

June 16, 1964

P. H. PELLEY

3,137,743

METHOD OF FORMING FOAMED STRUCTURES

Filed Nov. 3, 1960

5 Sheets-Sheet 1

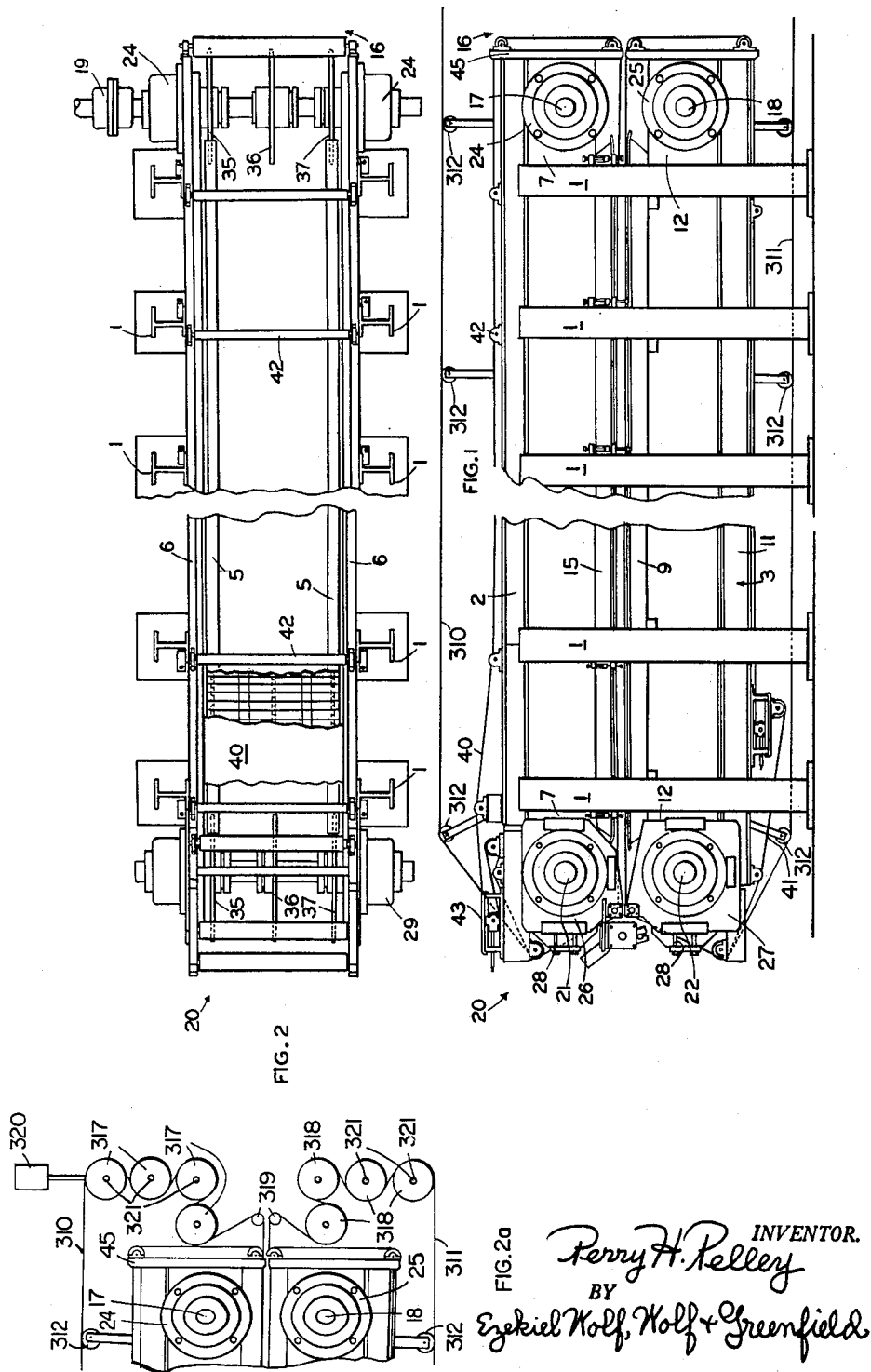


FIG. 2a

INVENTOR.  
*Perry H. Pelley*  
BY  
*Ezekiel Wolf, Wolf + Greenfield*

June 16, 1964

P. H. PELLEY

