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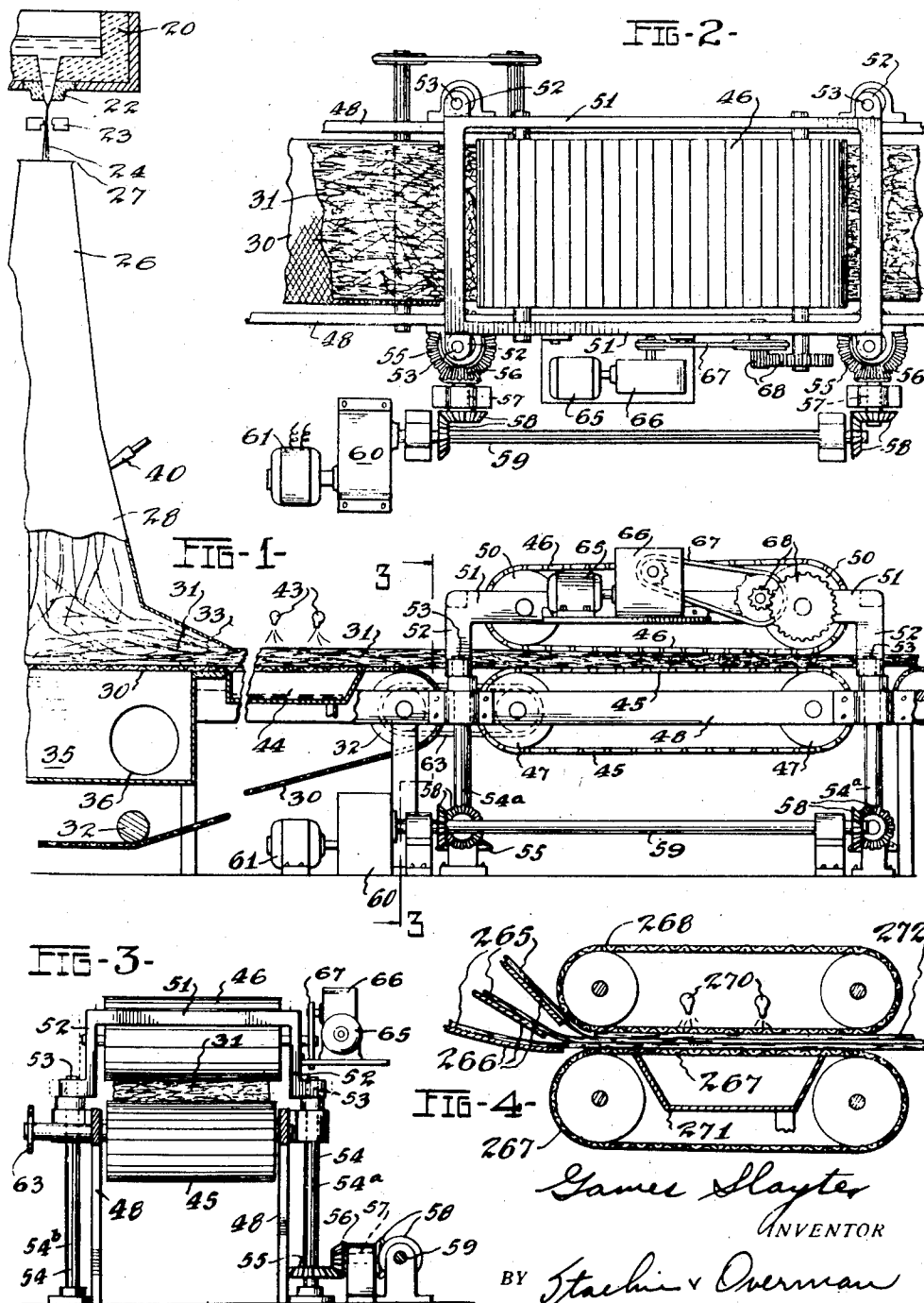
G. SLAYTER

