Nov. 7, 1939. O. W. FROST 2,178,631

APPARATUS FOR SURFACING FELTED SHEETS

Filed March 23, 1936 3 Sheets-Sheet 1

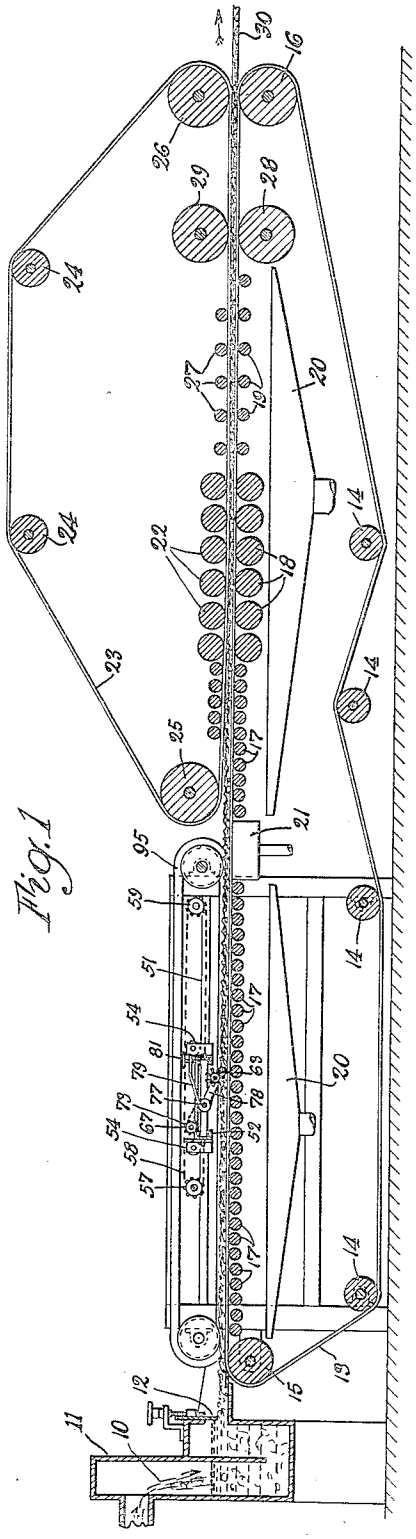


Fig. 1

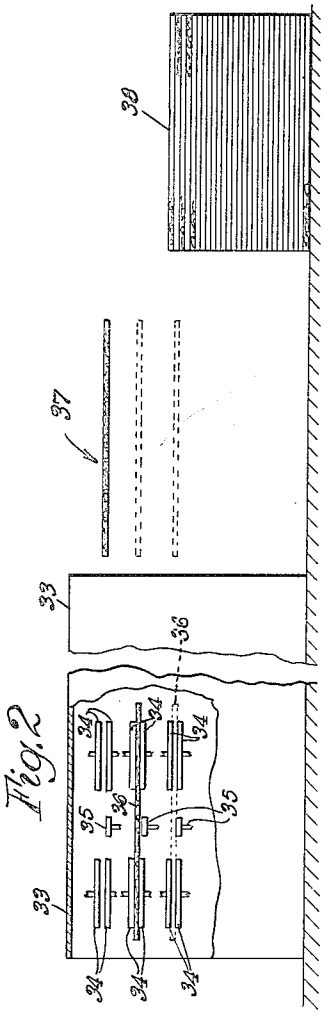


Fig. 2

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APPARATUS FOR SURFACING FELTED SHEETS

