Aug. 28, 1951 R. H. BARNARD 2,565,941

METHOD AND APPARATUS FOR PRODUCING LAMINATED MATERIALS

Filed June 17, 1946 3 Sheets-Sheet 1

FIG. 1

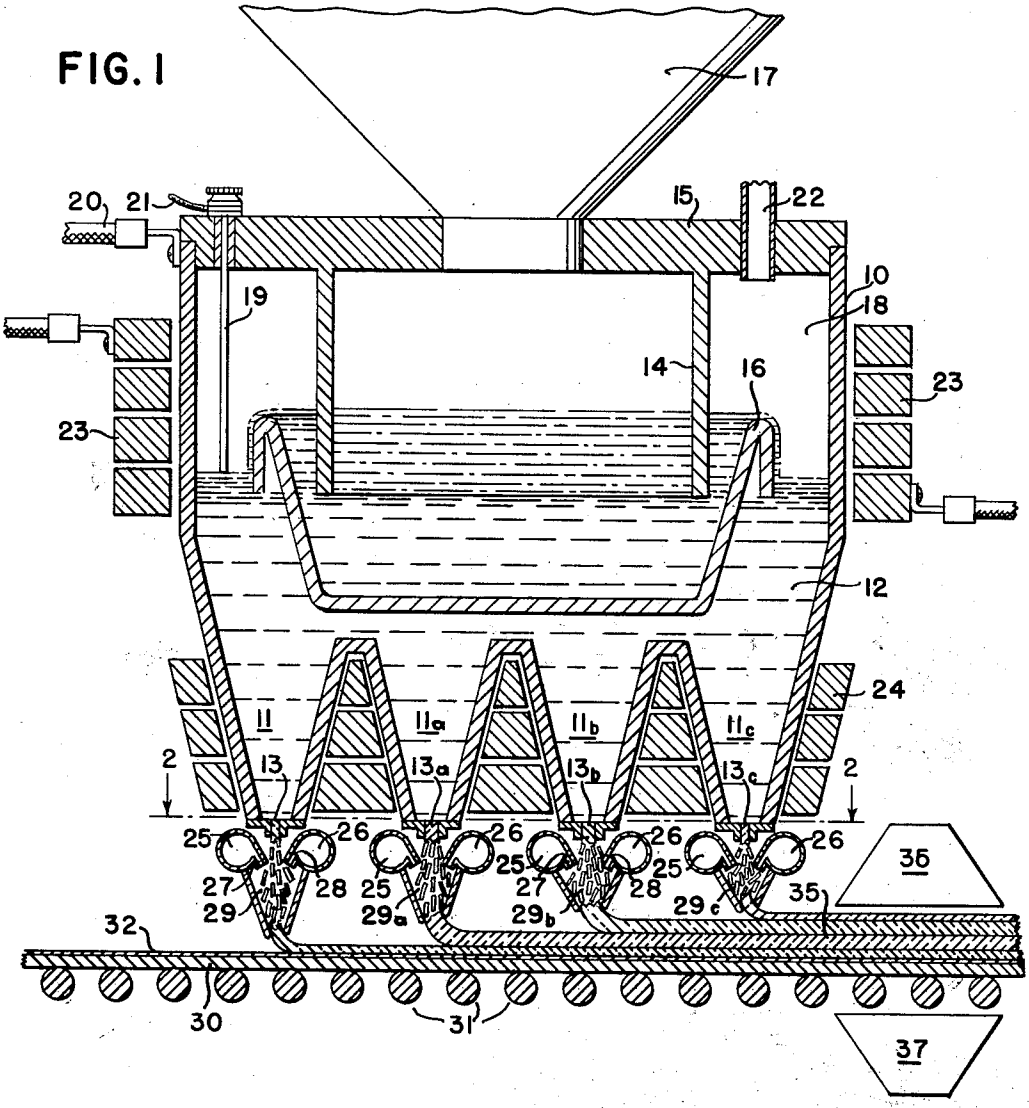
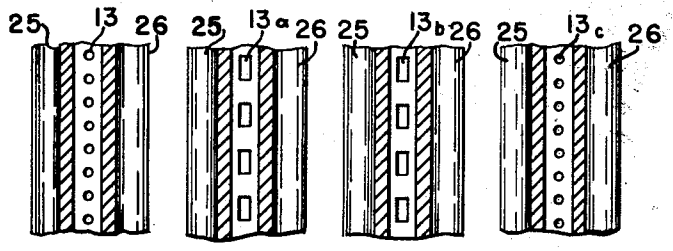