2,457,784

APPARATUS FOR FELTING FIBROUS GLASS

Original Filed Jan. 6, 1940

3 Sheets-Sheet 1



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INVENTOR

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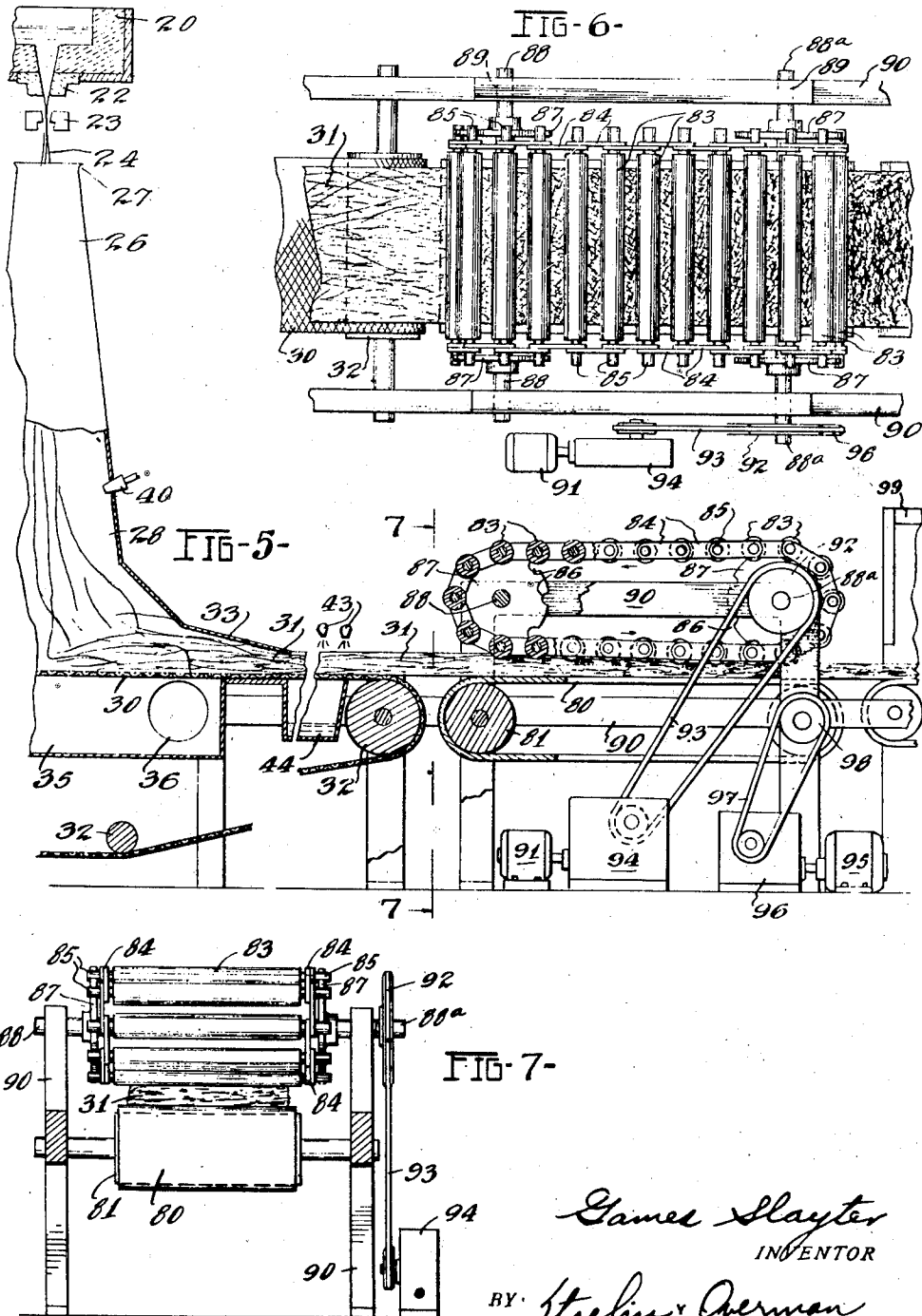
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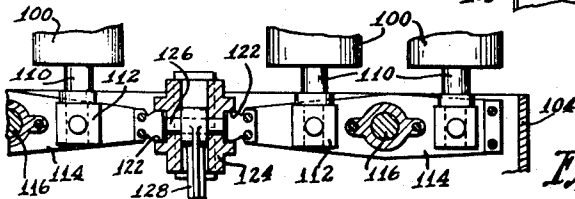
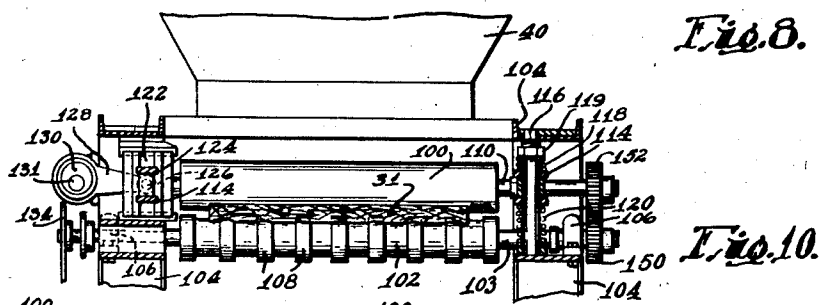
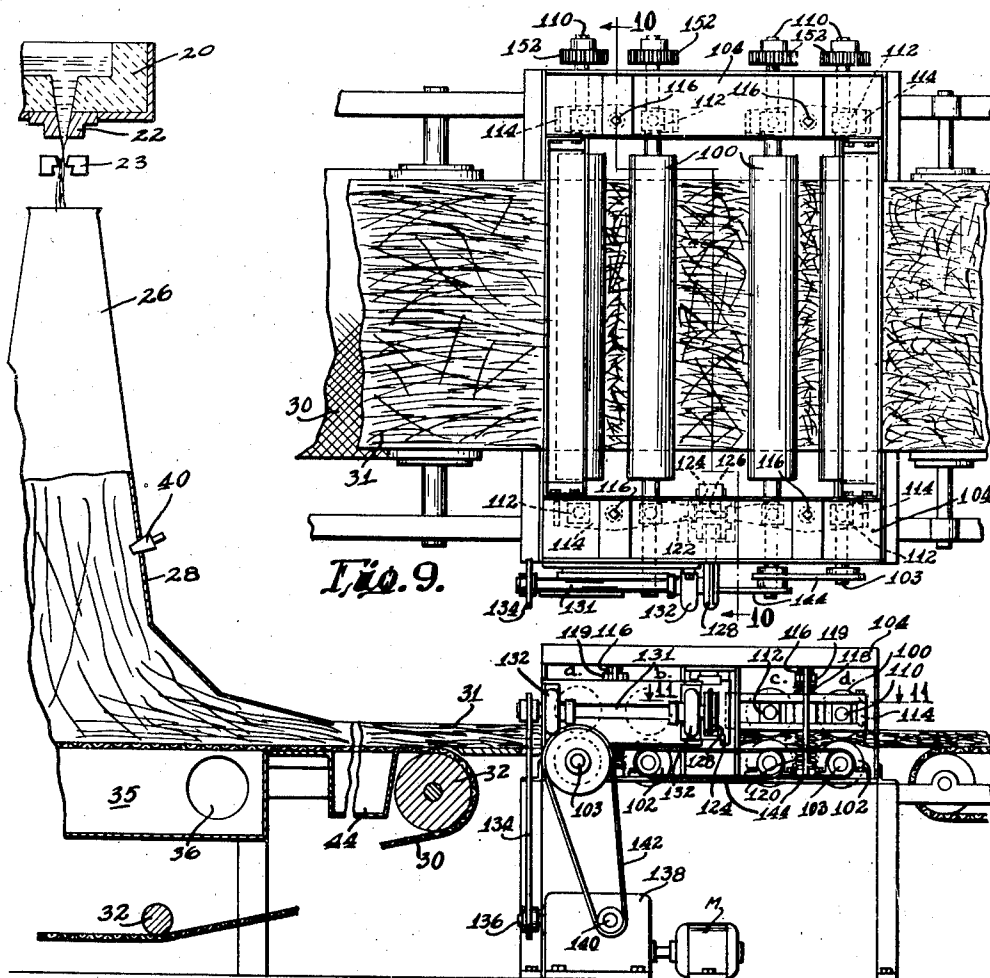
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APPARATUS FOR FELTING FIBROUS GLASS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,457,784