Filed March 23, 1936 3 Sheets-Sheet 2

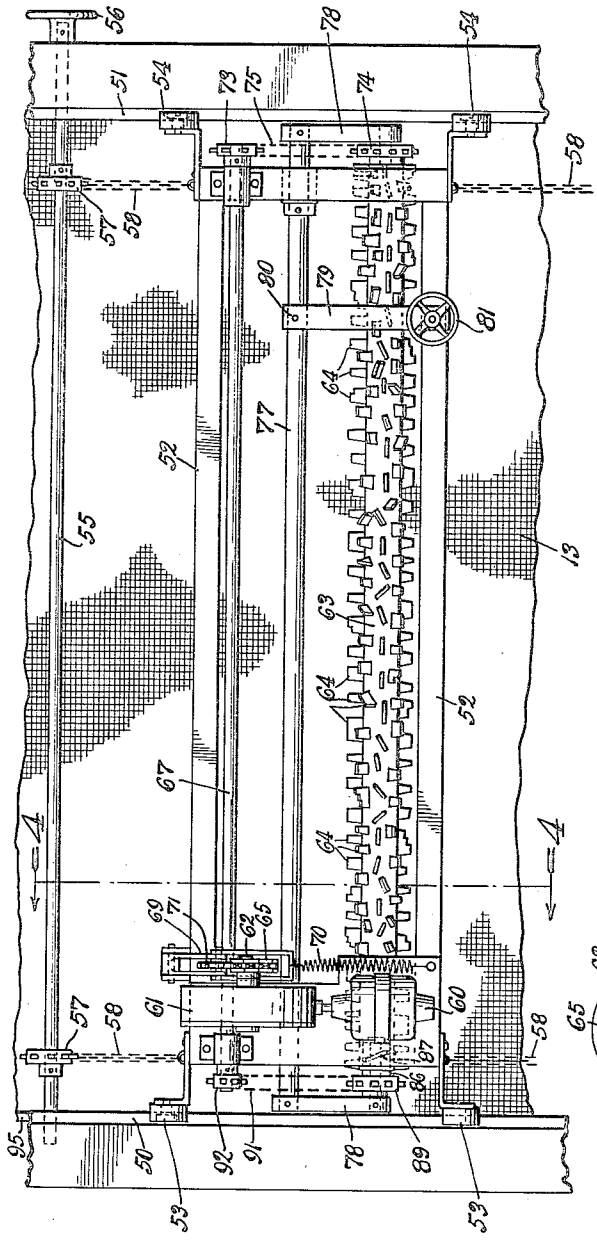


Fig. 3

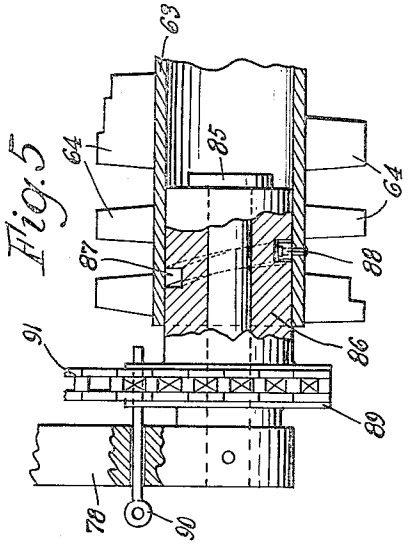


Fig. 5

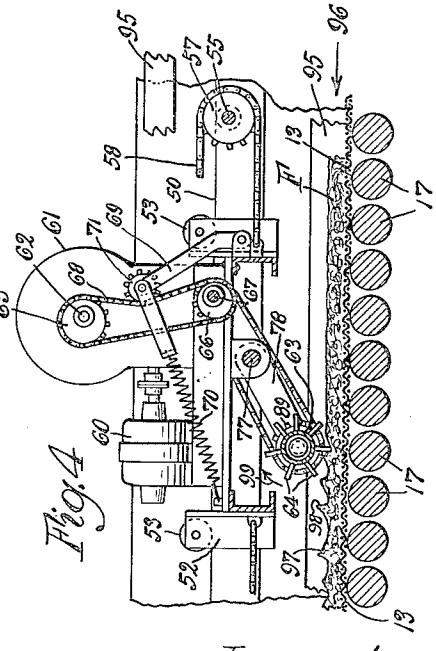


Fig. 4

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APPARATUS FOR SURFACING FELTED SHEETS

