Jan. 30, 1940. H. GALBER 2,188,456

APPARATUS FOR GROOVING RUBBER APPLICATOR ROLLS

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Fig. 1.

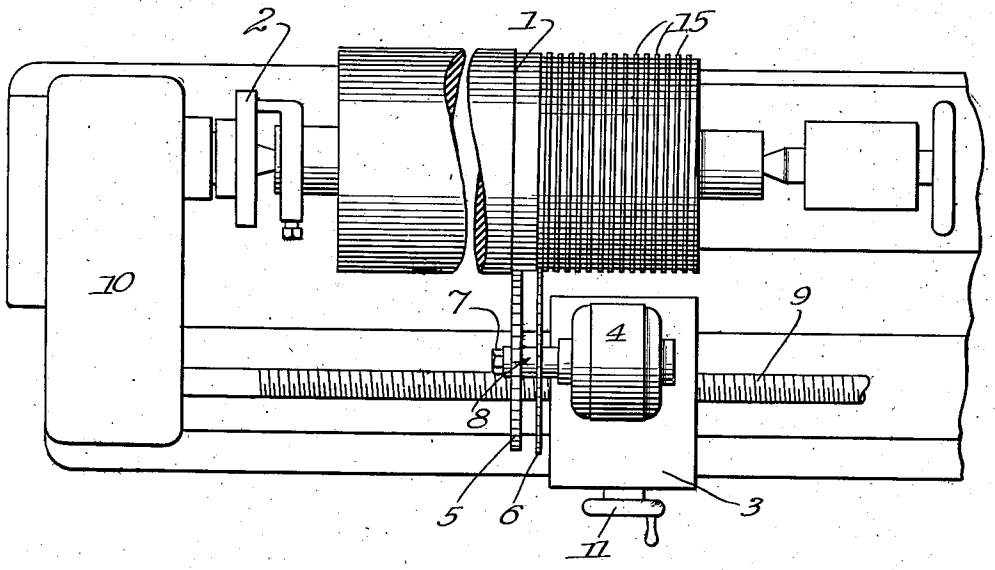


Fig. 2.

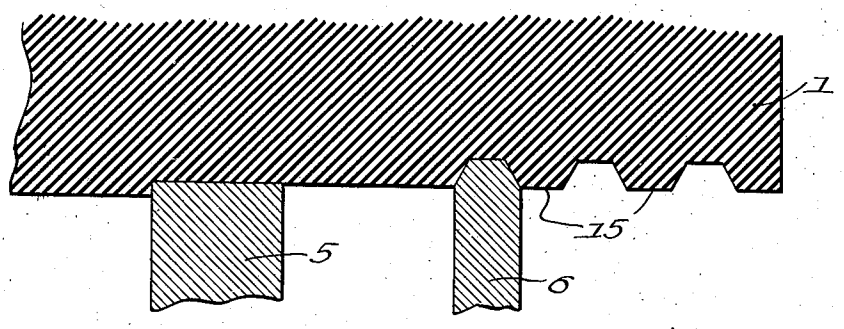
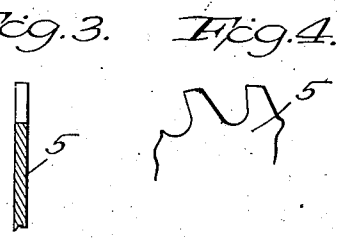


Fig. 5. Fig. 6.

Fig. 3. Fig. 4.



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APPARATUS FOR GROOVING RUBBER APPLICATOR ROLLS

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3 Claims. (Cl. 90—11)

The present invention relates to improvements in grooved rubber-surfaced applicator rolls for applying viscous adhesives and the like to sheet materials and to an improved method of and apparatus for making the same. The end in view is to provide a better method of and apparatus for grooving the roll surfaces with a much needed, but hitherto unattained degree of precision as to the form of the grooves and also to enable both members of a pair of rolls to be made exactly alike. Another object is to reduce the cost of both the initial grooving and the regrooving of worn rolls without any sacrifice of precision.

