C. S. I. R.

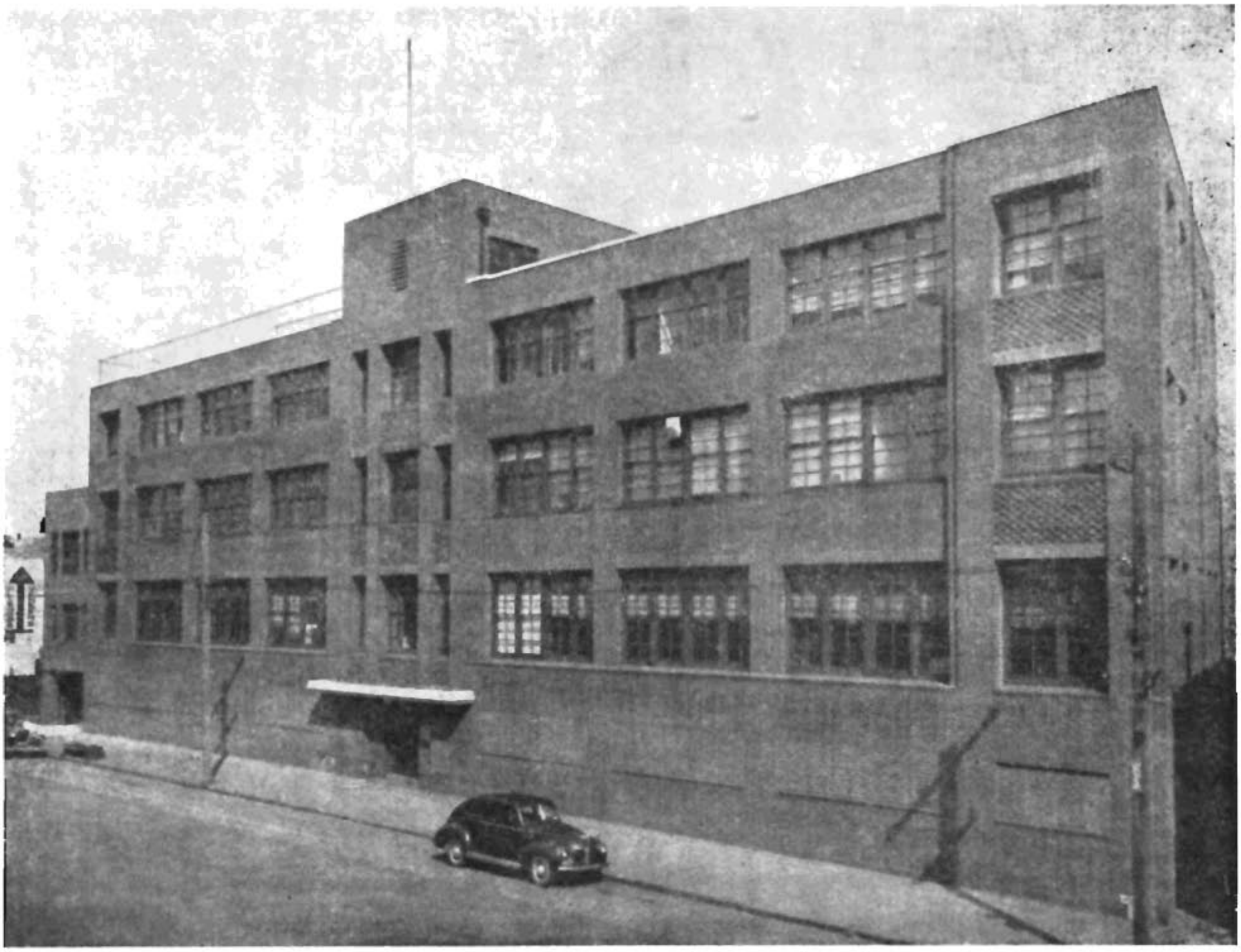
FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

No. 148 — 1947##148 — January, 1947

THE DIVISION OF FOREST PRODUCTS

(The following article is the first of a series in which it is proposed to discuss the organization and functions of the Division of Forest Products. It is considered that many readers of this News Letter do not have a full appreciation of the nature of the work of the Division and of the way in which it is carried out. These articles, therefore, should prove of considerable interest to many.—Ed.)



The Division of Forest Products forms one of the Divisions of the Council for Scientific and Industrial Research, an organization which has grown tremendously during the past decade, and which is now very well-known in Australia. The subject of forest products was early considered as one in which the Council should interest itself, and the Division of Forest Products was in fact the first Division of the Council which devoted its activities to secondary industry. It was formed early in 1929, with Mr. I. H. Boas, who is well-known to the timber trade throughout Australia and in other parts of the world, as its first Chief.

It is perhaps not so well-known that Mr. Boas had in 1919-1920 been in charge of the Forest Products Laboratory in Perth, Western Australia, which was a part of the old Institute of Science and Industry. During the period 1920-1929, the research activities in forest products were confined to chemical investigations, and it was during this time that the various officers of the old Institute of Science and Industry carried out the bulk of the early work on the pulping of eucalypts and *Pinus radiata*. In addition, a considerable amount of work was done on tannin investigations, culminating in the establishment of a semi-commercial tannin extract plant in Western Australia in co-operation with W.A. Forests Department.

Prior to the formation of the Division, two officers were sent abroad as research students under the Science and Industry Endowment Fund to the Forest Products Laboratory, Madison, Wisconsin, U.S.A. Officers who had received their training in the State forest services joined the staff, more officers were sent abroad for training, and gradually a staff was built up of officers who had a fundamental training in forest products research. Thus in the early stages of the life of the newly formed Division growth was not rapid, the work carried out being aimed at giving maximum assistance to the timber trade in problems related to seasoning, utilization and preservation.

From 1929 to 1936 the activities of the Division were carried out in the coach houses, sheds and stables of the old building at 314 Albert Street, East Melbourne, which was and still is the headquarters of the Council for Scientific and Industrial Research. At the end of 1936, however, the transfer was made to the present building in Yarra Bank Road, South Melbourne, which is shown in the accompanying illustration. The Division has grown and expanded on this site for a period of just over 10 years, developing from a nucleus into an organization employing nearly 200 individuals.

Mr. I. H. Boas retired as Chief of the Division in March, 1944, and Mr. S. A. Clarke, who had been Deputy-Chief for many years, took over as the new Chief. The Division is divided into a number of sections in which the various problems relating to forest products are investigated. These sections follow fairly closely the lines of sectional divisions in the Forest Products Laboratories of the United States, Great Britain and Canada and are set out in the following tree:—

the field in which he is particularly interested, and he directs the work of the other officers and organizes the investigations, arranging, where necessary, co-operation with other Sections. All the Sectional Officers-in-Charge are directly responsible to the Chief of the Division.

Such an organization calls for quite an extensive administration staff and there are, as can be imagined, a number of necessary ancillary services. No research organization is complete without a library, and the library of the Division of Forest Products is, it is claimed, the most extensive in this field in the Southern Hemisphere. Two trained librarians are on duty all the time, and they are available to assist both officers of the Division and members of industry who call to consult the large amount of material held in the library. The Division has, of necessity, a large typing staff, and a publications branch dealing with the editing and distribution of reports, articles for publication, Trade Circulars and the News Letter. There are also well-equipped engineers' and instrument makers' workshops, in addition to an extensive wood-working shop. Research into forest products calls for considerable equipment and material, and a lot of this has to be manufactured on the premises.

The Division was established in order that it might assist all those who are concerned in the utilization of timber or other products of the forest. It invites enquiries on any problem associated with forest products, and although those lines of investigation which promise advantage to the greatest portion of the timber industry must be given precedence, some measure of assistance is always available on all problems submitted.

The Division works in close association with State Forest Services, some of which have established forest products staffs of their own. The programme of work of the Division of Forest Products and these State services is closely integrated to avoid overlap and to give the maximum of service to the timber industry.

- Chief
  - Assistant to Chief (Administration)
  - Assistant to Chief (Publications)
    - Section of Wood Structure
    - Section of Wood Chemistry
    - Section of Timber Physics
    - Section of Timber Mechanics
    - Section of Seasoning
    - Section of Preservation
    - Section of Veneer and Gluing
    - Section of Utilization
    - Liaison CSIR Section of Mathematical Statistics

Each of the Sections listed above is under the control of a Section Head or Officer-in-Charge, who has a number of research officers, technical officers, assistants and junior assistants under his control. The Officer-in-Charge is responsible for the planning of the investigations within

In later articles in this series attention will be given to the organization and work of the individual Sections.

SAW GUIDES FROM IMPROVED WOOD

Saw guides are pads which are made from material such as hardwood or anti-friction metal and which rest against the sides of the band saw blade and steady and guide it near the cutting position. In machines such as twin horizontal band re-saws the conditions of service are severe and it has been difficult to obtain a satisfactory material for the guides.

Cast or rolled brass plates have been used, but have the following objections. Brass from the guide is rubbed on to the surface of the rapidly moving saw blade and builds up a deposit there; this has to be ground off. The friction between the saw and the guide is so great that the heat generated affects the "tension" and also causes small cracks at the rear edge of the saw. Under severe conditions the wear in the saw guides is such that they have to be removed every two hours and re-shaped before replacement.

Experimental saw guides of improved wood were made up at the Division of Forest Products and have now been tested for several months in a twin horizontal band re-saw at a Port Adelaide, South Australia, mill. These guides have given very satisfactory results. Not only did they stand up very well in service, but they have the added advantages that much time is saved from saw hammering to renew tension, and it is no longer necessary to grind off the brass. Cracking at the rear edge of the saw has been reduced to a negligible amount and the life of the saw is estimated to have been increased by 50 per cent.

Information regarding improved wood for this purpose is available from the Chief, Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne.

SYNTHETIC RESIN ADHESIVES

IV—Phenol-formaldehyde Resins.

(*Compiled by A. W. Rudkin, Veneer and Gluing Section*)

Undoubtedly the most durable wood adhesives in wide use up to the present time (December, 1946) are the phenol-formaldehyde (p.f. or P/F) resins, more often referred to as "phenolics." They are at least as durable as the urea-formaldehyde resins (described in a previous article of this series—News Letter No. 146) under all ordinary conditions, and show greater resistance to elevated temperatures, and to warm, humid atmospheres. For this reason they are superior to the u.f. resins for the manufacture of plywood for external use, especially in tropical climates.

Phenolic bonded plywood can be boiled in water for several hours without delamination. Although the strength of the plywood is reduced by such treatment, it is found that failure during test occurs mainly in the wood fibres, showing that it is the wood rather than the bond which is attacked. Phenolic bonded plywood exposed to severe accelerated weathering tests and to the action of moulds in warm, humid atmospheres has been found to undergo deterioration through decay and face checking rather than through delamination, showing that in these conditions also the bond is stronger than the wood.

Nevertheless the phenolics suffer from certain disadvantages as compared with the urea resins, which have prevented their ousting the latter from applications where high resistance to heat and warm, humid climates is not required. The chief of these disadvantages are:—

(1) Relatively high cost. Although, as in the case of the u.f. resins, the cost per unit area of glue line can be reduced considerably by the use of extenders or fillers, this reduces water resistance and so offsets the advantage of using a phenolic. In applications where an extended phenolic can be used it is usually equally effective and more economical to use a u.f. resin.

(2) High setting temperature. Whilst no u.f. resin requires platen temperatures higher than 240° F., and many will set at 70° F., very few phenolics will set below 280° F., and they usually require temperatures of 300°-320° F. for best results. This not only adds to costs of power, but also increases the risk of blistering (imprisonment of pockets of vapour in the glue line), warping and buckling. The danger is not entirely removed by dry gluing technique (using the glue in the form of a dry powder or, more usually, a film) because the moisture in the wood is largely vaporized at the pressing temperature, especially if pressure is released whilst the assembly is still hot, and a certain amount of water is formed as a by-product of the setting reaction. The danger can be eliminated by methods which will be described in a future article on hot press technique, but these methods add still further to costs.

High setting temperature completely rules out phenolics for use in very thick assemblies, unless "electronic" heating can be applied. So-called "cold-setting" phenolics, usually incorporating resorcinol, have been developed, but they are only "cold-setting" by comparison with the commoner types, requiring temperatures in the region of the boiling point of water or somewhat higher for best results. Moreover, they are more costly and are said to be at present somewhat less reliable in service than the "hot-setting" types.

The principal ingredients used in the manufacture of the early P/F resins were phenol and formaldehyde, hence their name; but the phenol is now often partly or wholly replaced by other substances of similar chemical constitution, such as the cresols or the complex phenols obtained from certain vegetable oils, such as cashew nut shell oil; and the formaldehyde may be wholly or partly replaced by any other aldehyde, such as acetaldehyde, or a substance which decomposes on heating to form formaldehyde. Various chemical reagents, such as caustic soda and certain sulphonic acids, are added at various stages during manufacture to modify the rate of reaction. Other substances (water, alcohol and fillers) may be added to modify the viscosity and other characteristics of the resulting mixture. The chemical reaction between the phenol and the aldehyde is not completed during manufacture, otherwise a substance resembling bakelite would be produced; but the reaction is completed during pressing by the application of heat, with or without a catalyst ("hardener"), to form a hard, infusible substance which is highly resistant to heat, moisture, fungi and bacteria, and all common solvents.

The hardener for "hot-setting" phenolics is usually an alkali; and for the so-called "cold-setting" types, an acid, usually a sulphonic acid. Since the hardener has little effect on the hot-setting phenolics at room temperatures, these can be marketed with incorporated hardener without seriously shortening the shelf life, and this practice is therefore much commoner than in the use of the u.f. resins.

Like the u.f. resins, the phenolics can be prepared in the form of a powder, a viscous liquid, or a film. They are much more frequently prepared in the last mentioned form than any other type of adhesive; practically all the phenol-formaldehyde adhesive used in Australia at the present time (December, 1946) is in the form of a glue film.

The film has a threefold advantage over other forms:—

(1) It is easier to handle; the only spreading equipment needed is a pair of scissors.

(2) The danger of blistering, warping and other difficulties associated with hot pressing of "wet" glues is much reduced since the glue is practically free from water and other volatile liquids.

(3) Since the resin is in solid form, it is possible to reduce time in the press by carrying the chemical reaction during manufacture of the film to a stage which would render liquid glues far too viscous for use in ordinary industrial practice, and powder glues immiscible with any convenient solvent.

The principal disadvantages of glue in film form are:—

(1) Relatively high cost.

(2) The fact that, for obvious reasons, it cannot be used as a gap-filler, and therefore requires accurately machined surfaces and relatively high pressures.

(3) The fact that it can only be used in flat or simply curved assemblies, i.e., for flat or moulded plywood and simple laminations.

Except for the third, these objections are less serious in the case of phenolics than other adhesives, since they are in any case only used where prime cost and costs of handling are a relatively minor consideration. On the other hand, the second and third of the advantages listed above are more important in the case of phenolics than other adhesives, since the high pressing temperature tends to aggravate ordinary hot pressing difficulties. These facts no doubt explain the popularity of phenolic resin glue films, contrasted with the very rare use of u.f. resins and casein cements in this form.

Pressing times depend on the type of resin used, platen temperature, thickness of assembly, and other factors. As in the case of u.f. resins, it is better to make the pressing time too long than too short. The appended table sets out minimum pressing times for a typical phenolic resin film. Times for a liquid glue or a powder mixed with water, alcohol or other solvent would usually be nearly twice as long.

SYNTHETIC RESIN ADHESIVES—(Continued).

Minimum Pressing Times for a Typical Phenolic Resin Glue Film.

(Based on the use of 16 ga. aluminium cauls. For timber cauls, add their thickness to the depth measurement.)

Depth from caul to furthest glue line in.	Platen Temperatures, °F.								
	280°	300°	320°	280°	300°	320°	280°	300°	320°
	⅛in. core			¼in. core			½in. core		
	Minutes under Full Pressure								
1/28	7	5	5	8	6	4	9	8	6
1/20	7½	5½	5	8½	6½	4½	9½	8½	6½
1/16	8	6	5½	9	7	5	10	9	7
3/32	9	7	5½	10	8	5½	11	10	8
1/8	10	8	6½	11	9	7	12½	11	9
3/16	12	11	8	13½	11½	9	15	14	11
1/4	16	15	12	18	16	13	20	18	15
5/16	—	20	16	—	20	17	—	22	20
5/8	—	24	22	—	25	22	—	28	26

In most important respects except those mentioned, the properties and methods of use of phenol-formaldehyde resins resemble those of hot-setting urea-formaldehyde resins already dealt with in a previous article in News Letter No. 146.

What is the Strength of Timber ?

(Prepared by the Timber Mechanics Section)

8. Toughness and Izod Value.

At the moment the ball comes in contact with the cricket bat, the timber in the bat is subjected to a shock or impact load. So also is a beam when a weight is dropped on it. When, however, a body supports a dead load—for example, the posts supporting the weight of a house—the body is said to be statically loaded. The term "static loading" is also used to cover the gradual and steady loading of a body such as occurs in a static bending test in a testing machine.

The various properties discussed in previous articles are all determined under static loading conditions. It would however be possible to determine similar properties under impact loading conditions, but the present state of knowledge of impact testing in general would not warrant it, particularly as there is considerable doubt as to how the results from standard size specimens could be used for designing the various components likely to experience shock loads in service. The results do, however, give a very useful comparison between species and between pieces of timber of the same species.

In the laboratory of the Division of Forest Products, only two impact tests, toughness and Izod, are carried out, and both of these are impact bending tests, in which a moving weight strikes the specimen, bends it and breaks it. The impact value determined in both types of tests is the amount of energy or work absorbed from the moving weight by the specimen. As the energy absorbed is the product of the average load and the distance through which the load moves, it will be seen that the impact value depends on both the impact load and deflection of the specimen. This dependence on deflection has an interesting outcome in the observed toughness values of green specimens of species which are normally quite low in toughness. For instance, some specimens of radiata pine have recorded quite high toughness values, although generally speaking this species is very low in toughness, especially when dry. The explanation for this is simply that although this species is only capable of withstanding a relatively low impact load, particular specimens do nevertheless deflect to an extraordinary degree and thus absorb as much energy and so are as tough as specimens of a normally tough species.

The two impact tests, viz., toughness and Izod, differ in type of specimen used and method of test, but for practical purposes the values from both tests may be used either for comparing species for shock resistance, or for separating brittle material from normal wood. Brittle wood absorbs much less energy, i.e., it has low toughness and Izod values, and it can be readily seen that such material would have to be culled from timber that was to be used in any part such as axe and hammer handles where resistance to shock is an important property.

It will be noticed that in tables of properties toughness is given as so many inch pounds. This means that on the average, standard size specimens would, in being completely broken, absorb the energy due to dropping one pound through a distance of so many inches. For instance, the well known species, hickory, has a toughness value of about 400 in./lb., i.e., if one pound was dropped from a height of 400 inches on to a standard size specimen of this species it would, on the average, just break the specimen. Izod values which are quoted in foot pounds may be interpreted in a similar manner.

Properties of Australian Timbers.

MOUNTAIN GUM.

Mountain gum is the standard trade common name for the timber known botanically as *Eucalyptus dalrympleana*, Maiden.

The timber is also known by the names of broad-leaved ribbon gum and white gum. It is closely related botanically to candlebark (*E. rubida*) and manna gum (*E. viminalis*).

Distribution.

The species occurring in commercial quantities in New South Wales is widely distributed at altitudes of approximately 3000-4000 feet on the mountains of the central and southern tablelands. It has been recorded in small quantities in Eastern Victoria and Tasmania.

Habit.

Mountain gum grows in the high mountain forests of New South Wales, where it may be found in association with alpine ash and candlebark.

It is a fairly large tree, growing to more than 100 feet in height and attaining diameters up to 5 feet. The bark on the lower part of the trunk is blotched and scaly, the remainder smooth and white in early spring, becoming salmon pink later in the season.

Timber.

The timber is light-brown to pink in colour, straight grained to somewhat interlocked, open textured, with well defined growth rings; the sapwood is pale-coloured and not readily distinguishable from the truewood.

The wood is easy to work, moderately light in weight, averaging 43.9 lb./cu. ft. at 12% m.c. before reconditioning. In drying from the green condition to 12% m.c. mountain gum shrinks 10.3% in the tangential direction (back sawn), and 4.7% in the radial direction (quarter sawn). After reconditioning the shrinkage is reduced to 5% and 2.6% respectively. Both for kiln and air drying the timber should be quarter-sawn, as back-sawn material is very liable to develop surface checks in the early stages of drying. Collapse is less severe than in mountain ash and can generally be removed by reconditioning. The seasoning schedule is similar to that used for mountain ash.

Mountain gum falls into strength group C and is similar in properties to mountain ash.

Durability is tentatively noted as class 4 (similar to mountain and alpine ash), but there are insufficient service records for more accurate rating.

Uses.

Mountain gum is used for scantling and case material, the better qualities being also used for door framing, flooring, lining, weatherboards and similar uses.

Availability.

The supply is limited and the species is commonly cut in association with the "ash" eucalypts.

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No. 149 1947##149 February, 194

SECTION OF WOOD STRUCTURE

(As indicated in Forest Products News Letter No. 148 it is proposed to discuss in turn the work of the various sections of the Division of Forest Products. The Section of Wood Structure is the first to be described.—Ed.)

General view of one of the Wood Structure Labaratories

It may safely be claimed that all forest products research is dependent in some degree on a knowledge of the structure of the wood that is being investigated. Obviously it would be impossible for all the engineers, chemists, physicists, foresters, etc., engaged in timber research work to be experts in the field of wood structure or wood anatomy as it is often called. Therefore, in the Division of Forest Products, as in all forest products laboratories and institutions, a group of specialists has been specially developed. The Wood Structure Section consists of an Officer-in-Charge, assisted by five research officers, several technical officers and a number of laboratory assistants. This team of workers has been gradually built up over the years: in the first place the attention of the Section was devoted almost entirely to problems of structure in relation to identification, but such difficulties having been largely overcome it is now possible to give more attention to such problems as the influence of wood structure on the properties of timber and the submicroscopic structure of the cell wall.

At the present time the Section is following four main lines of investigation. These are (i) structure in relation to identification and the anatomical classification of Australian timbers, (ii) structure in relation to properties, (iii) structure in relation to growth and (iv) fibre structure. The importance of these investigations has been illustrated in the answers to four questions set out below.

1. **What is this timber?** A detailed knowledge of the anatomy of the various timbers of the world is the answer to the problem of timber identification. During the past 16 years a considerable reference collection of Australian and overseas timbers has been built up and the results of the examination of numerous Australian timbers together with methods for their identification have been published. In recent years the work has been extended to cover the timbers of New Guinea and surrounding areas of the south-west Pacific.

