April 28, 1970 J. A. BROWN 3,508,301

METHOD AND APPARATUS FOR FORMING FELTS AND MATS

Filed May 15, 1967 3 Sheets-Sheet 1

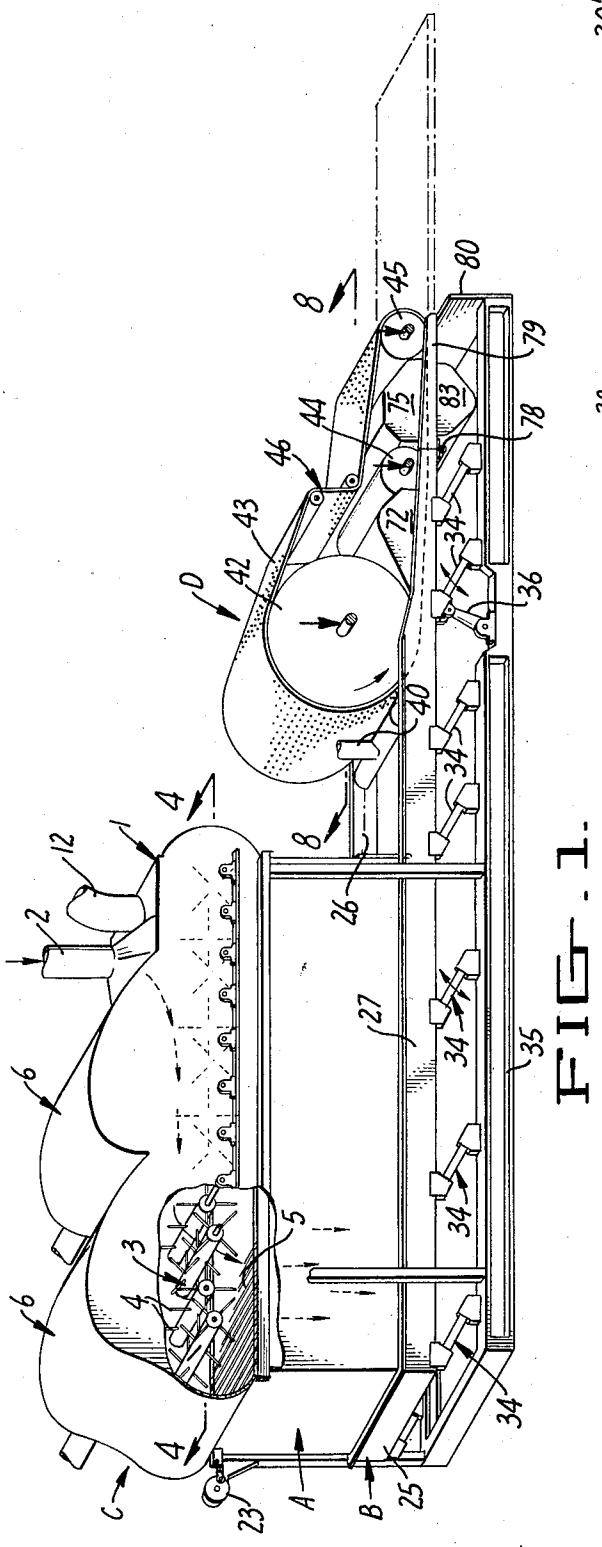
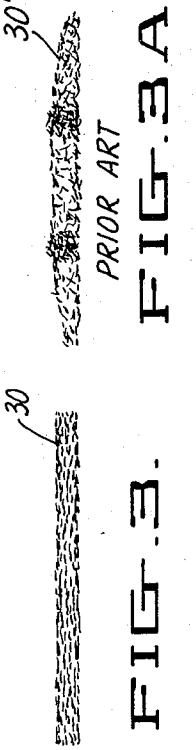


FIG. 1.



PRIOR ART

FIG. 3A.

FIG. 3.

