(21 years with a right of renewal) or long term Crown leases, i.e., renewable leases.

The disposal of forests upon a leasehold is governed by the conditions of the lease, and subject to these conditions arrangements may be made between the lessor, lessee and mortgagee which are mutually agreeable when a transaction affecting the forests is contemplated.

In the absence of expressed provisions in the lease the rights of the lessor and lessee regarding forests are determined at common law. These common law rights will not be discussed here, but the general property in timber trees is in the lessor subject to the right of the lessee to fell timber for the purpose of repairing buildings and fences, mending implements, and for the purposes of fuel if sufficient dead trees are not available. There is a considerable amount of case law dealing with the rights of the lessor and lessee in respect of timber both abroad and in New Zealand. The New Zealand case law includes some difficult judgments which appear to the writer to conflict in some cases, and which need interpretation.

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PLYWOOD

By J. L. HARRISON-SMITH.

Introduction.

The history of plywood and veneer can be traced back to about 2000 B.C., for articles so constructed have been found in the tombs of ancient Egypt.

In the modern sense, plywood is the term given to a panel made up from a number of thin sheets of wood glued together with the grain of adjacent layers at right angles, while veneer is usually understood to mean an outer sheet of valuable wood glued to a backing of wood of a commoner sort. The backing may be either one board or plywood. However, the term veneer is also used in plywood factories to denote the single thickness of wood before it is made up into plywood.

In Europe absurd prices are paid for logs that will produce the very highest classes of veneer and the writer has been told of a log
changing hands for as much as £6,000. Further, almost all parts of a tree can be used for veneer as distinct from plywood and the best figured wood is obtained from stumps, crotches and burrs. For ordinary plywood only the clean part of the trunk can be used.

Cutting the timber is done in several ways and the earliest was sawing. During the last 50 years the slicer and the rotary cutter (lathe) have been developed. The slicer works on much the same principle as the carpenter’s smoothing plane. There are two types, one in which the knife moves and the other in which it is stationary and the wood is moved past it. In the rotary cutter the timber is turned round as in an ordinary lathe and a knife peels off a thin sheet, advancing towards the centre as cutting proceeds.

The manufacture of plywood or three-ply is not new to New Zealand. The Ellis Veneer Company has been in operation for about 33 years and in 1941 Messrs. Fletcher Holdings formed N.Z. Plywoods in Auckland. More recently Messrs. Henderson & Pollard have established a factory, also in Auckland. The writer was at one time on the staff of the Fletcher organization and is indebted to the Directors for permission to publish a description of the many processes used in the factory at Penrose.

**Species Used.**

Before going on to describe manufacture it is necessary to say something about the class of timber used. In this country the principal species are rimu and miro, the latter being classed as rimu, while white pine and matai can be used and make good plywood. Totara, on account of its high price as sawn timber, is seldom used; the same applies to kauri. Of the secondary timbers tawa and taraire work well but require careful handling in the log while silver beech, rewarewa, hinau, mangao and various others can be used if there is a market for the product. At the time of writing white pine is controlled and there is none available for plywood.

The main use for white pine in this industry is in the manufacture of “scale-boards” used to separate cheeses in a crate and in the making of strawberry “chips.” For these purposes the veneer is peeled off very thinly, often down to 1/80 of an inch.

Not every log in the bush is suitable for making plywood and in rimu, miro and matai it is a very good bush that gives 40% of “peeler” logs. These must be reasonably round and with not too much taper, straight in the grain, free from knots, shakes, bark pockets and similar defects.

The usual system followed at the Penrose factory is to buy logs from sawmillers and bush contractors and owing to the fact that the miller is left with the rough logs it is necessary to pay a far higher price for “peelers” than for saw logs. It takes some time to educate suppliers into what is and what is not a peeler log and differences of
opinion between buyer and seller are apt to occur. There is a great deal of waste in a rough log and unless the standard is kept high the recovery or conversion factor falls rather quickly.

The factory at Penrose is divided into a number of separate departments and these will be described in the order in which the timber passes through them.

**Preparation of Logs.**

Logs arrive on flat top railway wagons and are unloaded by a gantry type crane and stacked in the log yard. Dimensions are checked and the logs indexed.

Rimu, miro and matai will keep for three or four months during the winter, but such timbers as tawa and beech are liable to open up at the ends. This can be largely obviated, however, by sealing the ends with a paint made from old engine oil and lime. It is mixed into a workable paste and applied with a whitewash brush. Silicate of soda also makes a satisfactory paint.

The next process is the cutting of the logs into suitable lengths according to the particular size of plywood being made at the time. This is done with a power cross-cut saw. Logs are rolled on to a set of live rollers which move them under the saw. The ply length is cut off and rolled out of the way and the log moved up for another cut. The saw is driven by a 15 H.P. motor and cuts a three-foot log in about 50 seconds.