FIG. 2



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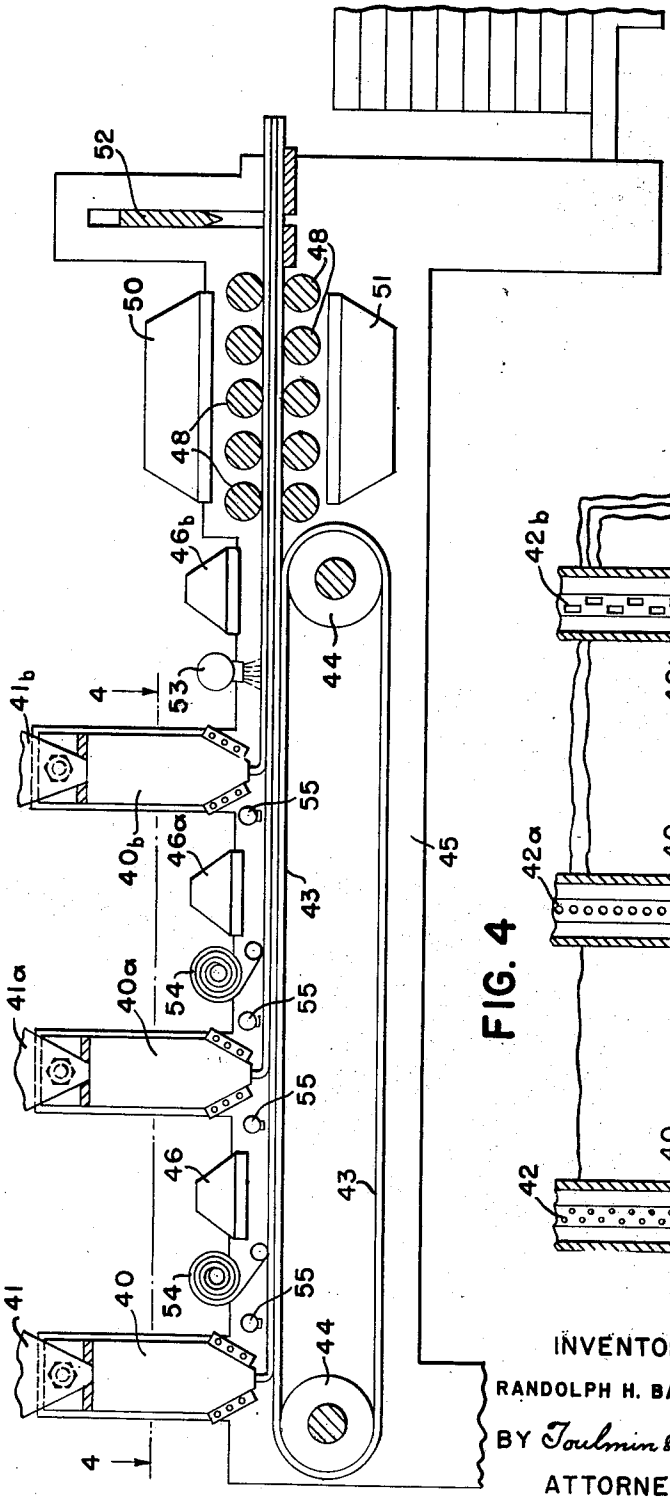