In identification work it is necessary to examine the structure of the timber and this is carried out by two main procedures (a) the examination of the arrangement and size of the various elements using a hand lens giving approximately 10 magnifications and (b) the examination under the microscope of thin cross, radial and tangential sections cut from the wood by means of a special instrument called the microtome (see illustration). It is possible to cut these sections as thin as 1/5000th of an inch and they can be stained, mounted on glass slides and filed away for future reference. Under a co-operative scheme with the State Forest Services, the Division prepares sections of timbers for reference by all these bodies and many thousands of slides have been distributed in this way. To assist identification numerous specially designed card sorting keys have been developed and such keys for Australian timbers are at present in course of preparation.

The extent to which the identification service provided by the Section is utilized may be gauged from the fact that approximately 1000 identifications are carried out every year.

2. **Why is this timber so brittle and how can such brittleness be avoided?** The Section has, from time to time, been called upon to answer such problems and, in this particular case, after research over many years, it has been shown that the brittle heart of numerous Australian timbers is closely related to the structure of the cell wall and with the disposition of the cellulose molecules within the cell wall. So much has been found out regarding brittle

Cutting thin pieces of wood

SECTION OF WOOD STRUCTURE—continued

heart that it is possible to suggest ways and means of avoiding such material when selecting timber for exacting purposes.

It is not fully realized how the variation in properties of different timbers or even of the one timber is related to the structure of the wood. It may be that the differences observed are a direct result of variations in the size and arrangement of the elements of the wood; on the other hand, it may be that the differences observed are due to variations in the submicroscopic structure of the cell wall and the arrangement of the molecules of cellulose and lignin within the cell wall. Therefore, it is essential that the reason for any variations be investigated in order to obtain a better utilization of the product. One example of the practical result of such investigations is the way in which it was possible during the war to suggest the replacement of various imported timbers by Australian timbers on the basis of similarities in structure.

At the present time, one major investigation being carried out is the comparison of the structure of the sapwood and truewood of certain Australian timbers. The importance of this needs no stressing because everyone is aware of the different behaviour of sapwood in comparison with truewood of the same species.

3. **Was the wood laid down by this tree during the past two or three years normal or abnormal?** It has become apparent that the growth of the living tree must also be investigated because it is the living tree that is laying down the future timber of commerce. Abnormalities in growth occur and greatly affect the properties of timber. It is possible to tell from the examination of the structure of the wood freshly laid down whether such abnormalities have been developed by any particular tree. The influence of growing conditions is also shown in the structure of the wood and a definite correlation can be obtained between such growth conditions and the gross and fine structure of the wood being formed. In such work the Section maintains the closest liaison with the Commonwealth Forestry and Timber Bureau and the various State Forest Services.

4. **What is the ultimate structure of the eucalypt fibre?** The large and growing Australian pulp and paper industry depends on the eucalypt fibre for its raw material. This fibre is a newcomer in a traditional industry where some materials have hundreds of years of practice behind them. Thus, there is considerable interest in its structure. The work in this field is difficult and calls for the co-operation of the chemists, physicists and botanists in the examination of the fine details of cell wall structure. Chemical and physical methods must be employed and use is made of the optical microscope, the polarizing microscope, the electron microscope, X-ray apparatus, the micro-manipulator and the other tools of the chemist and physicist. For some of this work it is necessary to obtain the co-operation of other Divisions of C.S.I.R.

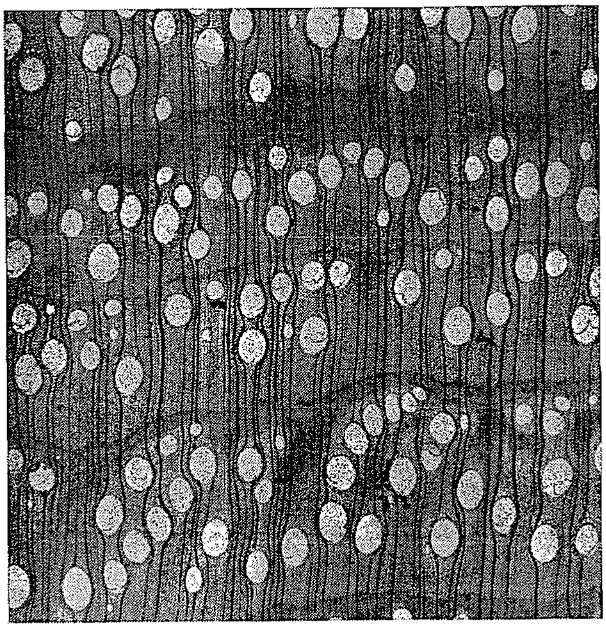
Photography.

In all work on the structure of wood it is necessary to record photographically the details of anatomy revealed by the microscopic examination. Photomicrographs are taken and magnifications up to 1000 have been employed, in some cases 20,000 when the electron microscope is used. It was because of the need for photographic facilities in connection with the work on wood structure that the photographic work of the Division has been closely allied to the Section of Wood Structure and comes under the Officer-in-Charge of that Section. However, during the war and since, the general photographic work has extended considerably and only portion of it now is related to recording details and the results of various experiments carried out by the Section of Wood Structure.

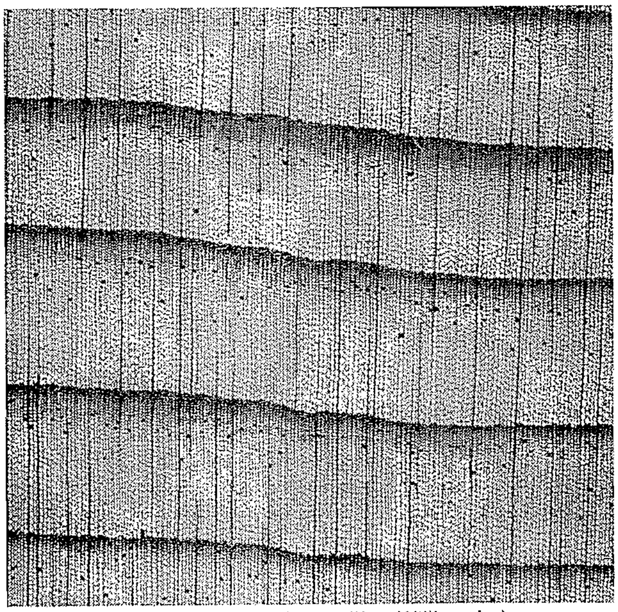
One important development has been in the field of photo-copying and articles published in research and other journals are copied photographically and the prints used by research workers within the Division and outside the Division to help them in their work. This photo-copying service has, from time to time, been extended to industry and in those cases where it is impossible for anyone to obtain copies of the literature required on a particular subject the Division of Forest Products will assist.

Summary.

Summing up it may be said that a knowledge of wood structure is essential to all forest products research, firstly, to check the identity of the material on which such work is being carried out; secondly, to assist in interpreting results because of the relation between variations in structure and variations in properties; thirdly, to determine the type of wood laid down during the growth of the tree and under varying growing conditions; fourthly, to provide information regarding the submicroscopic structure of the cell wall.



Cross section of a hardwood, Alpine ash (*Eucalyptus gigantea*) at approximately 25 magnifications



Cross section of a softwood (King William pine) at approximately 25 magnifications

SYNTHETIC RESIN ADHESIVES

V. Miscellaneous Resins.

Compiled by Arthur W. Rudkin, Veneer and Gluing Section.

Melamine-Formaldehyde Resins.

Melamine is a synthetic chemical substance which resembles urea in many of its properties, including its ability to react with formaldehyde to form a resin resembling a protein in many respects. This melamine-formaldehyde resin is similar to the urea-formaldehyde resins (dealt with in No. III of this series) in properties and in methods of use, but has the added advantage of being unaffected by boiling water.[1] Bonds made with this resin are therefore likely to be more durable under extreme climatic conditions than those made with urea-formaldehyde resins, and probably as durable, or nearly so, as those made with the phenol-formaldehyde resins. Melamine-formaldehyde resins, however, are too recent a development to have been tested as thoroughly as the U/F and P/F resins.

The melamine resins are available as liquids and as powders, and a melamine resin film has recently been successfully developed.[1]

Most of the melamine resins at present (January, 1947) on the market are hot-setting, and require approximately the same pressing temperatures, etc., as the hot-setting U/F resins (see article III of this series, News Letter No. 146, Nov., 1946). Cold-setting melamine resins, giving satisfactory bonds at temperatures from 75° F. upwards, have been developed, but are not quite as durable as the hot-setting melamines, though much more durable than the urea-formaldehyde resins.[2]

Melamine resins are indicated wherever a more durable bond than that given by U/F resins is required, and where it is impossible or inconvenient to use the high temperatures and pressures required to obtain satisfactory bonds with the phenol-formaldehyde resins (see article IV of this series, News Letter No. 148, Jan., 1947). They have so far failed to replace the U/F and P/F resins in general application because of their high cost.

Addition of a proportion of melamine-formaldehyde resin to a U/F resin, or use of the melamine salt of a strong acid as a hardener for a U/F resin, improves the durability of the latter while keeping the cost below that of a straight melamine resin.[1]

Resorcinol-Formaldehyde Resins.

The resorcinols are a group of chemical compounds resembling the phenols in chemical properties, but much more vigorous in their action, hence they can be made to react with formaldehyde at much lower temperatures than the phenols, yielding a resin almost identical in properties with the phenol-formaldehyde resins. Hence it is claimed that "resorcinol glues . . . have the general handling properties of the urea resins, but . . . the durability of hot-setting phenolics."[3]

The resorcinols do not react readily with formaldehyde below a certain concentration, hence it is possible to manufacture a rapid setting resin with long storage life, using as a hardener para-formaldehyde or some other chemical which decomposes readily to yield formaldehyde, thus bringing the concentration of the latter above the minimum required for rapid reaction.[3] This enables the resin and hardener to be supplied as neutral solutions (i.e., neither acid nor alkaline), which are less likely to weaken the wood substance in the vicinity of the glue line than resins with which acids and alkalis are used as hardeners.

The resorcinols react readily with formaldehyde under acid conditions, hence they can be used like melamine resins as "fortifiers" for U/F resins, giving improved durability whilst keeping the cost below that of straight phenolics, melamines and resorcinols.[1]

Limited availability of resorcinol and its high cost are the chief factors militating against the more general use of the resorcinol resins as adhesives. One of their main uses at the present time is for the manufacture of so-called "cold-setting phenolics." Addition of a proportion of resorcinol to a phenolic resin enables lower curing temperatures to be used than with straight phenolics, though higher than with straight resorcinol glues.

The minimum curing temperature for maximum bond strength with resorcinol resins varies according to the timber being glued. With light to medium timbers, satisfactory bonds are obtained at 75°-80° F., but for dense timbers the glue line temperature should be not less than 140° F., at which a pressing time of 10 hours is required.[4] As with other thermosetting resins, pressing times can be reduced by raising the temperature.

Furane Resins.

Furane resins are made from furfural, a chemical derived from various kinds of agricultural wastes, such as oat hulls. As usually supplied, they are considerably less viscous than other thermosetting resins. They can be cured by the action of heat alone, but by the addition of suitable catalysts ("hardeners") can be made to set at 80° F., though maximum strength is attained more quickly (overnight, instead of after several days) by raising the glue-line temperature to 120° F. The curing reaction is rather slow, and even at 120° F. the assembly should be kept in the press or jigs for several hours. Furane resins are said to give strong bonds at low pressures, to have good gap-filling properties, to be even more resistant than the phenolics to hot and cold water, and highly resistant to acids, but are attacked by alkalis.[5] They are considerably dearer than phenolics, hence their use is restricted to a few special applications.

Furfural can also be used to replace formaldehyde in phenol-formaldehyde resins.

Phenol-Acetylene Resins.

It has recently been discovered that the phenols react with acetylene in the presence of suitable catalysts to yield thermosetting resins, which vary widely in properties according to the type of phenol used, the proportions of phenol and acetylene, and the reaction conditions.[6] No details regarding their use as adhesives are available at the time of writing (Jan., 1947).

Phenol-Colophony-Formaldehyde Resins.

The addition of 40% of a suitable grade of colophony to a phenol-formaldehyde resin during manufacture gives a rapid setting product which is freely soluble in water, thus eliminating the need to dilute it with alcohol to render it liquid enough for spreading. Ordinary P/F resins can be made in water-soluble form but then require long curing times. Other properties of the resin are not materially affected, and the solubility in water disappears when the adhesive sets.[7]

Thermoplastic Resins.

These include a wide variety of chemical compounds, among which may be mentioned the polyvinyl esters and the acrylic resins. All have certain features in common, e.g.:—

(a) They soften when heated and do not harden until they are cooled down again. This process can be repeated. Each thermoplastic resin adhesive has its own "softening point." When heated and then cooled under pressure below this softening point it forms a strong bond under suitable conditions, but above this temperature it softens so that the bond can be easily torn apart. For this reason assemblies made with thermoplastic resin adhesives must be cooled in the press.

(b) For adhesive purposes they are most conveniently applied in the form of a solution in a suitable organic

Synthetic Resin Adhesives (cont.)

solvent. Application of heat evaporates the solvent and leaves the free resin in the glue line in a semi-liquid state. On cooling under pressure it solidifies and forms a strong bond. This bond, however, can be weakened not only by heat, but also by organic solvents.

The strength, durability and other properties of the bond and the setting times, temperatures and pressures required vary widely according to the type of resin used. Their use is indicated:—

(a) When it is desired to make a bond which can be pulled apart and reglued as often as required.

(b) For gluing certain plastics and other materials which are chemically or physically incompatible with other adhesives.

(c) In the manufacture of complicated curved laminations and moulded plywoods, where the use of thermosetting resins might lead to wastage owing to the chance of their setting before the components are placed in their correct relative positions.

In other applications they do not appear to have any outstanding advantages to compensate for their obvious disadvantages, hence they have found only limited application in the woodworking industries. They will therefore not be dealt with in detail here.

References.

[1]Hofton, J.: Aminoplastic Adhesives. Chemistry and Industry, 1946, No. 18 (May 4), 181.

[2]Bruce, H. D., Olson, W. Z., Black, J. M., and Rauch, A. H.: Gluing with Low-Temperature Setting Phenol, Resorcinol and Melamine Glues. U.S. Dept. of Agriculture, Forest Service, Forest Products Lab., Madison, Wisconsin. Report No. 1531. *See also* Olson, W. Z., and Cohodas, Leah: Stability of Low-Temperature-Setting Phenol, Resorcinol and Melamine Resin Adhesives Stored at 80° F. ibid. No. 1532.

[3]Evans, C. J.: General Investigation into Plastic Materials Visit to Materials Centre at Navy Yard, Philadelphia, Report IV. Brit. Air Commission, C.T.I. Tech. Note No. 111.

[4]Anon.: Glues Used by Boatbuilders. Veneers and Plywood, **40,** No. 5 (May, 1946), 21.

[5]Delmonte, John: Furane Resins. Brit. Plastics, April, 1945, pp. 140-144.

[6]Hecht, —: Resins from Phenol and Acetylene. Mod. Plastics, **23,** No. 11 (July, 1946), 152.

[7]Korshun, L. L., and Utkina, L. A.: Phenol-Colophony-Formaldehyde Resins as Adhesives for Plywood. Lesnaya Prom. (U.S.S.R.), 1944, No. 12, 14-15.

WOOD WASTE UTILIZATION

The September issue of "Pulp and Paper Industry" describes a new plant virtually completed at Springfield, Oregon, U.S.A., for the production of alcohol from wood waste. The United States Government has devoted almost three million dollars to this project. This indicates the development which has taken place over the last century since the discovery in 1819 by Braconnot that fermentable sugars can be produced from wood. One should bear in mind that the present plant is a demonstration plant and considerable research will be conducted during its operation.

The process employed is the opposite to the one of pulp manufacture in that the acid treatment takes the wood fibre into solution in the form of its component sugars and leaves the lignin as residue. The estimated production capacity of the plant is about 9,000 Imp. gallons of ethyl alcohol per day from 200 long tons of hogged wood, sawdust and green shavings. Five percolators fifty feet high each take an 11-ton charge of dry bark-free wood. Thereafter from fourteen to sixteen charges of dilute sulphuric acid change the cellulose to sugars under periodically increasing temperatures and pressures, all automatically controlled and recorded. The lignin residue is blown from the percolators to a modified cyclone and thence, after knots and packed material have been broken up, to rolls which squeeze liquor from the lignin until the moisture content is reduced to about 50 per cent. or about the same as green sawdust. From here it is conveyed to the fuel house. A battery of twelve tanks, each of about 60,000 gallon capacity, has been set up for the fermentation of the liquors, after they have been neutralized with lime slurry. Rigid heat economy has been practised throughout the design. Fractional distillation of the "beer" produces 13.5 gallons of ethyl alcohol to one gallon of methanol. The estimated cost of production of the ethyl alcohol is 26 cents per Imp. gallon.

Besides the alcohol there is a possibility of making several by-products. The spent beer in the beer stills contains about 0.8 per cent. unfermented sugar, chiefly pentoses, from which furfural or yeast can be produced. It is estimated that 10 tons of dry food yeast, rich in vitamins and with a 50 per cent. protein content, could be obtained per day. Hydrogenation experiments have shown that it is possible to produce high anti-knock cyclic alcohols from the lignin residue. The production of wall board from the lignin residue and the calcium sulphate resulting from the neutralization of the acid liquors with lime also appears to offer interesting possibilities. In fact it is considered that wall board as a product may become preferred to alcohol.

The plant is operated by a group of timber men on a fixed rental per annum from the Government.

. . . .

The plant described above is a development from the experimental work on wood hydrolysis carried out at the U.S. Forest Products Laboratory, Madison, Wisconsin. By arrangement with this laboratory four Australian timbers were tested in the pilot plant at Madison, the yield and fermentability of the sugar was determined for *E. regnans, E. obliqua, E. marginata* and *P. radiata.* The yields compared favourably with the yields obtained from American woods but some difficulty was caused by the kino of the hardwoods being released during the hydrolysis and flowing out into the pipes, where it hardened to a resinous mass. The full report on these tests is now available at the Division of Forest Products.

BREVITIES.

Recent visitors to the Division of Forest Products included:—Mr. D. A. Mountjoy, the newly elected member of the C.S.I.R. Executive, who was shown over the laboratories and introduced to members of the staff; and Mr. G. S. Tarboton, of the Natal Tanning Extract Co. Ltd., Pietermaritzburg, South Africa.

Mr. R. W. Bond, formerly of the Victorian Forests Commission, started duty with the Section of Timber Preservation, Division of Forest Products, early this month. Mr. Bond is editor of the journal "Australian Forestry."

Dr. W. E. Cohen, Officer-in-Charge, Wood Chemistry Section of the Division of Forest Products, has returned after ten months with the Australian Scientific Mission in Japan and will be resuming duty early in February.

Mr. J. B. McAdam, Secretary of the Forests Department of the Administration of Papua and New Guinea, spent approximately a week in the Division of Forest Products early in January discussing problems related to the identification and utilization of New Guinea timbers.

At the request of, and in co-operation with the South Australian Branch of the Timber Development Association of Australia, a Seasoning Class is being held in Adelaide during the week February 3rd to February 7th inclusive. It is being conducted by officers of the Division of Forest Products, who anticipate that some 40 students including wood-working instructors, kiln operators and other representatives of the timber industry will attend. The course will comprise a series of lectures and will include practical work and visits to seasoning plants. The opening address will be given by Mr. S. A. Clarke, Chief of the Division.

INDEX

to FOREST PRODUCTS NEWS LETTERS—Nos. 139—147 (1946)

TECHNICAL INDEX.

INDEX (continued)
to Forest Products News Letters—Nos. 139-147 (1946).

AUTHOR INDEX.

U.S. BIBLIOGRAPHY OF SCIENTIFIC AND INDUSTRIAL REPORTS

During the war a great deal of research was carried out under the auspices of the Allied Governments. It has been decided to release for general use a large proportion of the results of this research, together with information taken from former enemy countries as a form of reparations. With this end in view, the U.S. Department of Commerce, through its Publication Board, is making a weekly issue of ASTRACTS of reports in the form of a "Bibliography of Scientific and Industrial Reports." This Bibliography is now being received in Australia and relevant extracts are reproduced hereunder.

Copies of the original reports may be obtained in two ways: (a) Microfilm or photostat copies may be purchased from the United States through C.S.I.R. Information Service. Those desiring to avail themselves of this service should send the Australian equivalent of the **nett** quoted U.S. price to:—

C.S.I.R. Information Service,
425 St. Kilda Road,
Melbourne, S.C.2.

and quote the PB number, author's name, and the subject of the Abstract. All other charges will be borne by the C.S.I.R.

(b) The following reports may be obtained in approved cases without cost on making application to the Secondary Industries Division of the Ministry of Post War Reconstruction, 203 Collins Street, Melbourne, C.1. Copies of these reports are also available for reference in public libraries.

Further information on subjects covered in the reports and kindred subjects may be obtained by approaching the C.S.I.R. Information Service, the Secondary Industries Division of the Ministry of Post War Reconstruction, or the Munitions Supply Laboratories (Technical Information Section), Maribyrnong, Victoria.

LISKA, J. A., and GOTTSCHALK, F. W. Wood structural research and development. Off. Pub. Bd., Report PB 1274. 1945. 99 p. Price: Photostat, 7.00 dollars; microfilm, 1.00 dollar.

This report covers visits, interviews and observations at the following institutions and plants:—1. University of Munich and Institut fur Waldbau und Forstbenutzung at Munich. 2. Wood Research Laboratory at Kreuth. 3. Professor Otto Graf an der Technischen Hochschule und Direcktor des Instituts fur Bauforschung und Materialprufungen des Bauwesens in Stuttgart. 4. Dr. Hugo Setz and Karl Kubler of the Kubler Co. at Stuttgart. 5 Timber Research Laboratory in Hohenschwangau. 6. Prefabricated Wood House under development by the Otto Bosse Plywood Co. at Stadthagen. 7. Dr. Otto Kraemer at Blomberger Holzindustrie in Blomberg-Lippe. Recent developments in the utilization of wood for structural purposes are described and discussed. An extensive list of documents and publications from the laboratory of Prof. Otto Graf is given.

PRYOR, M. G. M. German plastic developments Homogenholzwerk "Holig" (F. W. Brugmann u. Sohn, Baiersbronn). Off. Pub. Bd. Report PB 956. 1945. 3 p. Price: Photostat, 1.00 dollar; microfilm, 50 cents.

Visit to factory of F. W. Brugmann and Son at Baiersbronn in June, 1945, with description of process for manufacture of the very high grade wall-board "Homogen-holz" from softwood waste and resins. Moulded products can be made from this material. "Schaum-holz," a low-density material, is also produced, as is "Tronal," made of layers of fine glass fabric impregnated with phenolic resins. The method of producing resin at Baiersbronn is given.

THE PROPERTIES OF AUSTRALIAN TIMBERS

MOUNTAIN ASH.

(This species has been previously described in News Letter No. 62, but in the light of more complete information this description has been modified and enlarged.—Ed.)