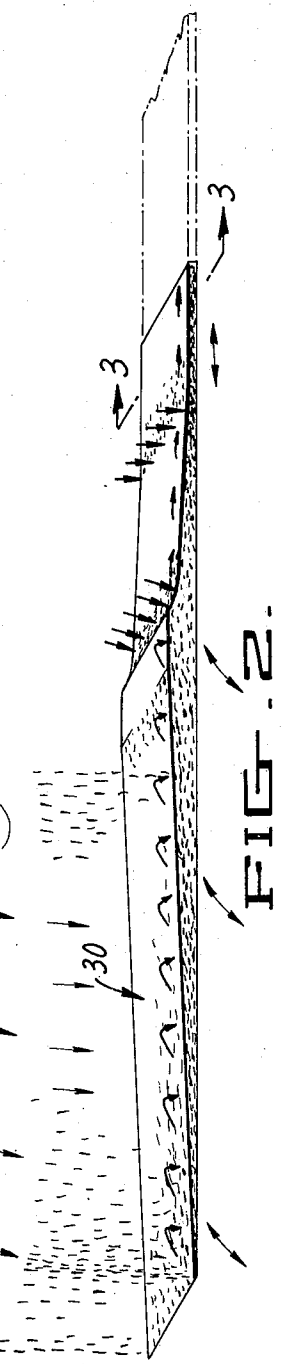


FIG. 2.

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METHOD AND APPARATUS FOR FORMING FELTS AND MATS

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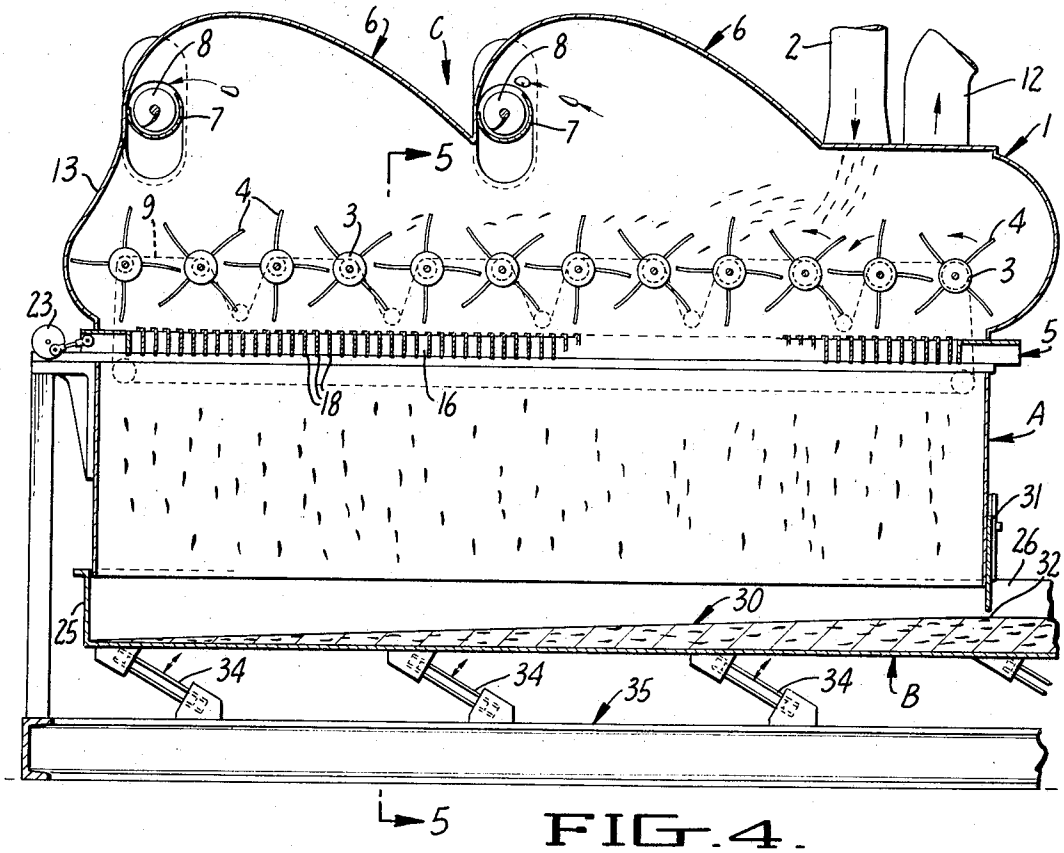

FIG. 4.

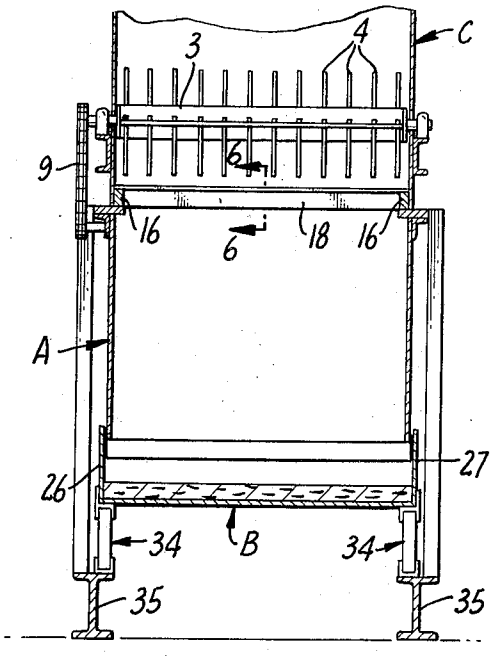

FIG. 5.

