Dec. 7, 1937. R. N. HARTZELL 2,101,542

METHOD OF COMPRESSING WOOD

Filed Aug. 2, 1935

FIG. 1

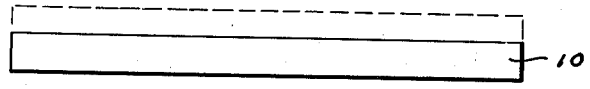



FIG. 2

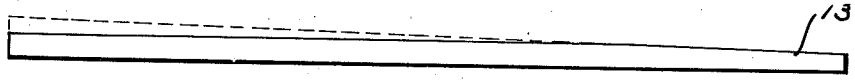
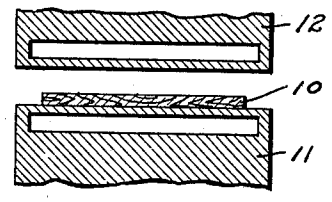



FIG. 3



FIG. 4

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# UNITED STATES PATENT OFFICE

2,101,542

## METHOD OF COMPRESSING WOOD

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1 Claim. (Cl. 144—309)

This invention relates to the treatment of wood and the production of wooden materials, where high strength per square inch is an important consideration.

One object of the invention resides in the process of compressing natural wood to a very large degree to produce a large increase in its unit strength.

Another object of the invention is the provision of wooden material in which the fibers have been greatly compressed, and in which the original strength of the fibers in resistance to compression, tension and bending forces has been maintained.

Other objects and advantages of the invention will be apparent from the following description, the appended claims and the accompanying drawing, in which—

Fig. 1 is an end view of a piece of wood compressed in accordance with the present invention, showing the original cross-section of the wood in dotted lines;

Fig. 2 is an elevation of a lamination board such as is employed in the construction of an aircraft propeller or the like;

Fig. 3 is an end view of a wooden propeller blade built up of laminated boards compressed in accordance with the present invention; and

Fig. 4 is a sectional view of a portion of a press employed in carrying out the invention.

The present invention is herein described with respect to the construction of a built up or laminated wooden propeller blade for aircraft use although the invention is susceptible to many other modifications and uses. In accordance with the invention, it has been found that a wooden board may be compressed to a thickness of only about 60% of the original thickness of the board, the compressed board having substantially the same resistance to compression, tension and bending forces as the original piece of natural wood. In other words the maximum compression and tension forces per square inch of the compressed board is about 166% of the corresponding maximum forces of the natural wood. In compressing the wood the process is such that there is sufficient time given for the fibers to move rather gradually into closer or more compacted relationship, although this time factor is very short as compared with extended heat treatments in order that the fibers will not be rendered brash or brittle.

The preferred way of compressing the board is to subject the board to heat and then to combined heat and pressure in a press capable of producing high compression forces. Referring more particularly to the drawing, and as shown in Fig. 2 for example, a piece of board 10 of natural wood, which may be an inch or so in thickness, and in which the grain is preferably quartered, is placed on a metal platen member 11 of a press of any suitable construction. This member is heated as by steam or in any other suitable manner to a temperature of about 300 degrees F. The movable pressure member 12 of the press is also heated to the same temperature and in a similar manner. The pressure member 12 is moved down onto the board and a comparatively small pressure of about 30 pounds per square inch or so is applied and maintained for twenty or thirty seconds or so to heat up the board thoroughly. This pressure may then be increased without relieving the same although it is preferred to first relieve this initial light pressure by moving the pressure member 12 entirely away from the board for an instant, thus permitting the release of any steam from the board. However, this release of the pressure is only for a few seconds or so and not long enough for the board to cool off.