Mountain ash is the standard trade common name for the timber known botanically as *Eucalyptus regnans* F. v. M. This common name presumably arose because of the resemblance of the timber to English ash. Mountain ash has also been known as white mountain ash, Victorian oak, Tasmanian oak, Australian oak, swamp gum and stringy gum. The name "oak" is very misleading because the timber shows none of the ray figure which is characteristic of the true oaks (species of the genus *Quercus*) nor of the Australian silky oak or the Australian sheoaks.

Distribution.

The species is found in abundance in Eastern Victoria, the Otway Peninsula of Victoria and in the moist mountain areas of Tasmania. It is essentially a mountain species and attains maximum development under moist, humid conditions at elevations ranging from 800ft.-3000ft. above sea level. At the lower elevations it is usually confined to the southerly slopes, but at the cooler higher elevations where the rainfall is more abundant it may be found on any aspect. It generally occurs in pure stands, but when associated with other species is always dominant. Undergrowth in the ash forest is usually composed of small trees, tree ferns, shrubs, etc., growing in dense formation.

Habit.

Mountain ash is the tallest hardwood species in the world; authentic measurements have revealed trees of over 300ft. in height. Indications are, however, that the height of the average tree in the mature mountain ash stands varies between 180-240ft. The trunk is straight with a long clean slightly tapered bole free from branches, enabling long clear logs to be obtained without difficulty. The crown is scanty. The diameter of mature trees varies greatly, but in the predominating class at felling height it is approximately 3½ft.-4ft. The bark of the tree is smooth and whitish on the stem and branches; at the base of the bole it is generally rough-barked, becoming ribbony and then smooth.

Mountain ash is a fast-growing species and has been known to reach a height of 50ft. in 5-6 years and a height of 130ft. in 20 years with a diameter of 15in. Trees 40 years old may have a butt diameter of between 2ft.-3ft.

Timber.

The wood of mountain ash is brown to light yellowish brown in colour, sometimes, but more rarely, pinkish. Growth rings are often distinct due to the bands of denser latewood and such growth rings are particularly noticeable in timbers from the higher altitudes. These growth rings give rise to a definite figure on backsawn surfaces. At times from butt logs some wavy and curly grained material of great beauty may be obtained. From such material highly figured timbers and veneers are derived.

The timber is moderately heavy in weight with an average air-dry density before reconditioning at 12% moisture content, of 44 lb./cu. ft. The density after reconditioning averages 39 lb./cu. ft. The average weight of green timber is 63 lb./cu. ft. The variation in weight before and after reconditioning is indicative of the occurrence of collapse. In drying from the green condition to 12% moisture content the average shrinkage of a backsawn board, including collapse, is 14.2% (tangential shrinkage) and the average shrinkage of a quartersawn board again including collapse is 7.3% (radial shrinkage). Reconditioning reduces these averages to 7.5% and 4.0% respectively.

Seasoning.—Successful methods for the seasoning of mountain ash have been developed over the past 15 years and are the result of a considerable amount of work in experimental kilns and commercial plants. There is some indication that the habitat of the material affects the seasoning properties of the timber. For example mountain ash grown in Tasmania is somewhat more difficult to season free of checks and is slightly slower in drying than that grown in Victoria.

With care, quartersawn Tasmanian mountain ash can be kiln dried reasonably well from the green condition in thicknesses up to 2in. Edge checking, which may be fairly pronounced in some material will almost certainly occur; but providing these checks can be removed in dressing or shaping or are no detriment in themselves the results are generally acceptable. From considerations of economy, however, kiln drying of green stock (except when in the form of thin case stock) is not recommended because seasoning can be carried out much more cheaply and with less degrade by combining a preliminary period of air-seasoning (to a moisture content of 30% or less) with final kiln drying. Backsawn stock in thicknesses of 1in. or over is difficult to season free from pronounced face checking. Approximately 2½ weeks are required to kiln dry Tasmanian 1-in. stock from the green condition. For stock which has been air-dried to approximately 30% moisture content about 5 or 6 days are required for final kiln drying. Case stock three-eighths of an inch thick can be kiln-dried from the green state in about 36 hours.

Victorian mountain ash does not check quite as readily as the material from Tasmania, and, if quartersawn, thicknesses up to 2in. can be satisfactorily kiln-dried from the green condition in less time than the Tasmanian timber. Kiln drying of green stock, except in thin case sizes is, however, not recommended and partial air drying prior to kiln drying gives a much more satisfactory result from considerations of both quality and economy.

The kiln drying time for 1-in. green stock cut in Victoria varies from 11-14 days whereas for stock which has been air-dried to approximately 30% moisture content the time is about 5 days. For 2-in. stock about 50 days are required for kiln drying from the green condition and approximately 15 days if air-dried to 30% moisture content.

Collapse may occur in drying but by means of the reconditioning treatment a good recovery in size is generally obtained.

Mechanical Properties.—Prior to the second world war sufficient scattered information was available on the strength properties of mountain ash for most practical purposes. However, as part of the testing programme carried out by the Division of Forest Products during the war a systematic survey of the properties of the timber was undertaken on material from a relatively large number of trees selected from both Victoria and Tasmania. The effects on the strength of the timber of different seasoning procedures, i.e., kiln drying green from the saw, kiln drying and reconditioning, air drying and reconditioning, were also investigated.

As might be judged from its somewhat higher density mountain ash is superior to Douglas fir and has been included in Strength Group "C" as against Strength Group "D" for Douglas fir. At 12% moisture content kiln dried reconditioned mountain ash has an average modulus of rupture of 15,900 lb./sq. in. compared with a figure of approximately 12,500 lb./sq. in. for Douglas fir. Its stiffness is over 50% greater than that of Douglas fir. (It is interesting to note that the stiffness of mountain ash is much the same as that of karri although the modulus of rupture is only about 80% of that of karri.) Mountain ash is inferior in impact strength to such overseas timbers as hickory, English and American ash and local timbers such as spotted gum and alpine ash. In compression parallel to the grain Victorian kiln-dried and reconditioned material gave an average value of 9,700 lb./sq. in. compared with 10,500 lb./sq. in. for karri and 7,700 lb./sq. in. for Douglas fir at 12% moisture content.

Because of its properties mountain ash was considered as a possible aircraft timber and it was found that on a

Properties of Australian Timbers—Mountain Ash (cont.).

strength for weight basis it is at least equal to or superior to sitka spruce in all properties except compression perpendicular to the grain, a property in which it is surprisingly on the low side compared with other Australian species such as hoop pine and coachwood.

General.—In the disastrous fires in January, 1939, much damage was done to the mountain ash forests of Victoria. It is extremely fortunate that much of the fire-killed timber has been salvaged and utilized. It has been found that fire-killed timber, if felled as soon as possible after fire and kept in moist storage can be milled up to eight years after felling without any deterioration of the truewood or serious conversion loss. If left standing deep checking will occur and recovery of a better grade timber is very much reduced.

The sapwood is not susceptible to the attack of the powder post borer (Lyctus) although some occasional records of attack have been encountered. In general, it would be classed with those timbers in which Lyctus attack is rare. While the attack of the pinhole borer is likely to be encountered to a small extent in any species the prevalence of such borer holes is more pronounced in the timber that has been converted from fire-killed trees. It should be realized, however, that the attack of this borer will not continue after the timber has been converted.

Mountain ash is a relatively good bending timber and in this regard is one of the best of the eucalypts. It may be considered as the equivalent of blackwood or silver ash.

Mountain ash can be peeled or sliced satisfactorily provided correct heating treatment is given; however, difficulties are encountered in drying the veneer as a result of collapse. These difficulties have, however, been somewhat overcome by employing quarter-sliced or semi-rotary peeled veneers. The main defects encountered in veneering this timber are end splits, collapse and checking on drying, and the occurrence of gum veins. The timber can be glued satisfactorily in either veneer or solid form with adhesives in general use for wood-working.

Chemical analysis shows that mountain ash is particularly low in extractive content; the percentage varying from 3-4%. The amount of lignin present averages 21% while the remainder of the wood, namely, 75%, can be considered as the total carbohydrate fraction. The species has proved particularly suitable for pulping and has been used to provide a good quality, easily bleachable soda pulp on the one hand and, on the other, a sulphate pulp which has been used for the manufacture of kraft paper. It also forms the basis of the Australian newsprint industry because it has been found to be the one eucalypt species which is most satisfactory for grinding. Newsprint is prepared from a mixture of chemical pulp and mechanical pulp or groundwood; in Australia the chemical pulp is, at the present time, imported and forms approximately 18% of the furnish while the mechanical pulp is derived mainly from mountain ash (although some messmate stringybark has been tried), and forms approximately 82% of the furnish.

Uses.—It may be said that mountain ash is a good general utility timber with high strength to weight ratio. Quite a considerable proportion of the cut produced is of first quality while the remainder would be classed as merchantable or second-grade quality. The timber itself will take a high polish and can be fumed with ammonia to a very pleasing shade. It is used especially for flooring, weatherboards, linings, joinery, furniture and cabinet work and carriage construction. Other uses are in aircraft construction, railway trucks, cooperage, veneers, boxes, wood wool, handles for tools of the broom and rake type.

Availability.—This species may be classed as one of the most plentiful in Australia and it is available in a large range of widths, thicknesses and lengths. The production has been in the vicinity of 130,000,000 super feet per annum.

"WHAT IS THE STRENGTH OF TIMBER?"

(Concluded)

Prepared by the Timber Mechanics Section.

In the preceding articles, an endeavour has been made to explain in simple non-technical language the meanings of the terms used to describe the various strength properties of wood. Whilst the two properties discussed in this, the concluding article of the series, could not, by any stretch of imagination, be called strength properties, no table of mechanical properties is complete without them. Although the terms "moisture content" and "density" are well known and understood, the actual properties as given in tables require some further explanation.

1. **Moisture Content.**

The amount of water in a piece of wood has an important bearing on its physical and mechanical properties. Its effect is dependent not on the total amount present but the relative amount. In other words, it would be practically useless to try to compare the properties of a certain piece of wood which had 5 ounces of water in it with another piece several times the size of the first containing say 8 ounces of water. Thus moisture content is defined as a ratio or percentage of wood weight. As the weight of a piece of wood varies with the amount of moisture in it, the basic figure used for determining this ratio is the oven-dry weight of wood, i.e., the weight of wood with no moisture in it. And so moisture content is strictly defined as the weight of moisture per unit weight of oven-dry wood.

2. **Density.**

Firstly it must be mentioned that the density values given in tables are not the "true density" figures for wood, but owing to its porosity, these values are actually "apparent densities." The porous structure of wood is so well known however that the property is simply referred to as "density."

The fact that wood holds moisture and also shrinks and swells gives rise to the determination of a number of different density values which may vary considerably from one another, but with a knowledge of moisture content and shrinkage, each value is convertible into any one of the others. Only three of these values need be considered here. Of immediate practical importance to the saw-miller and cartage contractor is the "green density." This is simply the weight per cubic foot of the green wood. As the wood dries, so will the density alter, but the value given in the tables for this particular density is sufficiently reliable for computing the weight of logs and heavy structural units. Another value, known as the "air-dry density," is similarly valuable for calculating the weight of seasoned timber. This value is based on the weight and volume of wood at 12% moisture content. Both these densities may be used for comparing species, but the one which is usually used for technical purposes, although it is of little practical value to the timberman, is known as "basic density." As its name implies it is derived from the basic values of weight and volume of wood. The weight of wood not subjected to change is the oven-dry weight as pointed out above. The volume used is the green or soaked volume which eliminates the difficulties involved with differences in shrinkage between species. This density is perhaps the best for comparing different timbers, but as pointed out is of more academic than practical importance to the timberman.

In conclusion, it must be pointed out that these notes have, by necessity, been rather brief and sketchy. Should more detailed information be required on any of the properties discussed in these articles, the Division's staff will be only too pleased to supply it. Enquiries should be addressed to the Chief, Division of Forest Products, 69-77 Yarra Bank Road, South Melbourne, S.C.4.

Victorian Railways Print. 846—47

C. S. I. R.

FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

No. 150 1947##150 March 1947

SECTION OF WOOD CHEMISTRY

(This is the second article in the series describing the work of the various sections of the Division of Forest Products.)

Wood is becoming increasingly important as a chemical raw material. This fact is not generally recognized except by those whose work brings them into contact with some of the products of the forest which have been manufactured as the result of a chemical process. For example, cellulose, paper, rayon, cellulose-plastics, base materials for photographic films, certain lacquers, some explosives and a host of other products are today derived from wood. In addition wood in the form of sawdust can be hydrolysed for the manufacture of industrial alcohol. Therefore it is essential for a Division of Forest Products to know everything possible about the chemistry of wood and in particular of the various Australian woods. For this reason the Division maintains a section of Wood Chemistry which has a staff of six fully qualified chemists and a number of assistants. Wood Chemistry is a very specialized branch of chemistry and it has been found that the trained chemist must spend some time familiarizing himself with the subject before he is able completely to undertake investigations in this field.

Early work on wood chemistry was concerned with the development of methods for the satisfactory pulping of eucalypts. That this work was of prime importance to Australia has been abuntantly demonstrated in recent years by the development of the Australian pulp and paper industry. For a long time it was considered that eucalypt woods were unsuited for paper making but this conception has now been completely reversed. Other work of economic value was the survey of tannin resources in Australia and the development of a pilot plant for the extraction of tanning materials from certain eucalypts occurring in Western Australia.

It is important to assess the suitability of a wood for various specific purposes and this is greatly assisted by chemical analysis. For example, a wood rich in extraneous materials, such as gums, resins and kinos, will be less suitable for pulping than one in which these materials are not so abundant. Woods with appreciable amounts of essential oil present, e.g., huon pine and cypress pine can be extracted by suitable processes to provide quantities of commercial essential oils. On the other hand such woods would be unsuitable for other purposes such as wood flour for use in plastic moulding compositions. The selection of timber for chemical plant can be greatly assisted by a knowledge of the resistance of various timbers to specific chemicals.

The work of the Wood Chemistry Section is closely integrated with the needs of the pulp and paper industry. An annual Co-operative Pulp and Paper Research Conference is held at which representatives of the three major Australian paper companies and of New Zealand Forest Products Ltd. discuss with officers of the Section various fundamental aspects of wood chemistry and related subjects and develop a programme of research for the ensuing year. Thus of recent years the chemical side of the work has been directed more to the clarification of the chemistry of the main components of wood, namely the carbohydrates (cellulose and hemicelluloses) and the lignin.

The chemistry of eucalypt cellulose and hemicelluloses is being investigated and it has been found that a knowledge of the hemicelluloses occurring in eucalypt woods is of importance to industries utilizing the cellulose from them. Numerous analyses have shown that eucalypt woods are richer in xylan, a carbohydrate material derived from the sugar xylose, than the softwoods. A more recent project is concerned with the hydrolysis of eucalypt wood. The rate of hydrolysis and the production of sugars under different conditions is being studied with a view to shedding further light on the chemical make-up of the cellulose and hemicelluloses. By arrangement with the United States Forest Products Laboratories, Madison, Wisconsin, U.S.A. several Australian woods have been subjected to pilot plant scale hydrolysis experiments. The yields of sugars and therefore of alcohol are of the same order as those obtained from American woods tested at Madison. A report on this work is now available from the Chief, Division of Forest Products, 69–77 Yarra Bank Road, South Melbourne, S.C.4.

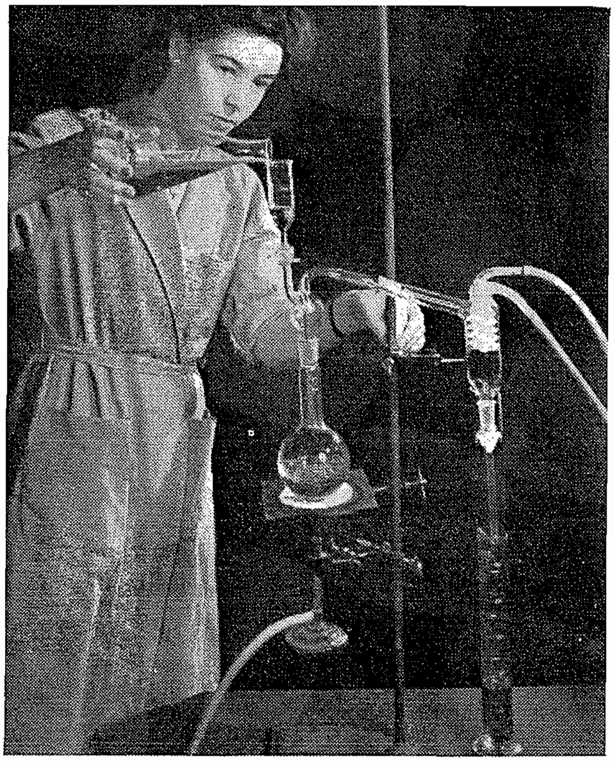


Illustration showing the apparatus used for the determination of xylan

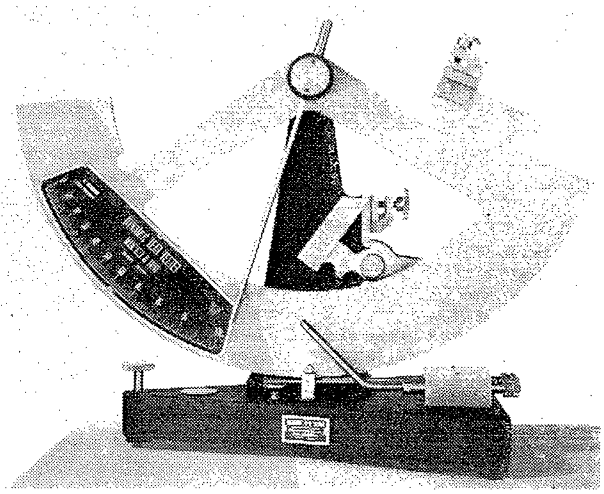
One of the greatest challenges and greatest opportunities to the wood chemist today lies in mastering the chemistry of lignin and finding an industrially satisfactory outlet for this material, which is at present discarded from paper mills at the rate of thousands of tons annually. Reports from abroad show that a great deal of effort is being devoted to this problem. One industrially successful process at present in operation in U.S.A. is the manufacture of vanillin (the active material in essence of vanilla) from the lignin of non-pored woods ; this, however, absorbs only a small fraction of the available lignin. Lignin has certain plastic properties and its incorporation into

SECTION OF WOOD CHEMISTRY—*continued*

plastic mixes therefore seems to offer definite possibilities of lignin utilization. From Germany come reports of the utilization of lignin in the manufacture of artificial tanning agents and water purification chemicals.

Considerable attention is paid to the study of methods of pulp evaluation, and this section of the work is carried out in close co-operation with the Australian paper industry. The methods employed in determining the strength characteristics of paper, such as bursting strength, tensile strength and tearing resistance, were developed in Europe and America for papers made from long-fibred pulp prepared from woods such as spruce. As the Australian paper industry is based largely on the eucalypts, which give short-fibred pulps, it has been necessary to submit overseas methods of pulp evaluation to a critical examination before adopting or modifying them to suit local conditions. Such studies have made it possible to carry out accurate determination of the strength properties of paper produced from eucalypt pulps, and have enabled standard conditions to be laid down for their evaluation. It has been found necessary during the course of these investigations to modify and redesign some of the testing equipment. The tearing tester illustrated on this page is one piece of equipment which has been redesigned to improve its performance. Considerable interest in this instrument has been shown by overseas organizations.

The Section of Wood Chemistry is particularly well equipped to handle the many and varied problems relating to the chemistry of wood and the chemical utilization of wood, and, as has been pointed out, is tackling a field which has great potentialities not only for Australia but for all those areas in the Pacific where there are quantities of the raw material "wood."



Dynamic Tear Tester

SYNTHETIC RESIN ADHESIVES

vi.—The Gluing Operation.

By H. G. Higgins, Veneer and Gluing Section.

Successful gluing with synthetic resins, as with other adhesives, depends on the control of certain variables during the operation. The more important of these include : proportions of ingredients, working life, moisture content of the joint components, condition of the gluing surfaces, glue spread, assembly time, pressing temperature, pressing time and pressure. These factors will be considered in turn. It will be noted that some of them will not always apply to certain forms of adhesive, *e.g.*, glue spread need not normally be taken into account when the adhesive is in the form of a resin-impregnated paper film.

Proportions of Ingredients.

In using powdered or liquid resin glues, it is necessary to follow closely the directions of the manufacturer in adding water or hardeners to the resin, and it is advisable to weigh out the various ingredients before mixing. Lack of attention to the correct proportions will result in either too thick or too thin a mix, which will render it difficult to obtain the best glue spread, and will also affect the working life of the glue.

Normally the rate at which mixing is carried out, either by hand or mechanically, should be slow enough to avoid foaminess, as "foamy" glues are apt to make comparatively weak joints. In some cases, however, resin glues may be deliberately foamd in the interests of economy, but this should be done only where high joint strength is not required.

Working Life.

The "working life" of an adhesive is the period from its mixing until it is no longer fit for use. For most synthetic resins the working life is a few hours at normal temperatures, and it should be stated by the manufacturer in his instruc.ions to the user. Most adhesives in liquid form, once the hardener is incorporated, can be used until they can no longer be spread easily, due to thickening. The working life of thermosetting resins such as urea and phenolic glues decreases at higher temperatures, and in hot weather it may be worth while to arrange for the glue to be kept cool during use.

When an adhesive is used towards the end of its working life, it is advisable to shorten the assembly time for best results.

Moisture Content of Joint Components.

The moisture content of the wood to be glued is an important consideration, and is indeed the source of much poor gluing technique. It is difficult to generalize on the best moisture content, because this will depend largely on the type of glue, and some glues operate well over a much wider range of moisture content than others. However, satisfactory results can be obtained with urea and phenol-formaldehyde resin with the wood at a moisture content of from 8% to 12%, and this range is a good one to aim at in drying material to be glued. Care should always be taken to see that all the members to be glued are at the same moisture content.

Condition of Surfaces.

Best adhesion is normally obtained between smooth surfaces, which allow the formation of a thin, continuous film of glue, or "glue line" at comparatively low pressures. Surfaces should be clean, and in particular should be free of substances of an oily nature, which will prevent adhesion.

After preparing surfaces for gluing, they should be glued up as soon as possible to prevent warping due to change in moisture content ; this is of particular importance when the timber is in heavy sections.

Glue Spread

The thickness of the glue line is a very important factor in the strength of a joint, and the attainment of the correct amount of glue per unit area depends in practice upon the thickness, or viscosity, of the mix, upon the method of application to the wood, and upon the subsequent pressure applied. Thin glue lines are stronger than thick ones, provided that a continuous film of adhesive is present between the glued members. If insufficient glue is applied to allow of a continuous film when the adhesive has contracted or diffused into the wood during drying, the result is a "starved joint," and a similar effect may be produced if the pressure is too high. However, insufficient pressure is perhaps a more frequent source of gluing trouble resulting in glue lines which are thick and consequently weak.