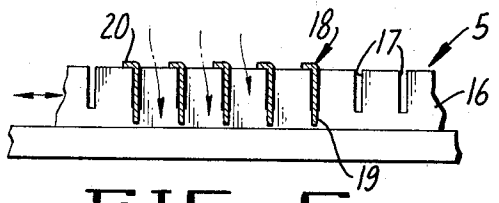

FIG. 6.

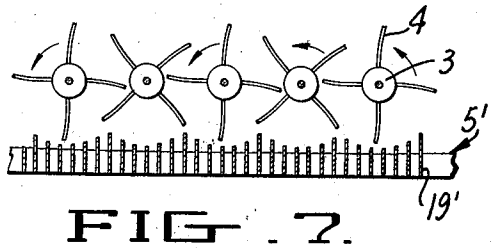

FIG. 7.

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METHOD AND APPARATUS FOR FORMING FELTS AND MATS

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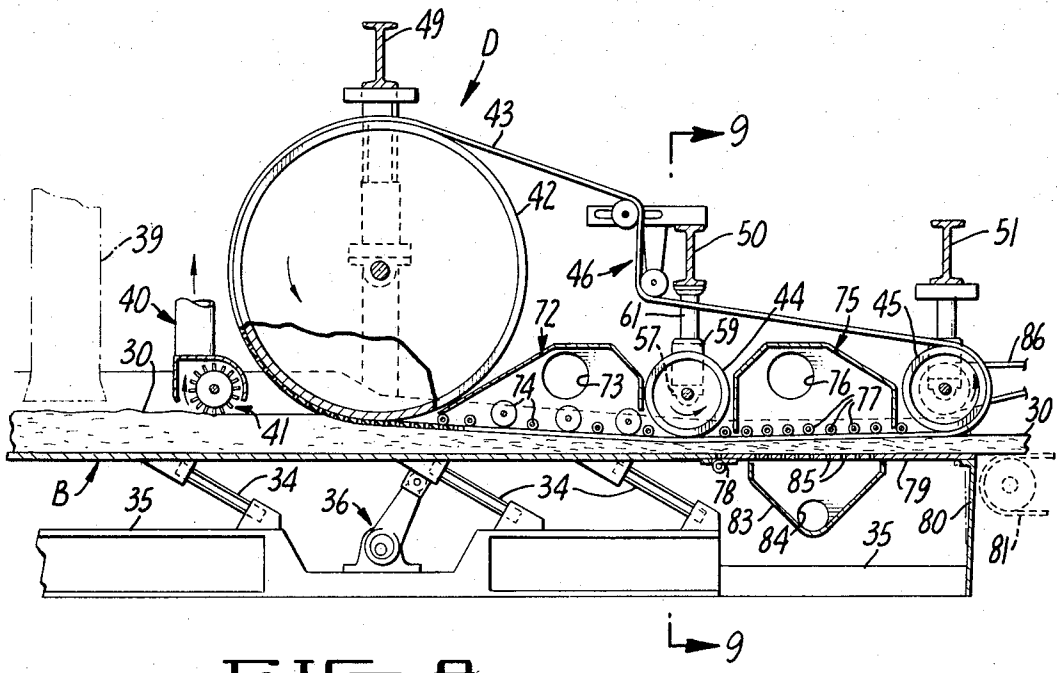

FIG. 8.

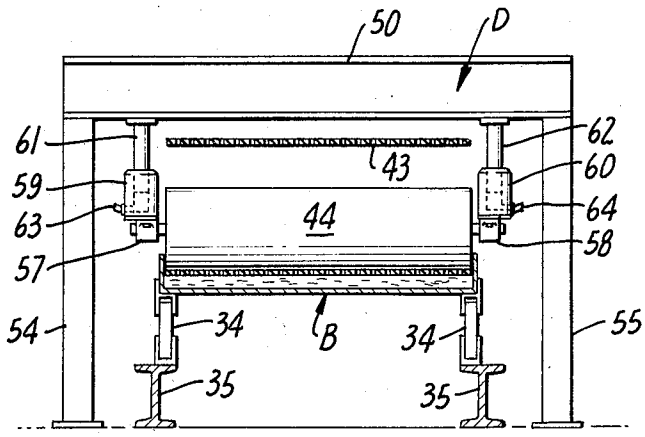

FIG. 9.