FIG. 3

FIG. 4

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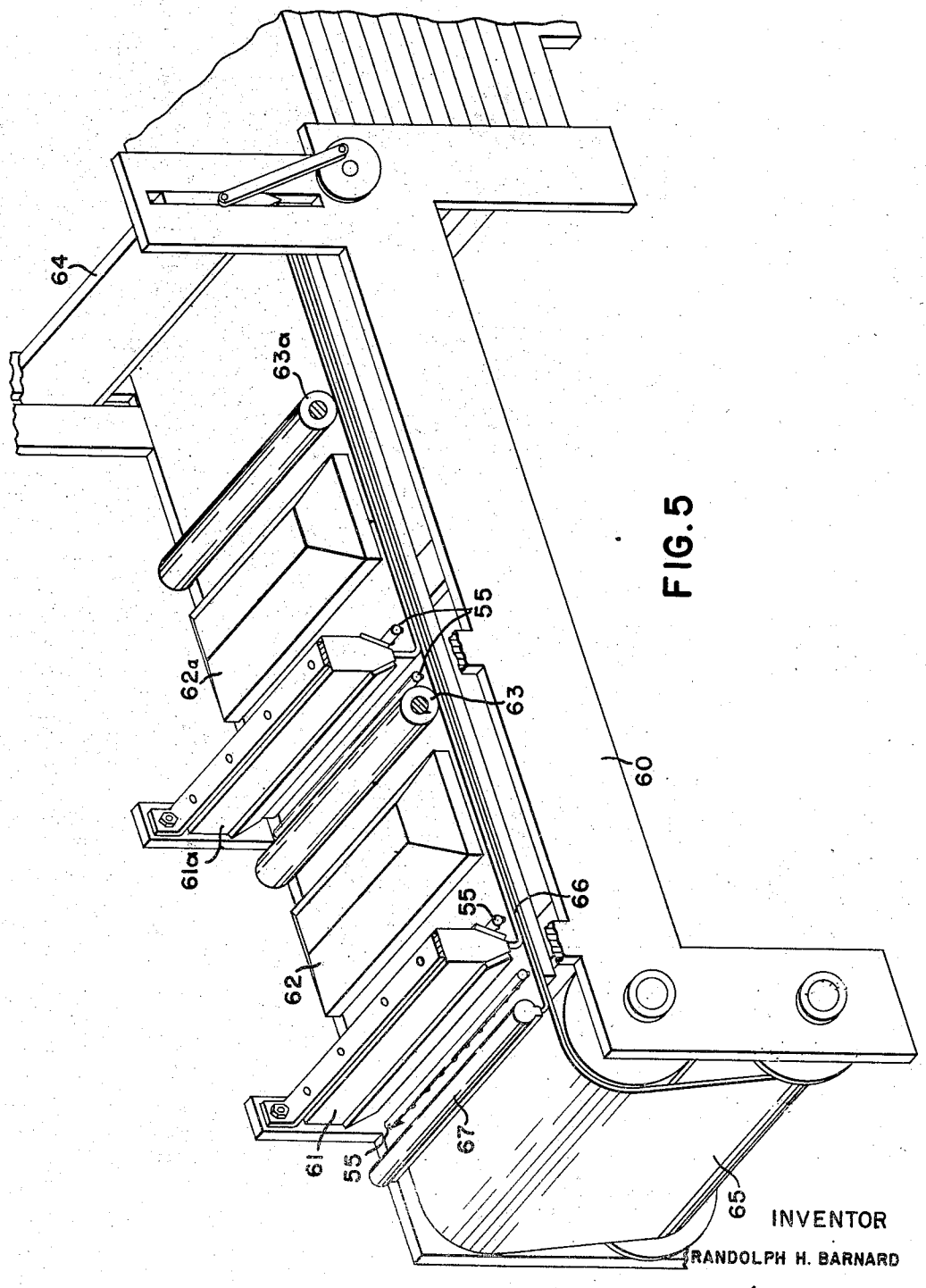


