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R. M. BOEHM ET AL
METHOD OF MAKING A CONDUIT
ENCLOSING SHEET PRODUCT
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2,465,348

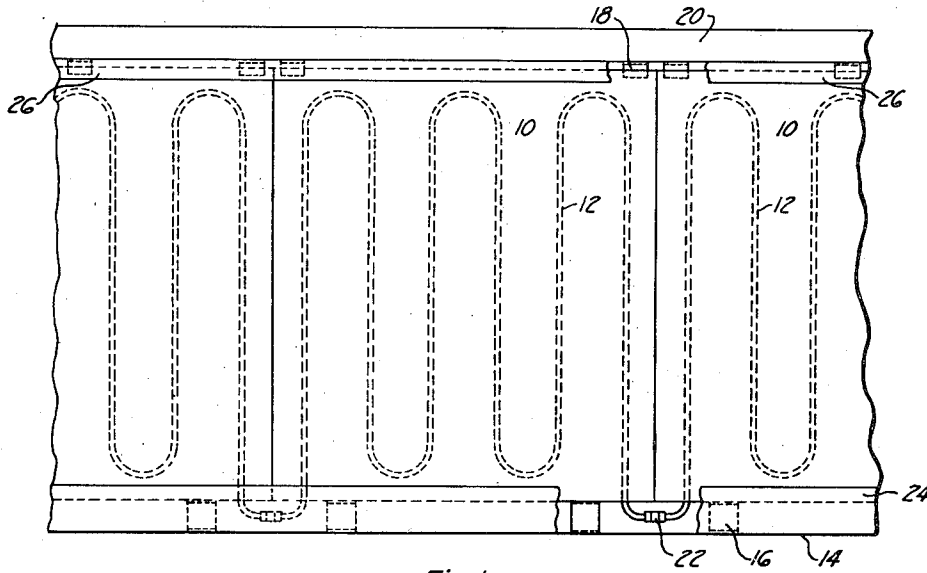


Fig. 1

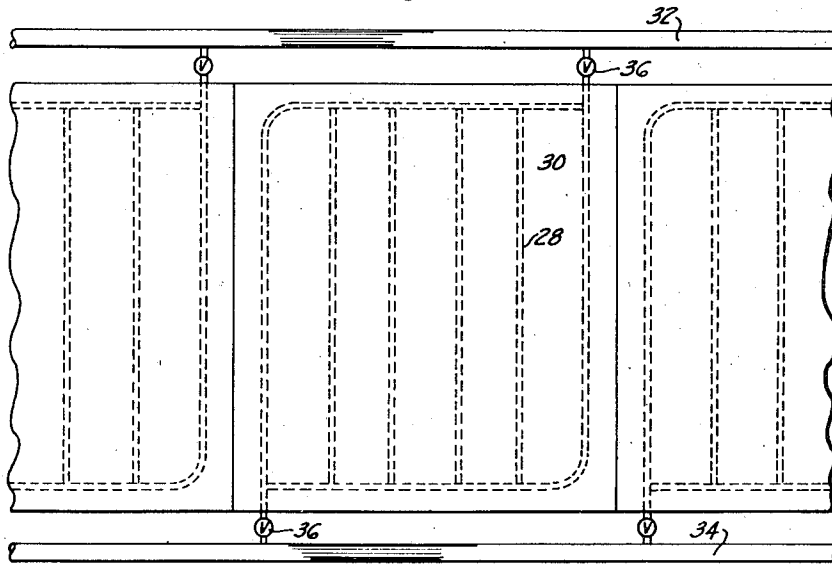


Fig. 2

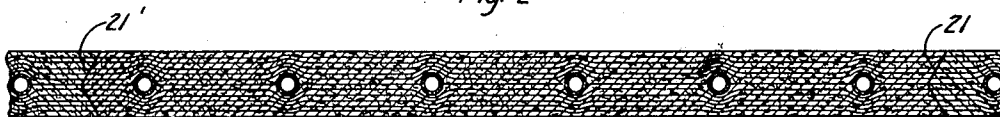


Fig. 3

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METHOD OF MAKING A CONDUIT
ENCLOSING SHEET PRODUCTRobert M. Boehm and George G. Simpson, Laurel,
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9 Claims. (Cl. 154-118)

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This invention relates to that system of heating or cooling an enclosed space in which the surfaces of the enclosing material are heated or cooled. More specifically, it relates to a thick sheet product of fibrous material including a system of pipes embedded in the body of the sheet and the method of manufacturing such sheets. The inlet and outlet ends of the pipes which extend from the edges of the sheet may be connected to a suitable source of heating or cooling mediums. Such sheets are adapted for use to form walls, ceilings and floors of buildings, railway cars, aeroplanes, cold storage units or the like.