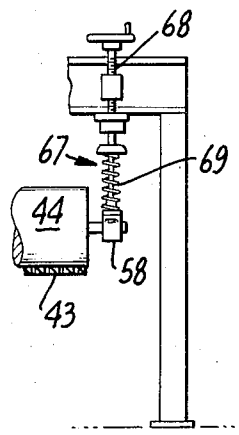

FIG. 10.

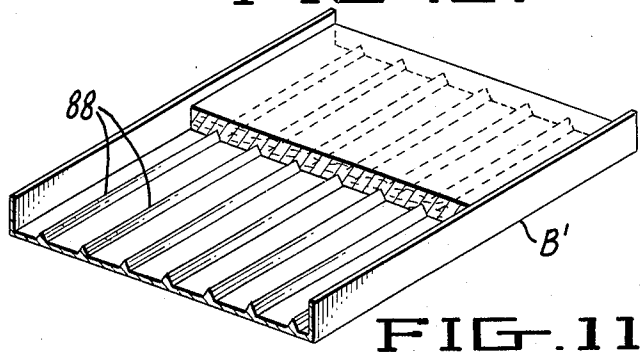

FIG. 11.

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METHOD AND APPARATUS FOR FORMING FELTS AND MATS

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Int. Cl. D04h 1/44
U.S. Cl. 19—155 3 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for forming felts and mats from fibers which are laid down by gravity on a horizontal supporting surface. The supporting surface is vibrated vertically and horizontally to compact the fibers and to advance the layer of fibers in one direction. A holddown member is provided for restricting the amplitude of vibration of the layer of fibers to enhance the compaction of the fibers and to improve the intermeshing of fibers in the horizontal direction.

This invention relates to a method and apparatus for forming felts and mats from fibrous material. The invention is particularly adapted for the production of basic mats preparatory to the manufacture of hardboard and particle board by the dry process. In certain respects the present invention is an improvement over my U.S. Patent No. 2,968,068.

Heretofore the products contemplated by the present invention have been formed by first providing a layer of fibers which have been previously treated with a resin so that in a subsequent pressing and heating step the layer is formed into a relatively thin rigid board of high strength. The dependability of such board for structural and other purposes is directly related to the uniformity of the density of the particles or fibers making up the board. Regardless of the amount of resin employed and regardless of the effectiveness of the curing press optimum reliability cannot be obtained if the fibers are not oriented to provide uniformly dense intermeshing of the same.

In the customary method of manufacture the fibers are permitted to fall downwardly by gravity within a settling chamber and are received in the form of a layer on a supporting surface such as a belt. It will be apparent that if mere gravity and random arrangement of fibers is relied on it is likely that certain portions of the layer will have relatively high densities and other portions relatively low densities thus creating an undependable product if the fibers are not subsequently rearranged to provide uniform intermeshing.

Presently employed methods and apparatus usually rely on a prepress operation to ready the layer for the curing step. Such a prepress operation, usually employing upper and lower rolls, merely squeezes the mat in an attempt to reduce the vertical extent of the same so as to minimize the size of the curing press. Such a squeezing operation in itself does not contribute to the reliability of the final product because it has no effect on the orientation of the fibers.

The main object of the present invention is the provision of a method and apparatus eliminating the disadvantages of prior art methods and apparatus having analogous purposes.

Another object of the invention is the provision of a method and apparatus which insures optimum uniformity in density of the fibers which intermesh to form the mat that is subsequently cured to provide the finished board product.

Another object of the invention is the provision of a

method and apparatus which effectively reduces the thickness of the fibrous mat so that the curing operation may be carried out in a more efficient manner.

Still another object of the invention is the provision of a novel method and apparatus for breaking up the furnish into individual fibers.

Yet another object of the invention is the provision of a mat forming apparatus which may be shorter in length and take less space than prior art devices having a similar purpose.

Other objects and advantages will be apparent from the following specification and from the drawings.

FIG. 1 is a semischematic perspective showing the essential portions of the apparatus of the present invention.

FIG. 2 is a schematic perspective showing the effect on the fibrous mat of the steps involved in the present invention.

FIG. 3 is a cross section of the mat before the same reaches the holddown means.