3,137,743

METHOD OF FORMING FOAMED STRUCTURES

Filed Nov. 3, 1960

5 Sheets-Sheet 2

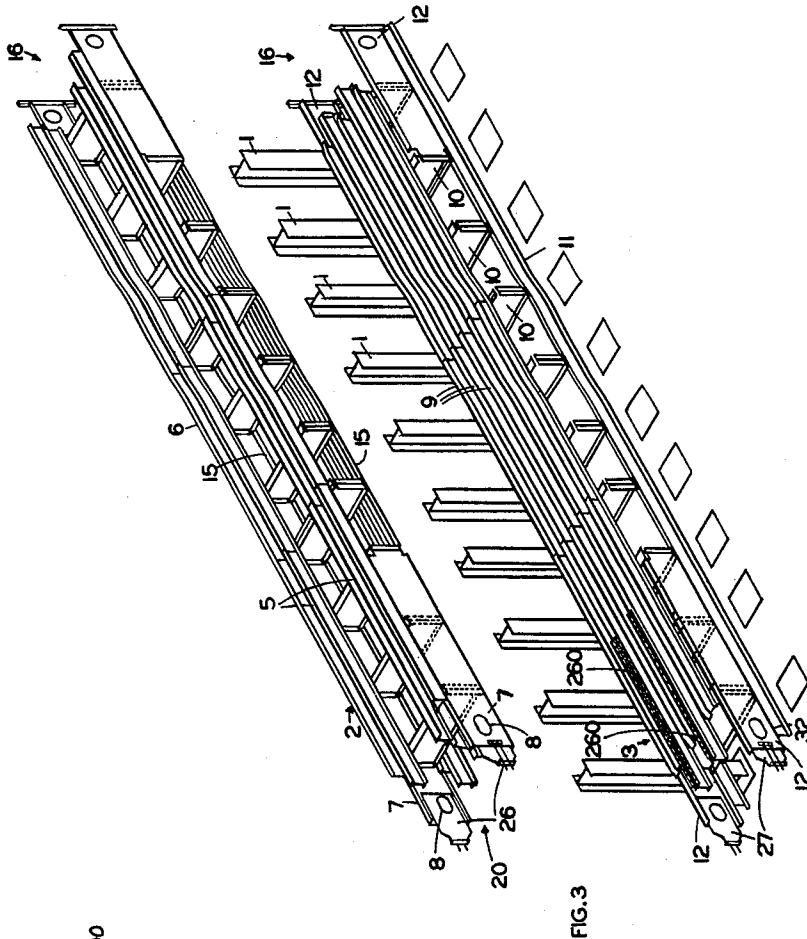


FIG. 3

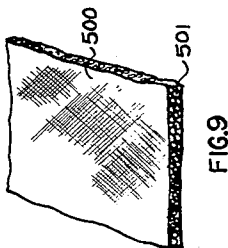


FIG. 9

INVENTOR.  
*Perry H. Pelley*  
BY  
*Ezekiel Wolf, Wolf + Greenfield*  
ATTORNEYS