FIG. 5

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Patented Aug. 28, 1951

2,565,941

UNITED STATES PATENT OFFICE

2,565,941

METHOD AND APPARATUS FOR PRODUCING LAMINATED MATERIALS

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Application June 17, 1946, Serial No. 677,383

7 Claims. (Cl. 49—1)

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This invention relates to a method and apparatus for producing flexible, semi-rigid or rigid mats or sheets of fine fibers drawn from molten materials, and is particularly applicable to the production of such mats or sheets from glass fibers.

An object of the invention is to provide a method and apparatus for producing fibrous mats or sheets built up in layers, and in a continuous process.

Another object of the invention is to provide a method and apparatus for producing a semi-rigid or a rigid board composed of a mat of drawn fibers or filaments.

Still another object of the invention is to provide a method and apparatus for producing mats of fine fibers or filaments that are laid down in layers and bonded together to form a mat wherein the fibers throughout are secured to one another.

Still another object of the invention is to provide a method and apparatus for producing mats of fibrous materials in accordance with the foregoing object wherein the layers of the matted fibers are plasticized sufficiently to allow the fibers of each layer, and the fibers in the layers to adhere to one another.

Still another object of the invention is to provide a method and apparatus for producing a mat of fine fibers or filaments wherein the mat is composed of fibers of different diameters, or different materials and wherein the fibers of different diameters or of different materials composing the mat are disposed in layers.

Still another object of the invention is to provide a method and apparatus for producing a mat of fine fibers or filaments wherein the filaments are drawn while the material is in a molten condition and the fibers are laid down in layers upon one another to produce a mat of desired thickness.

Still another object of the invention is to provide a method and apparatus for producing a semi-rigid or a rigid sheet from matted fine fibers or filaments in accordance with the foregoing object wherein the matted fibers are plasticized and compressed to obtain a sheet of desired thickness.

Further objects and advantages will become apparent from the drawings and the following description.

In the drawings:

Figure 1 is a vertical cross-sectional view through an apparatus for producing a product according to the teachings of this invention.

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Figure 2 is a cross-sectional view taken along line 2—2 of Figure 1, illustrating orifices of different size in the melting furnace illustrated in Figure 1.

Figure 3 is a side-elevational view, partially in cross-section, illustrating the method and apparatus for producing mats in layers according to this invention wherein the layers of fibers or filaments are plasticized between each layer to cause adherence of the fibers in the layer and of the layers with one another.

Figure 4 is a transverse cross-sectional view taken along line 4—4 of Figure 3.

Figure 5 is a perspective elevational view of an apparatus for producing semi-rigid or rigid sheets in accordance with the teaching of this invention.

In this invention the apparatus for producing a laminated mat of fibrous materials, such as drawn glass fibers or filaments, consists of a melting chamber of furnace 10 that has the lower portion thereof subdivided into a plurality of drawing chambers 11, 11a, 11b and 11c. The furnace 10, or melting pot, is rectangular in general transverse cross-section, the drawing chambers 11, 11a, 11b and 11c extending transversely across the melting pot and in spaced parallel relationship. The drawing chambers receive molten material from the body 12 of the material maintained in the melting pot 10, the body of material being maintained at a level above the chambers 11, 11a, 11b and 11c to evenly distribute the molten material into the drawing chambers and to insure their constant filling.

The drawing chambers 11, 11a, 11b and 11c are each provided with a plurality of orifices 13, 13a, 13b and 13c respectively, through which the molten material in the melting pot 10 is exuded. The orifices 13, 13a, 13b and 13c may all be of like size, or as illustrated in Figure 2, the orifices may be of different size, such as those in chambers 13a and 13b relative to those in chambers 13 and 13c, so that fibrous material of different size can be drawn from the various chambers to lay down fibrous laminae containing fibers of different size.