Filed March 23, 1936 3 Sheets-Sheet 3

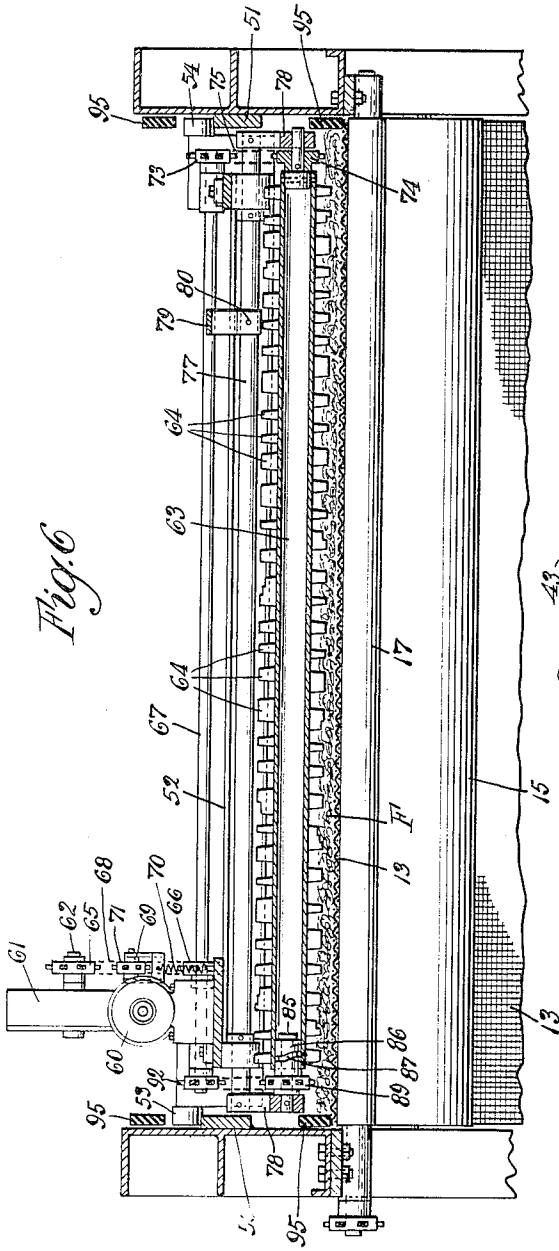


Fig. 6

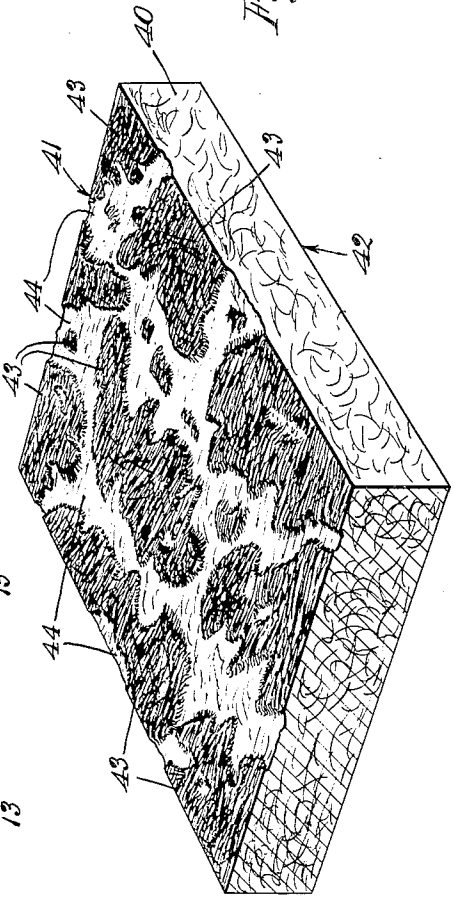


Fig. 7

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UNITED STATES PATENT OFFICE

2,178,631

APPARATUS FOR SURFACING FELTED SHEETS

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Application March 23, 1936, Serial No. 70,331

