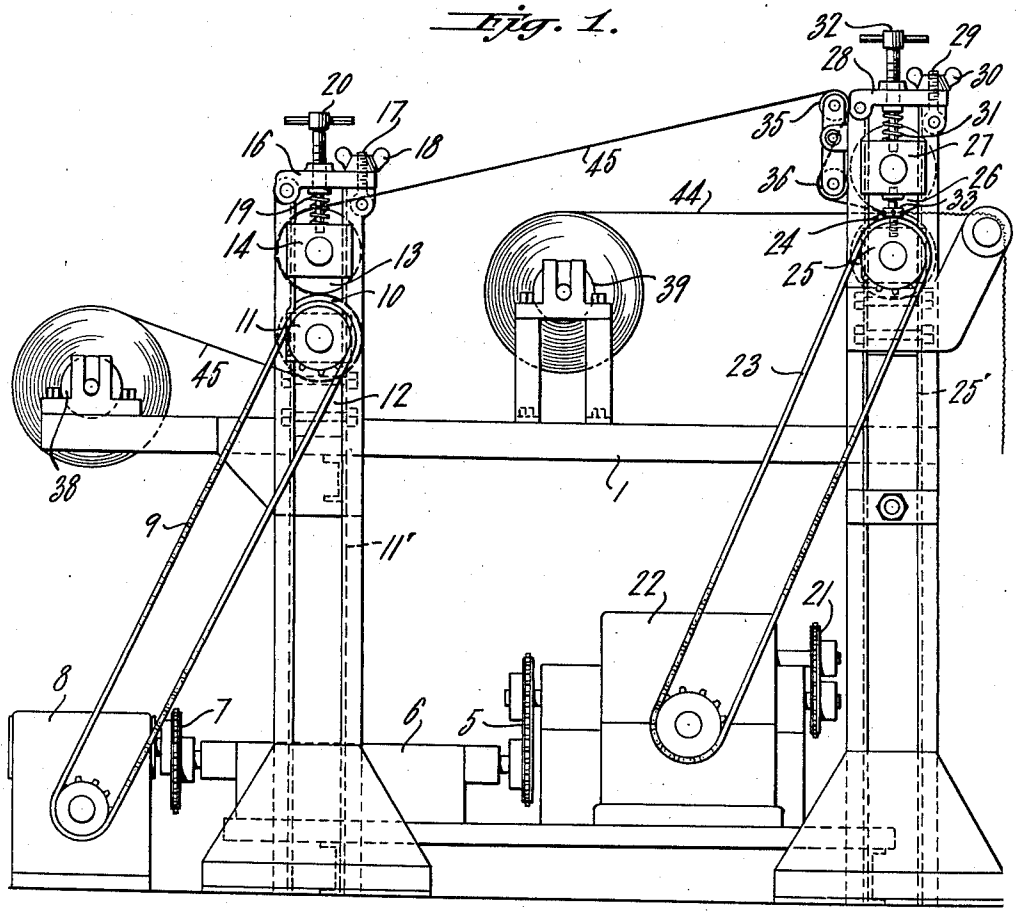
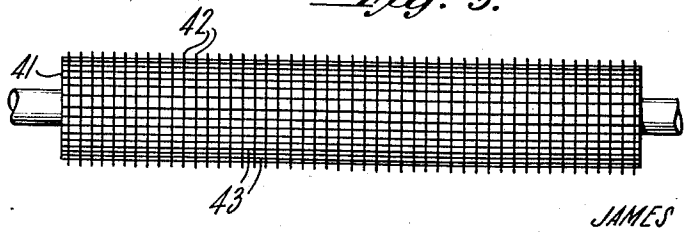


Fig. 5.