With the body of molten material 12 maintained at a level above the drawing chambers 11a, 11b and 11c the greater quantity of molten material removed from chambers 11a and 11b is automatically compensated for by more material flowing to these chambers without requiring complex feeding mechanisms for varying the rate of feed of material to the chambers in proportion to the rate of material removed therefrom. The

apparatus thus automatically compensates itself for any rate of drawing of material from the respective drawing chambers.

The melting pot 10 has a vertically depending baffle wall 14 secured to the top wall 15 of the melting pot. The baffle wall 14 extends downwardly to within a dish-shaped member 16 suitably secured therebeneath. The dish-shaped member 16 has the upper edge thereof disposed above the level of the lower edge of the baffle wall 14.

Batch material is fed into the melting pot or furnace 10 from a hopper 17 under control of any automatic feeding mechanism which regulates the rate of feeding into the melting pot 10. The batch material falls into the chamber formed by the dish-shaped member 16 and the baffle wall 14, and is melted therein. The level of the molten material in the dish-shaped member 16 rises until it overflows the upper edge thereof into the chamber 18 of the melting pot and mixes with the body 12 of molten material therein. Thus, the body of molten material 12 is fed with newly melted batch material to maintain the level thereof relatively constant.

The batch material is fed by the feeding mechanism in response to the level of the body of molten material 12, an electrode 19 extending through the top wall 15 of the furnace 10 for the purpose of being engaged by the surface of the body of molten material 12. The electric lines 20 and 21 connecting with the melting-pot 10 and the electrode 19 respectively, connect with the feeding mechanism, not shown, and cause the same to stop operation when the level of the body of molten material 12 rises to engage the electrode 19, electric current flowing between the electrode 19 and the melting-pot 10 at this time to complete electric circuit to the controls of the feeding mechanism for this purpose. Whenever the level of molten material falls sufficiently to disengage the lower end of the electrode 19, electric current will stop flowing through the lines 20 and 21 and thereby actuate the raw batch feeding mechanism to start the same in operation to replenish the supply of material into the melting-pot 10.

The chamber 18 in the melting-pot 10 may be maintained under pressure greater than atmosphere to cause the molten material to exude through the orifices 13, 13a, 13b and 13c by supplying gaseous pressure into the chamber 18 through the conduit connection 22.

An electric heating coil 23 is placed around the main body of the melting chamber 10 to melt the material within the member 16 and to retain the upper edge of the member 16 sufficiently hot to cause a fining of the glass when flowing over the upper edge of the member 16.

Electric heating coils 24 are also provided around each of the drawing chambers 11, 11a, 11b and 11c which may all be maintained at the same temperature, or be individually controlled to establish different conditions of fluidity of the molten material in the respective drawing chambers heated thereby according to the amount of material required to be exuded from the respective drawing chambers.

The heating coils 23 and 24 may either be electric resistance heating coils or the coils may be connected to a source of high frequency energy for heating the melting-pot 10 by high frequency induction current.

Beneath each row of orifices 13, 13a, 13b and 13c in the bottom walls of the drawing chambers 11, 11a, 11b and 11c respectively, there is provided high pressure air conduits 25 and 26 on opposite sides of each row of the orifices and extending longitudinally along the same. The air conduits 25 and 26 are provided with discharge outlets 27 and 28 respectively, which are directed toward one another to produce converging air streams which converge substantially vertically in alignment with the orifices 13, 13a, 13b and 13c respectively. The converging air streams pick up the molten material that is exuded through the respective orifices and draw the molten material into fine fibers which are collected in the collecting chambers or hoppers 29, 29a, 29b and 29c disposed beneath the rows of orifices 13, 13a, 13b and 13c respectively.