FIG. 3A is a similar view showing the cross section of the mat which results when typical prior art methods and apparatus are used.

FIG. 4 is a longitudinal cross section of the apparatus at the initial end of the process.

FIG. 5 is a vertical cross section taken in a plane indicated by lines 5—5 of FIG. 4.

FIG. 6 is a typical cross section of the grid as taken in a plane indicated by lines 6—6 of FIG. 5.

FIG. 7 is a longitudinal section showing a modified form of grid.

FIG. 8 is a longitudinal section of the apparatus constituting the holddown means.

FIG. 9 is a transverse section of the apparatus taken in a plane indicated by lines 9—9 of FIG. 8.

FIG. 10 is a fragmentary view similar to FIG. 9 showing the resilient means for applying the holddown mechanism.

FIG. 11 is a fragmentary perspective of the support trough showing a modified form thereof for use in forming a particular product.

The major components of the apparatus of the present invention are best seen in FIG. 1. A settling chamber A of generally rectangular configuration is provided and from which the fibers fall downwardly by gravity onto a support B. The furnish from which the fibers are formed are agitated and beaten in an upper compartment C positioned over the settling chamber A. The layer of fibers that constitutes the mat is vibrated along support B and under a holddown mechanism generally designated D from which the mat is discharged and conveyed away in any suitable manner.

In detail, and first with reference to FIG. 4, the felter portion of the apparatus is provided with a sheet metal hood generally designated 1 and into which the furnish from which the fibers are formed is fed in any convenient manner through a feed conduit 2. Extending across the width of hood 1 and rotatably supported on the opposite sides thereof are a plurality of beater cylinders 3 to which are connected elongated resilient beater fingers 4. The cylinders 3 are provided at one of their corresponding ends with a sprocket wheel which is driven by a chain 9. The beater fingers 4 are staggered along the length of cylinders 3 so that they pass betwen adjacent fingers to provide a combing effect. As the furnish is fed into the hood 1 the beater fingers 4, all rotating in the same direction, advance the furnish toward the left-hand end of hood 1 and at the same time break up the furnish into its fibrous components. Said fibers are thus permitted to fall downwardly by gravity through a grid generally designated 5.

The upper side of hood 1 is formed to provide one or more chambers 6 each provided with a trough 7 for receiving heavier portions of the furnish which have not

been broken into fibers. Such heavier portions of the furnish are conveyed out of the hood **1** by means of a screw conveyor **8** within each trough **7**. This heavier material may be subjected to further treatment and subsequently returned to the hood **1** through feed conduit **2**.

It will be apparent that the above described arrangement of beaters has the effect of advancing the furnish from the feed conduit **2** to the left-hand end or rear end of the apparatus. The furnish may thus be separated to permit the individual fibers to fall through the grid **5** in a fairly uniform manner. By the present invention the sprockets on cylinders **3** are preferably made progressively smaller toward the left-hand end of hood **1** so that the speed of the cylinders increases as the agitating and beating step progresses.

The hood **1** is preferably exhausted by means of a vent **12** and, since the air movement in hood **1** is generally to the left at the upper portion of said hood, such flow is reversed at the left-hand end of the hood by means of a flow reversing end wall **13** which directs the air and entrained fibers and particles to the lower sides of the beaters. The general air movement is to be right just above the grid **5** thus maximizing the agitation of the fibers and encouraging uniform removal of the same from the hood **1** through grid **5**. Depending on the consistency of the furnish the trough **7** with their conveyors **8** may be adjusted vertically to insure that undesirable portions of the furnish are removed from the hood.

Fibers passing through grid **5** enter the settling chamber A in which the air has no substantial movement. The structure of grid **5** shown in FIG. 6 should be such as to obviate clogging of the fibers during passage to the settling chamber. To this end the grid **5** is preferably composed of a pair of side rails in the form of longitudinally extending bars **16** provided with upwardly opening slots **17** into which are received grid elements **18**. Each grid element comprises a vertically extending leg **19** and an upper horizontally bent flange **20**. By this structure it will be seen that the effective area of the apertures of the grid is reduced in the plane of the flanges **20**. This insures that the fibers falling through said apertures encounter a greatly enlarged space between the legs **19** thus avoiding buildup of the fibers and clogging of the grid **5**. To further insure against buildup of the fibers the grid **5** may be slidably supported and subjected to a slow horizontal oscillation by means of a crank mechanism generally designated **23**. By this structure uniform exposure of the top of the grid to the beater fingers **4** is insured.