Some resin adhesives of high solids content are more resistant than most to cracking or "crazing" when they dry in thick films, and these so-called "gap-filling" adhesives are suitable for use where a thick glue line is unavoidable, as in some joinery work. However, the general rule "the thinner the glue line the stronger the joint" still applies.

The most desirable spread depends on several factors, and usually lies between 20 and 50 sq. ft. of glue line per lb. of liquid glue. Uniformity of spread is of course desirable in a particular operation, and can best be achieved by the use of mechanical spreaders with rubber rollers.

Assembly Time.

By "assembly time" is meant the period elapsing from the spreading of the glue until the application of pressure. This period is sometimes divided into the "open" assembly time and the "closed" assembly time, which are respectively the period from spreading until the components are placed in mutual contact, and the period from contact until pressure is applied.

Maximum permissible assembly times vary greatly with different types of resin adhesives, being as short as a few minutes for some cold-setting glues and as long as several days for some hot-setting liquid glues. For film adhesives, of course, assembly times may be practically unlimited.

It should be remembered that the setting of the common resin adhesives, such as urea and phenol-formaldehyde, is accelerated by heat, and that in hot weather, therefore, the maximum assembly times recommended for normal conditions should be reduced. In cold weather rather more latitude is allowable.

If the assembly time exceeds the permissible maximum for the glue used, the result is a "dried joint," *i.e.*, the glue has partially dried before the application of pressure, resulting in a weakening of the bond.

Pressure.

Pressure is applied to bring the components into intimate contact, and thus to ensure a thin glue line. The best adhesion will result from pressure adequate for this purpose, but not high enough to squeeze out too much glue and produce a starved joint. An adequate pressure depends firstly upon the depth of the irregularities in the surfaces to be joined, and flat, smooth surfaces will not require nearly as much pressure as irregular ones such as are left by the saw. Secondly the pressure required depends on the resistance offered by the material being glued, and in the case of wood this depends in turn mainly upon the density of the species. The heavier timbers require the greatest pressures. Again, thick laminations are more resistant than thin ones and for this reason require higher pressures during gluing. Stiff veneers which are badly buckled (such as those of certain eucalypts which are subject to collapse during drying), also require additional pressure to keep them flat. As a general rule, best results with resin glues are obtained at pressures between 100 and 200 lb./sq. in.

When using a hot press, care should be taken to close the platens and apply the pressure as soon as possible after the assembly is inserted, otherwise the resin will partially set before the pressure is on, with consequent weakening of the joint.

Pressing Temperature and Time.

The time required for any thermosetting synthetic resin to harden is decreased by raising the temperature, although the most suitable setting temperature for a particular adhesive should be specified by the manufacturer. Some adhesives, including many of the urea resins, are formulated for use in a cold-pressing operation at temperatures as low as 70° F.; others, including some of the phenolic resins, are best used at temperatures in the vicinity of 300° F. The minimum setting time for cold-press glues is of the order of a few hours, but a few minutes are sufficient for resins setting at the higher temperatures.

When a hot press is used, however, it is also necessary to take into account the time necessary to heat the glue lines to the required temperature, and this will depend upon such factors as the distance of the furthest glue line in the assembly from the metal caul (or, if wooden cauls are used, from the platen of the press), the platen temperature, the nature of the material being glued and the total thickness of the assembly. A table for use with a phenol-formaldehyde resin film was given in article IV of this series (News Letter No. 148, Jan. 1947, p. 4).

Heating times may be very considerably reduced by the use of high-frequency electronic equipment to produce a dielectric field in the vicinity of the glued assembly. This arrangement replaces the heating of the platens by steam or electricity in the conventional hot press.

Another method of heating glue lines is by using electrical resistance strips, operated at very low voltages and with a high power input, as the source of heat.

. . . . . .

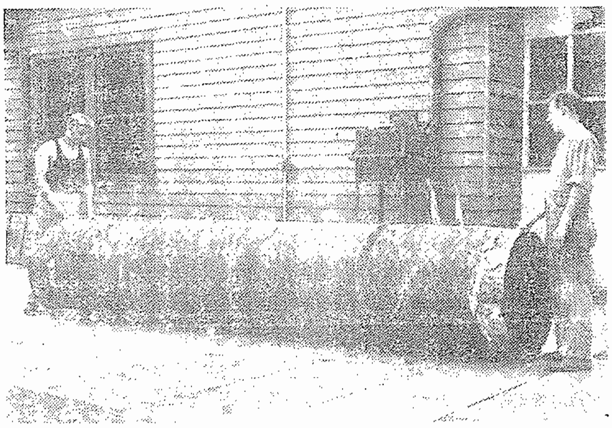
The prime object in most gluing operations is to effect a bond which is as strong as the materials joined under all the proposed conditions of use of the final product. Once this aim is achieved, it may be subjugated to considerations of economy in labour, time, equipment and materials.

Investigations on Klinki Pine from New Guinea

by **Alan Gordon, Officer-in-Charge, Veneer and Gluing Section.**

Since 1940 much has been heard of the timber resources of New Guinea, and widely varying opinions have been expressed as to the quantity and quality and potential uses of various timbers growing there, and the economics of exploitation. Perhaps the most discussed stands are those of klinki and hoop pines (*Araucaria klinkii* Lauterb. and *A. cunninghamii* Ait.) of the Wau-Bulolo goldfields area, and the greatest protagonist of utilization of this stand is Mr. J. B. McAdam, now Secretary, Department of Forests, Territory of Papua and New Guinea, formerly member of the New Guinea Volunteer Rifles and later C.R.E. New Guinea Forests during the war, and a pre-war forester in New Guinea. He has estimated the stand to comprise about 4–500 million sup. ft. of large straight cylindrical boled trees ideally suited for veneer and plywood manufacture and for sawmilling.

With a world shortage of plywood logs and the depletion of stands of hoop pine which has been the backbone of the Australian plywood industry, increased interest has been shown in the forests of New Guinea. Some months ago arrangements were made for the New Guinea-Papua Department of Forests to send to the Division of Forest Products, C.S.I.R., a log of klinki pine in order that preliminary tests on its peeling and



Klinki pine log assembled after cross-cutting to peeling blocks

Investigations on Klinki Pine from New Guinea—*continued*

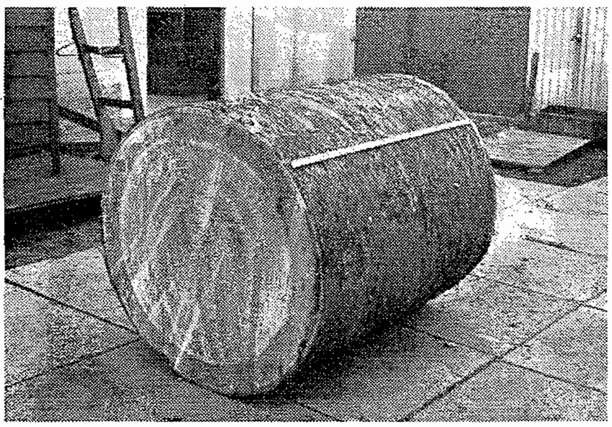
gluing qualities and plywood possibilities might be investigated in the Veneer and Gluing Laboratory.

The first log for these investigations was cut on 5th September, 1946, in the Bulolo area at an elevation of 2500 ft. above sea level. This log 12 ft. long and 8 ft. 8 in. in girth was cut from the butt of a tree with 82 ft. merchantable length, the girth of the 20 ft. top log being 5 ft. 5 in.

Unfortunately this log was delayed in its journey to Melbourne and at the end of January was still in Sydney awaiting fumigation under quarantine direction before despatch to Melbourne.

On account of the delay a second log 13 ft. 6 in. long, and 7 ft. 10 in. in girth was cut in December and was received in Melbourne towards the end of January. On arrival it was in almost perfect condition except for some blue staining of the 3 in. wide sapwood, some small end splits, and a small band of compression wood.

At the Forest Products Laboratory the log was cut into three 39 in. peeling lengths, two 5 in. discs, and after a 6 in. slab from bark to bark was cut through the centre of the fourth block, four quadrant sectioned lengths remained. The above material was used or distributed as follows :— Veneers 1/16th, 1/12th, 1/8th and 3/16ths in. thick were peeled from the three peeling blocks, one of which was peeled cold, the others being heated in water for different times. A high yield of good quality veneer was obtained in all thicknesses.



Peeling block 39 in. long, showing bark about 1 in. thick and sapwood 3-4 in. wide

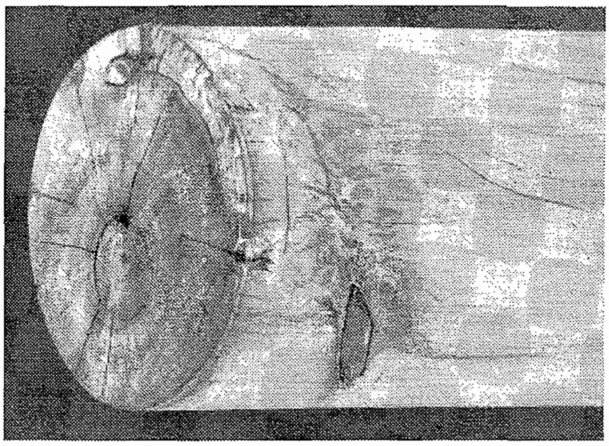
Veneers were air dried and kiln dried easily without degrade but as its initial moisture content was much higher, sapwood was slower in drying than truewood. Good adhesion was secured in plywood glued with casein, soybean, and urea-formaldehyde cold glues and a hot press phenol formaldehyde film glue. From these investigations it is readily apparent that no technical problems will prevent the production of satisfactory plywood from klinki pine.

In addition to using klinki pine veneers for plywood, tests to determine its potential for match splints and battery separators are being carried out. Some green veneer was supplied to a match company for splint manufacture and matches of good quality have already been made from it.

Information concerning the suitability of peeled and sliced veneer for battery separators will not be available for some time as extensive laboratory and service tests will be required.

Of the two discs cut from the log, one will be retained in the Forest Products museum, but the other has been divided to provide material for investigation by the Sections of Wood Structure, Timber Physics and Preservation, and a preliminary survey of mechanical properties will be made by the Timber Mechanics Section on specimens from the 6 in. slab cut through the centre of one length.

Two of the four quadrant shaped pieces were cut into flitches for conversion into battery separators at a Brisbane factory equipped with a slicer for battery separator veneers. A third of these was quarter rotary peeled in the Veneer and Gluing laboratory and the last piece is being held in reserve for miscellaneous tests and investigations at the Division of Forest Products.



Core 10 in. diameter, showing vine overgrown by wood

Hand samples will be prepared from the veneer cores so that none of the log supplied will be wasted.

An interesting feature of the peeling of one of the veneer blocks was finding embedded in the wood a vine which had been overgrown by the tree. One photograph shows the vine on the round and end surfaces of the veneer core.

Results from various investigations will be published when available.

TIMBER SEASONING CLASS.

A Timber Seasoning Class was held in Adelaide during early February at the request of the South Australian Branch of the Timber Development Association. The general arrangements and enrolling of students were carried out by Mr. E. J. Dowling, Director of Development, and the lectures and practical work were conducted by Mr. G. W. Wright, Officer-in-Charge of the Seasoning Section, and Mr. G. S. Campbell of the same Section, Division of Forest Products.

The Education Department of South Australia provided two large-sized class rooms in the Adelaide High School, and the class was attended by about 30 students. Half of these were manual training instructors from the Education Department, and the remainder included kiln operators, foremen and other timber workers as well as executives of several of the leading timber organizations of South Australia.

The class lasted for a week and all phases of timber seasoning were covered. In addition, the students themselves carried out practical work associated with seasoning practice. Through the courtesy of the several firms concerned, visits were arranged to Messrs. Globe Timber Mills, Lloyd Timber Mills, Port Adelaide, and the plant of S.A. Plywoods where veneer kilns were seen in operation.

Interest was shown by all attending the class and on the final day, instead of an examination, the class was divided into two halves and a competition in the form of a quiz was held. The class and instructors were then entertained at a short farewell function arranged by the Timber Development Association, where its President, Mr. A. K. Jeanes and some of the senior timber men of Adelaide had an opportunity of meeting members of the class.

Mr. F. S. Walker, who has been carrying out a forest survey in the British Solomon Islands Protectorate on behalf of the High Commissioner for the Western Pacific, passed through Melbourne on December 30th on his way back to England. The Division has been assisting Mr. Walker in the examination of the various timbers from the Solomon Islands and it was in connection with this work that he spent some time here. It will be of interest to some readers to know that Mr. Walker was with the Malayan Forest Research Institute and escaped to Australia at the time of the fall of Singapore. At that time he spent several months with the Division assisting with the work of the Seasoning Section.

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C. S. I. R.

FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

No. 151 1947##151 April 1947

SECTION OF TIMBER PHYSICS

(This is the third article in the series describing the work of the various sections of the Division of Forest Products.)

Many uses of timber depend on a knowledge of the physics of wood in general, and also on specific knowledge of the physical properties of the particular timber concerned. This knowledge is also important as a basis for many problems in applied research in all branches of wood technology. The study of the physics of wood requires complicated and expensive equipment, for example, extensive use is made of electronic equipment in such applications as temperature and humidity control, electrical strain gauge measurements, battery separator resistance measurements and high frequency heating.

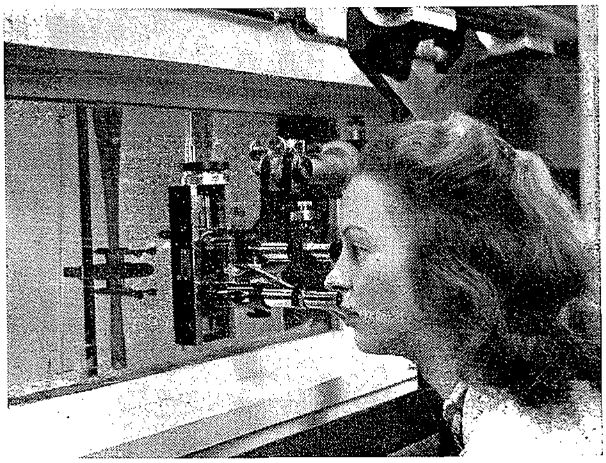
The Timber Physics Section consists of an officer-in-charge, three other research officers, four technical officers, and a number of laboratory assistants. This team of workers has just been completed, having been gradually built up as the need arose for research into additional problems.

In the first place, it was necessary to study such basic properties as density, shrinkage, electrical conductivity, (which is of importance in the measurement of moisture content), and moisture absorption. The field of activity has gradually been broadened to include research into the thermal and electrical properties of wood in general, a more detailed study of the relationship between wood and absorbed fluids of which the most important is water, the effect of prolonged loading, prolonged heating and of temperature on the physical properties of the wood, together with the application of physical methods in timber processing for various types of utilization.

During the war, four problems of immediate national importance were studied. The first of these consisted of the investigation of the effect of long exposure to elevated temperatures such as occur in seasoning. This was of importance as it was desirable to shorten the seasoning time of aircraft timber and so economise kiln capacity, but because of the low factors of safety used, no appreciable reduction of strength could be permitted. It was found that unduly high temperatures caused a change in some properties, notably a decrease in impact strength. This effect varied to some extent with species. Prolonged exposure to high temperatures was also found to render collapse difficult to remove, and this is especially important for aircraft timber on account of strict density limitations.

Another problem undertaken was the study of the effect of temperature change on the strength of wood, plywood and glued joints. This was found to be considerable for some properties, especially at high moisture contents. Correction figures for temperature were obtained for each of the more important aircraft timbers so that allowance for the effect of temperature could be made in testing or in the design. Associated with this problem is the question of the temperature and moisture content attained by wooden aircraft in service. This was studied in various parts of Australia in order to obtain values for the cooler parts of the country, and both the hot dry and hot moist areas. Tests were carried out on aircraft wings both on the ground and in flight. In connection with this work, a study was also made of the effectiveness of various surface treatments in reducing the temperature of the wing.

The fourth problem mentioned involved the search for a suitable Australian timber for use in the manufacture of battery separators for aircraft and ground vehicle starting batteries, as well as batteries for other service uses. Prior to the war, separators were made mainly from Port Orford cedar from the U.S.A. During the war, however, the supply of this species became difficult and a local substitute had to be found. Some likely Australian timbers were made up into separators and these were tested for electrical resistance, high discharge currents such as would be met with in starting,



Measuring creep in wood in tension.

behaviour under prolonged periods of successive charge and discharge, behaviour in service and softening in acid. The necessary chemical treatment to improve their performance was also studied. Hoop pine and kauri were found to be the most generally suitable species, the former probably being the better. Kauri, however, was much more largely used as, owing to the great demand for hoop pine and the shortage in supply, it was found impossible to make the necessary selection to avoid pin knots.

Tests are now in progress on further Australian species together with klinki pine from New Guinea. The latter is closely related to hoop pine and is reputed to be relatively free from pin knots.

At present the work of the section can be divided broadly along the following lines :

(*a*) **Wood Liquid Relations.** This includes the study of the phenomena involved in the adsorption of moisture and other liquids into wood, the shrinkage and swelling which result, the internal capillary structure, and the changes in the elastic and plastic properties of wood resulting from adsorption. This subject is generally spoken of as "wood-liquid relations."

The adsorption of water in wood and the phenomena associated with it are extremely important in all branches of wood technology, especially seasoning, preservation and chemical utilization in the paper industry.

SECTION OF TIMBER PHYSICS—*continued*

(*b*) **Thermal Properties.** This involves rather unusual problems as, if the results are to be useful, the measurements must be carried out at constant or approximatley constant moisture content. This is impossible with the usual methods owing to the effect of heating to a temperature many degrees above the surroundings for some hours, thus altering the moisture distribution in the test specimen. Hence it has been necessary to develop a special method, requiring a temperature change of only a fraction of a degree and taking only two or three minutes after the commencement of heating.

(*c*) **Electrical Properties and Processes.** This involves the investigation of the electrical properties of wood and the application of the results of this work to the processing of wood, for example, to the use of high frequency heating in gluing and drying. In the latter aspect of the problem, the co-operation of other sections is necessary. Dielectric heating, in which the wood to be heated is placed between the plates of a condenser, has been used extensively overseas and to some extent in Australia in the processing of materials such as plastics. It has been used in North America in large plywood plants to provide the heat necessary for gluing resin-bonded plywood. This process is being studied in relation to Australian timbers and the glues in use in this country. The question of specialty drying, gluing of solid timber and other possible uses is also being considered. The electrical properties of wood which control the application of dielectric heating to it are also being investigated, whilst later, the more fundamental nature of wood as an insulating material will receive attention. This may throw light on other aspects of the work of the Section such as the forces involved in adsorption phenomena and creep.

(*d*) **Creep Tests.** The effect of prolonged loading on wood in tension, compression and bending is being studied, and it is hoped later to study its effect on shear strength. Little more need be said about these tests as they have already been described in a previous issue of the News Letter.

(e) **Electrical Strain Gauges.** Electrical resistance strain gauging equipment is being developed for use in the mechanical testing of timber and timber structures in the laboratory for studies on completed structures such as the effect of wind loads, and in prolonged loading tests. It is intended to use these strain gauges as general strain indicators wherever they prove to be suitable. They depend on the fact that when wire is stretched its electrical conductivity is slightly decreased. They were first developed just prior to and during the war and were used to a considerable extent in determining the loads on the various parts of aircraft during flight and combat.

Determining the shrinkage of wood.

The study of the physics of wood is an essential part of forest products research and technology. In research, it provides the knowledge of the physical properties and constants which is required in other fields and also an understanding of the physical phenomena occurring in wood processing and utilization. In wood technology it enables the user to predict the behaviour of the material in various circumstances and physical environments and permits him to guard against the incidence of influences which would reduce the value and utility of the wood.

HOT DRY WEATHER AND GLUING TROUBLES.

By
Alan Gordon,
Officer-in-Charge, Veneer and Gluing Section.

Spells of hot dry weather in Melbourne in January and February brought the usual number of enquiries concerning the opening of glue joints and the splitting of ends of tables and other articles in which wide pieces of solid timber are used, and in addition several enquiries were received concerning bad adhesion following gluing operations on the hot dry days.

Investigation of a number of these enquiries revealed that in some instances the troubles had resulted from the use of timber of too high a moisture content, which had shrunk and split, sometimes in the wood and sometimes at glue joints, depending on which was the weaker. In most instances where splitting occurred along a glue line it was obvious that bad gluing technique had been used and the joint had not been properly made. In a number of small tables incorporating book shelves, the timber had been properly seasoned before use but in the construction, wide boards, by being fixed rigidly to other pieces of wood in which the grain ran at right angles to the original piece, were restrained from movement with changes in moisture content. During the periods when the trouble occurred, the equilibrium moisture content for wood dropped as low as 6 per cent. after the timber had originally been dried to 12 per cent. moisture content, and whereas the unrestricted ends of pieces had shrunk from 17 in. to 16–13/16 in., the other ends which were restrained from movement below 17 in. had developed splits approximately 18 in. wide. Some of the splits were in glued joints but most were in solid wood. Since well-made glue joints are stronger than wood, only those joints which had not been properly made would under the conditions experienced open in most timbers. More attention should be given by designers and manufacturers of furniture and wooden articles in which wide boards are used, to ensure that change in dimension with change in humidity can be accommodated without the width of board being restrained. If it be necessary to use wide boards fixed transversely to longitudinal wood or metal framing, slotted screw holes or buttons should be used in such a way as to permit movement.

Investigation of the actual gluing problems showed that two major causes were present. In the first problem pieces of timber approximately 6 in. x 3 in. cross section had been dressed on one face for gluing together to make posts 6 in. x 6 in. At least four weeks had elapsed between the dressing of the timber and the gluing of the assemblies. As the timber was at 16–17 per cent. moisture content when dressed, further drying accompanied by some cupping and warping had occurred.

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HOT DRY WEATHER AND GLUING TROUBLES—*continued.*

Consequently the surfaces to be glued were no longer flat and did not make intimate contact when placed together and although gluing pressures were nearly 200 lb./sq. in. this was not sufficient to flatten the thick wood to be glued. Glue lines were therefore too thick to provide a strong bond and partial separation was obvious when assemblies were removed from the press.

Other gluing troubles were met with urea formaldehyde glues in which the working life and assembly times recommended by the manufacturers were exceeded by the operator in the preparation of glue joints. Such glue joints were totally unsatisfactory, as the glue was not in a suitable condition for use.