In a number of industries it is necessary to spread viscous materials over the surface of sheets with a fair degree of uniformity. The spreading of the glues commonly used in the manufacture of plywood is typical of this problem, which is also encountered in other industries dealing with sheet materials, such as paper and textile processing. In such instances, it has been common practice to spread materials of this sort with a pair of grooved metal rolls, the sheet material being fed through the bite of the rolls and coated with the viscous adhesive material which is supplied in various ways to the roll surfaces.

In the plywood industry metal glue-spreader rolls have been standard for a long time and until recently their performance with most adhesives has been satisfactory. However, recent developments have confronted the industry with a new problem of extreme precision spreading because relatively costly adhesives, such for example as the synthetic resins, have come into prominence. These adhesives are capable of giving excellent results with much smaller quantities applied to the surfaces requiring exceptionally accurate distribution, both to prevent waste and to make sure that the minimum requirement for adhesion is everywhere available. Still more recently a new plywood process has been developed for the use of the inexpensive proteinous adhesives, particularly soybean glues, with the feature that fully effective results are obtained under proper conditions with only about half the quantity of adhesive formerly used. An adhesive of this character and its use in large scale plywood manufacture is described in the copending application Serial No. 95,460, of T. W. Dike and Harry Galber. A typical synthetic resin adhesive which is effective with very low spreads is described in United States Patent No. 1,992,180 of A. H. Bowen and T. W. Dike.

With adhesives of this character the vitally essential even, thin spreading is not obtained with the old style metal spreading rolls, but rubber faced rolls have been found considerably more effective and for several years they have been increasingly favored for this kind of work. Smooth faced ungrooved cylindrical rolls, either metal or rubber, do not give a satisfactory deposit of such material. Either with metal or rubber rolls some form of grooved or reticulated surface has been necessary. Such grooved applicator surfaces operate under the general principle that the volume and frequency of the grooving determines the quantity of the deposit. A common form of grooving is a spiral of low pitch giving the appearance of annular grooves at frequent intervals. These are cut with a pitch varying from four or five to as many as twenty grooves for each inch of length along the surface of the cylinder. Such grooves are readily cut in metal rolls by known methods, but, when the metal surface is replaced with rubber, a difficult problem arises in producing grooving having sufficient accuracy to enable small quantities of glue to be spread with full precision. It is particularly difficult to cut two rolls of a pair so that they will spread exactly alike.

A typical example of the kind of grooves that are desirable in rubber rolls is a spiral cut at a pitch of twelve grooves to the inch, the grooves being about 0.050 inch wide and 0.020 inch deep separated by a flat land 0.033 inch wide, the form of the groove being either an arc of a circle or approximating the shape of one-half of a regular hexagon. Hitherto the ordinary method of forming such grooves in rubber rolls has been to grind them out with a thin faced abrasive wheel, the rim of which has been carefully dressed down to the approximate contour of the groove to be produced. The roll to be grooved is then set up in a lathe and slowly rotated, while the grinding wheel, usually provided with an individual motor, is attached to the tool rest of the lathe and fed along the surface of the rubber roll at the required rate to produce spiral grooves of the desired frequency. Before grooving, it is generally customary to grind the surface of the rubber roll to a true, fairly smooth cylinder with a flat-faced grinding wheel.

The results obtained by this method are notably unsatisfactory for a variety of reasons. In the first place, as glue spreader rolls are often nine inches in diameter and as much as sixty-four inches in length, and as two identically grooved rolls are used in the same machine, it is import-