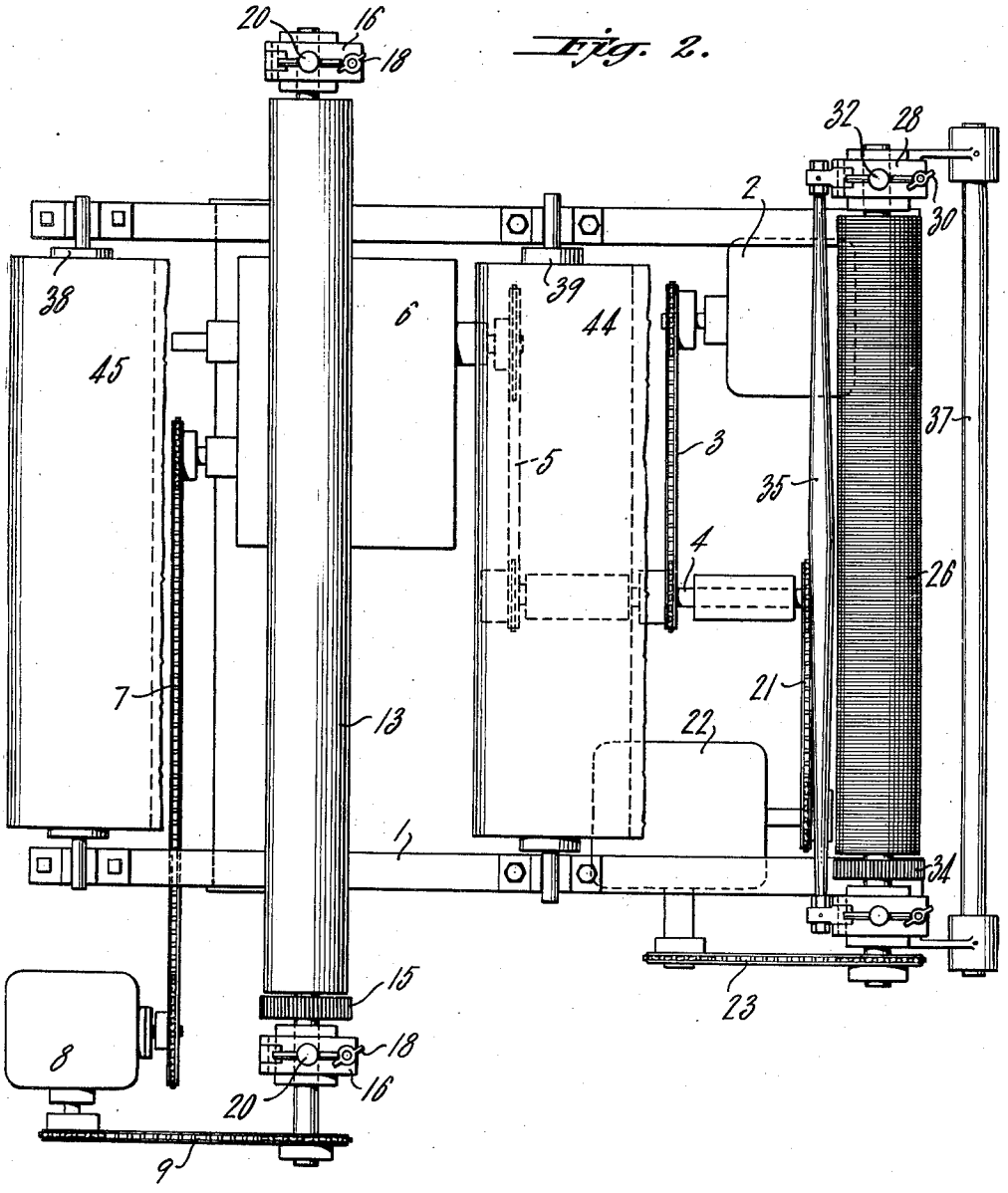
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CRINKLING APPARATUS

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Fig. 2.



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CRINKLING APPARATUS

Filed July 1, 1935 3 Sheets-Sheet 3

Fig. 3.

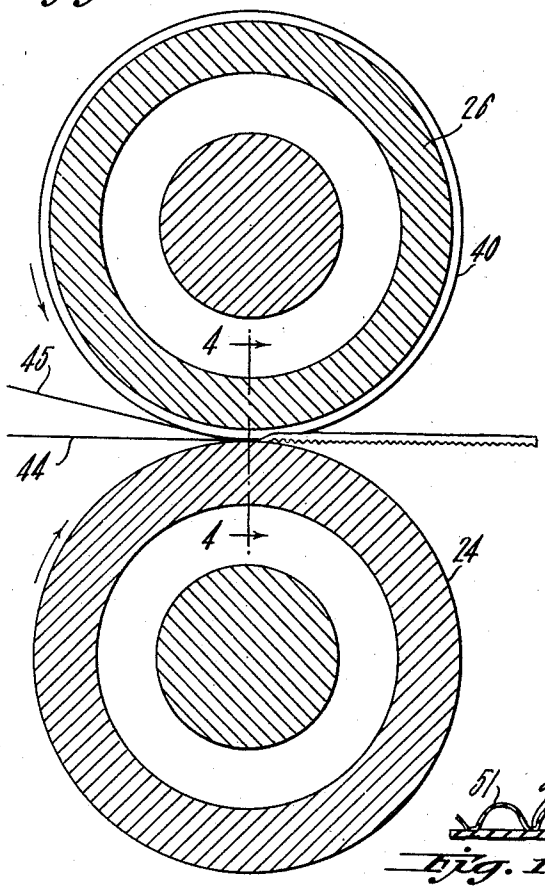


Fig. 6.