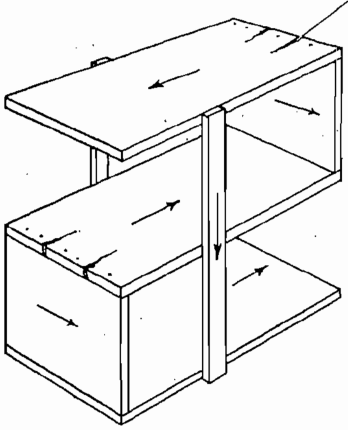
To obtain satisfactory results with cold press glues the following rules should be carefully observed :—

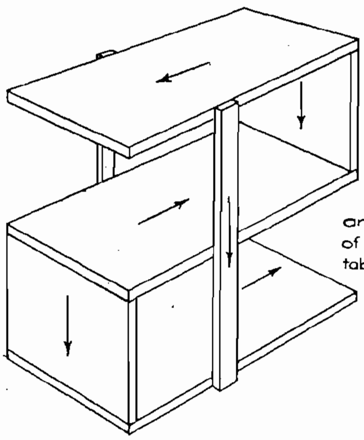
1. Timber to be glued should be thoroughly seasoned. A moisture content of 9–12 per cent is usually satisfactory.

2. All surfaces to be glued should be smooth and clean and joints should fit closely when assembled and pressure is applied.

3. Adequate pressure must be applied and maintained until the glue is set and sufficient strength in the joint to permit handling is developed.

4. Always follow carefully the manufacturer's instructions for mixing and spreading glues being especially careful to use clean mixing utensils, measuring by weight quantities of glue components and water, and to observe limits imposed on working life, open and closed assembly times and clamping times.





IS THIS BORER DANGEROUS ?

Part 1—The Auger Beetle (*Xylion collaris*).

by G. W. Tack, Preservation Section.

Each year, particularly during the summer months, January and February, the Division of Forest Products receives a considerable number of enquiries from householders in Melbourne concerning boring insects causing damage to timber. This season, in addition to the better known Lyctus (powder post) borer, another boring insect unfamiliar to the majority of householders has been unusually active.

Damage caused by this borer takes the form of small clean cut holes (approximately 1/8th inch in diameter) which appear in building scantling or in plaster sheet, plywood or other lining laid over such scantling.

The borers responsible for this damage are known as the Shot Hole or Auger beetles (from the appearance of their holes) and belong to the insect family, *Bostrychidae*. The shot hole borer most commonly encountered in building timbers in Melbourne is *Xylion collaris*. This beetle measures about 1/4 inch in length and has a rather striking colour scheme, especially when alive, which makes it easily identified. The body varies in colour from dark reddish-brown to almost black but the hood-shaped covering of the head is yellowish-red to dusky red. In live specimens the contrast in colour is very marked, but in dead specimens the yellowish-red tint usually becomes much darker with age.

The tips of the wing covers are sharply curved downwards, giving the hind end of the body a chisel shaped or cut off appearance when viewed from the side.

The life history of this beetle has not been accurately determined in Victoria but appears to be somewhat as follows :—

The adult beetles are active and numerous in the forest and during the summer months are found on the surface of freshly felled or dying trees, and also on recently cut green timber, where they cut circular shafts into the sapwood for the purpose of egg laying. After laying eggs, the dead female beetle may often be found with its chisel shaped hind end blocking the entrance to this shaft.

The eggs hatch into larvae or grubs which feed chiefly upon the sapwood and then pupate in a chamber just beneath the surface of the wood. Finally, the adult beetle cuts its way out of the timber, forming a clean cut shot hole similar to that made by the entering beetle. Emergence of beetles takes place principally in the warmest summer months.

Building scantling cut from an infected log or infected shortly after cutting at the mill or timber yard when still relatively green may show little sign of attack until the adult beetle emerges the following summer. The beetle is equipped with hard strong mouth parts and if trapped behind fibrous plaster, plywood or even lead sheet it will cut the typical auger-like exit hole to escape.

If the timber is still sufficiently green reinfestation may occur. **However, building scantling timber already erected for several months is too dry for reinfestation and after the first crop of exit holes all damage due to this borer will cease.** Although *Xylion collaris* does not initiate attack in seasoned timber, the larvae or grubs once formed can complete their life cycle and become mature beetles while the wood is drying from the green condition.

IS THIS BORER DANGEROUS ?—*continued.*

A white dust and some coarse frass or powder may be forced out of holes made by shot hole borers emerging through plaster sheet but this is readily distinguished from the fine flour-like powder produced copiously by the Lyctus borer. It should also be noted that the emerging Lyctus borer can pierce plaster sheet but the holes made are smaller (1/32nd to 1/16th inch in diameter) compared with the 1/8th inch dia. holes made by *Xylion collaris.*

Except in special cases where timber remains green for long periods (*e.g.*, logs in storage), no treatment is necessary, as normal seasoning is sufficient to render timber immune to further infestation. Where emergence holes impair a decorative effect, they may be patched at the end of the summer with a suitable filler (*e.g.*, putty, plastic wood, patching plaster, etc.) and tinted to match the surrounding material.

To summarize, *Xylion collaris* and species with similar habits are a relatively minor pest of building timbers due to their inability to continue attack as the timber dries. In this they differ from the powder post beetles (Lyctus spp.) which will be discussed in a later article.

ABSTRACTS FROM RECENT REPORTS.

The following abstracts are from internal laboratory reports, some of the results of which will eventually be published in research and trade journals. The reports are not intended for general distribution, but in some cases where spare copies are held, and the circumstances warrant it, the full report may be obtained on loan on application to The Chief, Division of Forest Products, C.S.I.R., 69–77 Yarra Bank Road, South Melbourne, S.C.4.

Veneer and Gluing Section.

Development of gluing schedules for rose mahogany (rosewood). Rosewood is one of Australia's most beautiful cabinet timbers but its popularity has been reduced by its tendency to bleed from the oil cells which it contains. This presence of materials of an oily nature has probably given rise to an idea that it is difficult to glue. Tests were carried out at the request of the Queensland Sub-Department of Forestry.

Three glues were used—animal glue, joinery grade casein glue and cold-setting urea-formaldehyde resin. Some specimens were glued immediately after machining and the remainder after being stored for about six months.

The joints were tested in shear in the standard manner and were all found to be of a satisfactory strength, usually with a high degree of wood failure, but there was evidence of a slight adverse effect of the urea-formaldehyde resin on wood strength.

Timber Physics Section.

The variation in shrinkage and density throughout the tree. The variation in tangential and radial shrinkage and the density of four logs of jarrah, three logs of manna gum and six stems of coconut palms have been investigated. A feature of interest is that not one sample of jarrah or manna gum showed any reduction in length from the green to the oven-dry state. All swelled slightly in the longitudinal direction.

BREVITIES.

On March 2nd, Messrs. N. Tamblyn, G. W. Tack and R. W. Bond of the Timber Preservation Section, Division of Forest Products left to inspect the pole tests at Wyong and Clarencetown, N.S.W. These tests form a co-operative project with the N.S.W. Forestry Commission, Division of Wood Technology.

After the pole test inspections they attended the C.S.I.R. Third Inter-Divisional Toxicology Conference in Sydney, where Mr. Tamblyn presented a paper on Lyctus.

THE PROPERTIES OF AUSTRALIAN TIMBERS.

ROSE GUM.

Rose gum is the standard trade common name for the timber known botanically as *Eucalyptus grandis* (W. Hill), Maid. The tree is also known as flooded gum in New South Wales.

Distribution.

Rose gum is found in the coastal forests of Eastern Australia, extending from the Atherton Tableland in Queensland southwards to the north coast of New South Wales.

The species occurs in the region where the mean temperature for the coldest month rises above 50° F., and northwards to around the 60° F. limit and with a minimum average rainfall of 1½ inches for any month.

Habit.

Under normal conditions the tree grows to a height of 120 feet to 150 feet with an average diameter at breast height of 3 feet 6 inches. The bole of this tree is usually straight and symmetrical with a smooth white bark. When shed this accumulates at the base as a thick brown litter.

Timber.

The timber is rose-red in colour and is one of the lighter, softer and more fissile of the Australian eucalypts. The wood is usually open and straight-grained and has a tendency to splinter with a certain amount of woolliness.

Rose gum is of medium weight with an average air dry density (at 12 per cent. moisture content) before reconditioning of 49.0 lb. per cubic foot with a 95 per cent. probability range of 36.1 to 61.8 lb. per cubic foot. The average air dry density (at 12 per cent. moisture content) after reconditioning is 46.8 lb. per cubic foot with a 95 per cent. probability range of 33.0 to 60.5 lb. per cubic foot.

It is a somewhat difficult timber to season and checking of backsawn boards can be avoided only by very careful control of the air conditions in the early stages of drying. Quartersawn material sometimes has a tendency to check on the edges and this also can be prevented by the exercise of care in regulating the drying conditions. So far as is known, little trouble is experienced with warping. A slight cupping of backsawn boards on the upper layers of a charge frequently occurs, but this may, if considered sufficiently serious, be removed by a steaming treatment.

Collapse in this timber is generally ignored, as it does not result in surface irregularities. Some recovery in size may be obtained by reconditioning, and it is a matter for individual consideration whether the increase in size justifies the expense and delay of the treatment and the re-drying that is then desirable.

In drying from the green condition to 12 per cent. moisture content, rose gum shrinks 7.5 per cent. in a tangential (backsawn) direction and 4.6 per cent. in a radial (quartersawn) direction. After reconditioning these figures are reduced to 5.7 per cent. and 3.8 per cent. respectively.

Rose gum falls into strength Class C, which is the same class as mountain ash. It cannot be regarded as a durable timber in the ground but above the ground stands exposure to the weather quite well ; however, effective treatments are available and rose gum poles which have been treated with creosote oil by the open tank method have proved satisfactory. The sapwood is rarely attacked by Lyctus. The timber is easy to work, nail, dress and finish and takes a good polish.

Uses.

Rose gum is a general purpose hardwood, used in building construction for scantling, flooring, lining, joinery, shingles, and split material for fence rails and palings. It is also used for furniture, interior trim, parquetry and boat oars. In the production of plywood it is used as corestock. During the war, rake and incendiary bomb handles were made from this timber.

Availability.

Rose gum may be obtained under normal conditions in a full range of scantling sizes, as boards, milled products and as core stock.

Mr. A Gordon, Officer-in-Charge, Veneer and Gluing Section, Division of Forest Products, has been granted 15 months' leave of absence to enable him to accept an appointment with the Food and Agriculture Organisation of the United Nations. He is leaving during April for Washington, U.S.A.

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C. S. I. R.

FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

No. 152 1947##152 May 1947

SECTION OF TIMBER MECHANICS

(This is the fourth article in the series describing the work of the various sections of the Division of Forest Products.)

The organisation of the section of Timber Mechanics is similar to that of other sections which have been described in this series of articles. Under the supervision of a section head a number of research and technical officers plan, and with the help of laboratory assistants pursue investigations into the mechanical properties of timber and plywood, the strength of fastenings, and the use of timber in buildings and engineering structures. Most of the work of the section deals with various aspects of the problems involved in using timber structurally, but there are also other projects which have come within its scope, all of which were of some importance during the war. The section is adequately equipped to tackle the problems which arise in the many and varied fields in which the mechanical properties of wood are of importance. An impression of the work of the section can possibly be best conveyed by discussing certain items in some detail.

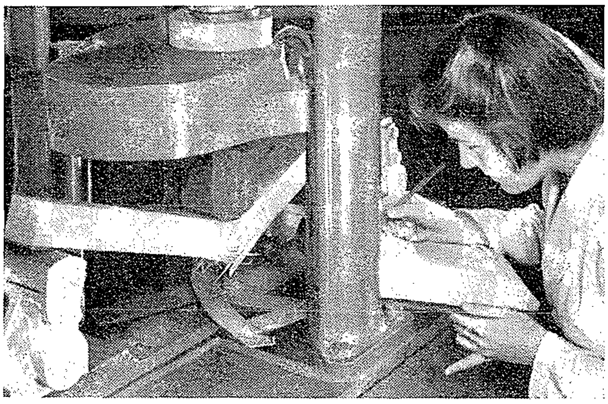
Steam Bending of Wood.—It is well known that the plasticity of wood increases with increasing temperature and that advantage is taken of this fact in the commercial process of bending steam heated wood. All species, however, do not respond equally well to treatment and what may be a relatively mild bend for one species may well be a severe bend for another. Before the war an investigation was undertaken of the bending quality of a large number of Australian species so that the Division is now able to advise on the suitability of different species for bending purposes. Not a great deal of work has been done in this laboratory in developing the techniques of bending, the methods developed elsewhere having been adopted, but such information is of value to firms and persons who may have no previous knowledge of the art, and is frequently supplied to them by the Division.

At one stage during the recent war, it appeared that old horse-drawn ordnance vehicles might need to be pressed into service and their reconditioning was undertaken. Solid wooden wheel felloes had been used but the Division investigated the production of bent laminated replacements which, as designed, were both more serviceable and less wasteful of timber than the original type.

Container Design.—The section is equipped to investigate box designs, the testing methods used, which simulate service conditions, consisting of simple drop tests, compression and "rumbler" tests. (The rumbler is a revolving drum of 7ft. diameter in which the container is picked up by rotation and falls back, against or over hazards, to the bottom of the drum. The number of drops at which the container spills its contents is usually taken as the end point of the test.) Investigations have not been confined to wooden boxes; plywood and fibre-board containers and even steel when comparisons are desirable, are also included and suggestions made for improvement in their design. As rather more than 20% of all the timber used in Australia goes into cases and crates the importance of this work is obvious, particularly when it is emphasized that many containers in commercial use are capable of considerable improvement. Some examples of what has been done were given in an article on "Box Design" in the June, 1946 issue of this News-Letter in which it was estimated that the saving in construction costs on cordite transit boxes alone, due to their redesign, amounted to approximately £500,000.

Specification Testing.—Although the primary function of the section is research, tests of a routine or commercial nature are occasionally carried out when special circumstances warrant it. Thus, as the section has a testing machine which can exert a force of 600,000 lb., the Division is occasionally called on to carry out tests which require such a large load and which cannot be conveniently provided elsewhere. Assistance in the testing of building units, such as wall and roof panels, covered with plywood, asbestos-cement or steel sheets, is also given to various departments and firms.

By far the most important testing of this nature which the section has undertaken was in connection with the use of Australian timbers in aircraft. These routine specification tests involved round-the-clock work so that the machines would be able to keep up with the great demand for timber, and all told some hundreds of thousands of tests of this nature were performed in this laboratory during the war.



Standard Centre-Point Bending Test.

Strength of Australian Timbers.—The chief interest and work of the section lies in the investigation of the strength of Australian timbers, in the evaluation of the effects of factors affecting the strength, and in the testing of new as well as old methods of using timber in structures.

In a recent series of articles in this News-Letter the various properties of timber included under the general term "strength" were discussed, and it was there pointed out that timber may be loaded in a number of different ways. The resistance of timber to the various types of loading to which it may be subjected is measured in tests which are standard not only in this laboratory but also overseas, thus enabling a comparison to be made between

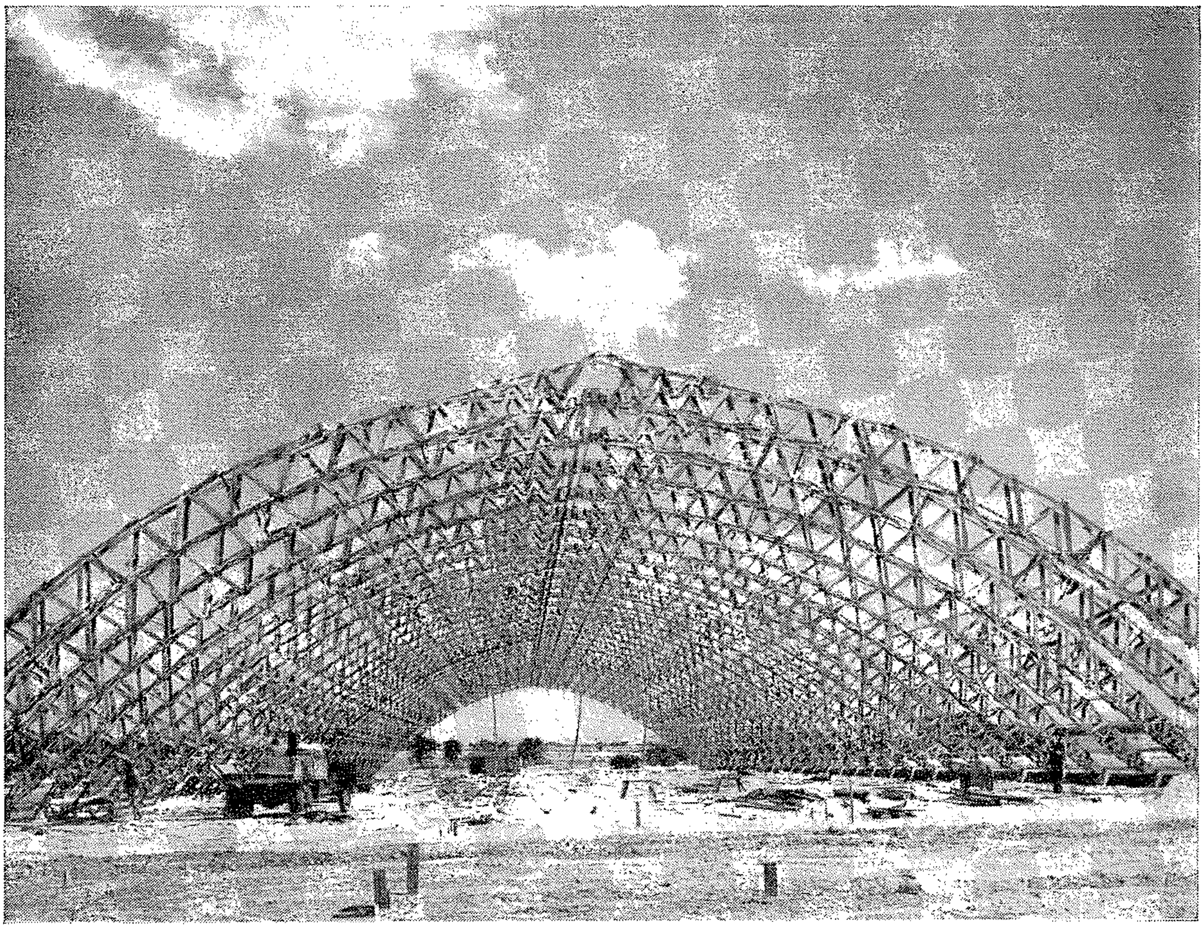
SECTION OF TIMBER MECHANICS—*continued*

different species whether indigenous, exotic or foreign. This is important to consumers in Australia in order that the accumulated experience of others may be applied to the problems involved in the utilization of local timbers, and it is also of importance to exporters as it enables a fair appraisal to be made of the properties of our timbers compared with others with which they compete in overseas markets. These standard tests are carried out on relatively small, defect-free specimens such as can be seen in the photograph which shows a specimen of 2" x 2" cross-section broken in a standard bending test.

Not only are the results of these mechanical tests useful for comparison between species, but they can also be used directly in engineering design provided the differences between laboratory and field practice are understood and correctly assessed. To interpret the results is another function of the section. The more important of the factors which have to be considered and which are continually under investigation by the Division are the variability inherent in any species, the conditions of growth, moisture content, temperature, duration of loading and defects. Sufficient knowledge of the effect of these factors has been obtained, in the various timber mechanics laboratories throughout the world, to enable design or working stresses to be set up from the test results.

Because of the great amount of work involved in the testing of a single species it has not been possible to carry out complete testing of more than a handful of the large number of species used as structural timber in Australia. It has therefore been decided to classify our species into a number of groups, according to their strength. This can be done with much less labour than would be involved in testing to find accurate values for all the properties of all species, and it is the present general policy of the Division to carry the testing of a species only so far as will enable it to be accurately grouped. Grouping, however, has an economic consequence of much greater importance than the reduction of testing time in the laboratory. It is true that in grouping species together and using working stresses common to all members of the one group some species must be degraded, but the great advantage of the procedure is that any species can be replaced by any other species of the same group. Further when one timber differs but little from others of closely related species, as is not infrequent in Australia, a group, rather than a species, specification should be made. Frequently, in the past, however, this has not been done, and one timber only has been accepted and others unreasonably excluded. Grouping thus helps the supply of structural timbers.

In silvicultural work some of the conditions of growth such as spacing, pruning and thinning, come under control. If the conditions are varied so as to give, for example, a maximum rate of growth of the trees, it clearly becomes important that the effects on the strength properties of



Cool Store under Construction. Department of Information Photo.

SECTION OF TIMBER MECHANICS—*continued.*

such variations should be evaluated. There will also be the problem of the utilization of the immature thinnings from the forests or plantations. In co-operation with the various Forest Services these questions, which are becoming increasingly important, are being investigated by the Division.

Fastenings will, in many cases, be the determining considerations in fixing the sizes of the members of a structure and any improvement in their efficiency will at once be reflected in the design of the whole structure. All types of fastenings come within the purview of the section although work has not been done on more than a few of them. It was from tests done in the Division that the basic design figures for use with Australian timbers were derived for the modern timber connectors known as shear plates and split rings which were widely used in the erection of wartime structures such as hangars, stores and munitions factories. Currently an investigation is proceeding of the effect of long continued loading on these connectors. The humble nail came into its own under wartime emergencies and nailed structures have given a performance beyond expectations. At an early date it is proposed to start an investigation of the capacity of nails to carry loads in structural joints which should supply the necessary information to place design on a surer foundation and raise the status of the nail to that of an engineering fastening.

Handbook of Structural Timber Design.—Information necessary for the design of timber structures, that originating in other laboratories as well as that resulting from the researches of this Division, has been gathered together into a handbook and thus made available for the use of engineers and architects. This book was published just at the outbreak of war which was a most timely appearance because, as the foreword says, "in time of national emergency particularly it is essential to have available, in a form as complete but as simple as possible, all essential information on the use of timber as a structural material." The photograph shows a construction view of one of the many hundreds of timber buildings and structures erected during the war, many of which were designed according to methods and with the working stresses recommended in the Handbook.

In a manner the two photographs reproduced with this article epitomize the whole of the work of the Timber Mechanics section. In the one is illustrated the controlled testing which is the basis of all investigations; in the other is seen an example of the ends to which the results of investigations may lead.

SYNTHETIC RESIN ADHESIVES

VII—Techniques of Pressing

(Concluding article)

Certain pressing techniques are more applicable to synthetic resins than to other types of adhesives, principally perhaps, because the resins often require the simultaneous application of heat and pressure. Cold-setting resins can, of course, be used with traditional pressure devices such as clamps, screw presses, nails, springs, or gravity applications by dead loading or levers, but as these methods are commonly used with all types of glue they will not be considered here. On the other hand, the techniques which are described briefly below have particular application to synthetic resins.

The Hot Press.

For making flat panels of plywood hot presses are used very extensively, because adhesives which make a joint of high quality can then be used, and because hot pressing permits a much higher rate of production than cold pressing.