APPARATUS FOR FELTING FIBROUS GLASS

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Original application January 6, 1940, Serial No. 312,730, now Patent No. 2,331,145, dated October 5, 1943. Divided and this application September 8, 1943, Serial No. 501,733

9 Claims. (Cl. 154—27)

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The present invention relates to a novel apparatus for forming an interfelted mass of glass wool in which the individual fibers, which because of their original long and fine nature inherently tend to lie parallel to a particular plane or surface upon which the fibers are accumulated, are caused, nevertheless, to partially depart from this inherent parallelism and interfelt throughout the mass of glass wool, to the end that the mass may attain mass integrity and tensile strength in all directions including directions transverse to the original plane or surface of inherent parallelism.

This application is a division of my copending application, Serial No. 312,730, filed January 6, 1940, now patent No. 2,331,145, and which was a continuation-in-part of my application Serial No. 117,589, filed December 24, 1936, now patent No. 2,206,059.

An object of the invention is to produce an interfelted product of glass wool having not only mass integrity and tensile strength in all directions but which is high in heat resisting and heat insulating quality. In order to procure a high insulating value from a product having long fibers, it has been found advantageous to lay the fibers predominantly transverse to the direction of heat flow. When the fibers are laid transverse to the direction of heat flow, the heat is prevented from flowing through the mass with the same ease as when the fibers are laid parallel to the direction of heat flow. It is an object, therefore, to provide a product in which the longer fibers predominantly do not lie in the direction of heat flow but have their major components extending in directions transverse to the direction of heat flow.

Another object of the invention is to provide a mineral wool mass having the foregoing characteristics which is flexible and resilient, so that when walked on or otherwise compressed or flexed, it will yield but will spring back substantially to its former shape and position when released. The so-called masses of mineral or rock wool heretofore and at present in general use, have serious objections as they lack the desirable features above noted which characterize the present invention. Such masses are generally a molded product and in view of the shortness of the fibers derive substantially all of their strength from the binding material. As a result, these products are solid, rigid and inflexible. When such material is stressed or bent, solid portions of it crack off and break away, and when the material is walked on or compressed, the mass

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merely crumbles and cannot resume its former shape or position. Moreover, in forming pipe covering of this material, the product has to be formed into two separate solid blocks which are generally hinged together along their longitudinal edges. If one of these halves is bent open, the material refuses to flex but merely breaks off in large pieces. An aim of the present invention is to overcome the above noted objections and difficulties and produce a felted mass which may be flexed and bent to a reasonably high degree and which does not crack off into large pieces.

Another object of the present invention is to provide an interfelted bonded mass of glass wool of light density, the density being of the order of magnitude of about 3 to 12, and preferably about 5 to 7 pounds per cubic foot, and having great strength although replete throughout with a multiplicity of dead air spaces.

Another object of the invention is to provide a felted mass with the foregoing characteristics, having a predetermined thickness and density, depending on the particular use to which it is to be put, as, for example, stove or refrigerator insulation, wall boards or the like.

Another object of the invention is to provide a felted mass of the foregoing characteristics in which a large portion of the glass fibers may remain long and reticulated and mutually interlaced and extending in all directions.

A further object of the invention is to provide apparatuses for interfelting a conventional glass wool mat having long fibers in substantial parallelism, the said apparatuses producing an interfelting without causing the mat to tear apart or become weak or infirm, and without causing the individual fibers to break up into a mass of short fibers such as conventional rock wool or the like.