The fibers that are collected in the chambers or hoppers 29, 29a, 29b and 29c discharge through the open bottom ends of the respective chambers onto a conveyor belt 30 that is carried by a plurality of rods or rollers 31.

As illustrated in Figure 1, a collecting sheet 32 may be placed upon the conveyor 30 to receive the first laminae layer of fibrous materials from the drawing chamber 11. However, this sheet 32 may be dispensed with, and the laminae layer delivered directly onto the conveyor belt 30.

The conveyor belt 30 moves generally in a rightward direction carrying the fibrous material therewith as discharged from the collecting chamber 29. As the conveyor belt 30 moves forward in its movement, the fibrous material from the collecting chambers 29, 29a, 29b and 29c is added to the fibrous material discharged thereonto by the prior collecting chamber so that a mat of fibrous material is built up in a plurality of individual layers. The laminated mat 35 may then pass between hoods 36 and 37 containing heating means either of which or both can be used for slightly plasticizing, or softening the laminated mat to cause the laminae to adhere together.

In Figure 3 there is illustrated an arrangement of apparatus for producing a laminated mat of fibrous material wherein the layers of drawn fiber may be processed before another layer of fiber is placed thereon.

In the apparatus of Figure 3 there is provided a plurality of individual melting-pots or furnaces 40, 40a and 40b in which batch material is fed for melting in the same manner as heretofore disclosed and described, the batch material being fed from the hoppers 41, 41a and 41b, respectively. In this instance, the melting-pots or furnaces 40, 40a and 40b are indicated as having a single outlet for fibrous materials wherein all of the orifices in the outlet for any one furnace are all of the same size. As illustrated, the orifices 42 for the furnace or melting-pot 40 extend across the furnace in the same manner as heretofore disclosed and described with regard to Figure 1, and all of the orifices are of the same size. The orifices 42a for the furnace 40a may be of a larger size, as illustrated, and the orifices 42b for the furnace 40b may be of a still larger size. The arrangement is such that each of the furnaces 40, 40a and 40b may be independently controlled and may, if desired, lay down layers of fibrous material of different type, as well as fibrous material having fibers of different size. Also, all of the furnaces could lay down fibrous material having fibers of the same size but of different type, various materials giving various physical characteristics to the laminated mat.

While the furnaces or melting-pots **40**, **40***a* and **40***b* are illustrated as each laying down a mat of fibers all of the same size, yet each of the furnaces could be replaced with the type illustrated in Figure 1 so that a plurality of layers of fiber could be laid down at each of the furnace stations indicated by the furnaces or melting-pots **40**, **40***a* and **40***b*.

The melting-pots **40**, **40***a* and **40***b* are positioned above a conveyor belt **43** carried between a pair of guide-rolls **44** supported by the machine frame **45**. Heads **46**, **46***a* and **46***b* containing a heating unit are positioned adjacent each of the melting-pots **40**, **40***a* and **40***b* respectively in the direction of advance of the conveyor belt **43**. The heat from the heating units in the hoods **46** is adapted to plasticize, or soften, the mat of fibrous material passing therebeneath to cause the fibers of the mat to adhere together and to cause the fibers between the layers to adhere.

The operation of the apparatus is such that the fibers or filaments produced from the furnace **40**, in the same manner as those produced as described with regard to the furnace shown in Figure 1, are laid down as a layer of fiber upon the conveyor belt **43**. The mat of fiber or filaments thus produced passes beneath the heating hood **46** to plasticize or soften the same before the mat passes beneath the second furnace or melting-pot **40***a* which lays down a second layer of fibrous material, the furnace or melting-pot **40***b* then laying down the third layer. After each layer of fiber is laid down, it is plasticized by the heat from the hoods **46**, **46***a* and **46***b*, and may be rolled or compressed to a selected thickness by means of rollers **48** when the laminated mat passes between the hoods **50** and **51** which also contain heating units for heating the laminated mat of fibrous materials.