Hot presses for plywood usually depend on some form of hydraulically-operated piston mechanism for producing the pressure, and are similar in principle to those used in other fields, such as plastic moulding. The essential feature in the design of a plywood hot press is that it must possess a rigidity and sturdiness of construction far beyond that necessary for the old-type cold-glue press. Deflection in a cold press is not serious, for it is distributed over perhaps 30 in. of a clamped bale. In a hot press, however, with usually only one panel of less than 1 in. thickness in each "daylight" (the opening between a pair of plates) the whole deflection may come in each panel. The press head should be in the form of a one-piece heavy steel casting constructed to ensure a maximum deflection not exceeding .003 in. The lower platen or head is usually of 1½ in. plates of special alloy steel with good heat conductivity and high compressive strength. Accurate machining of the surfaces is essential in order to ensure uniform pressure on the wood. Neglect of this may lead to uneven bonding of the plywood and perhaps the crushing of the wood itself. If steam is used as the heating medium the steam channels must be accurately bored and spaced to give equal heating or cooling over both surfaces of the plate. It is also essential that the heating units be efficiently insulated against the transmission of heat to the main frame of the press. Electric instead of steam heating is now coming into greater use and thermostatic control of temperature is desirable.

The hydraulic pump system must permit rapid closing of the press within 15 to 30 seconds and also maintain an accurate continuous pressure for the required period.

Hot presses have been constructed in sizes up to 15 ft. square possessing up to about 20 "daylights" or openings. Smaller presses with 5 to 10 "daylights" are most commonly used.

If a resin glue film is used the sheets which have been previously cut to size from the supply roll are laid between the plies to be glued. It is permissible to lap joints of the film about ½ in. to build up a larger sheet in order to utilize the smaller pieces which may accumulate. It is the general practice first to cut the film with a guillotine to multiple dimensions and to re-cut later on a veneer clipper to the required sizes.

Aluminium cauls 1/16 in. in thickness are commonly used to facilitate the handling of the plywood in and out of the press. It is the usual practice to place one sheet of plywood in each press opening but two sheets may be pressed at the one time if the plywood does not exceed 1/8 in. in thickness.

The loading operation must occupy a minimum of time in order to prevent setting of the resin before the pressure is applied. For the same reason the press closing time should be kept as low as possible.

After unloading, the panel continues to give off moisture during the greater part of the cooling period; consequently, the moisture content of the outer veneers is below the equilibrium moisture content of the surrounding atmosphere. This is adjusted by allowing the glued up stock, properly piled and stickered, to condition for a period until equilibrium is reached. With some species of timber, it is advantageous to plunge the panels into water at room temperature, bulk-pile for several hours, and then pile in the ordinary manner until equilibrium is attained. In this way, conditioning is facilitated and the procedure may have a beneficial effect on the future working of the panel.

High Frequency Heating.

The high-frequency method of setting glue lines, although of comparatively recent technical development, embodies a principle which has been known for nearly a century. If a dielectric is placed between the electrodes of a condenser which is attached to a high-frequency generator, heat is produced in the dielectric as the electrostatic field rapidly changes direction.

The hot press depends on heat conduction through the wood for raising the temperature of the glue line, and for this reason is unsuitable for the gluing of thick assemblies in which some glue-lines are a large distance from the platens. In the high-freqency heating process, however, the temperature is raised almost simultaneously throughout all portions of the wood between the electrodes, with a consequent considerable saving in time. Differences in the rate of heating depend not on the distance from the plates but on the nature of the dielectric material. Thus, it is possible with a suitable arrangement of assembly and electrodes to heat the glue lines selectively, so that their temperature is raised faster than that of the wood.

It is, of course, necessary to provide pressure, as with other methods of heating the glue lines, and it may be convenient to use the high-frequency equipment in conjunction with an ordinary hydraulic press. On the other hand, a clamped assembly may be placed in the dielectric field.

It appears that it is advisable to use adhesives which can be set rapidly at intermediate temperatures, rather than those which require temperatures above about 280° F. for quick setting. Above the boiling point of water there is a risk of steam forming within the wood, with the consequent necessity of maintaining the pressure until the wood cools to below that temperature.

High frequency apparatus has to be adequately screened to prevent interference with radio communications, and the whole pressing and heating equipment should be surrounded by a cage made of wire mesh. Suitable frequencies may eventually be allotted, which will render this unnecessary.

Bag Moulding.

While the hot press lends itself primarily to the manufacture of flat plywood panels, it is not the most suitable equipment for the production of curved plywood surfaces. The modern tendency is to use one or other of the "fluid pressure" techniques where the final product is to be of complex shape.

The underlying principle is similar for all these techniques, although several major variations are in common use. Upon a mould, or form, of the required shape veneer strips coated with glue are laid, the whole assembly is placed in contact with a flexible bag, usually made of rubber, and pressure is applied by establishing a higher fluid pressure on the side of the bag remote from the assembly than on the other. The fluid may also provide heat if the adhesive requires elevated temperatures for setting. In some cases the veneer is glued to the form beneath; in others precautions are taken to prevent adhesion.

An evident advantage of the bag-moulding process is that only one form is required, and thus the necessity of closely matched male and female forms or mating dies is eliminated. The technique is particularly well suited for structures having considerable compound curvature, or with simple curves bent through a large angle, for it can readily be seen that a fluid can provide pressure in every required direction simultaneously, whereas a mechanical press normally provides pressure in only one direction. The use of the technique is justified also if the manufactured parts are of variable thickness or are too thick to be made conveniently by steam bending.

The simplest method of bag moulding is that known as the "vacuum bag" technique, which is often used for veneering simple curved surfaces. The glue-coated assembly is inserted in the bag and the air exhausted, the external atmosphere providing the pressure. Under these conditions the maximum pressure that can be obtained is about 15 lb./sq. in., which is adequate providing that close contact can be attained between the glued members.

Another method is to bring portion of the outside of the bag into contact with the part to be moulded, while the other portion of the bag is restrained from expanding. The pressure inside the bag is then **increased,** and may be raised as high as the operation requires, being commonly of the order of 100/200 lb./sq. in. The fluid pumped into the bag need not necessarily be air, and sometimes water is used.

A combination of the vacuum bag and the pressure bag processes may be used for such purposes as the manufacture of aircraft parts. The assembly is placed within a bag as before, from which the air is evacuated, and this is placed in turn in a pressure chamber. Both heat, for setting the glue, and pressure, for bringing the members into intimate contact, are then supplied by pumping steam into the chamber. Again, hot water may be used instead.

The various moulding techniques have great possibilities in the proper utilization of wood, and will probably come into more general use in the future.

Only the bare outlines of the various pressing techniques have been given in this article: further details can be obtained on application to the Chief, Division of Forest Products, 69-77 Yarra Bank Road, South Melbourne, S.C.4.

RESISTANCE TO TERMITE ATTACK

An article of interest to Australian foresters generally, entitled "A List of Woods Arranged According to Their Resistance to the Attack of the West Indian Dry-Wood Termite," by G. N. Wolcott, appeared in the Caribbean Forester, Vol. 7, No. 4, October 1946. The list includes a few timbers available on the Australian market, including some native species. The purpose of this note is to give wide Australian circulation to a request by Dr. Wolcott that a correction be made. Owing to an unfortunate error in labelling, the first species in the list is *Syncarpia laurifolia* (turpentine), graded as "Repellent to Cryptotermes brevis." Actually, the specimen was *Callitris glauca* (white cypress pine) which is included on p. 332 under "Woods Susceptible to Attack of Cryptotermes brevis." It would be desirable for the names to be transposed in any copies of the above journal which are accessible to our readers.

CORRIGENDUM

In the first sentence of the article on "Urea-Formaldehyde Resins" in News Letter No. 146, the word "liquid" should be inserted before the phrase "synthetic resin adhesives."

BREVITIES

Mr. S. A. Clarke, Chief, Division of Forest Products, left Melbourne on April 5th to visit New Zealand, U.S.A., England and Sweden. He expects to return about the end of August.

Mr. A. E. Head joined the research staff of the Utilization Section, Division of Forest Products, during April. Mr. Head was previously an officer of the Victorian Forests Commission, and during the war held the rank of major with the No. 2 Forest Survey Co., A.I.F.

Miss Audrey M. Eckersley, who has been with the Wood Structure Section of the Division of Forest Products for fifteen years, resigned last month in order to be married. She is now living in Brisbane.

Mr. G. W. Wright, Officer-in-Charge, Seasoning Section and Acting Officer-in-Charge, Utilization Section, with Mr. A. E. Head, Utilization Section, visited Sydney early in May in connection with Standards Association business. Following this, Mr. Wright joined Mr. C. S. Elliot, Acting Chief, Division of Forest Products to attend the E.S.T.I.S. Conference at Coff's Harbour, N.S.W.

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C. S. I. R.

FOREST PRODUCTS NEWS LETTER

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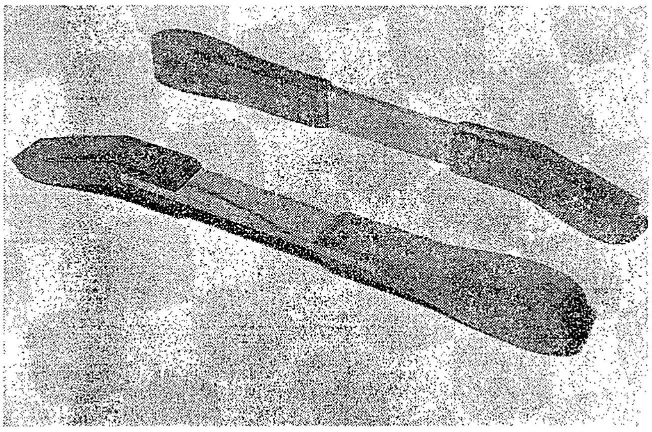
No. 153 1947##153 June 1947

SECTION OF TIMBER UTILIZATION

(This is the fifth article in the series describing the work of the various sections of the Division of Forest Products.)

The purpose of the Timber Utilization Section is twofold. In the first place it acts as a general information service to the timber industry, giving information and advice as a result of investigations carried out by the various Sections of the Division—while other Sections maintain direct contact with the industry in regard to many aspects of their work, the dissemination of information once it reaches a stage where it can be more or less standardised is handed over to the Utilization Section. In the second place it carries out investigations on its own account in connection with wood working factory and sawmill procedure, and to a lesser extent it may carry out preliminary investigations of a laboratory nature.

Owing to the wide range of general information regarding timber that has been built up within this Section, its two senior officers were seconded throughout the war years to the Timber Control Office, and only a skeleton staff was left to carry out the normal work of the Section. The staff is now being built up again. During the past couple of years however, it has been necessary to call on other Sections, notably the Timber Seasoning Section, to provide staff for some of the major investigations required of the Utilization Section, and an outstanding example of this is the work that has been done on sawmill studies in Queensland and Victoria. These studies aim at increasing the efficiency of sawmill operation by studying power consumption, output, etc. A paper dealing with these sawmill studies was read at the recent Eastern States Timber Industries Stabilisation Conference, and its value has been recognised by a request for continuation of the work. An independent request for a similar type of investigation aimed at reducing wastage in the production of case stock has also been received.

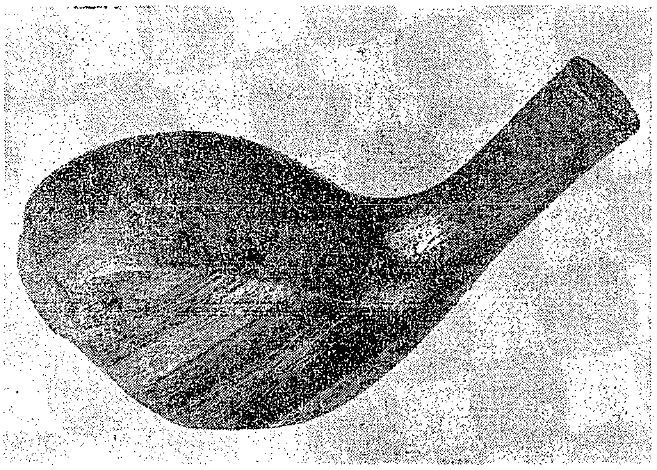


Densified wood in component of a fruit-grading machine.

Another activity which has also been taken up by the Section during the past 12 months has been the survey of sawdust supplies throughout Australia. Sawdust, representing a large proportion of the logs passing through a sawmill, is not only often a direct waste, but also a problem as regards disposal. Where not burnt to provide power, it is destroyed outright in sawdust incinerators or in sawdust dumps. Various methods of utilizing sawdust are known already, and their successful application is mainly a matter of economics, depending largely upon quantities available in a given locality. The object of the present survey is to get accurate information on the supply position with a view to investigating the possibility of establishing one or other of such industries, in suitably selected positions throughout Australia.

Throughout its existence, the Utilization Section has been called on repeatedly to suggest suitable Australian timbers to take the place of imported timbers previously used for specific purposes, such as axe handles, textile rollers, etc. To give reliable information in connection with such enquiries, it is necessary first of all to study the properties of timbers that have proved suitable for the particular use in question, and then to choose the local timbers with the properties approaching most nearly to those required. This obviously involves a wide knowledge of the general physical properties and characteristics of Australian timbers. This fund of information is collected by the Utilization Section from the work of other Sections within the Division. In some cases investigation shows that a timber which has been used for many years for a particular purpose has been chosen because of ready availability rather than for any particular physical attribute. In most cases, however, these specialty timbers have been chosen because of their particular suitability for the use in question. In giving advice regarding local timbers suitable for specialty purposes, due consideration has to be given to availability in quantity, and this involves another set of records which the Utilization Section has to keep continually up to date.

Ever since its inception, one of the main lines of work of the Utilization Section, has been to give advice in the lay-out of wood-working plants and in the development of plants being installed in Australia for the first time. Demands of this type have ranged from comparatively minor lay-outs to complete lay-outs for new and extensive mills and wood-working plants.



Laminated golf club head developed by the section.

Because of the nature of the experience of its officers, the Section has, since its inception, been representing the Division on the Timber Sectional Committee of the Standards Association of Australia, and on the Victorian Sub-Committee. The work involved in this regard is the preparation of grading rules and secretarial work in connection with the preparation of draft specifications preparatory to their final acceptance as Australian Standards.

IS THIS BORER DANGEROUS?

Part 2—The Pinhole Borer

by G. W. Tack, Preservation Section

The term "pin-hole" is used to describe certain small borer holes in timber usually ranging from about 1/32 to 1/16 of an inch in diameter. These holes are perpendicular to the surface of the timber (a pin may usually be inserted for almost its full length into them), free from copious dust or powder and are often stained bluish-black or black at the edges, the discoloration sometimes extending along the grain of the wood on both sides of the hole.

The group of wood-boring insects responsible for these "pin-holes" can attack only the living tree, the felled tree or green sawn timber; they do not, and cannot, initiate or continue attack in dry timber. They are therefore readily distinguishable from Lyctus (the powder post borer) and Anobium (the furniture borer) which can attack only dry timber. In addition holes made by Lyctus and Anobium are chiefly parallel to the grain of the wood, are usually full of a fine dust or powder and are free from stain or discoloration.

"Pin-holes" occur irregularly in timber either singly or in groups and unless a considerable number of holes are closely grouped together, the effect on the strength of a piece of timber is negligible for most everyday purposes. However, degrade in appearance may be caused by the holes and the degree of staining associated with them.

Of course, the effect of any degrade varies according to the use for which the timber is intended. Thus it is of more importance in plywood or furniture stock than in building timber such as flooring or scantling.

The various species of pin-hole borers are divided into three separate insect families known as the *Platypodidæ*, *Scolytidæ* and *Lymexylonidæ*. The pin-hole borers may be regarded from the point of view of the timber industry as a single fairly well-defined group, although the various species differ greatly both in their habits and appearance. However, as a matter of general interest an account of the three main pin-hole borer families follows.

The members of the families *Platypodidæ* and *Scolytidæ* are known as the "ambrosia" beetles, and differ from most other wood-boring beetles in that the adult insect and not the grub or larva does most of the damage to the timber. The adult beetles vary considerably in size but are generally about 3/16 of an inch long, and reddish-brown to black in colour. These beetles usually bore at right angles to the surface only through the depth of the sapwood, and do not commonly penetrate for any appreciable distance into the truewood before laying their eggs. Freshly fallen logs or unhealthy trees are attacked, some beetle species boring through the bark and others boring through a surface from which the bark has been removed.

The grubs or larvæ after hatching from the eggs live and develop in the galleries constructed by the parent beetle. They do not appear to feed on wood but on a fungus which grows on the walls of the galleries; this fungus, which is known as "ambrosia"—hence the name ambrosia beetles—is the cause of the staining around the holes and is introduced by the adult beetles when they bore into the wood. The fungus develops only in green wood where conditions are suitable for its growth: **thus infestation by these beetles cannot occur in dry timber nor can attack continue long after the timber begins to dry.**

The family *Lymexylonidæ* is a group of pin-hole borers the members of which are known almost entirely by their damage in the larval or grub stage. The adult insects are very unlike most beetles in appearance, being thin bodied, about ¾ of an inch long with short clear wings, and are very rarely encountered in the adult form. Eggs are laid in cracks on the surface of a tree or log, e.g., at fire scars, blaze marks or areas where the bark has been removed. After hatching, the young larva eats its way into the tree pushing a stringy frass out behind it. The larva is about 1/32 of an inch in diameter and is threadlike and longer than the larvæ of the "ambrosia" beetles. Although the galleries are often discoloured by fungal growth there is no evidence that Lymexylonid larvæ depend on fungal material for nourishment.

Pin-hole borers of this family appear to have a relatively long life cycle and their larvæ are more resistant to drying out of the infested timber as they are sometimes found in scantling etc. which has been cut for some time. Like the "ambrosia" beetles however, they cannot attack or develop in dry timber.

Methods of control are only applicable in the case of the fallen log or tree and are not necessary in sawn timber exposed to normal drying. In general, as the period for severe attack is confined to spring and summer, logs cut at these times should be removed from the forest as soon as possible after felling. Removal of the bark may also be an advantage in preventing or reducing pin-hole borer damage, provided such logs are exposed so that partial drying of the surface occurs rapidly making it less susceptible to attack. The spraying of logs, particularly the ends, with preservative solutions such as a creosote and soap emulsion (preferably hot) will also reduce the extent of infestation.

With freshly sawn timber, infestation and development of the eggs and larvæ can be effectively prevented by stacking out on strips so that air can circulate freely around the pieces and cause surface drying.

Where a decorative effect is involved and repair is necessary, pin-holes in dry timber should be cleaned out, filled with putty or plastic wood etc. and the surface finished as desired.

To sum up, damage due to pin-hole borers is restricted to living or recently fallen trees and the presence of pin-holes in sawn timber should not be cause for alarm. Pin-hole borer damage may be readily distinguished from that due to Lyctus or Anobium attack, by the absence of fine dust or powder and the presence of dark stains at the edges of the holes which are usually at right angles to the surface, i.e., across the grain.

Except on the grounds of appearance, the rejection of sawn timber because of pin-holes is not justified, unless, as very rarely happens, the holes are sufficiently numerous to cause a significant decrease in the strength of a piece of timber.

A COMPOSITE PANEL FOR A FACTORY ROOF

Some tests were carried out recently at the Division of Forest Products upon a composite panel proposed for an insulated roof with a purlin spacing of 8′ 9″. The Division was requested to advise upon the type of roof required for extensions to a machine room which housed a plant releasing large quantities of water vapour. It was essential that condensation, with consequent dripping from the roof, should not occur, so the roof had to provide good heat insulation. The existing roof consisted of two layers of 1⅝″ T. & G. western red cedar planking, but similar material would be difficult to obtain these days.

One proposal made by this Division was two layers of flooring separated by 4″ x 1″ spacing strips at 4′ 4″ centres, the whole to be firmly nailed together to develop composite beam action, with an insulating board between the layers. For erection purposes some expedient such as temporary purlins would have to be used.

To obtain an idea of the stiffness of this form of construction, a test panel 9′ x 3′ was made of two layers of 4¼″ x ¾″ select grade mountain ash T. & G. flooring. Three spacing strips 4″ x 1⅛″ were placed at 4′ 4″ centres, and two 4″ x 3″ bearers at 8′ 9″ centres were used to represent the purlins. The lower layer was fastened to the bearers by two 2″ x 12 g. nails through each end of each plank. The spacing strip at midspan was then secured to the lower layer by two 2″ x 12 g. nails through each plank. The other two spacing strips were placed in position and the upper layer fastened by two 3″ x 9 g. nails through each end of each plank and by two 2″ nails through each plank at midspan. As a matter of interest, a support at midspan was not used during construction but cramps held the planks firmly together.

<< Content

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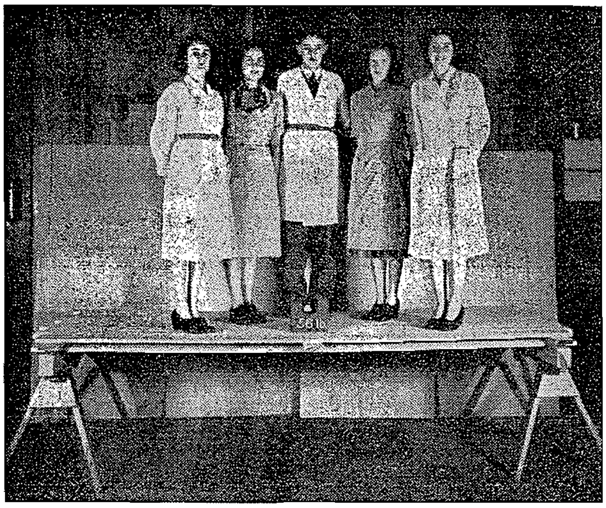
Test loads were applied to give an estimate of the stiffness under a point load of 180 lb. at various positions, and under a uniformly distributed load of 30 lb. per sq. ft. Some of the results are given in the accompanying table. As sufficient bags of shot were not available to provide a uniformly distributed load of 30 lb. per sq. ft. over the whole panel, a concentrated load of 525 lb. across the width of the panel was applied which would give approximately the same deflection. The panel was quite stiff, and as may be seen from the photograph, did not deflect unduly under a load of about 600 lb.

For a central point load of 180 lb., the deflection/span ratio was 1/540. For a uniformly distributed load of 30 lb. per sq. ft., the ratio was estimated to be 1/170, and for 20 lb. per sq. ft. a ratio of 1/270. The deflections were approximately proportional to the loads.

Tables of some Test Results on Composite Panel.

Load (lb.)	Position of load	Size of loaded area	Deflection at midspan at centre of panel.
180	Midspan, centre of panel ...	7′ x 4″	0.20″
525	Midspan, across entire width...	3′ x 3′	0.61″
180	Quarterspan, centre of panel...	7″ x 4″	0.11″
460	Quarterspan, across entire width	3′ x 3″	0.28″
200	Along middle three planks ...	8′ x 1′	0.14″



THE STRENGTH GROUPING OF AUSTRALIAN STRUCTURAL TIMBERS.

by K. L. COOPER,

Officer-in-Charge, Timber Mechanics Section.

(Prepared for presentation at the British Commonwealth Forestry Conference, London, 1947.)