8 Claims. (Cl. 92—39)

The present invention relates to the manufacture of fiber sheets and artificial fiber board with a high strength and uniformity of body structure and with a characteristic uneven surface. The said surface is one which is generally level, as in a board having an average uniform thickness, but which is locally high or low with respect to the general level, as in a board with local differences in thickness. Another feature of the desired surface is that the highest spots or areas may be leveled or flattened to substantially the same plane, corresponding to miniature plateaus of the same height in a miniature area of hills and valleys. It is another feature that the said plateau-areas are harder and more dense, and the lower areas are more porous and less dense. Still another feature of the invention is that the body of the board has a uniformly well felted texture, and that the miniature hills therein at the surface are well felted into the body of the board and substantially integral therewith.

The surfaces above referred to have desirable qualities for decorative appearance when used in a wall-board, either finished or unfinished. The sheet with flattened high spots has a more practical advantage when the sheet is exposed for use in sound deadening. The lower areas being less dense have greater porosity and higher efficiency as sound absorbing areas, than the plateau-areas of the higher spots. A further advantage is that the surface is apparently uneven, yet the high spots may be at one level to provide the plateau plane which determines the caliper of the sheet.

The problem of making a sheet with the required surface is not a difficult one. Likewise the problem of making a sheet of uniformly well felted texture is not a difficult one. But to accomplish both tasks together is difficult, because the ready solution of one problem is antagonistic to the other. For example, in the paper-making industry thin and thick sheets of felt may be formed on a wire by flowing on to the wire a thin slurry of pulp. That consistency which produces an even formation results also in an even top surface. To make an uneven surface, a lumpy, thick or non-homogeneous slurry of pulp may be used, and this does not produce a uniformly well felted body. The present invention is therefore directed to the making of a sheet from a thin slurry to produce uniformity and homogeneity in the texture of the body, and then at an appropriate place disturbing the surface only, to provide the desired characteristics. The process may be carried out intermittently or continuously as will be hereinafter more particularly described.

The present invention more particularly contemplates the use of a continuous process for producing a board with regular and uniform texture or formation throughout the major portion of its body, and the introduction into the process of a disturbing element for interfering with certain phases of the process which tend to effect a uniform surface, so that the disturbance produces desired breaks in the uniformity of the resulting surface.

A variety of means may be employed for creating the desired disturbance. The means will of course vary according to the kind of process used and the surface desired, for example whether it be a regular pattern or a haphazard or irregular pattern, or whether it be a deep or shallow variation. The means also may vary for adaptation to the place or step in the process where it becomes effective on the stock. In order better to explain the nature of the invention, the general process will be described.

The sheet-making process may be considered to follow generally the process of making paper either as hand-made sheets, or on a cylinder or on a Fourdrinier wire. A uniform water slurry of pulp having about 1% of fibers is placed in contact with a screen so as to form a fiber felt thereon. As the pulp is dewatered through the screen a sheet is formed with a uniformly felted texture and a uniform surface. In a cylinder machine the screen is a roll or is on a roll, which dips into the slurry. Suction or pressure flow causes motion of water through the screen which holds back the fibers in a felt-formation. As the screen moves out of the slurry water is drained from the mat and later at a suitable consistency the mat may be lifted from the screen.

In the Fourdrinier process the slurry flows in a constant stream from a head-box onto a moving screen. As the stock is carried away from the head-box, water drains from the stock forming the felt, and drainage may be hastened by suction means. Then pressure may be applied as through press rolls to squeeze out water which does not readily drain, and to compact the felt to a desired density. The compression may take place one or more times and either before or after the felt leaves the screen.