The object of the invention is the provision of inexpensive and effective laminated fibrous sheet products provided with a system of pipes embedded between and within its laminae, and to be used for the adaptations described.

Another object is the provision of a method for manufacturing such laminated fibrous sheet products including embedded pipes, wherein crushing of the pipes is avoided when relatively high pressure is applied to effect the consolidation of the stack of constituent relatively thin sheets or blanks, used in the manufacture of the thick sheet product.

In carrying out one of the preferred embodiments of my invention, ligno-cellulose fiber is first prepared from wood chips or equivalent by subjecting same to hydrolysis and fibrillation treatment, preferably by subjecting wood chips to the hydrolyzing action of high-pressure steam and explosion by means of a gun such as described in U. S. Patent No. 1,824,221. Other conventional modes of hydrolyzing ligno-cellulose material may be used, and reduction to fiber can also be accomplished mechanically as by grinding, etc.

The hydrolyzed fiber is felted into blanks and passed through a drier, such as a "Coe" drier, for example. These blanks are quite porous and relatively light in weight, having a specific gravity of about 0.4 and are about .4 inch thick, for example.

In making the sheet product from the blanks, several blanks are placed in a stack with a system of pipes, preferably copper tubing, placed at the desired position in the stack. The inlet and outlet ends of the pipe system extend beyond the edge portions of the stack so that the ends of the pipes may be readily coupled to other pipes. The number of blanks placed in the stack is dependent upon the thickness desired in the final product. If a sheet product is intended to be made with 8 blanks, then the pipe system is preferably placed between the fourth and fifth blanks. The thus-arranged stack is ready for hot pressing.

Thermoactive adhesive materials may be placed between successive blanks of the stack which is to be subjected to the pressing operation. This is

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desirable to obtain the best possible laminated sheet products. Various adhesive materials having thermoactive characteristics may be used, preferably those which tend to fuse and set at temperatures in the approximate temperature range of 100°-160° C. Thermosetting phenolic adhesives, as for example "Tego," which is obtainable in film or sheet form and sets at a temperature of about 135° C., are well adapted for this purpose.

The pipes are preferably copper tubing although any suitable piping material may be used. Copper tubing about 1/4 inch in internal diameter is well adapted for the purpose but the pipe diameter may be varied depending upon the amount of heating and cooling fluid to be circulated therethrough.

The stack is placed in a hot platen press. Before applying pressure to the stack, the ends of the pipe system are connected to a fluid pressure medium which will create an internal pressure within the pipes at least substantially equal to or greater than the pressure to be applied to the stack during the pressing step. Such fluid pressure medium may be either a liquid medium, as for example water, molten low-melting point alloys or oil, or a pneumatic medium, as for example air or steam. Hot water or steam under pressure is preferred to assist in heating the interior of the pile during the pressing operation.

After the pressure has been built up in the pipe system, the stack is subjected to hot pressing in the platen press. The pressure and temperature to be applied is dependent upon the characteristics desired in the final product. For example, if a high density sheet product, having, say, a specific gravity of 1.38 is desired, the stack is subjected to pressure of about 1500 p. s. i. with the platens heated to a temperature of about 180° C. until the center of the stack reaches a temperature of about 160° C., after which the compressed stack is chilled to about 65° C. while under pressure, as by circulating chilling water through the platen passages. The pressure is then released and the sheet product removed from the press. If a sheet product having low density, say for example, a specific gravity of .7, is desired, the stack is subjected to pressure of about 34 p. s. i. with the platens heated to a temperature of about 190° C. until the center of the stack reaches a temperature of about 145° C., after which the press is opened and the sheet product removed from the press. It is important that the pressure applied by the pressing platens should not be greater than the crushing strength of the pipes plus the fluid pressure maintained within the pipe system in order to prevent crushing or breaking of the pipes.

During the hot-pressing operation, the relatively porous blanks will flow and be compressed

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around the pipes and the blanks will be bonded together thus securing the pipes in place within the body of the finished sheet product. The blanks will be compressed considerably during this operation, the final thickness of the laminated sheet product being of course dependent upon the platen pressure applied during the pressing.

In compressing the blanks into relatively high density sheet products, it may be desirable to remove a portion of the blanks between which the pipe system is placed to provide a cavity for receiving the pipes in order to avoid forming areas of substantially greater density at the pipe locations as compared to the overall average density of the sheet product.