In the first edition of the C.S.I.R. " Handbook of Structural Timber Design " which was published in 1939, Australian structural timbers were classified into four groups in accordance with their strength. This was simpler than setting out the species separately but it was also desirable as the apparent precision of individual tabulation would have been misleading, the available information being far from sufficient to establish working stresses for all the species listed.

The basic property on which a species is grouped for strength is its green modulus of rupture. Bending strength is accepted as being the most important property of a structural timber, and, in Australia, such timbers are normally used unseasoned. The highest strength group (Group A) was built around the ironbarks, which are renowned for their durability as well as for their strength. At the other end of the scale the lowest group (Group D) was taken so as to include hoop pine, an important Australian softwood, and Douglas fir, which before the war was imported into Australia in large quantities. The two other groups (Group B and Group C) were taken intermediately in approximate arithmetic progression. For each group average figures for modulus of elasticity, maximum crushing strength parallel to the grain and shear strength were also fixed as well as values for the same properties when the timber is air dry (12% M.C.). The table shows the figures for each group.

Group	M. of R. lb./sq. in.		M. of E. 10^6 lb./sq. in.		M.C.S. lb. /sq.in.		Shear lb./sq.in.	
	Green	12% M.C.	Green	12% M.C.	Green	12% M.C.	Green	12% M.C.
A	15000	24000	2.4	3.0	7500	12000	2000	2500
B	12000	20000	2.1	2.6	6000	10000	1500	1900
C	10000	16000	1.7	2.2	5000	8000	1200	1600
D	7000	12000	1.5	1.9	3500	6000	800	1100

Between species neither modulus of elasticity nor shear strength is normally as well correlated with modulus of rupture as is the crushing strength, but it is believed that in most cases the tabulated group figures will lead to satisfactory design stresses.

When but little information is available concerning the modulus of rupture of a species, grouping can be done on the basis of some other property. It will usually happen however, that other strength properties are also not available, although the average density of the species may be known. It will not be as satisfactory to predict modulus of rupture from its correlation with density as it would be to determine it ; also the correlation of density with crushing strength and other properties is not as close as that of modulus of rupture with the same properties. Hence, when the information is obtained from the same number of trees, density will not be as satisfactory a basis for grouping as is modulus of rupture.

Whatever basic property is taken, the structure, behaviour, variability and other properties of a species will always be important considerations in determining the group in which to place it.

Working stresses are derived from the group figures in the usual manner by making allowances for variability, long-continued loading, defects and contingencies. It is implied in the use of these working stresses that the timber will be graded and hence the defects limited. The working stresses in bending are :—

Grade	Allowable Bending Stress (lb./sq. in.)			
	Group A	Group B	Group C	Group D
Select (75%) ...	3000	2500	2000	1500
Standard (60%)	2400	2000	1600	1200

The disadvantage of grouping is that the working stresses of the majority of the species in a group are degraded to those of the lowest. This is far outweighed by the great advantage that timber can be specified by group thus giving a wide choice of species that can be supplied. There are many instances in Australia where because a timber differs but little from closely related species a group specification should be made, although frequently in the past one particular timber has been specified and others have been unreasonably excluded. Strength grouping corrects this. It is of particular importance in the Eastern States of Australia where the important timbers of each State tend to fall in different groups—Groups A and B in Queensland and northern New South Wales, Group C in southern New South Wales, Victoria and Tasmania. In Western Australia where production is largely confined to karri and jarrah, and in South Australia which lacks any quantity of indigenous structural timber, classification by groups is not of such importance. Strength grouping can be regarded as firmly established in Australia and not likely to be discarded even when detailed information on individual species becomes available. Such information will only become available infrequently in the future however, as most species can be classified with much less information than would be necessary to derive specific working stresses—another advantage of grouping.

It is of interest to compare the amount of material required to group a species with that required to find its modulus of rupture. If, for example, the modulus of rupture of a species is determined from five trees with a standard error of 6%, it would require twenty eight trees if the chances of the tree species mean varying more than 5% from the observed value are to be restricted to one in twenty, and about one hundred and seventy trees if not to vary more than 2%. On the other hand, assuming the same variability and taking 11,000 and 13,000 lb. per sq. in. as the Group B limits for modulus of rupture, species with the observed means given in the table will be correctly classified in Group B at the same 0.05 level of probability from fewer trees as shown :—

Observed species mean lb./sq. in.	No. of trees required to determine grouping of a species from modulus of rupture with a probability of 0.05.	
	5% margin	2% margin
12,000	4	7
12,200	5	8
12.400	6	11
12,600	8	19
12,800	13	41
13,000	23	143
Average	9	31

On the average, with a 5% margin, the number of trees required is about one-third the number required to test for species mean by standard methods. The difference increases where large numbers of trees are used, the average requirement when only a 2% margin is allowed being less than 20% of that for determination of species mean.

Grouping in the C.S.I.R. Handbook is used not only for working stresses of the timber, but also for safe loads of bolts, nails and connectors, the same grouping being retained throughout. The procedure in the United States makes an interesting comparison. In the "National Design Specification for Stress Grade Lumber and Its Fastenings, 1944," allowable stresses are separately listed for twenty-five species and for different grades of each. In a few cases grades and stresses are identical, for example, beech, birch and hard maple, but even allowing for these there are still twenty different sets of stresses. Considering bending alone, there are seven prime grade stresses and ten for all grades, the number of grades per species varies from two to seven, and the number of stresses used for the compression stresses corresponding to the ten bending grades is no less than twenty-five, some of them differing between themselves by less than 2%. The number of compression grades used is nine. On the other hand for allowable loads in joints, the same twenty-five species with some additional ones not listed in the table of allowable stresses, are classified into groups. There are four groups for connector joints, four and five for coach screws, five for nails and wood screws and six for bolts. This comparison shows that a need for grouping is felt wherever a number of species is used structurally, and at the same time, emphasizes the relative simplicity of the system as developed in Australia.

PROPERTIES OF AUSTRALIAN TIMBERS.

MYALL.

Myall is the standard trade common name for the timber known botanically as *Acacia pendula* A. Cunn.; other names include Myall spearwood in Queensland and boree in New South Wales.

It is a low bushy wattle tree with a hard, dark, rough-barked, short bole and a willow-like crown of silvery blue foliage arranged on slender pendulous branches (hence "pendula").

Distribution: Myall favours a region having an average rainfall of 1 inch for the driest month of the year and a near temperature of 50°-65° F. during the coldest months. Although it is drought resistant, this species is sometimes found on the heavy, rich loams of areas having 20 in. to 30 in. annual rainfall. In Queensland it is recorded from the Roma-Dalby and Clermont districts and occurs as far south as central New South Wales as scattered trees or clumps.

Habit: Myall reaches a height of 20 to 30 ft. and has a girth of up to 40 in. at breast height.

Timber: The truewood of Myall is purple-brown, dense, hard, violet-perfumed and reflects a lambent sheen from its longitudinal surfaces. The sapwood is fairly narrow and pale cream to yellowish in colour. It is hard, straight and close grained, but cuts and turns cleanly without chipping and dresses glass-smooth, taking a brilliant polish. Other characteristics include strength, durability and high calorific value. The timber has a density of 72 lb. per cub. ft. (air dry). No information is available at this Division regarding seasoning, shrinkage and specific mechanical properties.

Uses: Myall was used by the aborigines in making boomerangs. Its special modern application is in hard turnery and fancy goods, e.g. walking sticks, serviette rings, egg cups, chessmen and rulers. It is an excellent firewood, and in time of drought the foliage is a useful stock fodder.

SILVER WATTLE.

Silver wattle is the standard trade common name for the timber known botanically as *Acacia dealbata* Link.

It is one of the best known of the wattles, its common name of silver wattle being derived from the silvery appearance of its feathery foliage.

Distribution: Silver wattle has a wide distribution in the moist eucalypt forests of Tasmania and on the eastern mountains of Victoria, forming an understory to mountain ash and ascending to fairly high elevations. It has a small distribution on the mountains and plateaux of southern New South Wales and in some parts of the central tablelands. Silver wattle is also grown on the Riviera of southern Europe and sold in England as "Mimosa". This tree has a rapid growth attaining the height of 30 ft. in 5 years and 45 ft. in 11 years.

Habit: Silver wattle is a small to medium sized tree up to 100ft. high and may attain a breast high diameter of 2ft. to 2ft. 6in.

Timber: The truewood of silver wattle varies from a light brown to a pinkish-brown colour. It is a moderately light timber with an average air dry density (at 12% moisture content) before reconditioning of 44.9 lb. per cubic foot.

In drying from the green condition to 12% moisture content, silver wattle shrinks 7.8% in a tangential direction (backsawn) and 2.5% in a radial direction (quartersawn). The shrinkage after reconditioning is reduced to 6.7% and 2.1% respectively. The sapwood of this species is immune from Lyctus attack.

From the preliminary tests on gluing, it can be said that it has good gluing properties. Little work has as yet been done by this Division on the seasoning and mechanical properties of silver wattle.

Uses: The timber is used for clothes pegs, shoe heels, cask staves, bakers' fuel and for wood wool. It has also been used for furniture and shows a good grain when polished. The bark is sometimes used for tanning, although it rarely contains more than 20-25% tannin.

Availability: The annual production in Victoria for 1946 was in the vicinity of 700,000 super feet.

Mr. S. A. Clarke, Chief, Division of Forest Products and Dr. H. E. Dadswell, Officer-in-Charge of the Wood Structure Section, Division of Forest Products are attending the British Commonwealth Forestry Conference being held in London for the month following June 16th as Commonwealth representatives. The Australian delegation comprises the two C.S.I.R. representatives and Mr. G. J. Rodgers, Director-General, Forestry and Timber Bureau and Mr. D. A. N. Cromer, Officer-in-Charge, Division of Forest Resources, Forestry and Timber Bureau.

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C. S. I. R.

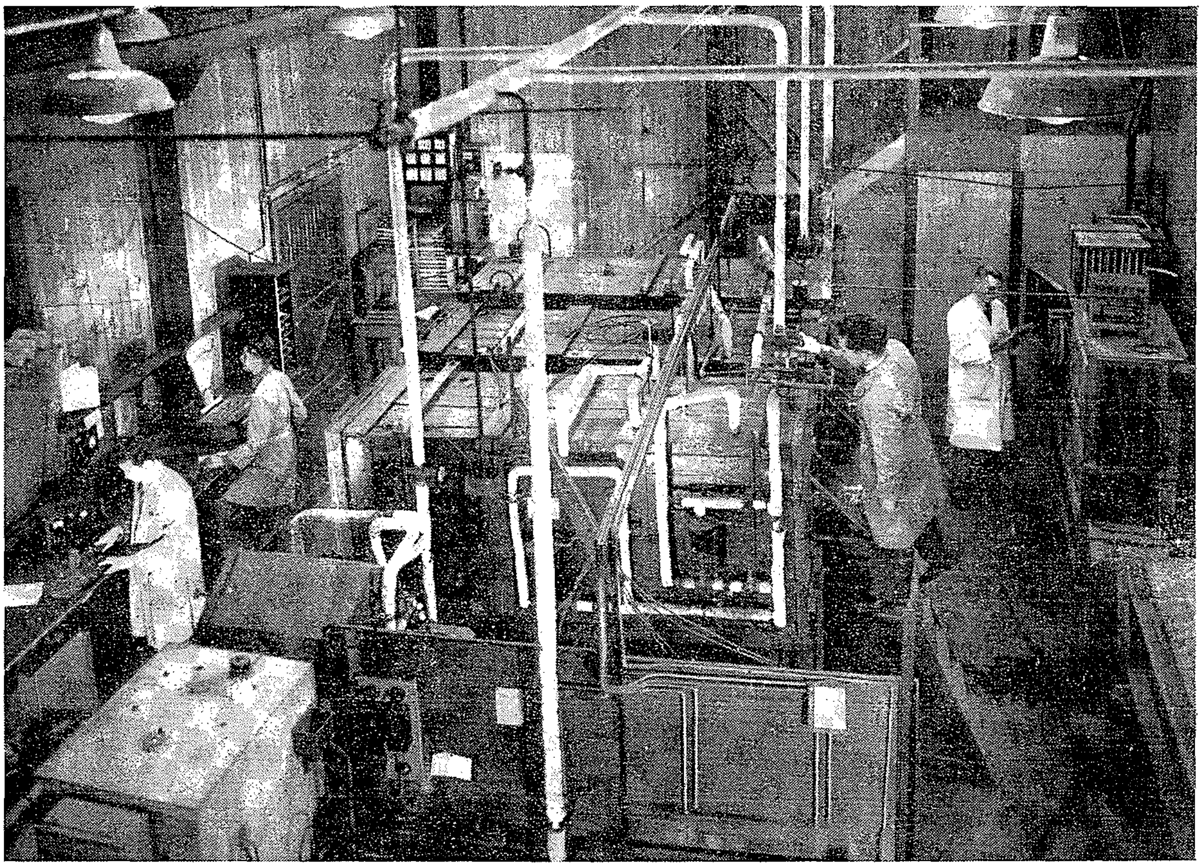
FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circu ation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

No. 154 | 1947##154 | July 1947

SECTION OF TIMBER SEASONING

(This is the sixth article in the series describing the work of the various sections of the Division of Forest Products.)



General view of one of the Seasoning Laboratories.

In the recent past very appreciable quantities of indigenous and imported timbers required for aircraft, rifle furniture, ship construction, munition supplies and a host of defence and vital civilian projects, have been seasoned in Australia to standards far above those commonly set for ordinary commercial or domestic purposes ; today, many critical operations throughout industry are dependent on a sustained supply of a wide range of carefully seasoned wooden components made from species chosen because of special or unique characteristics ; and in the immediate future, many millions of feet of seasoned timber in the form of floorings, linings, weatherboards and joinery stock must be provided from native timber resources if Australia is to achieve success in the fulfilment of urgent planned national housing programmes. That these requirements have been met and will continue to be met, is due largely to complementary and co-operative research and developmental work carried out over nearly two decades by the Australian timber industry, State Forest Services, and the Division of Forest Products of the C.S.I.R.

Since 1929 the responsibility of formulating and developing the seasoning research and applied work of the Division has been that of the Seasoning Section, the staff of which now comprises three research officers, four technical officers and a number of laboratory assistants. The esteem with which indigenous hardwoods are now regarded by Australian timber-using industries, compared with the strong prejudices previously held against them even for ordinary commercial purposes ; and the value of the precise drying quality control technique developed by the Seasoning Section prior to the war years, and supervised at munitions plants to exacting standards through that period, show the worth of the work done by the Section in these fields.

Naturally enough, early attempts to convert and season our hardwoods were based on concepts proved to have been satisfactory for European species. It was not appreciated that, because of the wide differences in structure between the exotic and indigenous timbers, the conversion and seasoning of the latter would need a new approach : that the extensive distortion which developed in many of the native hardwoods was a new phenomenon, not then recognised as collapse, and that the high shrinkage of these species, their slow diffusion rates, and their tendency to split and check, were simply manifestations of the differences in behaviour in these species and overseas timbers.

The problem of finding effective methods for converting and seasoning the refractory hardwoods became an immediate and major project for the Division on its establishment in 1929. In co-operation with the timber industry new techniques were developed and were proved to be satisfactory, and a long programme of laboratory research was begun to determine the most satisfactory kiln drying schedules for each thickness of a very large number of commercially available species, and for timbers required for special purposes, such as aircraft.

Next, the task of overcoming the established attitude of timber users, builders, architects, and the general public who, as earlier mentioned, had come to regard imported species as being much superior to local hardwoods for all the more critical conditions of timber usage, was undertaken through the media of pamphlets, articles, trade literature and demonstrations and lectures throughout Australia. At the same time, to ensure use of modern, proved equipment suited to the seasoning of the native hardwoods, the preparation of kiln designs and the supply, free of charge, of detailed plans and specifications covering kiln construction and seasoning plant layout was entered upon, as industry itself could not supply this need. This service, in turn, was extended to the preparation of designs for drying and conditioning rooms for all branches of the timber using industries, and to the testing of industrial timber drying units.

Finally, to ensure the proper training of plant personnel responsible for timber kiln operation, the development of a correspondence course in timber seasoning and kiln drying, the only course of this type in the world, was taken in hand. This, with all other activities previously referred to, is in current operation.

The effectiveness of the work of the Seasoning Section in this direction, and the fact that timber using industries are now conscious of the real value of Australian hardwoods today, is indicated by the growth in the number of timber seasoning kilns in Australia, the vast majority of which have been designed by the Section. In 1928 some 83 kilns, capable of drying approximately 20,000,000 super feet of timber per annum were in operation : today, the number of kilns amounts to well over 700, capable of drying some 300,000,000 super feet on a 1″ basis per annum, and this total does not include numerous drying rooms, veneer driers and conditioning rooms also designed by the Section.

The importance of this close contact with industry can be gauged from the results of a comparatively recent study made on some 50 kilns in one particular area following the war years, when visits to plants had of necessity been curtailed : it was found that kiln efficiency had been reduced by as much as 30 per cent. of what would be regarded as reasonable standards of operation, the operatives not having recognised the gradual reduction in performance which had occurred over a number of years. The loss in kiln output from this limited example was equivalent to some 5,000,000 super feet of timber per annum—sufficient additional seasoned timber to fulfil requirements for 2,000 homes per annum.

Through the war years, a considerable amount of immediate developmental work involving a specialised knowledge of the theory and practice of drying was carried out by the Section in association with the technical branches of the defence services. In this field investigations carried out ranged from an examination of the suitability of aircraft escape hatches when exposed to a wide range of temperature and humidity conditions, and the testing of aircraft sealing paints under simulated tropic conditions, to the development of methods to prevent condensation in military hutments and the drying and plasticising of materials for air rescue packs.

Of recent years, the scope of the Section's work has been widened considerably and investigations currently include developmental work on low cost building boards, floor surfaces, and partition walls from freely and economically available organic materials, and also studies in sawmill efficiency and performance, the latter being carried out in co-operation with the Utilization Section. In the field of building materials, a fairly comprehensive understanding of the properties of sawdust-cement as flooring material has now been obtained and the studies have covered the effects of timber species, sawdust particle size, sawdust moisture content, sawdust-cement ratios, water-cement ratios, neutralisers and setting accelerators, in addition to an examination of the extent of drying shrinkage and the amount of movement occurring from moisture equilibrium change. Experimental floor sections to determine the wearing qualities of this material have also been under test for considerable periods. As a result of this work, it is now possible to pre-select mixes to give a fairly wide range of desired performances. The data developed have been freely used by constructional authorities and several relatively large areas of sawdust-cement, including one area superimposed over certain of the steel decks of a 10,000 ton ship, have been laid.

Experimental work on wood wool-cement building panels for use as internal building partitions, or as external sheathing over a timber frame base is now also in hand, and a preliminary accelerated service test, in the form of a temperature-humidity cycling test, has been completed. In co-operation with the Building Materials Research Section of the C.S.I.R. a large scale exposure test designed to indicate the value of various constructional methods and finishes is also being prepared. Additional work on wood wool-cement ratios, forming pressures and setting methods is planned.

An examination of the possibilities of developing a sawdust-resin building board has been commenced by the Section, but, as yet, the experimental work has not developed sufficiently far to give positive indications of the future of this material. If satisfactory results can be achieved, a promising step will have been made in the field of sawdust utilization.

The sawmill studies which are currently being carried out by the Section in co-operation with the Utilization Section have provided a considerable amount of data on mill performances, on the effect of size of sawn product on production rates, and mill recoveries, on the effect of log size on the previous factors, and on the extent of lost production time and the reasons for this. Apart from the immediate value of this information to the sawmiller, it is anticipated that the close examination being made of factors affecting production will permit a proper estimation of the requirements of the sawmilling industry to be made, this latter becoming apparent in the development of sawmill designs planned on a functional basis.

In the veneer and plywood industry too, a major obstacle to development in the south-east of Australia has been the problem of overcoming the difficulties of satisfactorily drying veneers of the " ash " type eucalypts : collapse and the high shrinkage of these species cause both primary and secondary difficulties in the form of severe wrinkling, corrugating, and checking so that losses are high and production made extremely difficult. Investigation of the problem of ensuring satisfactory recovery of seasoned veneer from the " ash " type eucalypts is planned, and an early start on this project is anticipated.

It is perhaps appropriate here to remark that the work of the Seasoning Section is largely reflected in all fields of timber utilization. It is almost a truism to say that a thorough understanding of sound seasoning practice and a full knowledge of the relationship of moisture content to all other properties of timber is a fundamental essential to the economy of any timber using community.

BREVITIES

Dr. W. E. Cohen, Officer-in-Charge, Wood Chemistry Section, Division of Forest Products, has been invited to become a regular member of the Wood Chemistry Sub-Committee of the United Nations Food and Agriculture Organisation. Of the several technical sub-committees connected with the F.A.O.'s Division of Forestry and Forest Products, the Wood Chemistry Sub-Committee is rated as potentially the most important. This is because (i) pulp production, in overall magnitude, falls in the same category as the production of metals, oils and various basic foodstuffs, (ii) of the 1200 million tons of wood harvested annually, 1000 million tons are estimated to be wasted or burnt, and (iii) wood chemistry offers the best means of designing methods for converting this enormous waste to some useful purpose. Dr. Cohen hopes to attend the second meeting of the Sub-Committee which will be held during the first half of 1948, and which will coincide with the First International Congress of Wood Chemists.

IS THIS BORER DANGEROUS ?

Part III—The Lyctus Borer.

By G. W. Tack, Preservation Section.

1. **Introduction.**

Unlike the pinhole borers which can attack only green timber, the Lyctus borer is found infesting air dried or kiln seasoned timber which in practice is never too dry to be attacked. Lyctus attack is restricted to hardwood timbers and is characterised by the production of copious quantities of fine flour-like dust from whence comes the commonly used name of powder post borer.

Except in special cases, damage due to the Lyctus borer is usually of limited extent and generally should not be regarded as cause for great alarm. Unfortunately however, there is a wide-spread fear that all borer attack is dangerous and will lead ultimately to the complete destruction of the whole of the timber and the spread of infestation to furniture or other wood work. This misconception is due largely to ignorance and to the fact that the average house-holder and timber user has become greatly alarmed by advertising propaganda and the common spectacle of the timbers in new homes being sprayed with some " guaranteed " borer specific to prevent Lyctus attack.

2. **Essential Facts Concerning Attack.**

Until the following facts are clearly understood, there can be no intelligent understanding of the Lyctus borer problem.

(*i*) **The Lyctus borer confines its attack to the sapwood of certain hardwood timbers. Its attack is confined exclusively to sapwood and it cannot infest the rest of the timber. Softwood timbers such as hoop pine, radiata pine, firs, etc., are never attacked by Lyctus.**

The sapwood is the outer ring of wood in a tree which extends from beneath the bark inwards to a thickness of ½–1 inch in most eucalypt timbers. When a tree is cut into scantling sizes, etc., small strips and edges of sapwood may be included on occasional pieces. Normally with **eucalypt timbers** the percentage of sapwood present is small and its destruction has no significant effect on the strength and stability of a building. An exception to this statement may occur with small dimension timbers such as tiling battens where the percentage of sapwood may be high.