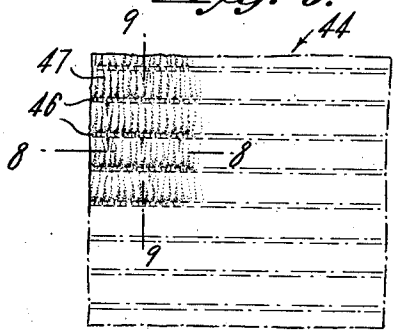
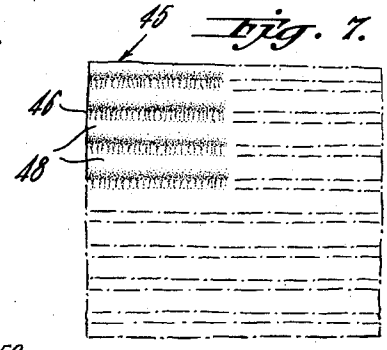


Fig. 7.



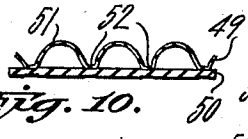


Fig. 10.

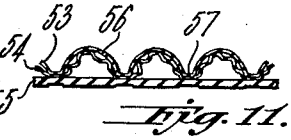


Fig. 11.

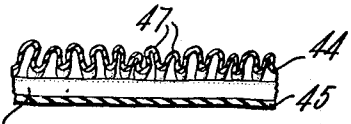
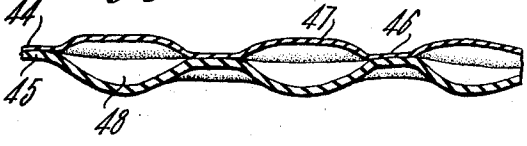


Fig. 8.

Fig. 9.



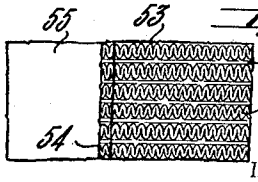
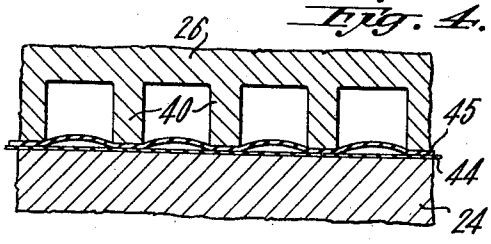


Fig. 12.

Fig. 4.



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UNITED STATES PATENT OFFICE

2,022,851

CRINKLING APPARATUS

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Application July 1, 1935, Serial No. 29,415

12 Claims. (Cl. 154—29)

This invention relates to a crinkling apparatus, and more particularly to an apparatus for crinkling or puckering rubber-like sheet material into an ornamental design.

The invention is intended to provide an apparatus for carrying out the method disclosed in our accompanying application Serial No. 29,416, filed July 1, 1935, and it is a continuation-in-part of our applications Serial No. 614,172, filed May 28, 1932, and Serial No. 631,313, filed September 1, 1932.

In the rubber industry, in the manufacture of various articles such as bathing suits, caps and shoes, belts, bags, etc., one of the desirable characteristics, in addition to utilitarian properties, is an ornamental appearance, and the ability to easily change such appearance. Such properties and appearance can be obtained by crinkling or puckering one or more sheets of rubber or rubber-like material in various designs.

An object of the present invention is to provide a simple, efficient and easily modified apparatus for producing sheets of rubber-like material in various ornamental crinkled or puckered effects.