Such uniformity of exposure of the grid **5** to the beater fingers **4** may also be effected by the modified form of grid structure shown in FIG. 7. In this case the grid **5'** is formed with a plurality of transversely extending flat bar grid elements **19'** which may or may not be provided at their upper ends with flanges but which are graduated in depth so that their upper ends define an arcuate locus corresponding to but slightly spaced downwardly from the outer peripheries of the beater fingers **4**. This structure also insures uniform exposure of the grid to the action of the beater fingers and obviates the crank mechanism.

The grid elements **19** and **19'** may be removably secured in place to permit the openings in the grid to be changed in size depending on the material being run.

The lower side of the settling chamber A is defined by an elongated support trough B which is provided at the rear end of the mechanism with an upwardly extending flange **25** and along its opposite sides by upwardly extending flanges **26, 27** (FIG. 5).

The fibers falling through the settling chamber A are deposited on the support trough B to form the mat indicated at **30** in FIG. 4. It will be noted that the depth of the mat **30** naturally increases toward the discharge end of the settling chamber since the density of fibers in the latter is substantially uniform throughout its length. At the discharge end of the settling chamber A the same is provided with a vertically adjustable closure **31** the lower end of which defines the upper side of the discharge opening **32** through which the mat **30** progresses out of the settling chamber A.

The movement of the mat **30** is effected by means of a conventional vibrator consisting of a plurality of longitudinally spaced spring assemblies **34** slantingly disposed between the base **35** of the apparatus and the support trough B. Such conventional vibrating apparatus includes an eccentric drive **36** which, because the support trough is rigid throughout its entire length, makes connection with said trough at only one point as shown in FIG. 8. This vibrating apparatus is designed and adjusted to provide a generally upwardly directed impact on the mat **30**. However, said impact has a horizontal component to the right in FIGS. 4 and 8 thus advancing the mat a slight amount on each vibration. The result thus obtained is substantially the same as that obtained from the apparatus disclosed in Patent No. 2,968,068.

Forwardly of the discharge opening **32** of the settling chamber A there is preferably provided a secondary feed chute **39** extending transversely across the trough B and adapted to deposit coarse material or flake stock which does not require felting. Alternatively a separate top dressing of other material may be applied to the layer through chute **39**. The mat is then subjected to the action of the conventional scalper generally designated **41** which in combination with an exhaust conduit **40** removes irregularities from the upper side of the mat **30** and dresses the latter to an exact predetermined thickness. The mat then proceeds to the holddown mechanism D.

The holddown mechanism D comprises a lead roll **42** around which is reeved an endless belt **43** of wire or fabric. This belt **43** is equal in width to the width of the trough and is passed below a pressure roll **44**, a tail roll **45** and through a tensioning device generally designated **46**. Lead roll **42**, pressure roll **44** and tail roll **45** are supported from above on cross beams **49, 50**, and **51** respectively. As best seen in FIG. 9 cross beam **50** is supported independently of the apparatus on uprights **54, 55**. Cross beams **49, 51** are similarly supported.

Pressure roll **44** is rotatably supported at its opposite ends in bearings **57, 58** which in turn are connected to the lower ends of fluid operated cylinders **59, 60**. These cylinders are provided with pistons **61, 62** secured at their upper ends to the cross beam **50**. By this structure the amount of pressure exerted downwardly by pressure roll **44** may be regulated by introducing a fluid into cylinders **59, 60** through flexible conduits **63, 64**. At this point it should be noted that, unlike prior art apparatus designed to prepress the mat, the pressure of pressure roll **44** exerted through belt **43** on the mat **30** need only be a few pounds and in some cases a few ounces per square inch and the extremely high pressures associated with prior art devices of like nature are not required nor are they desired.

An alternative form of support for the pressure roll **44** is shown in FIG. 10. In this case the bearings **57, 58** may be secured to the lower end of a pressure imposing mechanism generally designated **67** which includes a manually rotatable threaded shaft **68** and a compression spring **69**. Adjustment of the pressure exerted by pressure roll **44** may also be accomplished by other mechanisms as will be obvious to those skilled in the art. The adjustment of lead roll **42** and tail roll **45** may be obtained by mechanisms similar to those described above in connection with pressure roll **44**.