In either case the stock changes in moisture content from about 99% to about 50% to 65%, at which time the felt has considerable rigidity and is suitable to be dried into a sheet or board. As the original stock loses water it becomes less

plastic under mechanical force. Originally it is substantially a liquid, flows, and seeks a level. It is this quality which produces uniform felting in the body, and tends to produce a uniform thickness and a uniform surface. As it loses water it loses its tendency to flow laterally, and becomes subject to vertical compression (assuming it is on a horizontal screen) whereby water is squeezed from it without materially altering the formation.

At earlier stages vertical compression produces lateral flow. At less water content there is a stage where vertical compression does not produce lateral flow. In this stage any vertical compression is a mere anticipation in point of time of pressure from the subsequent general action of the pressing means. Localized pressures at such stage are therefore ineffective to alter the surface.

However, during the stage where vertical pressure will produce lateral flow, localized pressure is effective to alter the surface so that it is not uniform. It is satisfactory so far as the surface is concerned but it is unsatisfactory so far as the formation of the body is concerned. The local pressure is effective throughout the whole thickness, and hence the entire body of the board is thinned. Also the lateral movement disturbs the uniformity of formation in the body.

The present invention is based upon disturbing the upper layer or zone of the felted stock at such a stage that the disturbance is more generally confined to the upper layer and generally minimized in the lower layer, whereby the lower layer maintains its natural uniformity of felting. It is furthermore based upon disturbance of the upper layer which is so limited that it does not destroy an effective felted relation between the lower layer and the upper layer. Otherwise, in the dried board there may be loosely held aggregates of fibers which can be picked out or pulled out, as in cutting the board with a tool.

According to this invention only the upper layer is disturbed while the stock at said layer is at a consistency to maintain some permanent indications of the disturbance, and these indications constitute the desired surface. Regularity or irregularity may be obtained, but irregularity is preferred and is the more difficult to obtain. The said indications may be small or large giving respectively different degrees of fineness or coarseness of surface appearance.

The present invention is directed to means for disturbing the surface by fingers, pins or blades movable relative to the stock, and suitably controlled in such motion to make a desired pattern. The motion is designed to destroy the uniformity of felting and thickness in the top layer, without destroying its felted union with the bottom layer and without making pronounced separations of stock in the top layer. The motion may be compounded so as to give motion in various directions either with or against the stock, or additional motion vertically or horizontally with respect to the plane of the felt.

In the accompanying drawings there is shown a continuous machine of the Fourdrinier type as an example of a felting machine and process, and also an attachment therefor involving a cyclically moving group of teeth, pins or fingers which are operated to disturb the surface.

In the drawings:

Fig. 1 represents a vertical longitudinal section of a machine of the Fourdrinier type, showing a section of the surface disturbing mechanism.

Fig. 2 is a diagrammatic representation of the means for processing the felt after its formation on the machine of Fig. 1.

Fig. 3 is a plan view of the disturbing device.

Fig. 4 is a cross-section of the disturbing device taken on line 4—4 of Fig. 3.

Fig. 5 is a detail view of the end of the rotor which carries the teeth, illustrating means for producing motion of the teeth cross-wise of the felt.

Fig. 6 is a front elevation of the device as pictured in Fig. 3.

Fig. 7 is a representation of a felted board surfaced by the mechanism described.

A pulp slurry 10 enters any suitable head-box 11, well understood in the art, which is provided with a gate or slice 12, through which stock flows onto a Fourdrinier wire 13, passing endlessly over miscellaneous idlers 14, and held level between a breast roll 15 and a couch roll 16. In this level span groups of supporting rollers are provided, such as the groups 17, 18 and 19. The sheet is formed in this span. Water drains through the wire and between rolls of group 17, falling into catch basins 20. If desired, water may be more quickly removed by use of a suction device 21. Group 18 serves also as the lower part of a series of press rolls complementary to the upper set 22. The rolls on the upper set are arranged to present a tapering zone between them and rolls of group 18, for squeezing the felt gradually. However, before the felt is squeezed it comes into contact with a sheet 23, moving endlessly over idlers 24, and between end rolls 25 and 26. This sheet 23 may be a felt or a screen. A screen may be chosen so as to make some characteristic marking on the top surface. The finer the screen, the less visible its markings. Beyond the tapered pressing groups 22 and 18, there is a zone where the sheet can expand a little, as between rolls 19 and 27. Then the sheet gets a heavy squeeze between press rolls 28 and 29. The sheet then passes along to the couch roll zone where it leaves both upper and lower wires as shown at 30.