ant to groove both of them exactly alike. With an annular grooving as described above, having twelve threads to the inch, the total length of groove to be formed is very considerable, in the above instance amounting to about 3600 linear feet for the pair of rolls and it has been found impossible to maintain the grinding wheel without serious wear developing before the job is finished. When attempts are made to correct for wear, differences in the grooving from place to place result which seriously affect the uniformity of distribution of adhesive later on. Aside from the question of wear, the grinding wheel does not produce a very accurately formed groove and the shape of the groove tends to vary appreciably from time to time. Furthermore, it is not always cleanly cut and an injurious rubbing or burning effect on the rubber often occurs. Thus, the two rolls which form a pair do not usually spread exactly alike and besides that trouble local differences of spread occur here and there. These differences with many adhesives have proved serious. Another objection has been that the difficulty of grooving the rolls accurately by the grinding method is repeated every time the rolls have to be regrooved to restore a surface which has become worn. It is extremely difficult to regroove them so as to spread the same as they did originally. Another difficulty is the tendency of the grinding wheel to fill up with particles of rubber so that it burns and fails to cut. With white rubber composition containing a large amount of filler, such as wringer-roll composition, this can usually be avoided. It is often desirable, however, to use a long lived, more elastic composition, such as truck-tire composition. With this otherwise exceptionally durable wear-resisting material, the burning trouble is very serious and it is almost impossible to groove it satisfactorily by the grinding method.

It has been suggested that the grooves in the rubber rolls might be accurately molded by curing the rubber composition which forms the face of the roll in a correctly grooved metal form. This is impractical, first, because of the expense of the molds, and second, because there is no provision for regrooving rolls after wear. Attempts have also been made to cut accurate grooves by turning in a lathe at high speed as in wood-turning, but the rubber surface does not cut satisfactorily by the methods which are ordinarily used for turning either metal or wood.

In the accompanying drawing an apparatus adapted to practice the method of the present invention is illustrated diagrammatically.

Figure 1 is a diagrammatic plan view of a lathe having the novel instrumentalities hereinafter described associated therewith.

Figure 2 is a greatly enlarged fragmentary radial section through the rubber applicator roll and through the two saws of Figure 1.

Figure 3 is a radial section through the facing saw.

Figure 4 is a fragmentary face view of the same.

Figure 5 is a view similar to Figure 3, but showing the grooving saw, and

Figure 6 is a fragmentary face view of the saw of Figure 5.

In Figure 1, a rubber roll 1 is mounted in a lathe 2 which carries, on the tool rest 3, a motor 4. A smoothing or facing cutter 5 and a groove cutter 6 are carried on the motor shaft 7, separated by a spacer washer or collar 8. The tool rest 3 is mounted for movement longitudinally of the roll 1 on a line parallel to the roll axis. Movement may be imparted to the rest by any approved means, such as the feed screw 9. Rotation is imparted to the feed screw and to the chuck 2 by an appropriate speed change device within the gear casing 10, whereby the relative speeds of rotation of the roll 1 and of the feed screw 9 may be changed at will, for various purposes, for instance, to change the pitch of the spiral groove formed on the roll.

The distance of the axis of the shaft 7 from the axis of the roll 1 may be changed, in accordance with conventional lathe practice, by a hand wheel 11 associated with the tool rest support.

I have now found the following entirely satisfactory solution of this problem. My method is to set up the roll in the centers of an ordinary metal turning lathe taking great care to get the roll accurately centered and also to use a lathe capable of holding work accurately centered throughout a cutting operation. Such a lathe is represented diagrammatically in the accompanying drawing. I then mount on the tool post of the lathe a high speed ball-bearing motor carrying two multiple tooth cutters mounted on the rotor shaft. As cutters, I find that eight-inch diameter woodworking saws with about eight teeth to the inch are very satisfactory.

The relative dimensions of two saws adapted to make a grooved roll corresponding to the specific example given above, is shown in Figure 2, wherein the dimensions are ten times actual size. One saw 5 is carefully prepared with chisel-shaped teeth dressed flat and true, the teeth being preferably about a tenth of an inch wide. I also mount on the same shaft another saw 6 of similar character, but with teeth carefully formed to the exact contour of the groove to be cut, the radius of this second saw being greater than that of the straight-faced saw by the depth of the groove to be produced, in the present case, 0.020 inch. The width of the cutting portion of the second, grooving saw, should be considerably less than the width of the first saw. In the specific example shown, the saw 6 is 0.050 inch and the flat land 15 between the grooves is 0.033 inch wide. The relative speeds of rotation of the feed screw 9 and the roll 1 is, therefore, such that the tool rest 3 and the parts carried thereby move lengthwise of the roll a distance of 0.083 inch during each rotation of the roll, that figure being the sum of the width of the groove and of the land.