Other objects will appear from the detailed description and drawings, in which latter:

Figure 1 is a side elevation of an embodiment of the apparatus;

Fig. 2 is top plan view of the same;

Fig. 3 is a transverse section on an enlarged scale through the crinkling rolls;

Fig. 4 is a section on the line 4—4 of Fig. 3;

Fig. 5 is a more or less diagrammatic view of a modified form of crinkling roll;

Fig. 6 is a top plan view on an enlarged scale of one form of crinkled two-ply stock;

Fig. 7 is a bottom plan view of the same stock;

Fig. 8 is a section on an enlarged scale on the line 8—8 of Fig. 6;

Fig. 9 is a section on an enlarged scale on the line 9—9 of Fig. 6;

Fig. 10 is an enlarged section of a modified form of crinkled material at an intermediate stage;

Fig. 11 is an enlarged section of another modified form at an intermediate stage; and

Fig. 12 is a plan view of Fig. 11.

Briefly the apparatus consists of a pair of cooperating crinkling rolls rotating at even speed, one of the rolls being provided with small closely spaced projections capable of cooperating in pressure relation with opposed areas of the other roll, which is preferably smooth. Between these rolls may be fed one sheet of rubber in an unstretched condition and a second sheet in a stretched condition, the stretching being accomplished by feeding the latter sheet from between a pair of feed rolls operating at a lower peripheral speed than the crinkling rolls. The longitudinal stretching of the second sheet also causes it to contract laterally. Upon passage of the two sheets between the crinkling rolls, the projection on one roll in conjunction with the opposed areas of the cooperating roll unite the two sheets at closely spaced small areas by reason of pressure at these points, and upon passage of the united sheets from between the crinkling rolls, the stretched sheet tends to contract longitudinally and expand laterally, and this action therefore causes the intermediate free portions of at least the unstretched sheet to crinkle or pucker up, and, dependent upon conditions, the stretched sheet may also pucker up.

Referring to the drawings (Figs. 1 and 2) the frame of the machine is designated by the numeral 1. Disposed on the frame is a drive means, in the present instance an electric motor 2, which by means of the chain drive 3 rotates the main shaft 4 of the machine. This shaft through the chain drive 5 operates any suitable form of variable speed mechanism 6, which may be the well known form of Reeves drive. The variable speed mechanism through the chain drive 7 drives a speed reduction gear mechanism 8, which latter through the chain drive 9 rotates the lower roll 10 of a pair of feed rolls, preferably rubber covered. The roll 10 is mounted in bearing blocks 11 which are fitted in slideways 11' in the frame of the machine, and the bearing blocks are held against downward movement by the fixed block 12. The upper feed roll 13 is mounted in a pair of bearing blocks 14 slidable in the guideways 11'. The upper feed roll is driven from the lower roll at an even speed by the gear drive 15 (Fig. 2). Extending over the tops of the guideways 11' are pivoted keepers 16 which are held in closed position by the pivot bolts 17 and thumb nuts 18. The bearing blocks 14 are pressed downwardly so as to maintain the roll 13 against the roll 10 by means of the coil springs 19 interposed between the bearing blocks and the keepers 16, and the amount of compression exerted by the springs 19 may be regulated by the hand screws 20 threaded in the keepers 16.

The main shaft 4 also, through the chain drive 21, actuates a gear reduction device 22 which in turn by the chain drive 23 rotates the lower smooth roll 24 of the crinkling device per se. The roll 24 is mounted in bearing blocks 25 fitted in slideways 25' of the frame, and downward

movement of the bearing blocks is prevented by a fixed block in the same manner as in the case of the bearing blocks 11. An upper crinkling roll 26 is mounted in bearing blocks 27 slidable in the slideways 25'. Pivoted keepers 28 extend across the top of the slideways 25' and are held in position by the pivot bolts 29 and thumb nuts 30. Disposed between the keepers 28 and the bearing blocks 27 are coil springs 31, the compression of which may be varied by the hand screws 32 threaded in the keepers 28.

In order to limit approach of the roll 26 to the roll 24 adjusting screws 33 are provided, the upper ends of which are rotatable in the upper bearing blocks 27 while the lower ends of the adjusting screws are threaded in the lower bearing blocks 25. The upper and lower crinkling rolls are driven at an even speed by the gear connection 34 (Fig. 2). Adjacent the upper crinkling roll are an upper tapering spreader bar 35 and a lower tapering spreader bar 36. At the exit side of the crinkling rolls a guide bar 37 is disposed over which the crinkled material may be led after it leaves the crinkling rolls. At 38 is mounted a reel for the rubber stock which is to be stretched, while at 39 is a similar reel for the stock which is to be fed into the crinkling rolls in an unstretched condition.