Fig. 2 is a diagrammatic representation of subsequent steps well known in the art. The sheet 30 may require trimming or cutting, for which cutting means 31 is supplied. The cut sheets are distributed as at 32 to selected levels in a drier 33 which may vary in style. A plate drier is preferred for drying the sheet between heated platens, indicated at 34. These are plates which press on both sides of the sheet to boil the water out of it. Pick-up devices 35 urge the sheet forward as it is periodically released from the platens. The sheet in the drier is designated 36. The plates compact the high spots on the sheet (formed by the means later described) to the same general level and provide denser surfaces to the board at such high areas, leaving the lower areas less dense and unflattened. The resulting boards are shown leaving the drier at 37 and are stacked at 38. The flattened high spots give a regular caliper to the sheet, and provide slide-surfaces for one board on another, thereby eliminating danger of tearing or injuring high spots, as would occur in rough treatment of the same boards unflattened in this way.

Fig. 7 illustrates a characteristic surface and body made by this process. The body 40 of the board is uniform over its various areas and presents a sort of cleavage parallel to the faces 41

and 42. The cleavage is not in distinct planes, like the cleavage planes in minerals, for example mica, because there are fibrous connections between the apparent irregular laminations. This is a standard condition in felted sheets due to the compression processes whereby the fibers become more horizontal as the thickness of the felt is decreased. Such structure makes a stronger board. The face 41 has the flattened high spots 43 and the irregular low spots 44. High spots 43 are denser and lie in one plane. They may show differences in color and texture because of the different conditions of formation, some being more dense than others. They may all be different in appearance from the low areas 44, which have not been subjected directly to pressure from heated platens 34. Looking upon the surface as a miniature terrain, the low spots are valleys, and the high sports are mountains, leveled to form plateaus, all of the same altitude.

Another feature of the board is the different density characteristics on the two sides. The top is mottled as to density, leaving softer areas for better sound deadening effect. The bottom is more uniformly dense, and the smaller the valleys and the thicker the board, the greater the uniformity. Greater pressure is exerted on the board over the high spots, and the pressure is transmitted laterally because of the nature of the fiber and the solidity of the felt. Hence the bottom is practically uniform in density where the thickness is one-half inch. The formation is uniform, resulting in uniformity of strength.

During the travel of the pulp stock from the head-box 11 it becomes dewatered. At some point it is suitable for treatment to alter the surface as above described generally. The point cannot be definitely designated, and it may vary according to speed of wire, consistency of stock, temperature, and various factors. It has been found to vary for unknown factors, and hence provisions are made to locate apparatus to follow the point as it may change. The means generally is such as to permit longitudinal adjustment of the mechanism along the machine.

Parallel tracks or rails 50 and 51 are provided above the felt level for mounting the disturbing device. A framework 52 (Fig. 3) for the device has rollers 53 for track 50 and rollers 54 for track 51. A rotary shaft 55 across the machine has a hand wheel 56, and carries sprockets 57 for chain connections 58 having their ends secured to the framework, and the stretches passing over idler sprockets 59. This serves for adjusting the position of the framework on the tracks 50 and 51.

The framework 52 is thus a movable carriage. Upon it is mounted an independently operated power unit including motor 60 and a speed reducing mechanism 61 having a low speed axle or shaft 62.