June 16, 1964

P. H. PELLEY

3,137,743

METHOD OF FORMING FOAMED STRUCTURES

Filed Nov. 3, 1960

5 Sheets-Sheet 3

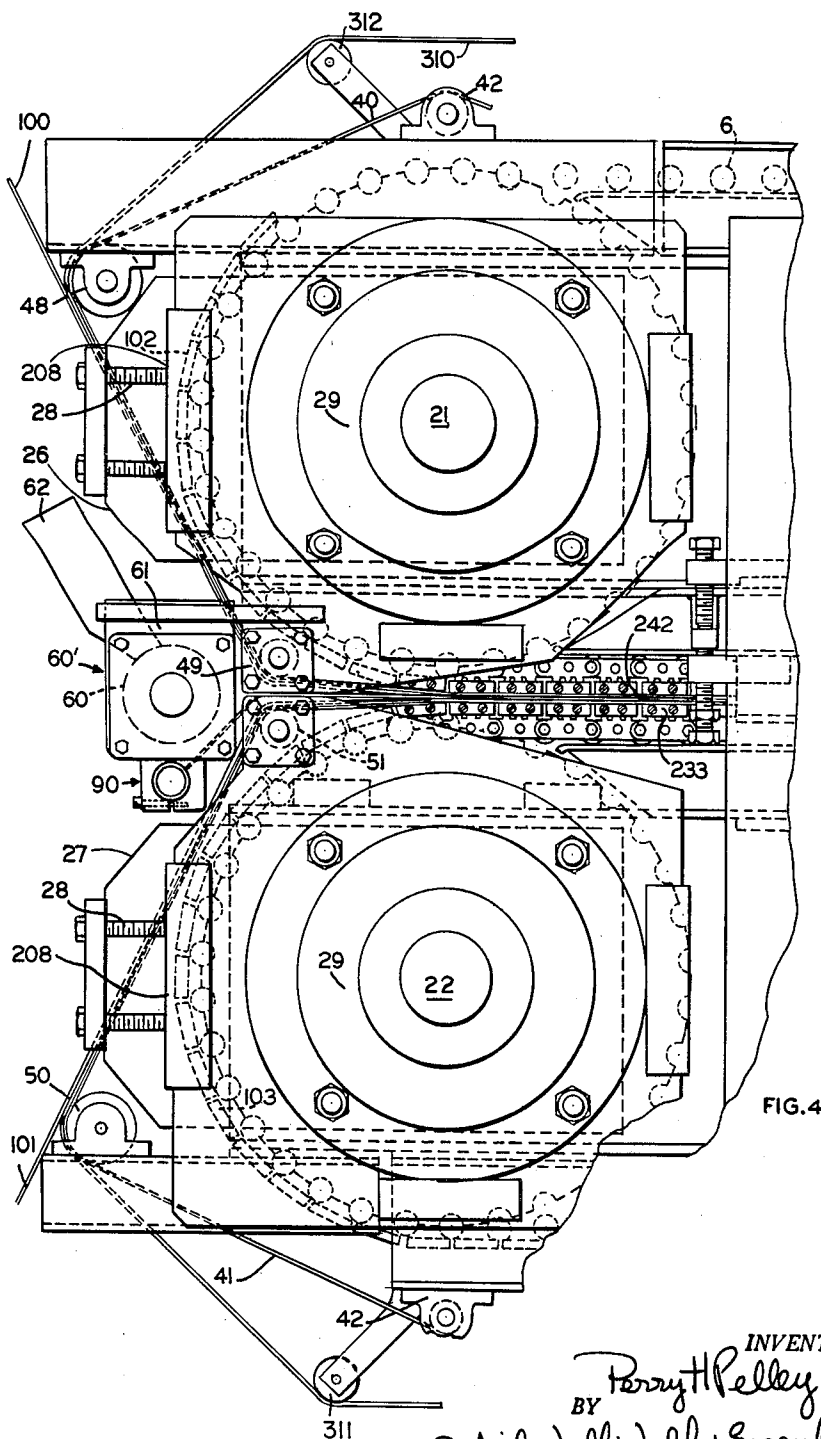


FIG. 4

INVENTOR.  
Perry H. Pelley  
BY  
Engel Wolf, Wolf & Greenfield  
ATTORNEYS



June 16, 1964

P. H. PELLEY

3,137,743

METHOD OF FORMING FOAMED STRUCTURES

Filed Nov. 3, 1960

5 Sheets-Sheet 5

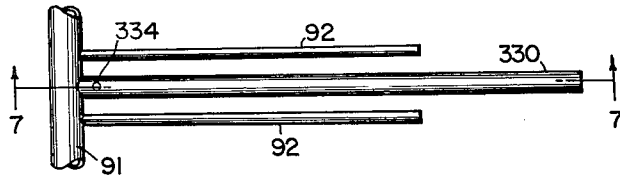


FIG. 6

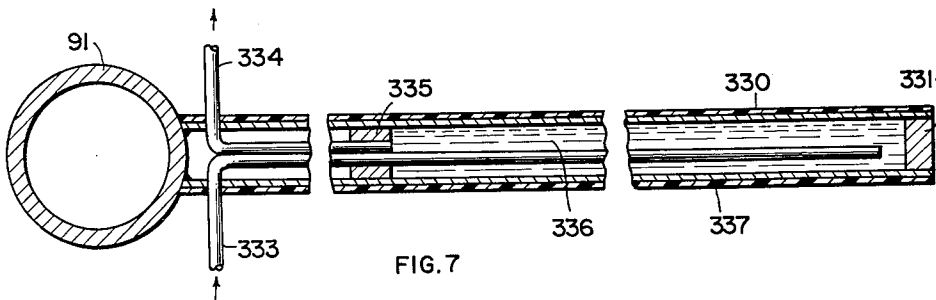


FIG. 7

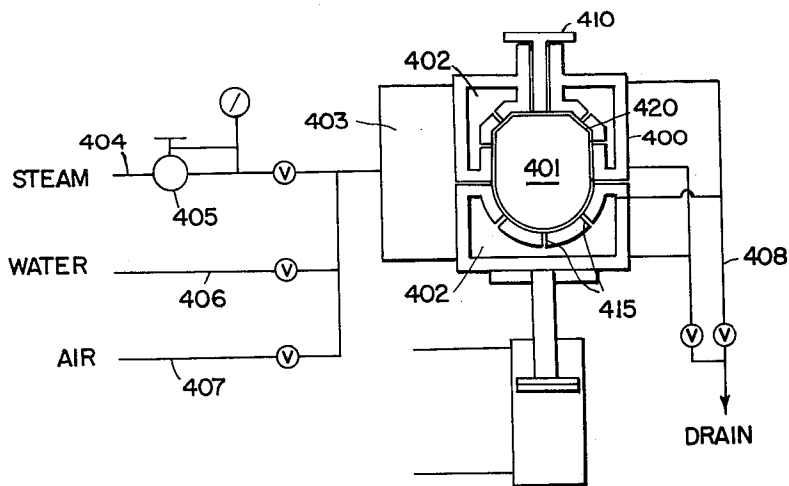


FIG. 8

INVENTOR.  
*Perry H. Pelley*  
BY  
*Ezekiel Wolf, Wolf & Greenfield*  
ATTORNEYS

1

3,137,743

## METHOD OF FORMING FOAMED STRUCTURES

Perry H. Pelley, Wichita, Kans., assignor to Tru-Scale, Inc., Wichita, Kans., a corporation of Kansas  
Filed Nov. 3, 1960, Ser. No. 66,994  
4 Claims. (Cl. 264—37)

The present invention relates to a method of forming foamed structures and more particularly to a method of forming structures from foamable plastic.

This invention represents an improvement over my co-pending application Serial No. 651,270, filed April 8, 1957, now U.S. Patent No. 3,037,897, for a Method of Making Structural Panel Articles, Serial No. 651, 222 filed April 8, 1957 for Production of Structural Articles, now abandoned, and Serial No. 848,996 for a Means and Method for the Continuous Formation of Paneling Having a Foamed Plastic Core, filed October 27, 1959.

Laminating machines such as described in co-pending application Serial No. 848,996 require substantial amounts of steam for expansion of the foamable beads into their desired form. Since the beads are foamed in a confined space, condensing steam is trapped in the foamed structure. In apparatus for forming foamed structures on a continuous basis and in devices for forming foamed structures on a discontinuous basis, heretofore no adequate means have been provided for removal of the vapor condensate of the steam used to foam beads. It has been found, however, that by reducing the amount of moisture in a foamed structure a relatively strong foamed structure of substantially lighter weight may be formed.