Interposed between lead roll **42** and pressure roll **44** is a plenum chamber generally designated **72** to which is connected an exhaust **73** for reducing the pressure within said plenum chamber and for accommodating the pulsations of air established by the vibratory force of trough B. This alternating pressure and vacuum or suction many times per second is extremely beneficial in reorienting the fibers or particles into closer intermeshing relationship. Rotatably supported between the opposite sidewalls of

plenum chamber 72 are a plurality of relatively small diameter rollers 74 which bear on the belt 43 for urging the latter against the mat 30. By this structure a uniform downwardly directed loading is applied to mat 30 and at the same time means is provided for removing extremely small particles from the mat 30. Interposed between pressure roll 44 and tail roll 45 is a similar plenum chamber 75 and is associated with exhaust conduit 76 and pressure rollers 77.

Forwardly of pressure roll 44 the rigid vibrating trough B terminates and is connected by means of a hinge 78 with a short trough section 79 which is secured at its opposie end to the upper end of a leaf spring structure 80 which in turn is fixed at its lower end to the base 35. By this structure the vibratory effect of the vibrations on trough B originating with the eccentric 36 is dampened so that the forward end of the short trough section 79 undergoes only a slight horizontal deflection. The mat 30 may then be directed onto any suitable discharging means such as take-away belt 81.

The short trough section 79 is preferably provided on its underside with a plenum chamber 83 exhausted by conduit 84. The short trough section 79 is provided with a plurality of apertures 85 so that the extremely small particles in mat 30 and some of the air captured therein is exhausted through exhaust 84.

The manner in which the holddown mechanism D operates on the mat 30 may now be described. As the mat 30 approaches the lead roll 42 it will be apparent that the vibration of the support trough B causes the mat 30 to undergo a series of vibrations during which it bounces with a relatively great amplitude away from the trough B. When the upper side of mat 30 engages the belt 43 at the lead roll 42 the effect is to dampen the vertical vibrations of the mat 30 and to enhance the compaction of the fibers constituting said mat by confining said mat against vibratory forces and in a gradually progressive increase of confinement. By adjusting the pressure roll to a position below the periphery of lead roll 42 it will be apparent that this dampening effect continues and becomes greater as the mat 30 proceeds toward the pressure roll 44. Since the amount of force applied to the mat 30 is relatively light, there is no interference with the constant agitation of fibers causing them to seek a more dense and uniform intermeshing relationship because of the air movements set up by the bellows action of the trough and belt.

Downward pressure on the mat is gradually released between pressure roll 44 and tail roll 45 during which time the exhausting effect of plenum chambers 75, 83 contributes to the removal of the fines in the mat 30.

The most important result of the above described method is that the fibers of mat 30 are arranged in optimum intermeshing relationship to provide maximum density. It will be apparent that the product resulting after the curing step is extremely uniform and has accurately predeterminable characteristics of strength and density. Another advantage accruing from the use of the above described method and apparatus is that the mat 30 having been settled to the greatest extent possible is much closer to the final thickness of the ultimate product than could possibly be achieved with prior art devices which rely on pressure alone. In this connection in prior art prepress operations upon release of the prepress the spring back is of the ratio of 3:1 so that such prepress operation has practically no effect insofar as obtaining the desired objective is concerned.

The eccentric 36 (FIG. 8) is preferably run at a rate of between 600 and 900 strokes per minute which results in the mat being literally suspended above the trough B and undergoing extremely fast fiber reorientation vibrations. In other words, without a top side holddown mechanism, and in the absence of any confining sidewalls it is possible to see daylight between the vibrating trough B and the bottom of the mat. When the holddown mechanism D is employed, however, the mat 30 is more or less forced to remain on the trough B and the result is that only reorientation of the fibers takes place rather than the actual vibration of the mat as a unitary mass.

Between the settling chamber A and the lead roll 42 the vibration of trough B in itself results in a consolidation of the mat so as to reduce the depth approximately one-half. Continued vibration without benefit of the holddown mechanism D would cause no further consolidation of the mass. With the use of the holddown mechanism gradually at first, with increasing pressure to the middle pressure roll, additional orientation of the fibers takes place. The cooperation of the vibrating trough and the opposed belt 43 results in a sort of bellows action in which the fibers are free to readjust and reorient themselves to the end that maximum uniformity of intermeshing of such fibers results. The plenum chambers 72, 75 and 83 are effective in their positions shown in FIG. 8 since the continued agitation of the mat 30 results in the fines being urged outwardly toward the top and bottom sides of the mat so as to localize the fines to the opposite surfaces of the mat.

