Dec. 18, 1951 R. S. BRUNDIGE 2,578,781

MANUFACTURE OF PLYWOOD

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Fig.1

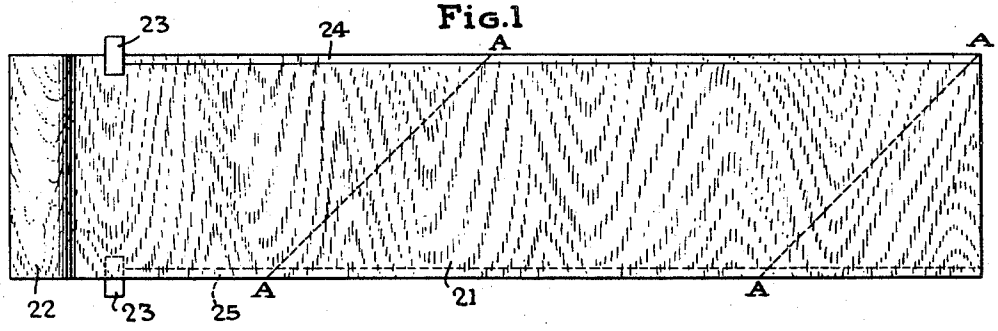


Fig.2

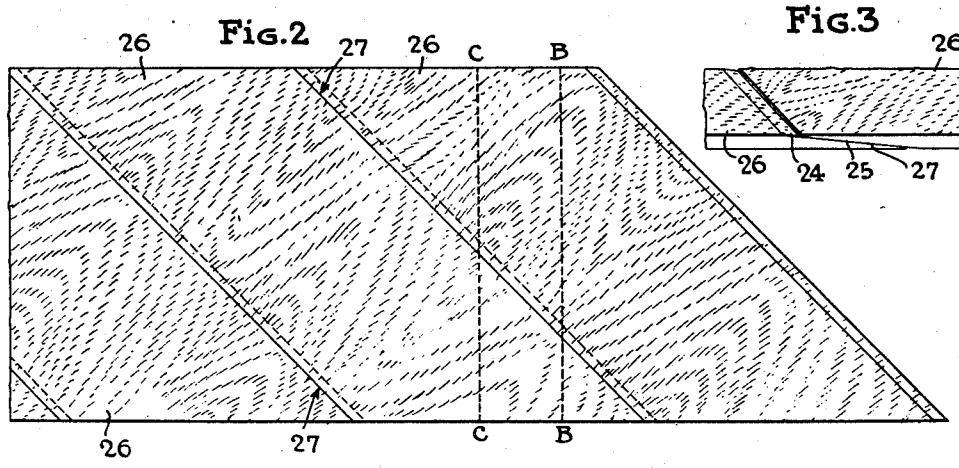


Fig.3

Inventor
Roy S. Brundige

Dodge Clay & Sons

Attorneys