The character of the crinkling depends among other things upon the size, shape and arrangement of the projections on the crinkling roll 26, and in Figs. 3 and 4 there is shown one form of roll which may be used. The upper roll 26 is provided with relatively narrow and closely spaced circumferential ridges 40, the outer periphery of which ridges is of the same diameter as the lower roll 24, and as the rolls are driven at even speeds, the peripheral speed of the ridges 40 will be the same as that of the lower roll 24. In Fig. 4 there is represented the manner in which the stretched sheet is pressed into adhesive union with the unstretched one.

In Fig. 5 there is shown more or less diagrammatically a modified form of roll in which there are provided not only spaced narrow circumferential ridges 42 but also closely spaced longitudinal ridges 43. The projections shown in Figs. 3, 4, and 5 are merely two forms of projections which may be used, and, as before stated, by varying the spacing, shape, arrangement and area of the projections a large variety of crinkled designs may be obtained.

While the apparatus is capable of use for the making of crinkled materials having one, two or more plies, there will first be described its operation in the making of a two ply material. By adjustment of the variable speed mechanism 6, the peripheral speed of the feed rolls 10 and 13 may be varied relatively to the speed of the crinkling rolls 24 and 26 to secure any desired amount of stretch in the sheet of rubber coming from the reel 38. It should be understood that, while in the preparation of crude rubber by the milling operation, its elasticity has been temporarily destroyed to a considerable extent in order to render it plastic enough for calendering, at the same time the calendered sheet when it has cooled and stood for awhile recovers sufficient elasticity to enable it to be stretched to some extent and to then contract when the tension is released. Therefore, in operating the apparatus of the present invention, the variable speed mechanism 6 will be so adjusted as to obtain the desired amount of stretch in the rubber sheet coming from the reel 38 without using such a tension on the unvulcanized sheet as to rupture or unduly extend it. While the invention is capable of use with both sheets of rubber in an unvulcanized condition, or one or both sheets in a slightly vulcanized condition, or with the stretched sheet in a well vulcanized condition, the operation will first be described with the use of two unvulcanized sheets. Preferably the sheet which is to be stretched is of such a character that it has greater tensile strength and elasticity than the unstretched sheet, as by using a thicker sheet for the stretched one or one of a stronger and more elastic rubber stock.

The sheet of stock 44 coming from the reel 39 is fed in an unstretched condition between the crinkling rolls 24 and 26. The sheet 45 coming from the reel 38, which sheet is to be stretched, is passed beneath the rubber covered feed roll 10, then between the rolls 10 and 13, over the rolls 13, around the tapering spreader bars 35 and 36, and thence between the crinkling rolls 24 and 26. By adjusting the compression of the springs 31 the pressure between the crinkling rolls can be varied as desired, and the rolls will be adjusted by the adjusting screws 33 so as to limit their minimum spacing for the particular gauges of rubber stock and number of plies used so as to not injure the stock by unduly thinning it at the points where pressure is applied. Due to the difference in speed of rotation of the feed rolls and the crinkling rolls, the sheet 45 will be stretched to the desired elongation while passing between the crinkling rolls.

As the two sheets pass between the crinkling rolls, the concentric ridges 40 and the smooth roll 24 press the two sheets together along narrow closely spaced areas, and by reason of the adhesiveness of the unvulcanized rubber stocks, the two sheets are firmly united at such points of pressure. Upon issuing from the crinkling rolls the stretched sheet 45 at once tends to contract longitudinally and expand laterally, and since the unstretched sheet 44 is united to it at the points where the ridges 40 engaged, the longitudinal contraction will force the unstretched sheet to crinkle up or pucker transversely, and dependent upon conditions, the stretched sheet 45 may also pucker. In Figs. 6 to 9 there is shown more or less diagrammatically the form of crinkled material obtained when an unvulcanized stretched and an unvulcanized unstretched sheet have been used. The unstretched sheet 44, which in use of the finished material is ordinarily the top sheet, appears with narrow parallel areas or joint lines 46 along which the two sheets have been adhesively united by the pressure between the rolls. These joint lines or narrow areas are more or less broken up by reason of small crinkles produced in them by the adjacent crinkles in the free portions of the sheet 44. Another possible reason for some irregularity in these lines may be a slight slippage of the rubber stock at the point of pressure between the two rolls, due to the stretching of the sheet 45 in rear of the rolls and its release in front of them. The unstretched sheet 44 appears with longitudinally extending rows of short transverse puckers 47 of more or less irregular size, height, width and length, these rows being disposed between adjacent joint lines 46. Directly below the rows of transverse puckers 47 and between the joint lines 46, the lower or stretched sheet 45 has continuous longitudinal puckers 48.