In the accompanying three sheets of drawings, three modifications of an apparatus for forming a conventional glass wool mat and thereafter causing it to be interfelted are disclosed. In these drawings:

Fig. 1 is a fragmentary elevational and diagrammatic view shown partly in section of an apparatus for forming a conventional glass wool mat and thereafter causing it to be interfelted and bonded;

Fig. 2 is a plan view of the interfelting apparatus shown in Fig. 1;

Fig. 3 is an end view shown partly in section of the same apparatus, the section being taken at the line 3—3 of Fig. 1;

Fig. 4 is a diagrammatic side elevational view

partly in section of a modified embodiment of a portion of the apparatus adapted to juxtapose a plurality of layers of glass wool mats or webs and cause interfelting of the fibers thereof;

Fig. 5 is a diagrammatic elevational view shown partly in section of an apparatus for forming a glass wool felt and a modification of the interfelting means;

Fig. 6 is a plan view of the modified embodiment of the felting apparatus shown in Fig. 5;

Fig. 7 is an end view of the same modification illustrated in Figs. 5 and 6, the section being taken on the line 7—7 of Fig. 5;

Fig. 8 is a fragmentary diagrammatic side elevational view partly in section and similar to Fig. 5, showing an apparatus for forming glass wool and a further modification of the interfelting means;

Fig. 9 is a plan view of the modified embodiment of felting apparatus shown in Fig. 8;

Fig. 10 is a sectional view taken substantially along the line 10—10 of Fig. 9; and

Fig. 11 is an enlarged sectional view taken substantially along the line 11—11 of Fig. 8.

With reference to conventional methods of making insulating material of the general type hereinbefore mentioned, when short hairy fibers are used such as those produced in the common rock wool or mineral wool operations, the fibers are commonly so short that it is impossible for them to interlace and mesh with one another to produce substantial mass integrity and inherent strength. For this reason various bonding agents are commonly intermixed with such materials, these bonding agents being products such as asphalt or the like, which more or less completely fill the interstices between the fibers and in any event cause a rigid high density product to be produced such as a cement product or board.

On the other hand, when mats comprising long fibers are produced, such as those mats formed by the deposition of long, fine, glass fibers, the inherent arrangement of these fibers is more or less completely parallel to the surface upon which the fibers are accumulated or disposed. There is little, if any, departure from the original parallelism. The fabric can readily be cleft or separated along surfaces parallel to the fibers without material resistance from the mat itself. In other words, the mat inherently lacks mass integrity and tensile strength in directions transverse to the mat. I have found, however, that by means of the present method as described more fully hereinafter, it is possible to produce a mat which utilizes the inherent orientation of the fibers and yet which possesses mass integrity and strength in all directions throughout the mass.

One of the features of the present invention is the production of insulating material comprising a mass of long mineral wool or glass fibers which lie predominantly in a plane or surface transverse to the direction of heat flow through the material but in which a large portion of the fibers have departed from parallelism with said plane and have been caused to interweave and interlace with the fibers which remain parallel with said plane. There is thus produced a felted mass having strength and mass integrity in all directions including the said transverse direction. Another feature of the present invention is the production of a heat insulating material which, while being interfelted, is, nevertheless, laminated to such a degree that it possesses a high degree of flexibility, yieldability and strength in all directions

and also possesses a high degree of insulating value.

Another feature of the present invention relates to an apparatus for felting a mat in which there is produced a series of successive short relative movements between the upper and lower surface portions of the mat, the movements being more or less in the direction of the surface of inherent parallelism. When layers of fibers parallel to a particular plane are juxtaposed and then caused to slide upon one another in a particular direction for a short distance, the fibers of each of these layers tend to interfelt and depart to a certain extent from the initial parallelism. If these layers are again given another short relative movement, they are permitted to further interfelt and further depart from their initial parallelism to the surface. If the individual movements, however, are excessive, the mat is merely torn apart without accomplishing the desired purpose. Mere agitation without intelligent guidance, therefore, is not sufficient. As these movements or impulses are repeated for a sufficient number of times, it is possible to cause a thorough interfelting, which I have so termed, having in mind a mass of fibers interlaced and extending in all directions including directions transverse to the original inherent parallel surface, although having components of direction predominantly parallel to the original parallel surface.

I have found that while repeated movements or impulses cause an interfelting action, it is generally preferable to produce these movements or impulses in the same direction or in more or less the same effective direction as brought out more fully hereinafter. When laminations or layers of fibers arranged in parallel planes are juxtaposed to one another and caused to slide upon one another in a particular direction for a short distance, the fibers of each of these laminations tend to interweave, interfelt and depart from the initial parallelism. If these laminations are then moved back again to their original positions, the individual fibers tend in part to resume their initial positions and regain substantial parallelism to the principal surface.

However, if successive impulses are given to the juxtaposed laminations in the same direction or at least in the same effective direction, as brought out more fully hereinafter, the fibers do not resume their original positions but continue to interfelt and intertwine and depart to a predetermined degree from the original parallelism. The result is that the original laminations are caused to be interfelted and a certain portion of the juxtaposed fibers are caused to intertwine and increase the mass integrity of the mat in the direction transverse to the original surface of parallelism. However, the fibers, and particularly the longer fibers, remain predominantly in directions approaching more or less closely, their original parallelism so that the original laminations are not necessarily entirely removed and the benefits derived from arranging the major portion of the fibers and particularly the longer ones transverse to the heat flow, are retained. Many of the shorter fibers thus extend in directions transverse to the major faces of the mat and thus serve to add strength in these directions leaving longer fibers principally lying in planes parallel to the major faces and serving to retain the strength of the mat in these directions.

The successive impulses or short relative movements in the same direction between two adjacent

laminations may be produced by several methods, as brought out more fully hereinafter.