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Fig. 4

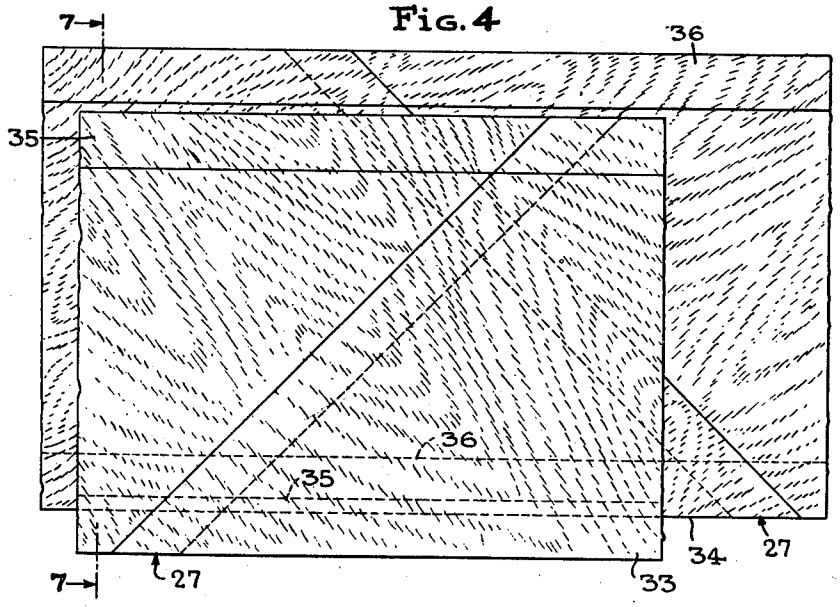


Fig. 5

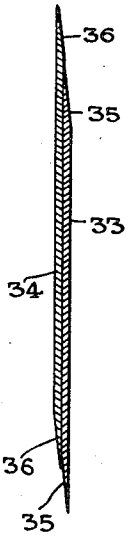


Fig. 6

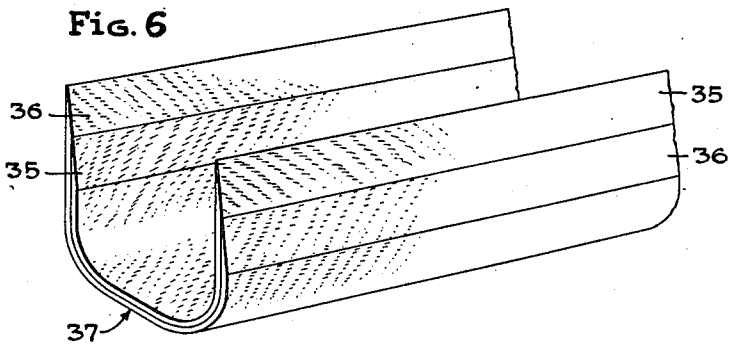


Fig. 7

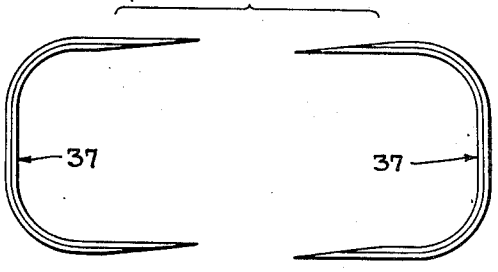
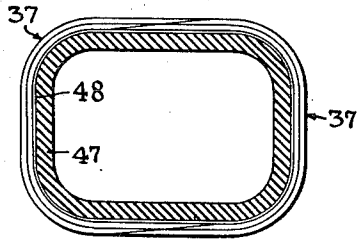