Whether or not the stretched sheet is puckered, and the size or height and other characteristics

of this puckering depends to a considerable extent upon the relative resiliency and tensile strength of the two sheets. If the stretched sheet is considerably stronger and more resilient than the unstretched one, as by reason of the use of a stiffer and stronger rubber stock, or greater thickness, or vulcanization, the stretched sheet when released will as before stated contract lengthwise and expand laterally, but in its lateral expansion its strength and resiliency will be sufficient to overcome any puckering effect exerted upon it by the crinkled unstretched sheet, and it will therefore remain substantially flat. However, if the two sheets are more nearly alike in their tensile strength and their resiliency, the crinkled unstretched sheet will resist the tendency of the stretched sheet to expand laterally to such an extent that the stretched sheet will be forced to pucker up. As this force is exerted laterally of the sheet, it will pucker up in the more or less continuous longitudinal puckers **48** as shown in the drawings.

If desired, more than two sheets may be used, and in such event the stretched sheet will be disposed between the unstretched sheets. Also it is not essential that the sheets be entirely unvulcanized, and instead, one or more of them may be lightly vulcanized, as by the use of a sulphur monochloride cure, but in the event that any of the sheets are vulcanized, this vulcanization must not be to an extent sufficient to destroy or seriously impair the tackiness or adhesiveness of the rubber sheets under pressure, and the vulcanization also must not be to such an extent as to so increase the resiliency and tensile strength that the sheets will not crinkle or pucker. In the event that lightly vulcanized rubber is used for only one sheet, it preferably should be the one which is to be stretched, and if more than one sheet is to be lightly vulcanized, it is preferred that the one which is to be stretched should have a slightly greater degree of vulcanization or that it be of slightly thicker gauge.

The described apparatus may also be used in the making of a single ply crinkled rubber sheet. When such a material is to be made, the sheet of rubber on the reel **38**, which is to be stretched in the crinkling operation, is made of somewhat heavier gauge and it is vulcanized to a considerable degree, sufficient to greatly impair its adhesiveness under pressure and also sufficient to impart considerable tensile strength and resiliency to it. When such a sheet is fed in a stretched condition into the crinkling rolls along with an unstretched unvulcanized sheet, the two will be united by the pressure of the crinkling rolls as before, but this union will be relatively weak and easily broken. As the sheets issue from the crinkling rolls and the stretched sheet contracts longitudinally, it will crinkle up the unstretched sheet, but due to its thickness and resiliency its lateral expansion will not cause it to be crinkled itself. The composite sheet may then be lightly vulcanized to a degree just sufficient to set the unstretched sheet in its crinkled form, after which the crinkled sheet may be stripped apart from the stretched or backing sheet to form a single ply crinkled material. The vulcanized backing sheet may be used a number of times, but obviously after each use it will have acquired a slightly more complete state of vulcanization, and ultimately it will become vulcanized to such an extent as to be unfit for the purpose, when it may be discarded and a new backing sheet substituted.

In Fig. 10 of the drawings, there is shown more or less diagrammatically an intermediate stage in the making of a single ply crinkled material, in which the unstretched ply of unvulcanized rubber **49** is united to the backing ply **50** of vulcanized rubber which was stretched, the crinkles being indicated at **51** and the narrow areas where the two plies are adhesively united being indicated at **52**.

In this modified manner of operating the apparatus a two-ply finished material may also be made if desired by feeding two unstretched sheets of unvulcanized rubber between the crinkling rolls along with the stretched sheet of vulcanized rubber but on the same side of the vulcanized sheet. In Fig. 11, there is shown diagrammatically an intermediate stage in the production of such a two-ply sheet, in which the two unstretched and unvulcanized sheets of rubber are indicated at **53** and **54**, while the vulcanized backing sheet which was stretched is indicated at **55**, the crinkles being shown at **56** and the lines of adhesion between the three sheets being indicated at **57**. In Fig. 12 there is shown a plan view of the intermediate stage corresponding to Fig. 11, and with the backing sheet **55** still attached. The crinkles **56** appear in a more or less zig zag condition when the crinkling has been done by the use of narrow spaced circumferential ridges on the crinkle roll, and the single ply material made in the last mentioned manner of operating the apparatus has a top surface appearance similar to that of the material shown in Fig. 12.