From here the ply lengths are picked up by a crane and lowered into vats for “cooking.” The vats consist of concrete troughs about 10 feet deep into which the logs are stacked. When full a lid is put on and the logs steamed or steeped in hot water sufficiently to heat them to the core. Without this process few timbers could be successfully peeled on the lathe. The time required varies with the species and size of the logs. With rimu of 3 ft. diameter about 36 hours are required but for hard or “boney” logs this must be increased.

**Peeling.**

After steaming comes peeling on the lathes. If the log is free from defects the veneer comes off in a continuous sheet just like unrolling a sheet of newsprint. The two lathes at Penrose are capable of handling logs 8 ft. 4 ins. by 5 ft. in diameter and 7 ft. 4 ins. by 4 ft. respectively. The extra few inches allow for trimming so that full 8 ft. and 7 ft. sheets may be produced. The larger lathe is driven by a 75 H.P. motor and the smaller by a 50 H.P.

Before being put on the lathe the ply lengths are barked and brushed free of dirt for grit is fatal to the knife. Then the length is lifted by a crane and lowered between the chucks of the lathe. When centred the pressing of a button causes one spindle to advance and engage the centre of the log while pressing it on to the other
chuck. The log is then held as in any wood turning lathe with the exception that there is a drive from each end. Then, with a final brushing to remove any remaining dirt, the clutch is thrown in—the motor runs all the time—and the still steaming log begins to rotate.

The knife is advanced towards the log by an adjustable mechanism, permitting the selection of 20 different thicknesses of veneer from 1/40th to 9/16th of an inch. As soon as the knife reaches the log peeling commences with the production of small pieces of veneer from the “high spots.” These rapidly increase in size and when useful dimensions are reached they are removed to a table fitted with conveyor chains. Small pieces are dropped through a hole in the floor on to another conveyor chain and eventually reach the boilers as hugged fuel. The large pieces are stacked on the table until there are a dozen or so and then the lathe operator presses a button and the conveyor chains move the pile along.

As mentioned before, if a log is perfect the veneer comes off as a continuous sheet. But unfortunately few logs are perfect and the usual practice is to “break” the sheet by tearing it from one side to the other once in every revolution. The break is made at the most serious defect which may be a shake or bark pocket, for no matter how good a log looks on the outside some sort of blemish is sure to show up as peeling proceeds.

The sheets are piled up one upon the other and then moved by the conveyor and finally reach the other end of the table where the “clipper” is situated. This is a power operated guillotine and its function is to cut the veneer into suitable sizes. Clipping is done to standard widths according to the size of the plywood sheets that are being made. This will be further explained later.

It should be realised that not all the log can be converted into veneer. There remains the centre or core of a size governed by the diameter of the chucks which spin the log. It will be evident that the knife cannot be allowed to advance far enough to touch them and automatic stepping gear is fitted to prevent this.

With large logs the chucks must be fairly wide to gain sufficient grip and the largest in use are about 9 ins. in diameter. Thus when using these chucks a core of slightly larger diameter is left. With smaller logs chucks down to 5 ins. across the face can be used on the small lathe. However, it often happens that defects make it necessary to discard the core before it reaches the minimum.

The fact that the cores are of heart timber makes for a ready sale. Those that are not sawn into boards may be used for fence posts or sawn for fence battens, box timber, etc.

**Drying Veneer.**

The next process is the drying of the veneer and this is done by feeding the clipped sheets into either of two drying machines. Here the sheets pass over hot rollers in one machine, hot plates in the other,
and by the time they reach the further end the moisture content is reduced to about 14% of the oven dry weight. Moisture content is checked by an ingenious instrument which depends for its action on the electrical conductivity of the wood. It gives a reading direct on a meter which must be calibrated for each species of timber if values closer than 1—2% are required.

We must now discuss the actual structure of a sheet of plywood. Firstly we have the "face" or outside of the sheet which is the visible part of an article made of plywood. This, except in the cheapest grades, must be a continuous sheet free from defects. Next comes the centre or "cross banding" and the grain of this is laid at right angles to that of the face. The cross banding is made up of narrow sheets laid side by side and here is the opportunity for working in all the narrow strips produced when cutting out defects at the clipper. Seven inches is the minimum width used. Lastly there comes the "back" and this may be one sheet or it may be made up of a number of narrow strips. In the latter case the back is built up first to the full size required by sticking narrow strips together, edge to edge, with adhesive paper tape. Strips are fed into a machine which forces the edges together and applies the tape: there are also tapeless jointers which use glue only to achieve the same result.

The built up backs are then ready, together with the cross banding and the faces, for the glueing process.