It is therefore an object of the present invention to provide a method for removing moisture from foamed structures as they are being formed in either a continuous or discontinuous process.

It is also an object of the present invention to provide a method for removing moisture during the formation of a foamed structure in such a manner as to improve the appearance and structural strength of the surface of the foamed structure.

A further object of the present invention is to provide a method of forming foamed boards or panels of substantially lighter weight than heretofore possible, without substantially weakening the panel.

In the present invention the form within which the foamed material is foamed to its desired shape is lined with moisture absorbing material such as cotton cloth or papermakers' felt. The function of this lining is to absorb moisture created by the condensation of the steam used to expand and coalesce the beads.

In conventional apparatus and molding devices the condensate is forced to the surface of the foamed structure as the beads expand, resulting in a beady surface. When an absorbent lining of the type herein described is employed, surface moisture is absorbed, thus causing an improved surface fusion and thereby eliminating a beady appearing surface. It also structurally improves the surface of the formed structure. This lining may be applied to a cavity mold where a discontinuous molding is practiced or to a machine for continuous formation of foamed panels, such as described in the aforementioned co-pending applications. As applied to a cavity mold the fabric or absorbent material lines the cavity. As applied to a machine continuously forming foamed structures the absorbent material is provided in the form of a pair of fabric belts which run between the restraining belts or forms, between which the foamable material is activated. The fabric belts pass through drying means at the end of the machine for removal of moisture absorbed from the foamable material.