The disturbing device proper is a cyclically moving element set with fingers or teeth, which are moved by it in a cyclical path. It may be a belt-like unit passing over rollers and suitably guided to cause the fingers to dip into felt F (see Fig. 4) on wire 13. Such a device can readily make elongated markings in a sheet. However, for simplicity of construction a rotary element 63 is employed with a concentric periphery on which heterogeneous teeth 64 are heterogeneously arranged. Means is provided for imparting a non-constant rotary speed to the rotor 63. A suitable device constitutes eccentric sprocket 65 on shaft 62, eccentric sprocket 66 on shaft 67, a chain 68 connecting the eccentric sprockets, a spring pressed arm 69 with spring 70 carrying sprocket 71 in mesh with chain 68 to take up the variable slack in the chain. Shaft 67 is thus variably driven from the constant speed of the motor. On the end of shaft 67 is a sprocket 73, and on the right end (Fig. 3) of toothed rotor 63 is a sprocket 74, and a connecting chain 75.

The rotor is also mounted for vertical adjustment to regulate penetration of teeth 64 into the felt F. A suitable arrangement for this involves bell-crank brackets at the sides, with a rigid pivotal supporting shaft 77 turning in framework 52. See Figs. 1 and 4. Side arms 78 of the bell-crank carry the toothed rotor 63 between them as one functioning arm. The other arm of the bell-crank is a strip 79 rigid with shaft 77 at point 80. Strip or arm 79 is threaded for a hand wheel screw-adjustment 81, the point of which rests on the framework (see Fig. 1).

There is also mechanism to cause the teeth to move laterally of the machine, which is axially of the rotor 63. This is readily accomplished by a cam device, and a construction is used which makes the device operate at a variable speed. The rotor 63 at its right end (Fig. 3) is free to move axially in its bearing in arm 78, carrying the sprocket 74 with it. The opposite end is of different structure as shown in Fig. 5. The arm 78 at the motor end has a fixed headed pin 85 holding a collar 86 with a cam groove 87 in its periphery. The end of rotor 63 is tubular and can turn on the collar. A pin 88 set in the rotor rides in the cam. Relative motion between the collar and the rotor thus moves the rotor axially. The collar 86 is rigid with sprocket 89, whereby the collar can be turned. A pin 90 may be used through the arm 78 and the sprocket to hold the latter stationary. Then the turning of the rotor 63 at variable speed will give the rotor a variable axial movement. The shape of cam groove 87 will also determine the character of the axial movement. A further variation may be made by connecting sprocket 89 by chain 91 to a sprocket 92 on shaft 67. If the sprockets 92 and 89 are the same as sprockets 73 and 74 no axial motion will result. By using a different ratio at these respective ends a very slow, a medium, or a very fast axial shift may be produced. The variable speed of shaft 67 working on both these mechanisms compounds the variability where heterogeneous markings are desired.

In operation a slurry of fibers flows as a thin liquid onto the wire 13, being held on the sides by deckel straps 95. On the screen the stock is automatically dewatered by drainage making the fiber felt more solid or plastic. At a region where the stock can take a permanent set, the teeth of the rotor 63 strike it. As the region may shift longitudinally of the machine, handwheel 56 is used to shift the carriage on which the toothed rotor is mounted.

The stock flows in Fig. 4 in the direction of arrow 96 and the rotor 63 turns clockwise in Fig. 4, in direction of arrow 99. By regulating the speed of the rotor, the relative motion between the teeth and the felt F may be reversed. At one time the two may move together relative to the frame of the machine, or the teeth may go faster, or go slower. The eccentric drive can produce these changes in ordinary operation of the machine. Thus, stock may be piled on either side of the teeth. In Fig. 4 the high spots in the felt

designated **97** and **98** have been made by different sides of teeth. Of course, the speed of the rotor may be adjusted so that there is no reversal in relative motion. The teeth may travel peripherally faster or slower than the stock on the wire. The heterogeneous arrangement and assortment of teeth produces a haphazard pattern. Since the rotor is small, a constant speed would tend to reproduce a pattern, especially where there is no axial movement. The variable speed of rotation and the axial shift, both aid in producing a haphazard pattern.