Fig. 8



Inventor
Roy S. Brundige

By Dodge & Dodge

Attorneys

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Fig. 9

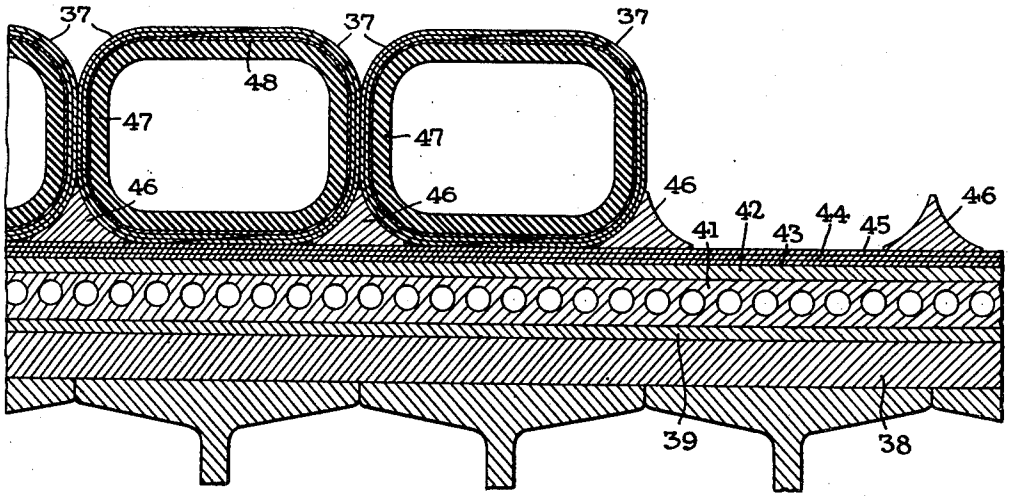
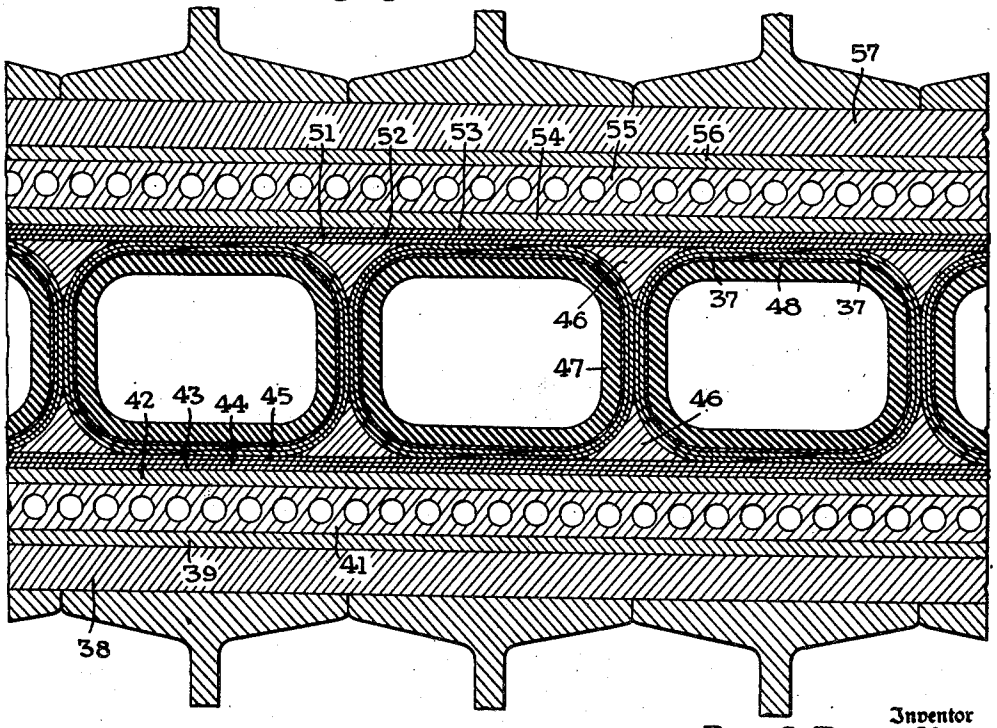


Fig. 10



Inventor
Roy S. Brundige

Dodge and Sons.