The pressure member 12 is then caused to move down again on the board and this time a considerably greater pressure is applied. For example, a pressure of about 300 pounds per square inch is now applied, the temperature of the members 11 and 12 being maintained at about 300 degrees F., the combination of heat and pressure serving to render the fibers yieldable and deformable without, however, destroying their character or their strength. After holding the pressure of about 300 pounds per square inch applied as above described, the holding time varying somewhat in accordance with the particular character of the wood but preferably being twenty or thirty seconds or so, the pressure is again released to zero for a few seconds. The pressure is then again applied, this time being increased to about 700 pounds per square inch. That is,—the initial pressure applied in this last step is about 700 pounds per square inch, although this pressure rapidly causes the reduction in the thickness of the board and the pressure therefore lowers rapidly. The pressure member 12 is therefore moved down still further so as to maintain the pressure of about 700 pounds per square inch until the reduction of the thickness of the board no longer takes place at a rapid rate. When the pressure decreases comparatively slowly, the pressure member 12 is raised in order that the fibers will not be compacted to such an extent as to cause their complete or partial destruction.

The complete time required in compressing a

board is only about a minute and a half, the entire process being carried out at such a rate that the fibers will not be unduly heated for any extended time. Any protracted heating of the fibers under the applied pressures would produce brittleness and considerable loss of strength, but it has been found, with the temperature mentioned, and with the comparatively short time of application of only about one and a half minutes that an undue or destructive heating of the fibers is not produced.

If desired the pressures mentioned of about 30, 300, and 700 pounds per square inch may be considerably varied and an additional step or steps can be employed so as to use, for example, an initial pressure of about 20 pounds per square inch and employing three additional steps of about 200, 500, and 700 pounds per square inch, still keeping the time short and not much in excess of one and a half minutes for the entire operation.

The process as above described may be carried out on natural wood of various types. It has been found that there is practically no loss in strength of the individual fibers in pieces of birch, oak, white pine and other hard woods and soft woods which have been compressed in accordance with this invention. In fact, with some woods, white pine for example, there is a material increase in the ultimate strength per square inch in the compacted or compressed wood.

In its preferred form as applied to propeller blades the process is carried out on natural wood boards in such a way as to give a variable density at different points, as desired. The entire board strip such as is used in the construction of a laminated aircraft propeller may be uniformly compressed in order to give less bulk with the same strength, but, as may prove advantageous in many instances, only a portion of the board may be compacted to the maximum extent as set forth above, while other portions are compacted to a much lesser degree, some portions, in fact, being left in their original state. Thus as shown in Fig. 2, the board lamination 13 may be originally cut somewhat wedge shaped as shown by the dotted lines which indicate the original shape of the piece, and the pressure is applied in a graduated manner by moving the pressure member 12 down under pressure while maintaining its lower surface horizontal. This gives a compacting of the left-hand or thicker end of the board, which can be used for the hub portion of the blades, while the right-hand end of the board is left in its original or natural condition, this end serving to make an outer or tip portion of the blade where the latter does not have to assume the large bending forces that are applied to the hub portion. This invention is especially useful in the construction of adjustable pitch blades, the hub portions of which are preferably made round in cross-section and operate in ferrules or the like or in a hub construction in which they are held in an adjustable manner so that the pitch of the blades can be varied as desired. The inner ends of such blades, where the blades are made of natural or untreated wood, are quite bulky in order to withstand the necessary bending and other strains applied to them. But by compacting the wood used in the construction of the inner end of the blade, this portion of the blade can be made comparatively small, although having adequate strength.

In some cases where the particular design of an airplane propeller blade has been found to require added strength at any particular location outward of the hub portion, wood used in the construction of such a blade may be made thicker at such location and then compressed at that particular location to provide the required high strength.

It has been found desirable, in order that the compressed wood will maintain its compressed character, that the surface of the compacted wood be treated with some material to prevent the entrance of moisture into the wood. For this purpose the exterior surface of an article made from laminated boards compacted in accordance with the present invention, or the individual boards themselves, are preferably given a coating of bakelite, varnish, or other moisture resisting material.

While the process and article herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise process and article, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claim.

What is claimed is:

The method of making a laminated propeller comprising forming strips of wood of tapering thickness, heating and compressing the strips to produce graduated degrees of compression with the greatest degree at the thicker portions of the strips, the heating and compression to which the strips are subjected being carried out at a temperature of about 300° F., at a time of about a minute and a half and a maximum pressure of about 700 pounds per square inch, so as to permanently compress the fibers progressively to various degrees at various points along the length of each strip while maintaining the strength of the fibers, and gluing the strips together to form a propeller blade with the denser portions of the blade being used for the hub portion.

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