Another important feature of the present invention is the discovery that the use of a large amount of water or other suitable liquid throughout the mass of fibers materially assists in the interfelting action. For this purpose I preferably drench the fibers with a large amount of binder solution prior to the interfelting action. The liquid performs two principal functions, (1) it lubricates the fibers and permits them to slide past one another during the interfelting action, and (2) the forcible removal of the liquid from the fibrous mass, as, for example, by centrifugal force, causes displacement of the fibers from their original orientation. Thus, the mere fact that the fibrous mass has been drenched with a suitable liquid facilitates the interfelting and consequently increases coherence of the mass as a whole.

The liquid, which may be caused to fill the interstices between the fibers originally, may weigh as high as ten or more times as much as the fibers, owing to its heavy concentration throughout the mass. As the liquid is removed from the mass of fibers either by centrifuging, suction, or other suitable means, it causes the fibers and particularly the shorter fibers, to be displaced from their original position and approach an alignment in the direction of removal of the water. When the liquid is removed in the direction transverse to the original inherent parallelism, the fibers tend to align themselves in the transverse direction and thus facilitate an interfelting of the mass.

In carrying out my invention, it is possible to produce articles of planular form for various uses as, for example, stove insulation, refrigerator insulation, wall board and the like, or any other desired insulating material.

Referring now to the drawings, Fig. 1 shows an apparatus for producing glass wool bats and forming them into an interfelted mass. A glass melting and refining tank or forehearth 20 is shown in which a head of glass is maintained. The molten glass flows continuously through feeders 22 in the floor of the furnace in a multiplicity of small streams which are acted upon by blowers 23. The issuing streams of glass are enveloped by the downward blast of steam or other gas supplied by the blowers and are thereby continuously drawn out to fine fibers or filaments 24.

Spaced below the feeder 22 of which there may be a plurality, are vertically disposed spouts 26. The steam blasts from each blower are thus directed downwardly through the spouts 26, carrying with them the attenuated fibers 24. The spouts 26 are preferably of streamline formation, the walls of each spout being downwardly divergent and having their upper marginal portions 27 curved to provide a flared mouth. The spouts 26 are preferably of the venturi type, the shape and arrangement being such that a draft of air is induced from the drawing force of the steam blast and a considerable volume of air is drawn into and intermixed with the steam.

The lower ends of the spouts 26 open into an expansion hood or chamber 28 which is also preferably of streamline construction and forms an accumulating chamber within which the fibers from the spouts 26 are laid upon and intermatted on the reticulated conveyor belt 30 to form a mat 31. The conveyor belt is supported on rollers 32 and continually advances, carrying the mat 31 forward as it is formed. At the front end of the hood or chamber 28 is a skirt 33 which

overlies the mat and tends to compact it to a predetermined depth as the mat emerges from the hood 28.

Arranged below the belt 30 and in register with the hood or chamber 28 is an exhaust chamber 35 having an exhaust outlet 36. If it is desired, suction may be applied to the outlet 36. Mounted preferably in the hood are one or more adjustable spray gun nozzles 40 which are aimed upon the mat as it is being formed and serve to apply a suitable coating material to the mat. Various coating materials have been found advantageous for glass wool, such coating materials being oils, soaps, gelatins and other suitable plastics or oleaginous substances, and it has also been found advantageous to incorporate a suitable free acid radical to counteract the presence of alkali in the glass which may leach to the surface.

During the formation of the mat upon the belt 30, the fibers descend upon the mat in such a manner that they inherently all lie parallel or substantially parallel to the belt itself. That is to say, as the long, fine, attenuated fibers are arrested upon the mat they weave back and forth over the belt and build up in layers, all of which are parallel to the belt 30. A mat of this characteristic has little tensile strength in a direction transverse to the belt itself for it is generally a simple matter to lift the layers of fibers apart layer by layer.

In carrying out my invention, I have provided various apparatuses for interfelting the glass wool mats to a predetermined degree. One of these apparatuses adapted to interfelt the individual layers of glass wool into a planular form, has been illustrated in Figs. 1 to 3.

Referring to Figs. 1 and 3, the mat 31 as it is formed, is advanced continuously by the belt 30 and passes under spray nozzles 43 adapted to apply a large amount of dilute binder solution throughout the mat. The excess solution flows down through the mat and into a trough 44 underlying the belt 30.

After the material is soaked with the binder solution, the advancing mat 31 passes between two coating caterpillar belts 45 and 46, the inner surfaces of the belts 45 and 46 being juxtaposed upon the mat 31 and moving concurrently with and at substantially the same speed as the mat.

The belt 45 runs over drums 47 which are mounted upon a stationary frame 48 and the belt 46 runs over drums 50 which are mounted on a rectangular frame 51. The frame 51 is provided at its four corners with posts 52 to each of which is imparted a circular motion in a horizontal direction. In order to produce this circular motion the posts 52 are mounted on eccentrics 53 which are fastened to vertical shafts 54a and 54b. Two of these shafts 54a are preferably power driven by means of gears 55 through gears 56, shafts 57, intermeshing conical gears 58, shaft 59, gear box 60 and motor 61. The remaining shafts 54b may be idlers or merely form bearing supports for the superposed posts 52.

The belt 45 may be driven by any suitable means as, for example, by being interconnected to the belt 30 by means of a chain 63 or other suitable means. The belt 46 is provided with a driving means comprising a motor 65, gear box 66, drive belt 67 and gear train 68, all of which are preferably mounted upon the frame 51.