Attorneys

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MANUFACTURE OF PLYWOOD

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Fig. 11

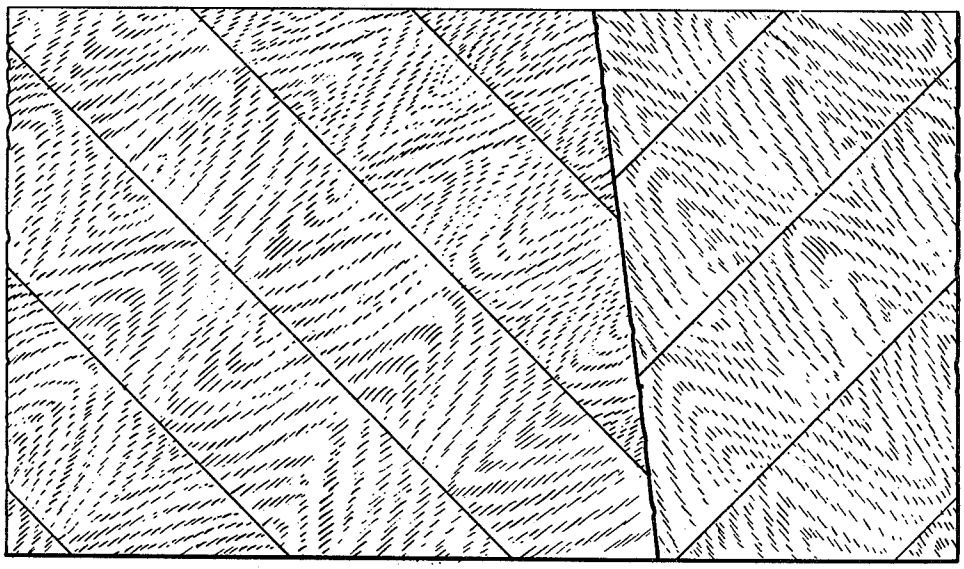
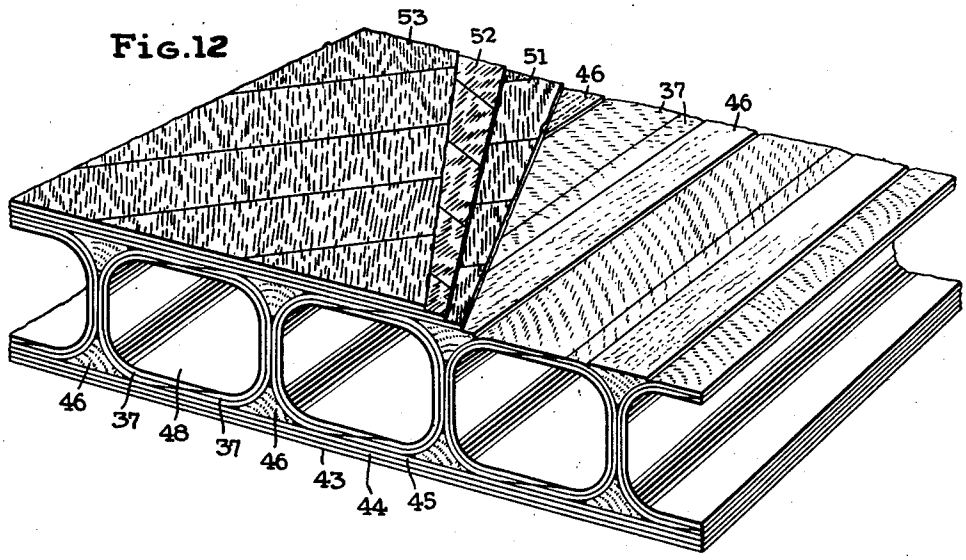


Fig. 12



Inventor
Roy S. Brundige

Attorneys

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MANUFACTURE OF PLYWOOD

Roy Samuel Brundige, Los Angeles, Calif.

Application January 18, 1945, Serial No. 573,376

10 Claims. (Cl. 20—91)

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This invention relates to methods of manufacturing cellular plywood and the resulting article.

In plywood as at present manufactured the grain in alternate plies runs lengthwise and crosswise of the rectangular piece. This imposes rather definite size limitations, particularly as to length. Economic considerations limit the thickness of plywood panels to one inch or less.

The present invention contemplates the production of cellular plywood by the use of a bias-grained veneer sheet which will be described hereinafter. The use of such a bias-grained sheet relieves dimensional limitations imposed by the prior art methods.

The mode of producing a bias-grained sheet involves peeling veneer from a log, which may be comparatively short, scarfing the edges preferably as the veneer is peeled, and clipping the veneer ribbon by bias cuts into strips of the desired length.

From these strips, a bias-grained veneer sheet is formed by adhesive joining of the scarfed margins which were the side edges of the veneer ribbon as peeled from the log.

At least two such sheets are assembled with the bias-grain crossing to produce multi-ply elements of any desired length or breadth.

An outstanding advantage of this invention is its economy of timber. The timber resources of the United States are limited and are not being reproduced as fast as used. It is, therefore, highly important to develop and maintain the most economical basis of utilization.

It is a well established fact that logs, when cut into veneer by rotary means, give much larger yields than when sawn into lumber.

The waste in sawmill operations due to slabbing, ripping off wany edges, discarding defective heart sections, and for saw kerf between the boards, amounts of from 34 per cent to 40 per cent of the actual board foot content of a log eighteen inches in diameter.

The waste in cutting an eighteen-inch log into veneer, including a seven-inch core amounts to approximately 15 per cent.

Ultimate economy is achieved by the present invention because practically the whole of sound logs is utilized. Long, straight, clear logs, suitable for the rotary veneer process, are scarce and the longer the log the greater the diameter of the core that must be discarded.