**Glueing.**

Glue is applied only to the cross banding. The backs are first laid flat beside the glue spreader. The cross banding is then put through the spreader, one piece at a time. The spreading machine is composed of two revolving rollers dipping into troughs of glue. The glue is thus distributed over the surfaces of both rollers and when a sheet of cross banding is run between them it receives a coat on both sides. To get good results it is necessary to control rigidly the amount of glue applied. The glued sheets are then placed side by side on the back until the panel is made up. Then the face is placed on top and the panel is ready for the press.

To facilitate handling into the press each newly glued panel is placed on a "caul" which is a sheet of aluminium or plywood slightly larger than the particular panel being made. The use of the cauls prevents any possibility of displacing the sheets of the newly made up panel, for the glue has but poor adhesive properties when wet.

**Pressing.**

Two presses are used. They consist of a series of steam heater plates (technically platens) 100 ins. by 50 ins., which are free to slide up and down. The cauls, carrying the newly glued panels, are placed in the "daylights" between the platens of the press; when full, a number of rams rise from underneath and force the platens together.
The rams which are operated hydraulically are so regulated that the pressure on the plywood is from 150 to 200 lbs. per sq. inch, according to the species of timber being used. This calls for between 2,000 to 3,000 lbs. per sq. inch in the rams and the pressure is kept up by an electrically operated pump and relay. Control of both pressure and temperature is effected automatically by a system similar to the Foxboro' controls used in drying kilns.

When the sheets have been in the press the correct time—and timing is important—a bell rings, pressure is released and the rams sink into the floor allowing the platens to separate. The load is then taken out and after a new charge has been inserted the sheets of plywood are taken away and stacked.

**Drying and Trimming Plywood.**

The next process is drying in a kiln somewhat similar to those used for timber except that there is no steam, warm air only being employed. The sheets are stacked on trolleys and fed into one end of the kiln, the individual sheets being separated by light frames so as to allow the free passage of air. The time in the kiln is about 24 hours.

Trimming the sheets comes next and is done on two saw-benches set at right angles to one another. Each bench has two saws per spindle and the distance between them is varied according to the width and length of the panels being made. The benches are peculiar in that the saw spindles are above the work and not below as usual. The saws are about 12 inches in diameter and run at 3,000 R.P.M. The sawdust, which is very fine and dry, is removed by a suction system similar to that used with planing machines.

After trimming, the sheets are graded and stacked and the ones suitable for sanding are picked out. The sanding machines have special feed arrangements for handling the large thin sheets. One machine can do two sides at once, the other one only.

Finally there is the despatch department where the plywood is crated ready for shipment.

Though the above completes the description of the various processes employed it might be of interest to mention a few details of the accessory equipment.

All waste timber, bark, veneer trimmings and short ends of logs are used for fuel. The waste veneer passes through a special hog which reduces it to chips. It is then elevated to fuel bins above the boilers and gravitated to Dutch ovens as required. Shavings and sawdust from the neighbouring joinery factory are also brought over by a suction system and deposited in the same bins. The amount of waste from a plywood factory is inadequate to provide steam for all the processes and alternative fuels have to be kept on hand.

The boilers are Babcock & Wilcox and run at a pressure of 150 lbs. per sq. in. A smoke stack 120 feet high makes forced draught unnecessary.
The glue is mixed on the floor above the spreader. A laboratory where regular testing of both glue and plywood is carried out is also on this floor. There are many types of glue suitable for making plywood and the number is increasing all the time. In America in particular, research workers are paying considerable attention to the subject. The two main types are those with a casein base used for plywood that will not come in contact with water and the synthetic resin glues that are more or less waterproof. Both types are in use at Penrose, the waterproof phenol formaldehyde board being exclusively for war purposes and not yet available to the public.

The lighting system of the factory is of interest. It is of the neon type with florescent powder inside the tubes. The light is very like daylight and one does not realise that it has been in operation until turned off.

All transport within the factory is by hand operated lift trucks capable of being run under trays on which the veneer etc. is stacked so that tray and all is moved about.

The present output of the factory is over a million square feet of 3/10 in. three-ply a month and about half of this is of the waterproof type.

The Future.

In these uncertain times it is not easy to discuss the future of the industry and in any case the writer is now out of touch to some extent.

The present high price—about 45/6 plus sales tax per 100 square feet for 3/10th heart three-ply—will restrict sales in the building industry, for wall boards are much cheaper. But there are other uses, as in the furniture trade, where there is no substitute as yet.

At the other end of the operation there is the ever present difficulty of procuring peeler logs. As already remarked, millers are not keen on parting with their best logs and the great majority refuse point blank even to consider selling, in spite of the excellent price offered. It would seem that sooner or later use will have to be made of exotic species and in the years to come there should be a supply of pruned timber which will at least partly make up the supply.