The operation of this device is such that the mat, in passing between the juxtaposed belts 45 and 46, is interfelted and partially compressed. As the mat 31 passes between the belts 45 and 46,

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the upper belt 46 is given a horizontal circular movement preferably of about $\frac{1}{2}$ inch diameter or so, in a plane parallel to the surface of the mat. The space between the belts is gradually tapered from the charging end to the discharge end of the line so that, for example, if a 4 inch glass wool bat soaked with binder were fed in at one end, it may be felted into a mat of, say, about 1 inch in thickness according, of course, to the degree of interfelting and the density desired.

The relative circular movement between the two belts causes an interfelting between the parallel layers or fibers whereby a certain portion of the fibers lying parallel to the surface of the mat are caused to depart from the original parallelism and are caused to intertwine and interlace with the adjacent layers to produce an interfelted mass.

The circular motion made possible by the mat, it will be noted, causes any two juxtaposed points upon respective layers of fibers to receive impulses or relative movements in only one direction, that is to say, as one point is moved in a circular motion relative to a second juxtaposed point, the second point passes the first point in only one direction. When passing back in the other direction, it will be noted that the second point is at a distance from the first point, this distance being comparable to the diameter of the circular motion. It has been found that mats of glass wool given this type of motion are caused to interfelt and produce a fibrous mass having an interfelted appearance in which the individual fibers in parallel layers are caused to interfelt and intermat to a predetermined degree.

The binder which is added to the mat is preferably a dilute solution, say, 1 to 10% of a suitable binder such as starch, bentonite, casein, dextrin, agar agar, gelatin, rubber, asphalt, etc. The solution of binder performs two principal functions, (1) it serves as a lubricating medium between the fibers during the interfelting action, and (2) after the interfelting action the solution may be dried, leaving the binder coating the fibers and binding adjacent fibers preferably at points of intersection, whereby a flexible porous mass is produced. The binder solution, being dilute, permits the binder to be distributed uniformly throughout the mass and when the solution has been evaporated a relatively small amount of binder remains. I have found that a small amount, such as 1 to 10% binder, and preferably about 2 to 5% binder, is sufficient for most purposes.

Referring more particularly to Figs. 5 to 7, another embodiment of the present invention is disclosed in which a planular interfelted board or cake of glass wool may be produced. In this embodiment the method and apparatus for forming a mat of glass wool may be of any particular type, one of which has been diagrammatically illustrated in Fig. 5 and is similar to that described in Fig. 1. Here, again, it will be noted that the mat 31 is soaked with a suitable binder, the overplus of which drains into the trough 44. From here the mat advances from the conveyor 30 to another conveyor belt 80 which may run over rolls 81. Mounted over the conveyor belt 80 and coating therewith are a series of rollers 83 which are interconnected by chains or interconnecting links 84 in endless formation. Each of the rolls 83 is also provided at its outer extremities beyond the links with outwardly extending lugs 85 which engage with the gear teeth

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86 of sprocket wheels 87. The sprockets 87 are keyed to shafts 88 and 88a which revolve in bearings 89 of the framework 90. The shaft 88a near the discharge end of the device is preferably provided with suitable driving means such as a motor 91. Driving connection between the motor 91 and the shaft 88a may be made through a pulley 92, drive belt 93 and gear box 94, the latter being actuated directly by the motor 91. The pulley 91 is also provided with a driving means such as the motor 95, gearing within the gear box 96, the interconnecting drive belt 97 and the pulley 98. If preferred, both the belt 80 and the rollers 83 may be driven by other suitable means or by the same motor or power unit.

The motor 91 advances the rollers 83 over the mat 31 in the same direction as the mat is moving although at a speed preferably greater than at which the belt 80 is traveling. This causes each roller 83 to impart to the material forming the mat, a progressive wavelike or rolling movement, each wave advancing relative to the mat.

By regulating the speed of the rollers relative to the speed of the mat 31, it is possible to regulate the number of times the mat receives a rolling action. It will be noted that with this arrangement, it is possible to provide a machine which takes up little room and yet applies to the mat any reasonable predetermined number of impulses, wavelike motions or rolling actions, as desired.

The rolling movements upon the mat 31 cause the upper surface of the mat to advance a short distance forward relative to the lower surface of the mat. One factor assisting in the interfelting of the glass fibers is a small node or swelling which forms in front of and precedes the roller 83 in its passage across the mat, this node causing the fibers to be raised a certain extent and permitting adjacent lines of fibers to interlace and interfelt more completely. In this connection it is to be noted that the present apparatus serves to provide successive relative movements in the same direction between adjacent layers of fibers, all of which lie originally substantially parallel to the principal surface of the mat. As these successive movements in the same direction are given to the mat, a large portion of the fibers, starting particularly at the ends thereof or loops therein, are caused to interlace and interfelt and provide a mass integrity and strength to the mat in the direction transverse to the principal surface thereof. After the mat has been interfelted, it is conveyed through a drying oven 99 which serves to remove the water present in the solution and thus permits the binder present in the original solution to solidify and cause the adjacent fibers to be held firmly together.

Referring more particularly to Fig. 4, I have illustrated an apparatus adapted to juxtapose a plurality of mats of glass wool fibers preparatory to forming them into a felted planular mat or board by a process and apparatus such as those illustrated in Figs. 1 to 7. In this apparatus a plurality of mats or webs 265, which have been formed on a suitable forming machine such as illustrated in Figs. 1 or 5, are fed in over supporting means or chutes 266. The supporting members 266 prevent the mats or webs 265 from pulling apart or otherwise disintegrating.