Cores remaining from peeling operations are used for making the slender spacing splines.

Log imperfections, such as large knots, crotches

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and crooks, greatly reduce the number of long logs suitable for cutting veneer and, it is necessary to cut away considerable wood in order to secure the necessary perfect cutting cylinder.

By using short logs, which is practicable with applicant's method, such imperfections may be economically eliminated and excessive round-up waste due to the natural growth taper is materially reduced.

Another advantage is that the veneer used in the process can be produced at a mill located near the source of log supply and then be shipped to an assembly or manufacturing plant remote therefrom.

The methods and articles, as embodied in preferred procedures will now be described by reference to the accompanying drawings.

Figures 1 to 3 are drawn on a relatively small scale and show a method of producing bias-grained sheet of any reasonable width and of indefinite length.

Figure 1 is a diagram indicating how veneer may be peeled from a relatively short log, scarfed and then clipped into rhomboidal strips.

Figure 2 is a view illustrating how the strips formed, as shown in Figure 1, are assembled to form a continuous bias-grained sheet whose width equals the perpendicular distance between the bias clipping cuts indicated in Figure 1.

Figure 3 is an enlarged detail of a scarfed joint used in joining the sections shown in Figure 2.

Figures 4 to 10 are drawn on a scale much larger than Figures 1 to 3 and show steps in the formation of cellular plywood according to the invention.

Figure 4 shows two bias-grained scarfed sheets assembled preparatory to formation into a channel unit.

Figure 5 is a section on the ilne 7—7 of Figure 4.

Figure 6 is a perspective view of the formed channel unit.

Figure 7 is an end view of two channel units ready to be assembled.

Figure 8 shows two channel units assembled over a forming and heating mandrel.

Figure 9 shows the lower mold platen with three outer plies, the splines and units such as that shown in Figure 8 in place.

Figure 10 shows the complete assembly in place between the mold platens.

Figure 11 drawn on a small scale illustrates how veneer sheets such as are shown in Figure 2 are assembled reversely on adjacent plies to form a plywood sheet of indefinite length.

Figure 12 is a perspective view of the cellular plywood with certain of the outer plies partially broken away to show the construction.

In forming cellular plywood adhesive is used between all contacting surfaces. No attempt has been made to illustrate the adhesive in the drawings, because to do so would lead to confusion and add nothing to the disclosure. Adhesives could be applied in any known way, in liquid or in powder form or in the form of sheets, but the practice common in the plywood art of using a thermosetting adhesive in sheet form is preferred. No novelty inheres in gluing methods used, and applicant contemplates the use of any preferred method, or the use of different methods particularly appropriate to different components.

The method of producing bias-grained sheets of veneer of unusual length and breadth will first be discussed.

Refer to Figures 1 to 3. A ribbon of veneer **21** is peeled by the use of a conventional veneer lathe (not shown) from a log **22**. Scarfing devices diagrammatically indicated at **23** reversely scarf the two edges of the ribbon as shown at **24** and **25**. It is characteristic of the invention that the ribbon of veneer is cut at an angle of approximately 45 degrees to its edge along bias lines A—A to produce strips **26**, three of which are shown in Figure 2.

The edges of these strips are characterized by the scarfs **24** and **25**. The scarf **24** of one strip is lapped upon the scarf **25** of another and adhesively joined as indicated at **27** in Figure 3 to produce a relatively wide, continuous sheet of bias-grained veneer, a short length of which is shown in Figure 2.

It is evident that sheets thus formed may be of any desired length or breadth. Breadth is determined by the length of the strips **26** (Figure 2). Any length peeler log **22**, within the capacity of the lathe, may be used. Short logs merely require that more scarfed joints be made.

The bias-grained sheet of veneer shown in Figure 2 is then cut at a right angle to its edge into any desired length. Two or more pieces so cut are then assembled face to face so that their inter-strip joints and the grain of the wood in each alternate ply crosses at right angles as shown in Figure 11.

Plywood can be manufactured in this manner to any desired length and breadth. One advantage in using peeled veneer, as above, is that broad widths can be formed from rather short logs, with attendant reduction of waste.