Use of sheet products, prepared as described above, is illustrated in the accompanying drawing, wherein

Figure 1 is an elevation of a portion of a wall section showing sheet products in panel form with embedded pipes, and showing the ends of the pipes projecting from the edges of adjacent sheets or panels in the wall section and coupled together.

Figure 2 is an elevation of a portion of a wall section showing a modified arrangement of a pipe system wherein the pipes in the several sheets forming the wall section are separately connected to the feed end return lines of a suitable heating or cooling apparatus (not shown), and

Figure 3 is an enlarged sectional view through the sheet products of Figs. 1 and 2 and showing the embedded pipes.

In Figure 1 several sheets 10, having a system of pipes 12 embedded in each sheet, are shown in abutting relationship to form a section of a wall. The sheets are held in position above the surface of floor 14 by means of brackets 16 which are secured to the floor. The upper edges of the sheets are similarly held in a rigid position by means of brackets 18 secured to ceiling plate 20. If desired, means may be provided for holding the separate sheets or panels in alignment, and such means may take the form of a shallow V-groove 21 at one edge of a panel and a conforming V-shaped projection 21' at the opposite edge as indicated in Figure 3.

The ends of pipes 12 of adjacent sheets are coupled together at 22 thus connecting the system of pipes in the several sheets forming the wall section. Upon circulating heating or cooling fluids through the pipes from a suitable apparatus (not shown), the surfaces of sheets 10 will be heated or cooled, that is, the temperature of the surfaces will be raised or lowered.

Open space at the bottom and top of the sheets may readily be closed and the projecting parts of pipes and pipe connections concealed by means of a suitable baseboard 24 and ceiling molding 26.

In Figure 2 we have illustrated a modified arrangement wherein the pipe system 28 in sheets 30 is connected to feed pipe 32 and return pipe 34 of a heating or cooling apparatus (not shown). Valves 36 associated with the pipes of each sheet allow control of the temperature of the separate sheets and closing of such valves will permit separate sheets to be removed from the wall without shutting down the heating or cooling apparatus.

Walls constructed as described are especially suitable for use in prefabricated houses. In such

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construction a wall may be built with a single thickness of the relatively thick sheet products, one inch thick sheets having sufficient load bearing capacity for the partitions of a small house. With heating or cooling fluid mediums flowing through the pipes, the surfaces of both sides of the sheets will be heated or cooled and serve to heat or cool the space on both sides of the wall.

If such sheets are used for inside wall surfaces on outside walls, suitable insulation of the reflecting type is preferably placed between the back of the sheets and the outside wall surface.

The above procedure and product may be modified but the invention embraces modifications coming within the spirit and scope of the claims.

We claim:

1. The method of making sheet products including a system of pipes embedded therein which comprises lacing a multiplicity of relatively porous fibrous blanks in a stack with a system of pipes placed between blanks of the stack, applying fluid pressure to the interior of the pipes, and compressing the stack under heat and pressure to consolidate the stack into an integral laminated sheet product while maintaining the pressure in the pipes.

2. The method as described in claim 1, and wherein the pressure maintained in the pipes plus the crushing strength of the pipes is at least equal to the pressure applied to consolidate the stack.

3. The method as described in claim 1, and wherein the pressure maintained in the pipes is at least substantially equal to the pressure applied to consolidate the stack.

4. The method as described in claim 1, and wherein the specific gravity of the blanks is about .4 prior to consolidation and the specific gravity of the finished sheet product is greater than 1.

5. The method as described in claim 1, and wherein the pressure medium applied to the interior of the pipes is a heated fluid which will heat the interior of the stack.

6. The method as described in claim 1, and wherein the pressure medium applied to the interior of the pipes is water.

7. The method as described in claim 1, and wherein the pressure medium applied to the interior of the pipes is a heated fluid which will heat the interior of the stack and the pressure maintained in the pipes is at least substantially equal to the pressure applied to consolidate the stack.

8. The method as described in claim 1, and wherein an adhesive film is placed between the blanks of the stack.

9. The method as described in claim 1, and wherein a portion of the blanks is removed to form a cavity to receive the pipes.

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REFERENCES CITED

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

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2,160,108	Reid	May 30, 1939

Certificate of Correction

Patent No. 2,465,348.

March 29, 1949.

ROBERT M. BOEHM ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 4, line 19, claim 1, for the word "lacing" read *placing*;
and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of October, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.