The laminated mat produced in the manner heretofore described may be cut to predetermined lengths by a reciprocating knife **52**.

If desired, various synthetic resins may be applied to the surface of the laminated mat to impart selected colors thereto or to give the mat added physical strength by the use of the resins. The resins may be sprayed upon the surface of the laminated mat from a spray-head **53** extending transversely across the mat, and may be applied either before or after the last heating step, or may be applied between the layers of the laminae, if desired.

Also, if desired, moisture barriers can be placed between the laminae to prevent passage of moisture from one side to the other of the laminated mat. The material may be supplied in rolls positioned between the melting-pots **40**, **40***a* and the heating hoods **46** and **46***a* heretofore referred to, the vapor barrier being laid upon the laminae of fibrous materials after the fibrous materials are laid down upon the conveyor belt **43**.

It may be that under certain circumstances, the plasticizing of the laminae of fibrous materials will suffice to cause the vapor barrier **54** to adhere to the surface of each layer of laminae. However, if desired, suitable adhesive materials can be sprayed upon the surface of the layers of fiber or on the vapor barrier from spray-heads **55** to cause the laminae of fibrous materials to adhere to the vapor barrier positioned between them.

In Figure 5 there is illustrated a modified arrangement of apparatus wherein the layers of fibrous material are formed into a semi-rigid or a rigid sheet, depending upon the degree of softening of the fibers and the amount of compression applied thereto. In this arrangement, the apparatus is in most respects like that of the apparatus disclosed in Figure 3 wherein the machine frame **60** carries the melting-pots or furnaces **61** and **61***a*. Adjacent each of the melting-pots **60** and **61** there is provided a heating hood **62** and **62***a*. In operation, the laying down of the layers of matted fiber is the same as heretofore disclosed and described. However, to form a semi-rigid or a rigid sheet, compression rollers **63** and **63***a* are adapted to compress the layers of fibers after they have been plasticized or softened under the heating hoods **62** and **62***a* respectively to thereby produce a more rigid and dense structure in the laminated mat, or in this instance, a laminated sheet. The cut-off knife **64** shears the laminated sheet to predetermined lengths.

If desired, the fibrous materials, as disclosed in Figure 5, may be laid down upon a sheet **65** that is surfaced with an adhesive material **66** from the distributing head **67**. The sheet **65** may be one which acts only as a vapor barrier, or the sheet may be in the form of a decorative surface for the rigid sheets so that they will have greater utility as a wall decoration.

It will, of course, be understood that while the apparatus shown herein illustrates various features of this invention wherein a laminated fibrous mat or a laminated fibrous sheet can be obtained, and that the various drawings illustrate these features separate and apart from the features illustrated on other figures of the drawings, that the various features disclosed and described herein can be transferred from one apparatus to the other to incorporate them in any desired arrangement, and that the applicant does not intend to be limited in this invention to the specific arrangements of the features of this invention as disclosed in any one figure of the drawings, but only in the various combinations of these features that fall within the scope of this applicant's invention. While the apparatus disclosed and described herein constitutes preferred illustrations of apparatus incorporating features of this invention, and of methods of obtaining laminated fibrous mats or sheets, either rigid or semi-rigid sheets, yet the apparatus and the methods performed thereby are capable of alteration without departing from the spirit of the invention, and all apparatus or methods performed thereby that fall within the scope of the appended claims are intended to be included herein.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A continuous process for producing a multiple-layer mat of glass fibers that comprises, melting batch material, forming a plurality of individual mat-like films of glass fibers from the melted batch material, separately delivering each of the films concurrently and individually upon a surface moving therebeneath in sequential advancing progression one upon the other to produce a laminated fibrous mat, and applying heat to each of the laminae of the fibrous mat immediately after a lamina is laid down and before another lamina is placed thereupon to plasticize the laid-down lamina whereby to cause adherence between the fibers in the heated lamina and between the laminae.