Plywood so made can be used with or without special facing sheets just as present commercial plywood is used, but it has other uses, an important one of which is as the outer or facing plies of a cellular plywood. The intermediate cellular structure is also formed from the bias-grained, bias-jointed sheets.

The method of producing cellular plywood panels of extraordinary length, breadth and thickness will now be explained.

Narrow channel-strips of bias-grained veneer for use in forming channel-shaped elements will first be discussed. Such channel-strips are preferably produced by cutting the wide, bias-grained sheets shown in Figure 2 at right angles to its edge. The width of the channel-strip is determined by the interval between cuts B—B and C—C indicated by dash lines in Figure 2. Two narrow channel-strips **33**, **34** thus produced are shown in Figure 4.

To form the channel-shaped elements such narrow, bias-grained channel-strips are scarfed along each edge as indicated at **35**, **35** and **36**, **36** in Figures 4 and 5. The channel-strips **33** and **34** are of slightly different width and are assembled face to face but with their grains and inter-strip joints crossed, as shown in Figure 4. Note the position of the scarfed edges in Figures 4 and 5. The two channel-strips are then made pliable by any suitable treatment and curved to the channel section illustrated in Figure 6. The purpose in using channel-strips of slightly different width is to cause the scarfed surfaces of the two plies to aline (compare Figures 5 and 6). The channel-shaped elements will be designated by the numeral **37** in Figures 8, 9, 10 and 12.

These channel-shaped elements are used between two outer facing elements, as a glance at Figure 12 will make clear. These two outer facing elements are arranged as indicated in Figure 11 and are built up from the sheet of Figure 2.

Figures 8, 9 and 10 indicate the procedure in forming the thick, cellular plywood.

The lower portion of the mold is shown at **38**, insulation at **39**, the lower heating platen at **41** and the lower caul at **42**. On this caul is laid a facing sheet **43**, which may be wood veneer with the grain running in any direction, or a sheet of some synthetic plastic, or metal or asbestos or cork, or any other suitable substance capable of withstanding without damage the heat and pressure of the forming operation. Adhesive is applied to the upper surface of said sheet.

On this facing sheet and with interleaved adhesive are placed two reversely laid bias-grained sheets of veneer **44** and **45** in the manner shown in Figure 11 (which have been cut from a sheet such as that shown in Figure 2). Parallel splines **46** properly spaced are adhesively attached to the upper sheet, prior to this layup.

Metal foil **48** is wrapped around the collapsible mandrels **47** and adhesive is applied to the exterior surfaces of said foil.

Adhesive is applied to the scarfed flanges of the channel-shaped elements **37** and said elements are assembled in tube-forming pairs over the foil coating which is wrapped around the collapsible pressure mandrels **47**. These mandrels later receive temperature controlling fluids under pressure and serve as combined sustaining, heating, cooling and pressure means.

Adhesive is applied to the exterior surfaces of the tubular-shaped elements thus formed and the combined elements are then laid between adjacent splines **46**, as diagrammatically indicated in Figure 9.

The mandrels **47** can conveniently be made of any hollow, flexible material capable of withstanding the necessary heat and pressure of the forming operation. For manufacturing a panel of cellular plywood a gang of these tubular mandrels would be arranged with connections for selectively admitting hot and cold pressure fluids, and for equalizing the pressures in the various mandrels.

The exact details of the mandrels are not features of the present invention. The significant characteristic is that they are used to develop pressure in the tubular cells of the plywood.

The rounded corners of the channel-shaped elements **37** fit snugly against the coved sides of the spacing splines **46** which have the same curvature as the corners of the channels. This

confines each pair of channels to the interval between adjacent spacing splines and any variation in their size will cause their edges to slide, one way or the other, along the scarfs 35, 36. Thus, the tube formed by two channels is permitted to adjust itself to the limits imposed by the accurately spaced splines 46.