The rubber roll which has been mounted in the lathe is approximately cylindrical as received from the manufacturer, but needs a slight finishing cut to make it perfectly cylindrical and concentric. I then start the lathe rotating at a low speed which may be either forward or reverse without making much difference in the work. The speed of the surface of the roll should not ordinarily exceed about five inches per second and with soft gummy types of rubber should be much less, even as low as three-quarters inch per second in some cases. The cutters are now revolved by the motor at high speed, generally between 1800 and 6600 R. P. M. and adjusted by the hand wheel 11 to the surface of the roll, so that the straight faced cutter on the end of the rotor shaft just cleans up the surface of the roll to a true cylinder, while the large diameter grooved-shaped cutter follows behind and cuts out the groove; the motor and saws being fed along the face of the roll at a rate corresponding

with the pitch desired in the spiral grooves, the direction of the cut being preferably downward into the rubber.

Obviously, the longitudinal feed per rotation of the roll should not exceed the width of the straight faced cutter. The successive, flat, spiral cuts made by that cutter should overlap slightly. In the specific embodiment shown, the feed per revolution is, as stated, 0.083 inch, since the grooves are each 0.050 inch wide and the lands are 0.033 inch wide. Thus, if a smoothing cutter 5 having a width of 0.10 inch is used, satisfactory results will be accomplished.

I find that if certain critical speed relations are maintained, this method and apparatus produce grooves of extraordinary accuracy and have none of the disadvantages connected with the grinding method, and either wringer-roll or truck-tire types of composition can be grooved easily and accurately. For instance, I find that the teeth of the cutters will stand up without appreciable change of shape to groove a pair of nine-inch diameter sixty-four inch rolls, while a grinding wheel changes its shape appreciably before a quarter of one roll is completed. Furthermore, the groove produced by this method is shaped with precision and cut very smoothly. Since the relationship between the straight faced saw which cleans up the surface and the grooving saw is constant, the finished dimensions, such as the diameter of the roll, the depth of groove, and the character of the land, or flat space between the grooves, are consequently maintained constant throughout. By this method, I can groove rubber rolls in about half the time and at about half the cost of the grinding method with the great advantages of accuracy and ability to reproduce previously done work which the grinding method does not provide.

The correct speed relation I find is largely a matter of the thickness of the cut performed by each individual cutter tooth and the frequency of cuts modified somewhat by the character of the rubber composition. The velocity of impact of the tooth on the rubber must be high to cut the rubber away cleanly before it is able to stretch appreciably and cause a rubbing action against the tooth which would generate considerable heat. The speed of the saw assists materially in keeping it and the rubber reasonably cool. In all cases, the temperature of the rubber in the locality of the cut must be kept below the softening point or a melting and burning action will set in, making proper cutting impossible. In general, I find that white rubber composition containing a considerable amount of filler can be cut faster than pure gum rubber or truck-tread composition. The latter has excellent wearing properties and is particularly suitable for rolls of this character. I find that a satisfactory rate of rotation for the roll in the lathe should not much exceed a surface speed of about five inches per second, while the frequency of cuts should generally exceed five thousand per second and the thickness of cut by any one cutter tooth should not much exceed 0.0002 inch. I find that higher cutter speeds and less rates of feed are not ordinarily objectionable, but outside of the limits stated, at lower cutter speeds and greater rates of feed, serious difficulties are encountered with heating up and burning of the rubber, inability to make a clean cut, etc.

It must be understood that the figures for the tooth speed and thickness of cut vary quite substantially for different compositions of rubber. The important things are (*a*) to maintain a high enough impact speed in the cutter tooth to sever the rubber cleanly, without stretching, which, if it occurs, results in prohibitive heating and consequent burning; and (*b*) to keep the feed low enough so that the individual cuts can substantially merge or coalesce to form a reasonably smooth groove. With a less elastic rubber, the feed may be higher, and the impact speed required to cut cleanly without stretching or burning may be lower. The conditions are not broadly critical for all types of rubber compositions, but for a specific composition, critical speeds and feeds may be determined. The figures given above are for standard applicator roll compositions.