These and other objects and advantages of the present

2

invention will be more clearly understood when considered in conjunction with the accompanying drawings in which,

FIGURE 1 is a side elevational view of the machine embodying my invention with portions omitted for clarity, FIGURES 2 and 2A are plan views of the device shown in FIGURE 1 with portions removed for clarity,

FIGURE 3 is a perspective exploded view of portions of the machine,

FIGURE 4 is an enlarged fragmentary side elevational view of the forward end of the machine,

FIGURE 5 is a greatly enlarged fragmentary side elevational view of the forward end of the machine,

FIGURE 6 is a fragmentary cross sectional plan view taken substantially along the line 6—6 of FIGURE 5,

FIGURE 7 is an enlarged cross sectional view taken substantially along the line 6—6 of FIGURE 5,

FIGURE 8 is a cross sectional schematic view of another embodiment of the invention, and

FIGURE 9 illustrates an embodiment of panel formed by the process and machine.

The embodiments of the invention shown in the drawings are illustrative of the present invention. The embodiments illustrated in FIGURES 1 to 6 inclusive utilize a machine of the type specifically illustrated in the aforementioned applications. The present invention however represents additions to the aforementioned machines. The machine illustrated in FIGURES 1 to 6 is formed with an elongated frame supported by a plurality of vertical I beams 1 arranged in two parallel rows (only one of which is shown). The I beams 1 are secured at their bases by suitable means and project upwardly to support the upper and lower frame assemblies 2 and 3 respectively. The upper frame assembly 2 comprises a plurality of elongated parallel inner rails or support beams 15, preferably five in number. These rails are rigidly and longitudinally secured to the lower edges of the cross beams 10'. A pair of outer rails 5 are secured to the upper surfaces of the cross beams 10'.

Side supports 6 are also secured to the cross beams 10'. These supports 6 in turn support the rollers 42 for the insulating web more fully described hereafter.

At the ends of the side rails 6 there are provided side bearing plates 7 having elongated openings 8 adapted to support a rotatable shaft 21.

The lower frame assembly is formed with inner rails or support beams 9, preferably five in number, rigidly secured to and above the cross beams 10. The number of rails will, of course, vary with the machine width. Side rails 11 are secured on either side edge of the cross beams 10 and are adapted in turn to be secured to support the roller assembly for the insulating web more fully described hereinafter. The cross beams 10 may be rigidly secured by suitable means to the I beam 1. The lower frame assembly 3 is also provided with side bearing plates 12 (FIGURE 3) similar in construction and corresponding in location to side bearing plates 7 on the upper frame assembly 2. The upper frame assembly 2 and lower frame assembly 3 are secured between the I beams with the inner rails or support beams 15 and 9 spaced apart a selected distance dependent upon the thickness of the composite paneling to be formed on the machine.

Carried by the side bearing plates 7 and 12 at the rear end 16 of the machine, and suitably supported in bearings 24 and 25 are shafts 17 and 18 (FIGURES 1 and 2), respectively. These shafts 17 and 18 are suitably geared or chain coupled to a driving means (not shown) for synchronous operation, as through couplings 19.

At the forward end 20 of the machine, shafts 21 and 22 are mounted in adjustable bearing plates 26 and 27 respectively. The bearing plates 26 and 27 in turn are slideably secured to side bearing plates 7 and 12 respec-

tively. The plates 26 and 27 are longitudinally adjustable by means of adjusting screws 28 threaded through flanges 208 of the plates 26 and 27 (FIGURE 4). The shafts 21 and 22 project respectively through the openings 8 and 32 (FIGURE 3).

Each of the shafts 17, 18, 21 and 22 carries three sprockets 35, 36 and 37, preferably uniformly spaced on the shaft and intermediate the side rails 6 and 12 (FIGURE 2). Two sets of endless conveyor belts 102 and 103 are carried by these sprockets with one set operatively engaging and circumscribing the sprockets 35, 36 and 37 mounted on shafts 21 and 17. The other set is operatively engaged by the sprockets mounted on shafts 22 and 18. These endless conveyor belts 102 and 103, as well as their means for incorporation in the machine, are identical with the corresponding belts illustrated in application Serial No. 848,996. These belts 102 and 103 form a restraining moving surface defining a confined area within which the foamable material is activated.

Auxiliary rollers 260 as illustrated in FIGURE 3 may be incorporated and secured to the rails 9 and 15 in a manner similar to that described in aforesaid co-pending application Serial No. 848,996.