The unvulcanized crinkled material or the lightly vulcanized in part or in whole material obtained by the first manner of operating the apparatus, or the lightly vulcanized material obtained by the second mode of operation, may be vulcanized in sheet form, and then cut up and united as by cementing to form desired articles, or instead the sheets of crinkled material may be directly cut up and assembled into articles and then vulcanized in completed form. It is preferred to use this latter method particularly in the case of crinkled material made entirely from unvulcanized rubber, because any scrap produced in cutting can be readily remilled and used over again.

In vulcanizing the crinkled rubber stocks produced by the present apparatus, there may be used the vapor cure employing sulphur monochloride. This method has the advantage of simplicity, cheap equipment and it does not cause dulling or dimming of bright colored stocks. Moreover, it permits the ready use of varying degrees of light cure in those cases where a slightly vulcanized stock is to be employed in making the crinkled rubber. However, any other suitable method of vulcanization may be employed, particularly those utilizing modern, high powered low temperature accelerators of vulcanization. There may also be employed the diffusion method of vulcanization disclosed in patent to Cadwell No. 1,777,960, dated October 7, 1930, by which a rubber stock may be compounded with only a portion of the vulcanizing ingredients of a powerful vulcanization combination and the balance of the combination introduced by diffusion from the surface of the stock. These last two methods of vulcanization have the advantage of in general producing vulcanized stocks of better aging qualities. It will be understood that in the case where the sulphur monochloride cure is used, it is unnecessary to include any vulcanizing ingredients in the rubber stock, since vulcanization is accom-

plished entirely by diffusion of the sulphur monochloride into the rubber stock.

The term "vulcanizable" as used in this specification is intended to comprehend a stock having no vulcanizing ingredients therein or an unvulcanized stock which contains vulcanizing ingredients, or a stock which has been lightly vulcanized and is capable of still further vulcanization before assuming the condition which in the rubber art would be considered as substantially or fully vulcanized for the finished article.

In place of rubber, it is obvious that any rubber substitute or synthetic rubber having the desired properties may be used, and the term "rubber" as broadly used is intended to comprehend such materials. The crinkled materials produced by the apparatus of the present invention are of high utility and ornamental appearance, and as stated in this specification, by suitable variation in the procedure, they may be made in one or more plies, and they may be crinkled on one side only and substantially smooth on the other, or they may be crinkled on both sides. The crinkled sheet stock produced is very light for its bulk, and it is very flexible, elastic and resilient. By using different colored stocks for the plies a contrasting color appearance, as well as a contrasting design, may be obtained on opposite sides of the finished material. The material is applicable for a wide number of uses, such as bathing caps, suits and shoes, belts, bags and for beach wear generally. It is also useful for aprons, baby pants, doilies, table covers, wash cloths, etc.

The apparatus is simple, easily operated, and by merely changing the roll having the crinkling projections, a wide variety of crinkling designs may be obtained. This change in the design will depend upon one or more of the following conditions; pressure between the rolls, variation in the shape, effective pressure area, arrangement and spacing of the roll projections, gauge of the stock, character of the rubber stock, use of unvulcanized rubber and/or rubber of varying degrees of light vulcanization, number of plies, tension of the stretched roll, and by uniting the sheets with the tensioned or backing sheet in contact with either the smooth roll or the roll having the projections.

It will be seen from the above that by simple changes in the apparatus or in the procedure, an enormous variety of ornamental designs for the crinkled fabric may be obtained. While a specific embodiment of the invention has been shown and described, it is obvious that numerous modifications may be made therein and it is not desired to limit the invention otherwise than as set forth in the appended claims.

Having thus described our invention, what we claim and desire to protect by Letters Patent is:

1. An apparatus for crinkling or puckering rubber-like material comprising a substantially smooth roll, a cooperating roll having spaced projections thereon, means for tensioning a sheet of rubber-like material passing between the bite of said rolls, and means for supplying an untensioned sheet of rubber-like material to the bite of said rolls, whereby said sheets are united at the points of cooperation between said projections and said smooth roll.