2. A continuous process for producing a mul-

tiple-layer mat of glass fibers that comprises, melting batch material, forming from the melted batch material a plurality of individual mat-like films of glass fibers at individual spaced aligned forming stations, moving a common supporting member past all of said stations, and laying down each of the separately formed mat-like films individually directly upon said supporting member in sequential advancing progression one upon the other to produce a laminated fibrous mat.

3. A continuous process for producing a multiple-layer mat of glass fibers that comprises, melting batch material, forming from the melted batch material a plurality of individual mat-like films of glass fibers at individual forming stations, individually laying down each of the separately formed mat-like films concurrently and individually upon a surface moving therebeneath in sequential advancing progression one upon the other to produce a laminated fibrous mat, and applying heat to the laid-down film between adjacent stations to plasticize the fibers in the film between the stations to cause adherence between the fibers in the film and provide for adherence to the heated film of a subsequent film laid down from a subsequent station.

4. A continuous process for producing a multiple-layer mat of glass fibers that comprises, melting batch material, forming from the melted batch material a plurality of individual mat-like films of glass fibers at individual forming stations, the glass fibers of at least one of said films having different characteristics than the glass fibers of other of the films, individually laying down each of the separately formed mat-like films concurrently and individually upon a surface moving therebeneath in sequential advancing progression one upon the other to produce a laminated fibrous mat, and applying heat to the laid-down film between adjacent stations to plasticize the fibers in the film between the stations to cause adherence between the fibers in the film and provide for adherence to the heated film of a subsequent film laid down from a subsequent station.

5. A continuous process for producing a multiple-layer mat of glass fibers that comprises, melting batch material, forming from the melted batch material a plurality of individual mat-like films of glass fibers at individual forming stations, individually laying down each of the separately formed mat-like films concurrently and individually upon a surface moving therebeneath in sequential advancing progression one upon the other to produce a laminated fibrous mat, applying heat to the film laid down at each station while moving between stations to plasticize the fibers in the film between the stations, and thereafter applying pressure to the so-heated film and mat to compress the film and obtain rigidity of the laminae upon cooling.

6. An apparatus for producing a multiple-layer mat of glass fibers in a continuous process comprising, means forming a plurality of individual stations at which batch material is heated and held in a molten form, each of said stations including means for producing a mat-like stream of glass fibers from the molten material, a conveying surface beneath said stations, said stations being spaced longitudinally of said conveying surface, the said conveying surface being movable progressively beneath said stations, each of said stations including means delivering said streams onto said conveying surface individually in sequence in an advancing progression one on the other to produce a laminated mat, and heating means disposed adjacent said conveying surface and between adjacent stations whereby to heat the film laid down by a prior station before the film is laid down by a subsequent station to plasticize the fibers in the so-heated film to cause adherence of the fibers therein and adherence between engaging films.

7. An apparatus for producing a multiple-layer mat of glass fibers in a continuous process comprising, means forming a plurality of individual glass fiber forming stations at which batch material is heated and held in molten form, each of said stations including means producing a stream of glass fibers from molten material passing therethrough, each of said stations also including individual hopper means receiving the glass fibers as produced at the respective stations associated therewith, said hopper means being arranged in spaced aligned relationship for delivery of glass fibers therefrom in streams independently of each other, a conveying member movable past each of said hopper means in advancing progression from the first of said stations to the last thereof, each of said hopper means having the discharge end thereof positioned relative to said conveying member for independent delivery of glass fiber streams from each of the hopper means on to the conveying member in a sequential advancing progression one upon the other as the conveying member passes each of the hopper means to thereby produce a laminated mat.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,712,124	Stack	May 7, 1929
1,940,975	Shaver	Dec. 26, 1933
2,189,840	Simison et al.	Feb. 13, 1940
2,206,059	Slayter	July 2, 1940
2,257,767	Slayter et al.	Oct. 7, 1941
2,287,006	Kleist et al.	June 16, 1942