Insulating flexible endless and continuous imperforate support webs 40 and 41 preferably formed of rubber or the like encircle the upper and lower restraining belts respectively. These insulating webs 40 and 41 pass between the inner rails 15 and 9 and define the upper and lower limits of the confined space 241, within which the laminated panel is formed. The web 40 is supported above the upper frame assembly 2 by a series of rollers 42 suitably journaled at their ends and supported on side rails 6. A suitable tensioning device for adjusting the tension of the web 40 may be provided as illustrated at 43 (FIGURE 1). At the rear end 16 of the machine, the web 40 is supported by rollers 42 mounted in journals, in turn supported on vertically oriented beams 45 at the end of the side bearing plate 7.

At the forward end 20 of the machine, the web 40 extends about rollers 48 and 49 (see FIGURES 4 and 5). These rollers are mounted in journals, in turn mounted respectively to portions of the frame. Roller 49 positions the web 40 away from the restraining conveyor belt 102 in an area just before the web enters into the confined area 241 between the parallel portions of the restraining belts 102 and 103. Lower web 41 is similarly engaged by rollers 50 and 51 corresponding respectively with rollers 48 and 49. Rollers 49 and 51 are positioned so that the webs 40 and 41 extending over them form a very acute angle from the rollers 49, 51 to the beginning of the confined area 241. The webs 40 and 41 between the conveyor belts, are spaced closely together over the length of the confined area. Ordinarily the webs 40 and 41 may be no more than one fourth to three quarters of an inch apart. It should be understood, however, that the thickness is primarily determined by the desired end products. The frictional engagement of the webs 40 and 41 with the conveyor belts 102 and 103 causes the webs 40 and 41 to move the conveyor belts during the operation of the machine.

Moisture absorbing flexible endless and continuous webs 310 and 311 preferably formed of linen or cotton fabrics, woven or knitted, in weights of from 4 ounces to 20 ounces per square yard or the like, encircle the upper and lower flexible webs 40 and 41 respectively. These moisture absorbent webs 310 and 311 pass between the inner rails 15 and 9 and parallel adjacent portions of the webs 40 and 41 and define an absorbent lining for the confined space 241 within which the laminated panel is formed. The absorbent web 310 is supported above the upper frame assembly 2 by a series of rollers 312 suitably journaled at their ends and supported on side rails 6. At the forward end of the machine, the moisture absorbent web 312 extends about rollers 48 and 49 (see FIGURES 4 and 5). These rollers which also carry web

40 are mounted in journals, in turn mounted respectively to portions of the frame. Lower web 311 is similarly engaged by rollers 50 and 51 corresponding respectively with rollers 48 and 49. The absorbent webs 310 and 311 thereby lie flat against webs 40 and 41, and in the confined area 241 are ordinarily no more than between one quarter to three quarters of an inch apart. As previously indicated however, the thickness is primarily determined by the desired end product. The frictional engagement of the webs 40 and 41 with webs 310 and 311 cause the webs 310 and 311 to move with webs 40 and 41 during the operation of the machine.

At the rear end of the machine 16 the webs 310 and 311 pass over a plurality of rotatable steam heated dry cans 317 and 318 and over idler rollers 319. These steam heated dry cans are maintained at a dry elevated temperature sufficient to evaporate moisture at a relatively rapid rate from the fabric as it passes over the cans. Any suitable means may be utilized for heating these cans including for example a steam generator suitably connected to cans 317 as schematically illustrated in FIGURE 1 at 320. These dry cans 317 and 318 are each suitably mounted on support bearings 321 which may or may not be in turn secured to the frame of the machine.

Secured intermediate opposite side plates 7 is a feeder and distributor 60' for the foamable material (FIGURES 4 and 5). This feeder and distributor 60' may be identical in construction and functioning as the feeder and distributor illustrated in the aforementioned co-pending application Serial No. 848,996.

Positioned immediately below the distributor 60' and preferably suitably secured to a supporting plate 61 for the distributor 60' is an insulated steam plenum 90 (FIGURES 4, 5, 6 and 7). This steam plenum is provided with an insulating outer cover 93 (FIGURE 5) supporting a cylindrical casing 91 preferably coextensive with the length of the distributor 60'. A steam conduit is provided for conducting steam into the casing 91. A series of parallel preferably closely spaced steam probes 92 are connected to the casing 91. These steam probes 92 are preferably insulated up to their proximity with rolls 51 and are formed with openings at their free ends, and if desired, at longitudinal positions along the length of the probes, preferably close to their free end. The steam probes are elongated tubes which project well into the forward end 20 of the machine between the absorbent webs 310 and 311 with free ends terminating in the confined area 241 between the webs 310 and 311, at which point the desired thickness of the lamination to be formed is defined by the height of the space between the webs 310 and 311. The particular shape of the probes may be varied for improved results under various conditions.