Next are laid in the order stated and with adhesive as before a second sheet of veneer 51 to which spacing splines 46 were previously attached, a second sheet of veneer 52, and a second facing sheet 53. (This second facing sheet may be of different material from that of sheet 43.) The caul 54 is placed on the facing sheet 53, the upper heating platen 55 is laid on the caul 54, insulation 56 on the heating plates and then the upper part 57 of the mold is lowered to a fixed position determined in any suitable way.

The upper and lower parts of the mold are then securely clamped together. Thereupon heating pressure fluid is slowly admitted to the pressure mandrels 47, the pressure in the various mandrels being carefully equalized. The platens 41 and 55 are heated simultaneously and when temperature and pressure appropriate to the type of adhesive being used have been maintained for a suitable period, cooling pressure fluid is exchanged for the heating pressure fluid and is maintained until the material is cool enough to be removed from the mold.

The mandrels are then emptied and collapsed by suction and withdrawn. The finished product (see Figure 12) is then removed from the mold.

It should be observed, that (as shown best in Figure 14) the grain in all contacting veneer surfaces is crossed at right angles.

It should also be noted, that the pressure used in forming this cellular plywood is applied from the inside of the material. Variations in the thickness of veneer sheets and other irregularities which may occur are thus confined to the interior of the material so that the finished cellular plywood panel comes from the mold with smooth, finished faces which do not require further treatment.

In the foregoing description of the methods and products, apparatus used in manufacturing has not been elaborated because it is subject to considerable variations and because the invention can be carried out by manual control of apparatus already in commercial use.

The foil coating which is applied to the mandrels adheres to the channel units in the finished structure so that when the mandrels are collapsed and withdrawn the foil is left as a coating within the cells of the plywood. The foil thus serves two useful purposes. It protects the mandrels against adhesion to the plywood; a contingency which would be entirely possible because of squeezing out of adhesive when the mandrels are under pressure. If this were the only function to be served any thin sheet of material might be substituted for the foil, but bright metal foil restricts the transmission of radiant heat and the foil coatings within the plywood, which result from the described procedure, have the effect of improving the thermo-insulating characteristics of the product.

What is claimed is:

1. The method of producing cellular plywood which consists in wrapping each of a series of elongated expansible forms with metal foil; coating said foil with adhesive; assembling over the series of expansible forms a series of mating plywood channel units each unit made up with adhesive between plies and on the surface of the unit, which units coact to form tubular units; assembling the tubular units side by side and in contact with the expansible forms in place, between facing units of sheet material; sustaining the facing units against separation; expanding said expansible forms causing said adhesive to set; and thereafter contracting and withdrawing the expansible forms, leaving the foil as an adhering coating.

2. The method of producing cellular plywood which consists of assembling over each of a series of elongated expansible mandrels a series of mating multi-ply channel elements each element made up with adhesive between plies and on the surface of the element, which elements coact to form tubular elements; assembling the tubular elements side by side and in contact with the expansible mandrels in place, between facing elements comprised of sheet veneer with adhesive between plies; sustaining the facing elements against separation; expanding said expansible mandrels causing said adhesive to set; and thereafter contracting and withdrawing the expansible mandrels.

3. The method of producing cellular plywood which consists of assembling over each of a series of elongated expansible mandrels a series of mating multi-ply channel elements each element made up with adhesive between plies and on the surface of the element, which elements coact to form multi-ply tubular elements; assembling the tubular elements side by side and in contact with the expansible mandrels in place, between facing elements of sheet veneer with adhesive between plies; each channel element and each facing element being made up of at least two sheets of preformed veneer, said preformed sheets being formed of strips of veneer of rhomboid shape with the grain running perpendicular to their longitudinal side edges, said strips crossing the sheets from edge to edge in a continuous piece at an angle approximating 45° and in side edge to side edge relation with said side edges adhesively joined and end edges alined; successive preformed sheets being reversely arranged so that their inter-strip joints and the grains of strips in face contact cross at right angles; sustaining the facing elements against separation; expanding said expansible mandrels causing said adhesive to set; and thereafter contracting and withdrawing the expansible mandrels.

4. The method defined in claim 3, in which parallel uniformly spaced coved splines are adhesively attached to proximate faces of the facing elements, prior to their assembly with the tubular elements, said splines serving to position the tubular elements.