The mats or webs 265 as they advance beyond the supports 266 are brought into juxtaposition with one another between the coating belts 267 and 268 which lie on each side of the juxtaposed mats. Spray guns 270 are mounted over the

juxtaposed mats or webs 265 and cause a large amount of preferably dilute binder solution to drench and thoroughly soak the mass of glass wool fibers. A trough 271 underlies the belt 267 to collect and conserve the excess liquid which may run through the mat. The juxtaposed layers 272, after having been drenched with a suitable liquid, may then be fed into one of the interfelting apparatuses illustrated in Figs. 1 to 7.

When interfelting a plurality of juxtaposed layers, the fibers of the individual layers are caused to interfelt with the fibers of adjacent layers to produce a coherent mass of glass wool fibers, in a similar manner to that illustrated and described hereinabove or as more fully brought out hereinafter in connection with the other embodiments.

After interfelting by any of the mechanisms disclosed herein the product may be dried, baked, or otherwise treated as desired in accordance with the type of binder employed in order to bond adjacent fibers together and form a strong flexible coherent mass.

Referring now to Figs. 8 to 11 inclusive, a still further embodiment of the invention is shown involving a somewhat different method of causing interfelting of the fibers in a mat produced according to the fiber-forming apparatus shown in Figs. 1 or 5. The forming apparatus per se, including the refining tank or forehearth 20, the feeders 22, spouts 26, hood 40 and other associated parts, is substantially the same as the apparatus shown in the preceding figures and identical reference characters have been assigned thereto. The mat 31 is soaked or impregnated with a binder, the surplus of which drains into the trough 44 as previously described. The mat advances from the conveyor 30 and passes successively in between several pairs of interfelting rolls designated successively at *a*, *b*, *c* and *d*, each pair consisting of an upper roller 100 and a lower roller 102, the character and movements of which will be described presently.

Referring now to Fig. 10, it will be seen that each of the lower rollers 102 is disposed on a shaft 103 supported in a framework 104 by means of stationary bearings 106 on opposite sides of the framework. The rollers 102 are formed with a series of relatively wide ribs 108 thereon, by means of which the mat 31 is held against lateral shifting thereon under the impulses applied by the upper rollers 100.

The upper rollers 100 are arranged in pairs, those associated with the rolls *a* and *b* constituting one pair and those associated with the rolls *b* and *d* constituting the other pair.

The upper rollers 100 are each mounted on shafts 110 (see also Fig. 9) which are supported at opposite sides of the framework in pivoted or swinging bearing blocks 112 which are mounted for limited turning movement about a vertical axis in a pair of tiltable cages 114 which are pivoted medially of their ends upon vertical shafts 116 mounted in the framework 104. The cages 114 are suspended or floated between upper and lower springs 118 and 120 respectively, adjusting means 119 in the form of a nut being provided to regulate the normal elevation of the cages 114 and vary the pressure exerted upon the mat 31 by the various pairs of rollers 100, 102.

Each oppositely disposed pair of cages 114 is designed to support therein one of the pairs of adjacent upper rollers and it will be seen that upon turning movement of the cages 114 about the vertical axes of the shafts 116 one upper roller

of each pair, will be moved transversely in one direction, whereas the other roller of the pair will be moved in the opposite direction.

The cages 114 on opposite sides of the framework 104 are normally disposed substantially in alignment with the inner ends thereof opposing each other. These latter inner ends of the cages 114 project into recesses 122 formed in a transversely shiftable block 124. The block 124 is connected as at 126 to the inner end of an eccentric arm 128, the other end of the arm being attached to an eccentric 130 provided on a shaft 131 (see also Fig. 8) journaled in bearings 132 mounted in the framework 104.

Referring now specifically to Fig. 8, the eccentric shaft 131 is driven through a belt connection 134 from a driven shaft 136 of a gear reduction device 138 which is in turn driven by an electric motor M. The gear reduction device 138 is provided with a second driven shaft 140 having a belt connection 142 leading to the shaft 103 upon which the first lower roller in the series is mounted. Motion imparted to this latter lower roller 102 is transmitted to all of the other lower rollers in the series by means of various belt connections designated generally at 144, connecting the shafts 103 in unison.

One end of each of the shafts 103 is formed with a relatively wide spur gear 150 thereon. Similarly, an end of each upper shaft 110 is provided with an equally wide spur gear 152 thereon meshing at all times with the former spur gear 150. The widths of the gears 150 and 152 are such that the two gears will at all times remain in mesh despite the limited shifting movement of the upper shaft 110 relative to the lower shaft 103. Thus it will be seen that rotation of the lower shaft 103 in one direction will cause its corresponding shaft 110 to be rotated in the opposite direction.

From the foregoing description it will be observed that as the eccentric shaft 131 rotates in one direction the block 124 is reciprocated transversely of the apparatus. Such reciprocal movement of the block transmits lateral reciprocation to the various pairs of upper rollers 100, alternate rollers moving in the same direction. The rollers 100 during such shifting movement remain substantially parallel to a fixed axis since they are in effect the opposite sides of a collapsible parallelogram-like structure. Such lateral shifting of the rollers is accompanied by a relatively small longitudinal component of movement inasmuch as the ends of the cages 114 in their respective movements describe relatively small arcs. The magnitude of these arcs however is nevertheless sufficient to cause a significant drawing together and separation of the rollers of each pair each time the block 124 is reciprocated. In this manner interfelting of the fibers in the mat is enhanced.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes therein are contemplated. For example, while I have shown four pairs of rolls, in turn arranged in pairs of two each, additional pairs of rolls may be provided together with means for shifting the upper rollers relative to the lower ones. Only insofar as the invention has particularly been pointed out in the claims is the same to be limited.