Also secured to the plenum 91 is one or more elongated members 330 (FIGURES 6 and 7). These elongated members are adapted to form longitudinal passages in the foam panel material as it is being formed. These longitudinal passages lighten the overall weight of the foam panels and in addition maintain the substantial rigidity of the panel, since means are provided for cooling the foaming beads immediately adjacent to the elongated members 330, thereby forming a relatively tough skin for the wall for the elongated passages formed. The elongated members 330 are tubular each with a plug 331 at the free end, and with the other end rigidly mounted or anchored to the plenum 91. The end of the elongated member 330 anchored to the plenum 91 is sealed from it, the plenum merely forming a support. A narrow diameter inlet tube 333 passes into the member 330 adjacent to the plenum 91 and extends substantially the length of the member 330. An outlet tube 334 also passes into the interior of the member 330 adjacent to steam plenum 91 and extends through at a sealed plug 335 in the member 330 a

short distance from the plenum. This arrangement forms a fluid cooling reservoir 336 into the elongated member 330. Suitable means (not shown) are provided to circulate water into the member 330 through tube 333 and out of the member 330 through tube 334. The elongated member 330 is covered by a relatively tight fitting "Teflon" sleeve 337. The "Teflon" sleeve 337 prevents adhering of the coalescing beads to the elongated member 330. The elongated members 330 are positioned preferably in planes parallel to the probes 92 and may be varied in number. The members are preferably longer and of greater diameter than the probes as illustrated in FIGURE 6.

The present invention utilizes beads of a type described in the aforementioned co-pending applications and operates in a manner substantially similar to the machines described in those applications. However, in the present invention a preferred utilization of the present invention does not contemplate the use of outer laminates of kraft paper, although a paper laminated structure can also be made in the present invention. Because of the utilization of moisture absorbent webs a unitary foamed panel may be formed having a sufficiently tough skin as to eliminate the necessity in many applications of outer kraft paper laminations. However if kraft paper laminations are desired, kraft paper rolls are suitably journaled and mounted in rolls for feeding over idler rolls to the forward end of the machine. This kraft paper in the form of opposite webs 100 and 101 is fed into the machine in facing relation, respectively, with adjacent portions of webs 310 and 311 so that the surfaces of the confined area 241 are defined by these paper webs.

In the preferred form of the invention however where no paper lamination is contemplated the beads are foamed directly between the moisture absorbing webs 310 and 311 in a manner described in the aforesaid co-pending applications. It has been found that the foaming beads coalesce between the absorbent webs 310 and 312 and adjacent to the elongated member 330. The webs 310 and 311 rapidly absorb the condensed steam emitted by the probes 92 and thereby prevent this moisture from being trapped in the foamed panel. Dramatic evidence of the effectiveness of the removal of this moisture are tests which indicate a reduction in moisture permeability for a one inch thick one pound per cubic foot board from conventional 1.7 perms where a perm equals grains/hours/square feet/inches of mercury to .63 perm.

In addition the weight of the board is substantially reduced by the formation of the elongated passages by the elongated members 330. The lightening holes or passages which run continuously through the board permit the manufacture of a low density relatively strong panel with insulating values higher than otherwise possible.

FIGURE 8 illustrates an embodiment of the present invention utilized in connection with discontinuous forming of foamed structures. In this arrangement a steam chest mold 400 having a cavity 401 of suitable configuration is lined with a moisture absorbent liner or material formed of such material as cotton, duck, felt, etc. The mold is provided with a manifold 402 adapted to contain steam supplied from a steam chest 403. The steam chest 403 is suitably supplied with steam from a steam source 404. Conventional pressure regulators 405 as well as water and air taps 406 and 407 may be incorporated in the structure together with a suitable moisture drain system 408. A plug 410 suitable for closing an opening through which the foamable material is injected into the mold is provided. After the foamable material is positioned within the mold and a plug 410 is closed, the steam heat is turned on to activate the foamable material within the mold. The live steam

passing into the mold through the passages 415 activates the foamable material. The condensing moisture or condensing steam is quickly absorbed by the moisture absorbent liner 420. This removes from the body of the foamed structure a substantial portion of moisture and thereby reduces the moisture permeability and weight of the foamed structure. In addition the foamed structure has a surface which conforms to the surface structure of the absorbent material. Whereas in systems not using a moisture absorbent liner, the foamed structure has a surface on which the individual beads are clearly defined, in the present invention the foamed structure has a surface in which individual beads cannot be readily discerned but rather the surface of the material conforms with the absorbent material. On this surface the beads are merged into a homogeneous mass with the individual beads not discernible as illustrated in FIGURE 9. In FIGURE 9 the individual beads are not discernible on the surface 500 which is formed adjacent the fabric belt. This is in contrast to the sides 501 where the beads are discernible.