2. An apparatus for crinkling or puckering rubber-like material comprising a substantially smooth roll, a cooperating roll having spaced projections thereon, means for tensioning a resilient sheet of rubber-like material passing between the bite of said rolls, means for supplying a second sheet of rubber-like material to the bite of said rolls to be attached to said first sheet at spaced intervals by the pressure of said projections, and means for varying the pressure between said rolls.

3. An apparatus for crinkling or puckering rubber-like material comprising a pair of yielding held together crinkling rolls, one of which is provided with spaced small projections, adjustable means for limiting the approach of said rolls, a pair of yieldingly held together feed rolls, means for varying the relative speeds of rotation of the feed rolls and crinkling rolls, means for supplying a sheet of rubber-like material to said crinkling rolls, and means for supplying a second sheet of rubber-like material to said feed rolls and thence to said crinkling rolls.

4. An apparatus for crinkling or puckering rubber-like material comprising a pair of even peripheral speed rolls, one of which is provided with small, relatively closely spaced projecting areas adapted to coact in pressure relation with opposed areas of the other roll, with intermediate areas out of pressure relation, means for feeding a sheet of rubber-like material in a stretched condition between said rolls, and means for feeding another sheet of material between said rolls in an unstretched condition.

5. An apparatus for crinkling or puckering rubber-like material comprising a pair of even peripheral speed rolls, one of which is provided with small, relatively closely spaced projecting areas adapted to coact in pressure relation with opposed areas of the other roll, with intermediate areas out of pressure relation, means for feeding a sheet of rubber-like material in an unstretched condition between said rolls, a pair of feed rolls, means for supplying a sheet of rubber-like material between said feed rolls and thence between said first rolls, and means for varying the relative speed of rotation of the feed rolls with respect to said first rolls.

6. An apparatus for crinkling or puckering rubber-like material comprising a pair of crinkling rolls, one of which is provided with spaced small projections cooperating with the other roll, means for yieldingly pressing said rolls together, adjustable means for limiting their approach, means for driving said rolls at even speed, means for supplying a sheet of rubber-like material to said rolls, and means for supplying a second sheet of rubber-like material to said rolls under tension.

7. An apparatus for crinkling or puckering rubber-like material comprising a pair of crinkling rolls, one of which is provided with closely spaced small projections cooperating with the other roll, adjustable means for yieldingly pressing said rolls together, means for limiting their approach, means for supplying a sheet of rubber-like material to said rolls, a pair of feed rolls, means for supplying a second sheet of rubber-like material to said feed rolls and thence to said crinkling rolls, and a variable speed drive means for said feed rolls.

8. An apparatus for crinkling or puckering rubber-like material comprising a crinkling roll provided with relatively closely spaced circumferential ridges, a smooth roll cooperating with said ridges in pressure relation, and means for supplying an untensioned and a tensioned sheet of rubber-like material to the bite of said rolls in superposed relation.

9. An apparatus for crinkling or puckering rubber-like material comprising a crinkling roll pro-

vided with relatively closely spaced and narrow circumferential ridges, a second roll cooperating with said ridges in pressure relation, means for driving said rolls at even speed, means for varying the pressure and spacing between said rolls, means for supplying an untensioned and a tensioned sheet of rubber-like material to the bite of said rolls in superposed relation, and means for varying the tension of said tensioned sheet.

10. An apparatus for crinkling or puckering rubber-like material comprising a crinkling roll provided with closely spaced small projections, a second roll cooperating with said projections in pressure relation, means for varying the pressure and spacing between said rolls, means for supplying sheets of rubber-like material to said rolls, means for exerting a variable tension on one of said sheets, and guide means for said tensioned sheet disposed adjacent said crinkling rolls.

11. An apparatus for crinkling or puckering rubber-like material comprising a crinkling roll provided with relatively closely spaced small projections, a second roll cooperating with said projections in adjustable pressure and spacing relation, means for driving said rolls at even speed, means for supplying an untensioned and a tensioned sheet of rubber-like material in superposed relation to the bite of said rolls, and means for varying the tension on said tensioned sheet.

12. An apparatus for crinkling or puckering rubber-like material comprising a roll provided with relatively small and closely spaced circumferential ridges, a smooth roll cooperating therewith in pressure relation, adjustable means for pressing said rolls together and for limiting their approach, means for supplying a sheet of rubber-like material to said rolls in an untensioned condition, means for supplying a second sheet of rubber-like material, a pair of feed rolls for said second sheet, variable speed drive means for said feed rolls, and a guide bar for said tensioned sheet disposed adjacent said crinkling rolls.

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