The felt F after passing the surfacing device is further dewatered by drainage, by suction device **21**, and by the pressing rolls. The wet felt is discharged at from 50% to 65% of water content and is passed to the drying ovens. Then surface has been generally levelled down and presents indistinct high and low spots. In the oven described the platens **34** serve to reduce the high spots to the same level and give them different densities. They thus present different surface qualities and appearance. They may be darker in varying shades than the low spots, and may even present a scorched appearance. All these variations add to the attractiveness of the board for decorative purposes.

The kind of surface may be changed by different settings of the device described, and by a different arrangement of teeth. The carrier of the teeth (the rotor **63**) may be modified to a different type of cyclically movable member, or even be made larger in circumference, to give a greater time period for movement of a tooth in the felt. The vertical setting may be changed, which also varies the time of action of a tooth in the felt. Various other modifications and changes may be made in construction and operation without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A surfacing machine comprising a cyclically movable member having teeth or fingers thereon adapted to act upon a surface interposed in the path of the teeth somewhere in the cycle, and means for moving said member cyclically at a non-constant speed.

2. A surfacing machine comprising a cyclically movable member having teeth or fingers thereon the ends of which are adapted to penetrate a surface of a moving plastic mass interposed in the path of the teeth somewhere in the cycle, means for moving said member cyclically at a non-constant speed with reference to constant speed of said moving mass, and means for moving said member in a different path, the second means being dependent for operation upon the movement in the first cycle, whereby to form hills and valleys in the plastic mass.

3. A surfacing machine comprising a cyclically movable member having teeth or fingers thereon the ends of which are adapted to penetrate a surface of a moving plastic mass interposed in the path of the teeth somewhere in the cycle, a rotary driven element for moving said member cyclically, and a drive for said element arranged to rotate the element at a non-constant speed with reference to a constant speed for the motion of the plastic mass, whereby to make hills and valleys in the plastic mass.

4. A surfacing machine comprising a cyclically movable member having teeth or fingers thereon adapted to act upon a surface interposed in the path of the teeth somewhere in the cycle, a rotary driven circular element eccentrically mounted for driving said member cyclically, a rotary driving circular element connected to the driven element, said driving element being eccentrically mounted.

5. A surfacing machine comprising a rotary member having teeth or fingers thereon adapted to act upon a surface exposed to the periphery of the toothed member, two noncentric rotary elements, one connected to the axis of the said toothed member, the other having a driven axis, an endless belt-like connection over the peripheries of said elements, and means to maintain said connection taut.

6. A machine for surfacing artificial board in its formation comprising in combination, a Fourdrinier wire on which a thick felt is formed as the stock thereon is dewatered, and a cyclically movable element providing teeth located where the stock is plastic and about to set and in position to cause the ends of the teeth in a cycle of travel to penetrate the stock and displace it without tearing a displaced portion from the body of the felt to effect a marking of the surface of said felt while it is plastic and before it has set, and means to move said element to produce a variable relative motion in the direction of the motion of the felt between the teeth and the felt.

7. A machine for surfacing artificial board in its formation comprising in combination, a Fourdrinier wire on which a thick felt is formed as the stock thereon is dewatered, a cyclically movable element providing irregularly placed irregular teeth located where the stock is plastic and about to set and in position to cause teeth in a cycle of travel to penetrate the stock and displace it without tearing a displaced portion from the body of the felt to effect a marking of the surface of said felt, and means to move said element to produce a variable relative motion in the direction of the moving felt between the teeth and the felt.

8. A machine for surfacing artificial board in its formation comprising in combination, a Fourdrinier wire on which a thick felt is formed as the stock thereon is dewatered, a cyclically movable element providing teeth located where the stock is plastic and about to set and in position to cause teeth in a cycle of travel to effect a marking of the surface of said felt, means to move said element to produce a variable relative motion in the direction of the motion of the felt between the teeth and the felt, and means to move the element back and forth across the felt.

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