Having now described my invention I claim:

1. A method of making a foamed plastic structure of reduced moisture permeability from separate, discrete and at least partially preexpanded plastic beads which comprises positioning a quantity of said beads in a confined molding space, heating the confined beads and effecting expansion and coalescence thereof into a foamed structure by condensing steam in contact therewith, removing condensed moisture from said structure and thereby causing the outer beads to merge together into a homogeneous outer surface layer by simultaneously contacting said outer surface with a layer of moisture-absorbent fabric, and removing the resulting moisture-laden fabric from contact with said outer surface and drying it for reuse in the process.

2. A method of making a structural panel of reduced moisture permeability from separate, discrete and at least partially preexpanded plastic beads which comprises introducing a layer of such beads into a molding space confined between a pair of moving restraining members, heating the confined beads and effecting expansion and coalescence thereof into a foamed panel by injecting steam into said space and condensing it in contact with said beads, removing condensed moisture from the panel and thereby imparting a homogeneous outer surface thereto by interposing a travelling moisture-absorbent fabric between said panel surface and its adjacent restraining member, and removing the resulting moisture-laden fabric from contact with said panel surface and drying it for reuse in the process.

3. The method as set forth in claim 2 wherein elongated passages having toughened walls are formed in the foam panel material by passing the flow of beads within the molding space in longitudinal contact with a plurality of positively cooled parallel elongated members positioned therein.

4. A continuous method of making structural paneling of reduced moisture permeability from separate, discrete and at least partially preexpanded plastic beads which comprises continuously interposing a layer of such beads in a confined travelling molding space between a pair of moving restraining members, heating the confined beads and effecting expansion and coalescence thereof into foamed panel material by injecting steam into said space and condensing it in contact with said beads, removing condensed moisture from the panel and thereby imparting homogeneous outer surfaces thereto by interposing a travelling moisture-absorbent fabric web between each of said surfaces and its adjacent restraining member, and then drying said webs and returning them to said molding space for reuse in removing moisture from succeeding portions of said panel.

## References Cited in the file of this patent

## UNITED STATES PATENTS

|           |                  |               |    |
|-----------|------------------|---------------|----|
| 1,453,617 | Bond             | May 1, 1923   |    |
| 1,455,946 | Wester           | May 22, 1923  |    |
| 1,487,726 | Debay            | Mar. 25, 1924 | 5  |
| 1,650,687 | Bond             | Nov. 29, 1927 |    |
| 2,075,735 | Loomis           | Mar. 30, 1937 |    |
| 2,096,338 | Randall          | Oct. 19, 1937 |    |
| 2,141,405 | Randall          | Dec. 27, 1938 |    |
| 2,260,081 | Lefebure et al.  | Oct. 21, 1941 | 10 |
| 2,376,653 | Boyer            | May 22, 1945  |    |
| 2,377,846 | Dreyfus et al.   | June 5, 1945  |    |
| 2,441,235 | Blair et al.     | May 11, 1948  |    |
| 2,590,757 | Cornelius et al. | Mar. 25, 1952 | 15 |
| 2,673,370 | Goss             | Mar. 30, 1954 |    |

2,774,991  
2,779,062  
2,841,205  
2,872,965  
2,874,407  
2,962,407  
2,977,639  
3,065,500

|                |               |
|----------------|---------------|
| McCurdy et al. | Dec. 25, 1956 |
| Stastny        | Jan. 29, 1957 |
| Bird           | July 1, 1958  |
| Sisson         | Feb. 10, 1959 |
| Chabot et al.  | Feb. 24, 1959 |
| Aykanian       | Nov. 29, 1960 |
| Barkhuff       | Apr. 9, 1961  |
| Berner         | Nov. 27, 1962 |

## FOREIGN PATENTS

|           |        |              |
|-----------|--------|--------------|
| 1,165,798 | France | June 2, 1958 |
|-----------|--------|--------------|

## OTHER REFERENCES

The BASF Booklet: New Methods for the Fabrication of Stropor, pages 4 and 5 (reprinted from "Der Plastverarbeiter", 7, 242-250 (1955)).