In dressing the teeth of circular saws, it is common practice to dress the tops of the teeth with an abrasive stone. This produces a flat area at the top of the teeth or not strictly a flat area, but an area having the same curvature as the saw itself. Obviously if this so-called flat area is of any considerable width and length, it will produce rubbing friction and heat in contact with material having the elastic properties of rubber. Since it is necessary in practical operation to keep the temperature of the rubber locally below the softening point, it will be readily understood that, if, in a given instance where other conditions are favorable, burning occurs, this can be prevented by gumming the teeth further back so as to shorten the flat area which causes the friction. In some instances, a satisfactory cut will be made at a certain feed and speed, but, if the speed is increased without changing the feed, the unexpected result of prohibitive heating may ensue. In such cases this trouble can be cured by gumming the teeth farther back so as to reduce the flat area which is the main source of the frictional heat.

A new article of manufacture is produced by the apparatus of and in accordance with the method of this invention. The rubber applicator roll so produced is characterized by an improved groove. It may be distinguished from applicator rolls made in accordance with the methods of the prior art, since the grooves have definite structural characteristics which are determinable upon inspection under a low power microscope.

When examined under such a microscope, the surface of a roll having the grooves grounded by the abrasive method of the prior art discussed, appears generally rough, woolly and dusty. A moulded roll appears much smoother and shows a reproduction of the tool marks on the mould. A roll cut in accordance with the present method is rougher than the moulded rolls, but much smoother than the rolls ground with an abrasive. It is free from the dusty, woolly, shaggy appearance and shows a succession of minute fractures in the rubber which are apparently the lines of demarkation between the cuts of the individual teeth. The bottom of each groove is comprised of a great plurality of minute, circumferentially aligned, individual, concave, arcuately cut surfaces, joining each other on extremely flat angles and merging together to form a substantially smooth bottomed groove. As stated, these structural characteristics can be determined by careful inspection under a microscope.

Other modes of applying the principle of my invention may be employed, change being made

as regards the details described, provided the features stated in the following claims, or the equivalent of such be employed.

I claim:

1. An apparatus for facing and grooving the surface of a rubber applicator roll comprising means for slowly rotating the roll about its axis, a shaft mounted for rotation in spaced relation to said roll on an axis parallel to the roll axis, a pair of spaced saws on said shaft, means for rapidly rotating the shaft and saws, and means for moving the same lengthwise of the roll, the first saw having flat teeth of substantial width, and the second saw having teeth shaped to equal the desired cross-section of the groove and being projected outwardly beyond the teeth of the first saw a distance equal to the desired depth of the groove.

2. An apparatus for facing and grooving the surface of a rubber applicator roll comprising a lathe for slowly rotating the roll about its axis, a tool slide movable in a path parallel to the roll axis, a motor on said slide having a shaft parallel to the roll axis, and a pair of saws on said shaft, the leading saw being thicker than the trailing saw and having flat teeth, the trailing saw being of larger diameter than the other to project into the roll surface, and means for controlling the ratio between the speed of movement of the tool slide and the speed of rotation of the roll.

3. An apparatus for facing and grooving the surface of a rubber applicator roll comprising means for slowly rotating the roll about its axis, a shaft mounted for rotation on an axis parallel with the roll axis and for movement longitudinally of its axis, a pair of saws mounted on said shaft having peripheral teeth adapted to cut into the surface of the roll, the leading saw having flat teeth and being thicker but of smaller diameter than the trailing saw, and means for moving the shaft and saws longitudinally of the shaft axis a distance during each rotation of the roll less than the thickness of the leading saw but more than the thickness of the trailing saw, whereby the leading saw trims the roll surface to cylindrical shape and the trailing saw forms a spiral groove of low pitch in the trimmed surface.

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