5. Cellular plywood comprising two facing multi-ply elements and an interposed series of tubular-shaped multi-ply elements arranged in side by side relation and in contact with each other each tubular element composed of two channel-shaped multi-ply elements with flanges abutting on each other, all of said elements being adhesively connected together, each of said elements being composed of at least two sheets of preformed veneer, said sheets being composed of narrow rhomboid strips of veneer with the grain crossing perpendicular to their longitudinal side edges, said strips crossing said sheets from edge to edge at an angle approximating 45° and in edge to edge relation with said edges adhesively joined, the preformed sheets forming successive

plies being in adhesive face contact and reversely arranged so that their inter-strip joints and the grains of strips in face contact cross at right angles to each other.

6. Cellular plywood comprising two facing multi-ply elements and an interposed series of tubular-shaped multi-ply elements arranged in side by side relation and in contact with each other, each tubular element composed of two channel-shaped multi-ply elements with flanges abutting on each other, all of said elements being adhesively connected together, each of said elements being composed of at least two sheets of preformed veneer, said sheets being composed of narrow rhomboid strips of veneer with the grain crossing perpendicular to their longitudinal side edges, said strips crossing said sheets from edge to edge at an an angle approximating 45° and in edge to edge relation with said edges adhesively joined, the preformed sheets forming successive plies being in adhesive face contact and reversely arranged so that their inter-strip joints and the grains of strips in face contact cross at right angles to each other, and a foil lining adhesively attached to the inner surfaces of the tubular-shaped elements.

7. Cellular plywood comprising two facing multi-ply elements and an interposed series of tubular-shaped multi-ply elements arranged in side by side relation and in contact with each other, each tubular element composed of two channel-shaped multi-ply elements with flanges abutting on each other, all of said elements being adhesively connected together, at least the facing elements being composed of at least two sheets of preformed veneer, said sheets being composed of narrow rhomboid strips of veneer with the grain crossing perpendicular to their longitudinal side edges, said strips crossing said sheets from edge to edge at an angle approximating 45° and in edge to edge relation with said edges adhesively joined, the preformed sheets forming successive plies being in adhesive face contact and reversely arranged so that their inter-strip joints and the grains of strips in face contact cross at right angles to each other.

8. Cellular plywood comprising two facing multi-ply elements, a series of parallel uniformly spaced coved splines adhesively attached to the proximate faces of said elements, and an interposed series of tubular-shaped multi-ply elements arranged in side by side relation and in contact with each other, each tubular element composed of two channel-shaped multi-ply elements with flanges abutting on each other, all of said elements being adhesively connected together, each of said elements being composed of at least two sheets of preformed veneer, said sheets being composed of narrow rhomboid strips of veneer with the grain crossing perpendicular to their longitudinal side edges, said strips crossing said sheets from edge to edge at an angle approximating 45° and in edge to edge relation with said edges adhesively joined, the preformed sheets forming successive plies being in adhesive face contact and reversely arranged so that their inter-strip joints and the grains of strips in face contact cross at right angles to each other.

9. A cellular plywood panel free of dimensional limitations normally imposed by the length of peelable logs, comprising two facing multi-ply elements and an interposed series of channel-shaped multi-ply elements arranged in pairs with the flanges of each pair contacting each other to form tubular elements and the webs of each pair in contact with the webs of adjacent pairs, all of said elements being formed of preformed veneer sheets characterized by joints between component strips crossing said sheets at an angle approximating 45° and bias grain crossing said sheets at substantially 90° to said joints, the sheets forming successive plies being reversely arranged so that their inter-strip joints and the grains of strips in face contact cross at right angles to each other, all of said elements being made up with adhesive between plies and adhesively connected together.

10. A cellular plywood panel free of dimensional limitations normally imposed by the length of peelable logs, comprising two facing multi-ply elements and an interposed series of channel-shaped multi-ply elements arranged in pairs with the flanges of each pair contacting each other to form tubular elements and the webs of each pair in contact with the webs of adjacent pairs, all of said elements being made up with adhesive between plies and adhesively connected together.

ROY SAMUEL BRUNDIGE.

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