It will be understood that the vibration of support trough B results in the mat 30 being advanced at a particular rate of speed depending on the speed and amplitude of the eccentric 36. The reorientation of the fibers in the mat 30 is more effectively achieved when the belt 54 is traveling along its lower run in the same direction of movement as the mat but at a slightly slower speed. By thus introducing relative movement between the mat 30 and the lower run of belt 43 the fibers of the mat are subjected to an endwise consolidation in addition to the consolidation caused by the presence of the holddown belt itself traveling at the same speed as the mat, the difference in speeds, causing a horizontal force to be applied to the mat, opposite to the horizontal force component caused by vibration of the conveyor. By the present invention it is therefore preferable to move the belt 43 by driving the tail roll 45 such as indicated at 86 in FIG. 8 so that the forward speed of the lower run of belt 43 is slightly less than the natural speed of advance of mat 30.

Another advantage resulting from the above described method and apparatus is that edge trim operations are substantially reduced. In this connection in prior art methods and apparatus, due to the absence of fiber reorientating steps, the mat 30' as shown in FIG. 3A does not reach a sufficient depth adjacent the side edges to form a uniform product but rather builds up at the center and tends to have a convex upper side. This result is clearly distinguishable from the relatively uniform cross sectional shape which the mat 30 assumes after being processed in accordance with the present invention and as shown in FIG. 3. Thus by the present invention a simple final trimming step is all that is necessary to give the desired product whereas by prior art methods and apparatus frequent and wasteful trimming steps are usually required.

The present invention also has certain advantages in the formation of special products such as the manufacture of drop siding and other types of standard lumber patterns. Patterns such as V rustic, bevel and others as presently made on standard milling machines from lumber and which are applied to buildings one board at a time usually on the horizontal can be produced in continuous mats of four or five foot widths. For example, in FIG. 11 the trugh support B' is provided with a plurality of longitudinally extending ridges 88 which causes the final product to be complementarily formed along its lower side so that by employing a correspondingly shaped mold in the curing operation the final sheet is provided with parallel grooves of the desired type.

A modified structure similar to that shown in FIG. 11 may be employed to provide a product having improved strength in a longitudinal direction. To this end a plurality of closely spaced apart relatively thin vanes may be formed on the upper side of trough B' in the same manner as ridges 88. Such a structure encourages the longi-

tudinal alignment of fibers as distinguished from transverse alignment.

Although a unitary trough B is disclosed above, the present invention contemplates a double deck trough having an upper perforate support with the two decks of the trough defining a chamber therebetween. Such a structure permits undesirable small particles to fall through the upper deck and also permits the introduction of heated air into said chamber for special purposes.

The felting apparatus shown in FIG. 4 may be duplicated to provide two or more in tandem so that each felter may deposit different types of material on the supporting surface to provide a layer composed of laminations of different material. For example, by such a tandem arrangement of felters an inner core of less expensive material may be formed with laminae of better quality and finer material or both sides of said core to provide a finished product having smooth and dense opposite sides.

It will also be understood that flake stock and other material may also be introduced into the felter through feed conduit 2 if this is desirable depending on the product desired.

The above very specific description of the preferred forms of the invention is not to be taken as restrictive as it is apparent that various modifications in design may be resorted to by those skilled in the art without departing from the scope of the following claims:

I claim:

1. The method of making a felt from fibrous material comprising the steps of:

suspending fibers of such material in air and permitting them to fall downwardly by gravity,

supporting a layer of the fallen fibers on a horizontally extending surface and simultaneously subjecting said surface to vibrations having an upward vertical component and a horizontal component,

said horizontal component being operative to advance said layer in one direction relative to said surface while said vertical component is settling said fibers in relatively closely intermeshing relationship,

and simultaneously applying a downwardly directed substantially uniform pressure to the upper side of said layer throughout its width and throughout a substantial portion of its length while said surface is vibrating.

2. The method of claim 1 wherein said force is in the order of a few pounds or less per square inch of said layer.

3. The method of claim 1 wherein said downwardly directed force has a horizontal component opposite to the direction of said first mentioned horizontal component.

References Cited

UNITED STATES PATENTS

2,698,271	12/1954	Clark	264—113
2,708,303	5/1955	Walton et al.	28—5
2,968,068	1/1961	Brown	264—72
2,974,394	3/1961	Walton	28—14
3,044,111	7/1962	Caughey	264—120
2,517,903	8/1950	Luhrmann	198—220
2,700,177	1/1955	Mottet	156—372
3,012,290	12/1961	Harmon et al.	19—161
3,286,007	11/1966	Wilkie et al.	264—109

FOREIGN PATENTS

234,708	7/1959	Australia.

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U.S. Cl. X.R.

156—372; 264—109