I claim:

1. Apparatus for forming a coherent mass of interfelted glass fibers which comprises, a con-

veyor having a mat-supporting surface disposed in a plane, means for continuously moving said conveyor in its plane and thereby continuously advancing a mat supported thereon, liquid applying means in advance of said conveyor for applying a liquid to the mat as it advances to thoroughly impregnate the mat, and means for interfelting the fibers of the liquid-impregnated mat by causing short relative movements between opposite faces of the mat including a member having a mat-contacting surface supported in spaced relation with the said surface of the conveyor and in engagement with the surface of the mat and means for moving the mat-contacting surface of said member relative to the mat-supporting surface of the conveyor in the direction of travel thereof.

2. Apparatus for forming a coherent mass of interfelted glass fibers which comprises, a conveyor having a mat-supporting surface disposed in a plane, means for continuously moving said conveyor in its plane and thereby continuously advancing a mat supported thereon, liquid applying means in advance of said conveyor for applying a liquid to the mat as it advances to thoroughly impregnate the mat, and means for interfelting the fibers of the liquid-impregnated mat by causing short relative movements between opposite faces of the mat including a member having a mat-contacting surface supported in spaced relation with the said surface of the conveyor and in engagement with the surface of the mat and means for moving the mat-contacting surface of said member in a circular direction relative to the mat-supporting surface of the conveyor, and means for moving said mat-contacting surface in the direction of travel of said mat-supporting surface.

3. Apparatus for increasing the mass integrity of a mat of long glass fibers which comprises supporting means for the mat having a face contacting the mat and being movable in a direction to advance the mat in a path parallel with its major surfaces, mat-engaging means cooperating with the mat-contacting surface of said supporting means to grasp the mat between the mat-contacting face and the mat-engaging means and movable in the same direction as said supporting means, and means moving said mat-engaging means relative to said supporting means in directions having at least a component of movement extending in the general direction of the movement of said supporting means.

4. Apparatus for increasing the mass integrity of a mat of long glass fibers which comprises supporting means for the mat having a face contacting the mat and being movable in a direction to advance the mat in a path parallel with its major surfaces, mat-engaging means spaced from the mat-contacting surface of said supporting means a distance less than the normal thickness of the mat and cooperating therewith to grasp the mat between the mat-contacting face and the mat-engaging means and compress the mat, said mat-engaging means being movable in the same direction as said supporting means, and means moving said mat-engaging means relative to said supporting means in directions having at least a component of movement extending in the general direction of the movement of said supporting means.

5. Apparatus for forming a felted coherent mass of glass wool fibers from a mat in which the fibers lie crisscross with one another and predominantly parallel to the major surfaces of

said mat, which comprises a conveying supporting surface for said mat movable in a direction to advance the mat in a path parallel with its major surfaces, a series of parallel spaced-apart rollers rotatably journaled on a supporting member in spaced relation with the said conveying supporting surface, the axis of rotation of said rollers extending in a direction substantially transverse to the movement of the mat, and means for moving the rollers relative to and in the general direction of movement of the conveying supporting surface successively over the surface of the mat to cause an interfelting of the fibers.

6. Apparatus for increasing the mass integrity of a mat of long glass fibers which comprises supporting means for the mat having a face contacting the mat and being movable in a direction to advance the mat in a path parallel with its major surfaces, mat-engaging means in the form of rotatably journaled, substantially parallel related rollers spaced from the mat-contacting surface of said supporting means and translatable in the general direction of the movement of said supporting means, and means moving said rollers toward and from each other and relative to said supporting means to impart short relative movements to opposite faces of the mat.

7. Apparatus for increasing the mass integrity of a mat of long glass fibers which comprises supporting means for the mat movable in a direction to advance the mat in a direction parallel with its major surfaces, mat-engaging means in the form of a pair of rotatably journaled, substantially parallel related rollers spaced from the mat-contacting surface of said supporting means and movable in the same direction as said supporting means, and means moving said rollers toward and from each other and relative to said supporting means to impart short relative movements to opposite faces of the mat, the ends of the rollers at each end of the pair being journaled in bearings mounted for oscillatory movement about an axis interjacent the bearings at each end of said pair of rollers, and means for oscillating said bearings.

8. Apparatus for increasing the mass integrity of a mat of long glass fibers which comprises supporting means for the mat having a face contacting the mat and being movable in a direction to advance the mat in a direction parallel with its major surfaces, mat-engaging means in the form of a rotatably journaled roller spaced from the mat-contacting surface of said supporting means and extending transversely of the direction of advance of the mat, means moving said roller relative to said supporting means to impart short relative movements to opposite faces of the mat including bearings for the ends of said roller mounted for arcuate movement, and means for moving the bearings alternately in reverse directions in an arc.

9. Apparatus for forming a felted coherent mass of glass wool fibers from a mat in which the fibers lie crisscross with one another and predominantly parallel to the major surfaces of said mat, which comprises a supporting surface for said mat movable in a direction to advance the mat in a path parallel with its major surfaces, a series of parallel spaced-apart laterally movable rollers rotatably journaled at opposite ends in bearings connected to endless chains, so that the rollers move laterally when said chains are moved, spaced-apart sprocket wheels supporting said chains in positions with said rollers in spaced

relation to the said supporting surface, and driving means connected with said chains to move them in the general direction of the movement of the supporting surface and relative thereto.

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