In some Queensland and New South Wales non-eucalypt hardwoods such as white cheesewood and white birch etc., a band of sapwood many inches in thickness may be present. Many of these timbers are susceptible to Lyctus attack and are liable to very extensive damage. Unless treated by the boric acid process or other recommended practice to give complete penetration of the sapwood with a toxic chemical they should not be used in any permanent construction.

(*ii*) **The Lyctus borer does not attack the living tree or the green log, but almost as soon as timber is cut and surface drying has occurred the sapwood becomes susceptible to Lyctus attack.**

Because the Lyctus borer is very widespread throughout Australia, breeding in dry forest logs, dead trees, sapwood off-cuts etc., the chance of infestation during the first year after cutting is extremely high.

(*iii*) **In some hardwoods the sapwood is very susceptible to Lyctus attack while in other very similar timbers it may be completely immune from attack.**

Two conditions govern the susceptibility or non-susceptibility of the sapwood of any species (or tree) ; these are (*a*) starch content and (*b*) pore size.

(*a*) Starch is essential for the nutrition of the borer and usually the more starch the greater the extent of the attack.

(*b*) The pores in the wood must be large enough to allow the female beetle to insert her eggs into them.

Hardwoods (pored timbers) such as alpine ash (*Euc. gigantea*) and mountain ash (*Euc. regnans*) have a sapwood with sufficiently large pores for egg laying to occur but as they are almost completely free from starch they are practically immune from Lyctus attack. On the other hand messmate stringybark (*Euc. obliqua*), the principal hardwood scantling timber used in Victoria, usually has a sapwood of very high starch content and is thus very susceptible to the Lyctus borer.

In certain other hardwood timbers, usually non-eucalypts such as coachwood (*Ceratopetalum apetalum*) and southern sassafras (*Atherosperma moschatum*) the sapwood is never attacked, not because of lack of starch, but because the pores in the wood are too small for the female Lyctus to insert her eggs.

All **softwoods**, e.g., pine, fir, spruce, etc., are immune to Lyctus attack.

3. **The Life History of the Lyctus Borer.**

In its development the Lyctus borer passes through four distinct stages, namely, egg, larva or grub, pupa, mature beetle.

During the spring and summer the adult female beetle searches actively by crawling and flying (usually after dusk) for starch-containing sapwood. When suitable sapwood is found the beetle inserts her eggs into the pores of the wood.

After about a fortnight the larvae (grubs) hatch out and bore in the sapwood for about 10 months forming a network of connected tunnels closely packed with a fine powdery dust (hence the name " powder-post "). They confine their attack to the sapwood and do not attack the rest of the timber.

The grubs then pupate and finally change to mature beetles which cut the well known flight or exit holes (about 1/16th of an inch in diameter), sometimes boring through plaster or even lead sheeting if these materials block their way. It should be clearly understood that it is the emergent beetles which make these exit holes.

Under normal conditions the beetles emerge about 10–14 months after the eggs are laid, but in heated buildings or stores, where conditions are very favourable for rapid development of the grubs, this period may be as short as six months.

4. **Recognition of Lyctus Borer Attack.**

Lyctus attack is easily identified by the abundant flour-like dust which is packed in the tunnels in the wood and which often forms small heaps beneath the flight holes made by the escaping beetles. Only hardwood timbers are attacked.

5. **Common Fallacies.**

(*i*) There is a widespread belief that once Lyctus attack has begun in a piece of timber it will spread throughout the piece until it is completely destroyed. This belief, is of course, quite erroneous where most eucalypt hardwoods are concerned because as explained earlier Lyctus attack is confined to the susceptible sapwood. Once this sapwood has been destroyed no further damage will occur—the rest of the timber being completely immune from attack.

(*ii*) Another common fallacy is the belief that if the Lyctus borer is present in scantling or other hardwood timber in the house, furniture and other decorative woodwork may be attacked and destroyed. Firstly, if the timber is a softwood such as pine, fir or spruce, the Lyctus borer cannot attack it under any circumstances. Secondly, if the timber is a hardwood it can only be attacked if it contains susceptible sapwood. In this case the presence of Lyctus borers in scantling or other timber in the house will not appreciably increase the hazard. This is because Lyctus beetles breed naturally in such timber as sapwood offcuts, in fences, telegraph poles, dead timber etc., and may enter the house from outside sources.

In general, if untreated hardwood timber shows no sign of Lyctus attack after two or three years of use then it is probably safe for all time from damage by this borer.

(*iii*) It is sometimes claimed that kiln dried hardwood will never be attacked by Lyctus. This is not so, and kiln dried or even oven dried timber **containing susceptible sapwood** is liable to subsequent attack by Lyctus.

Kiln drying will kill all stages of the Lyctus borer, but this is a temporary effect and if unprotected, susceptible sapwood is again liable to attack.

6. **Control and Remedial Measures.**

Many methods have been suggested for the eradication of this insect pest. However in this brief article it is not intended to give full details of special commercial processes, e.g., the boric acid treatment for certain Queensland and New South Wales timbers, but rather to give practical treatments applicable by the average householder and timber user.

Structural Timbers.

(*a*) **General.**

As mentioned previously, the maximum Lyctus attack which can occur in sawn eucalypt hardwood is limited to strips or edgings of sapwood. Destruction of which does not significantly endanger the strength of a structure.

It is thus seldom necessary to treat such timber unless a decorative effect is involved or the falling dust is a nuisance.

In special cases such as pergolas or log cabins where round timbers are used, or fence palings which may contain a high percentage of sapwood, treatment may be necessary. For such outdoor use a mixture of equal parts of creosote oil and kerosene, or creosote oil and crude oil applied by dip, spray or brush may be used very effectively where the strong odour and brown colour of creosote oil are not objectionable. Copper naphthenate (green) or zinc naphthenate (colourless) used as a 20 per cent. solution in mineral turpentine or kerosene are suitable alternatives which are cleaner to use. These latter preservatives should be used instead of creosote oil in all cases where it is desired later to paint the treated wood.

Creosote oil should not be used indoors on account of its odour and the danger of staining plaster sheet.

In workshops, factories, etc., where falling dust may be objectionable, brush or spray application of copper or zinc naphthenate is usually effective. The preservative should be applied liberally wherever attack is occurring.

(*b*) **Building frames.**

Spray treatment of framing timbers during erection of a building **is not recommended** by the Division of Forest Products for the following reasons :—

(*i*) The amount of Lyctus borer damage which can occur in eucalypt scantling timbers in Australia is never likely to cause significent loss in strength in a structure. The expense of spray treatments is not justified by such damage which involves no decorative effect.

(*ii*) Spray application of a preservative however toxic is often not effective in preventing all attack because in practice **eggs have often been laid already** and the grub is at work in the timber at a depth not reached by superficial treatment. In such cases damage will continue until all beetles have hatched and will be arrested then only if the preservative is sufficiently a deterrent to prevent beetles re-entering the flight holes to lay eggs in the untreated inner wood.

(*iii*) Spray treatments to be permanently effective, must not only be applied before infestation has occurred, but must present an unbroken coating which retains its toxicity for at least a life time. In practice this is seldom achieved and attack does occur frequently in timbers which have been spray treated by some "guaranteed" process.

For these reasons the Division recommends that the practice of spray treating eucalypt hardwood building scantling against Lyctus borer attack be discontinued. In rare cases some treatment or replacement may be necessary but in the long experience of this Division the present commercial methods of treatment of building frames are a waste of money.

Flooring, Interior Trim, Joinery and Furniture.

It is almost inevitable that some timber used for flooring, skirting boards, door architraves, shelving and even furniture contains susceptible sapwood which is attacked by Lyctus. Sometimes the damage to the appearance is sufficient to make replacement of the piece of timber desirable, but in most cases simple remedial measures are sufficient.

Recent work on control of Lyctus has led to the discovery and use of several very effective preservatives for dry timber which may be applied in such cases. Treatment should be made as soon as the first holes are noticed as Lyctus attack develops rapidly. The following methods are recommended.

(*a*) **Treatment with insecticides.**

Treatment with insecticidal solutions should be made with the object of obtaining good penetration of the preservative into the flight holes. This can be achieved by dipping, by liberal brush application, by flood spraying or by injecting holes with a pressure syringe. Pressure syringing is most applicable to decorative woodwork where treatment must be made with minimum risk of affecting the finish. Where a special syringe is not available an eye dropper with a fine nozzle and a small rubber bulb may be used. As holes are interconnected beneath the surface it is usually unnecessary to treat every hole.

The following solutions are effective if correctly used. In general they do not affect painted, varnished or polished finishes and treated timber may be subsequently finished as desired. However some caution in their use is advised where highly polished surfaces are involved.

(*i*) **Pentachlorphenol or trichlorphenol.** These chemicals should be dissolved in kerosene at the rate of 1 oz. to the pint of solvent. It will be necessary to add a very small amount of methylated spirits to the kerosene to obtain complete solution of the chemical. The amount of spirit added should be kept to a minimum to prevent marring of polished surfaces. Trichlorphenol is manufactured in Australia and pentachlorphenol should be available shortly.

(*ii*) **Zinc or copper naphthenate.**

Both chemicals are readily available as prepared 20 per cent. solutions in kerosene or mineral turpentine. They may be applied without further dilution or may be diluted to half strength with either of the above solvents. Zinc naphthenate is colourless but copper naphthenate stains woodwork a deep green.

(*iii*) **Paradichlorbenzene or orthodichlorbenzene.**

Paradichlorbenzene is a solid while orthodichlorbenzene is liquid. Both chemicals may be purchased cheaply at most large chemical warehouses.

Either chemical, dissolved at the rate of 1 oz. to a pint of kerosene is effective for treatment of Lyctus. These chemicals are highly effective in destroying Lyctus within the wood but their effect is not permanent unless the affected areas are sealed off to prevent re-infestation. It is therefore necessary to plug the holes and wax, varnish or paint the surface within a few weeks of treatment. This is unnecessary with pentachlorphenol and metallic naphthenates but is an additional precaution which may well be followed in all cases.

(*iv*) **Other insecticides.**

In an emergency kerosene, mineral turpentine or commercial fly-sprays may be used provided they are very liberally applied and the holes plugged and the surface sealed as recommended for paradichlorbenzene.

(*b*) **Heat Sterilization.**

Where applicable, heat sterilization is quite effective provided temperatures not lower than 120°F. are maintained overnight. However this treatment **will not prevent re-infestation** unless flight holes are plugged and the surface sealed as soon as possible with wax, varnish, paint etc. to prevent subsequent egg laying in the pores of the wood.

(*c*) **Fumigation.**

Fumigation by reputable firms is an effective treatment for furniture etc. but should not be attempted by private individuals. Modern fumigants applied after preliminary vacuum in closed cylinders, destroy infestation without affecting the finish or leaving objectionable odours. However it should be stressed that fumigation does **not prevent re-infestation** unless holes are plugged and the surface sealed as soon as possible after the article is returned. Fumigation of houses to destroy Lyctus attack is not practicable.

Commercial use of the Boric Acid Process.

This treatment has been developed by the Division of Forest Products in co-operation with the New South Wales and Queensland Forest Services as a commercial process for the complete and permanent immunisation of veneer and sawn timber against Lyctus attack. The treatment is specially intended for certain Queensland and northern New South Wales timbers such as white birch, yellow carabeen, white cheesewood etc., which have a wide Lyctus susceptible sapwood. Timbers of this type should not be purchased by timber users except for temporary use, unless accompanied by a guarantee that the above treatment has been given. In New South Wales legislation has been enacted to control the sale of such timbers unless treated by the boric acid or other authorized process.

In brief the treatment consists of immersing the **green** veneer or sawn timber in a hot solution of boric acid for periods varying with the thickness and species of the timber. The treatment is non staining and does not affect the gluing with animal, casein or urea glues or the finishing properties of the veneer or timber.

The object of the process is to impregnate the timber completely with the preservative so that treated material may be machined and worked without exposing any untreated wood. As the preservative is non-volatile, treated timber is permanently immune.

Further advice may be obtained from the Division of Forest Products, 69–77 Yarra Bank Road, South Melbourne S.C.4, or any of the State Forests Departments.

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C. S. I. R.

FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

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SECTION OF VENEER AND GLUING

(This is the seventh article in the series describing the work of the various sections of the Division of Forest Products.)

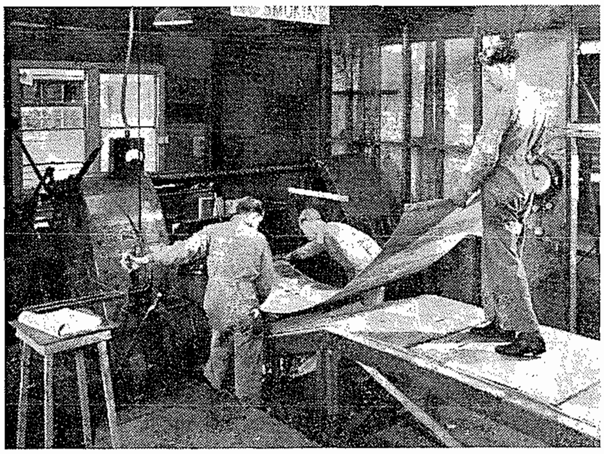
Recently plywood and other composite wood products have assumed an importance hitherto unsuspected in structural engineering and other fields. This circumstance has been due principally to the development of new types of adhesives possessing properties very much superior to those of the older natural glues. Industry has not been tardy in availing itself of the wide possibilities of the new materials, while the solution of the problems of manufacture and utilization has demanded the initiation of new lines of research.

The Section of Veneer and Gluing was established in 1938, and the necessities of the situation largely determined that its work should not be of a basic character in the early years of its existence, but should rather be devoted to the solution of some immediate problems of industry. The work was primarily technological during this phase. Not until the end of the war in 1945 was the way opened for a study of some of the basic phenomena involved in the techniques of plywood, such as adhesion, plasticity and heat transmission.

The staff of the Section includes research officers qualified in physics, chemistry, biological sciences and forestry, and it is hoped to add technical officers with engineering qualifications as soon as possible.

This is a form of organization suitable both for carrying out practical projects and tackling investigations of a fundamental nature. In addition to the research staff, a number of assistants are employed, some of whom possess special practical qualifications by virtue of their experience.

An idea of the scope of the Section's activities may be gleaned by considering them under the following headings :



Peeling hardwood veneer.

Plywood Manufacture.

The growing demand for plywood and the dwindling supplies of logs of species traditionally used for veneer production have focussed attention on other species as potential sources of veneer. The first major task undertaken by the Section was to carry out a survey of the suitability of Australian timbers for veneer and plywood, and up to the present time some 50 species have been examined. It is now proposed to issue the information so far obtained in concise form.

This work has borne fruit in the extension of the plywood industry to Western Australia, where karri and jarrah are peeled, and in moves to develop the manufacture of plywood from other native eucalypts in Victoria and Tasmania. During the war extensive tests were carried out in conjunction with the Section of Timber Mechanics to select a species suitable for aircraft manufacture.

Recently investigations have been made on certain New Guinea species, including klinki pine and garawa, and it seems probable that some of the veneer resources of this region will be utilized. Other current work is exploring the possibilities of young plantation-grown exotic species for plywood : investigations which have a bearing on silvicultural policy.

Phases of the process which receive detailed study include : treatment of logs before peeling, conversion to veneer, drying, and gluing. The utilization of hardwoods of the "ash" eucalypt group, which is of topical interest, involves particular attention to seasoning, as the species are subject to collapse, with consequent buckling and checking of the veneers.

Preparing a synthetic resin adhesive.

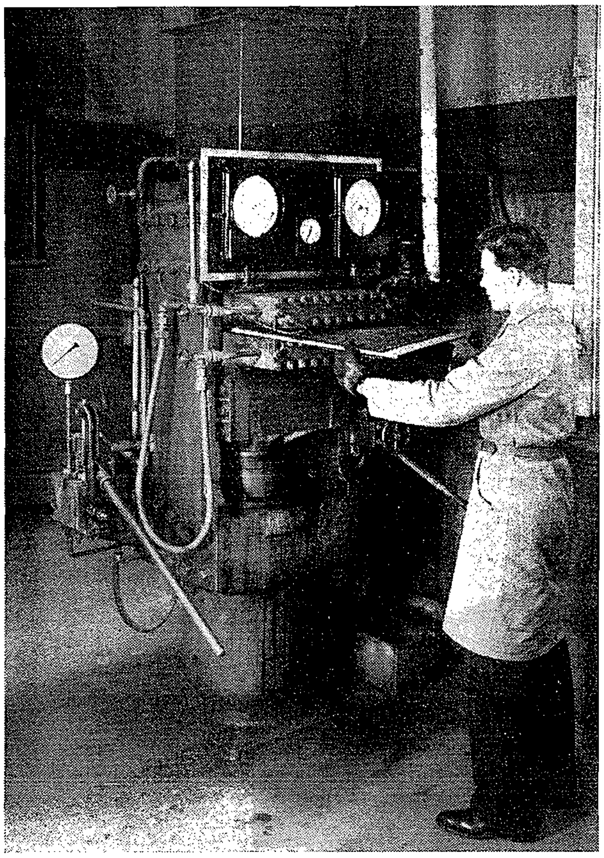
Glues and Gluing.

In the early days of the Section, and during the war, a considerable amount of testing of proprietary adhesives was carried out to routine specifications. This function is now seen as a subsidiary one, however, and is being replaced by the development of new adhesives and the determination of optimum formulations for specific purposes. Work at present in hand includes the possible use of lignin as a constituent of resin adhesives, and a comprehensive analysis of the effect of varying proportions of the constituents upon the properties of glues made from soya bean protein.

One of the earliest projects initiated, and one which is still continuing, is a survey of the gluing characteristics of Australasian species with various types of adhesives, and a study of methods of overcoming difficulties encountered in particular instances. The scope has gradually been widened to include substances other than wood.

Uniform testing methods are in use, some of which have been taken directly or adapted from overseas standards, others developed for specific purposes. Such standardization is necessary when comparing either adhesives or adherends. Properties of adhesive joints which are commonly examined include glue shear strength, water resistance, durability under exposure, response to elevated temperatures, bacterial and fungal resistance, and response to cycles of different conditions. Special attention is being paid at present to the mechanism of deterioration of glued joints.

In the gluing process are many variables, and a study of these is necessary for the best results. Some indication of their importance is given in an article on "The Gluing Operation" in News Letter No. 150, in which such factors as proportions of ingredients, working life, moisture content of joint components, condition of surfaces, glue spread, assembly time, pressure, and pressing temperature and time are briefly discussed.



Making plywood in the hot press.

New Techniques.

It has been necessary for the Section to develop some familiarity with all the modern techniques of plywood, laminated and moulded constructions, and "improved" wood, but it has not always been possible, owing to limitations of equipment and staff, to investigate all of these on a laboratory scale.

During the war a considerable amount of work was done on the improvement of the properties of wood by the process of resin impregnation of thin veneers and densification under heat and pressure, but this project is no longer of such urgency as it was then, and has been suspended.

Very little experimental work has been done in this laboratory on the various moulded plywood techniques which were described briefly in News Letter No. 152, although the subject falls within the scope of the Section. However, the C.S.I.R. Division of Aeronautics has been working on the fluid moulding of aircraft components.

Investigations are carried out on a pilot plant scale on methods of improving the usual techniques of veneer and plywood production, having regard to the relevant economics.

Basic Studies.

The phenomenon of adhesion involves some very fundamental concepts, and an investigation of its nature has been made one of the major projects of the Section. Initial experiments have approached the problem from a chemical standpoint, but it is planned also to investigate physical factors. The study of adhesion, is, of course, closely related to that of cohesion in matter, and although both are common phenomena a great deal remains to be found out about them, and about their relations to the properties of bonded structures and of materials generally.

Another project being given major attention is the study of the plastic deformation of wood, particularly in radial compression. This investigation was originally called forth because of its importance in the fabrication of plywood in the hot press, but results soon showed that general conclusions regarding the behaviour of wood under various conditions could be drawn from the experiments, and that they could contribute to the knowledge of the nature of wood. Some of this work has been published elsewhere.

It should be remembered that a research group can best fulfil its true functions of pointing the way to economic advances by approaching its problems in a fundamental way, even when the immediate applications are not evident. At the same time, it should maintain close contact with the relevant branches of industry or agriculture so that the applications, as they arise, can be put into effect. In the Section of Veneer and Gluing, efforts are made to put this policy into operation.

FOREST PRODUCTS RESEARCH SOCIETY
AUSTRALIAN MEMBERSHIP

In January of this year, there was formed in the U.S.A. the Forest Products Research Society. This is a non-profit Organisation which aims to cover the fields of research development, production and utilization of forest products by fostering the interchange of information, abstracting results, publishing information, encouraging co-operation, providing test methods and procedure, sponsoring meetings, and in general encouraging and promoting the efficient utilization of wood and other forest products.

Launched as an "international" organisation for the interchange of information and furtherance of wood research, limited staff made it necessary to confine membership in the first instance to residents of the U.S.A. and Canada. However, the Society has now approved a resolution to accept membership from Australia, this extension in membership being provided so that those in Australia who wish could apply for Charter Membership, which expires on 30th September.

Members will receive (*a*) the membership subscription to Wood Magazine (America) which carries the Monthly Bulletin of the Society ; (*b*) Proceedings of the annual meetings, and (*c*) abstracting service when it is established in the near future. The Society is open to all individuals or Organisations whether they are in wood research or are producing or using forest products. Membership is divided into three classifications :—

(*a*) Voting member shall be any individual who is actively engaged in research, development, production or utilization of forest products.

(*b*) Associate member shall be any individual who is interested but not actively engaged in research, development, production or utilization of forest products.

(*c*) Supporting member shall be any Organisation or individual who financially assists the Society through the payment of larger dues. The annual dues for voting and Associate members are £10 and for Supporting members £100.

Applications for Charter Memberships should be addressed to Mr. Thomas R. C. Wilson, Secretary-Treasurer, P.O. Box 2010, University Station, Madison, Wisconsin, U.S.A., and dues must be paid in U.S. funds ; the International money order has been suggested as a convenient method of exchange. Applications should state the type of membership for which application is made, should give the full name in block letters, the applicants title or occupation, the name of the organisation if any, the nature of business and the mailing address.

ADDENDUM

In the July News Letter it was stated that silver wattle is immune from Lyctus attack. There is now some evidence that the sapwood of this timber is occasionally susceptible. The degree of susceptibilty however is now being thoroughly investigated and a further statement will be made as soon as possible.

IS THIS BORER DANGEROUS ?

Part IV—Anobium or the Furniture Borer

By G. W. TACK, Preservation Section.

1. Introduction.

In the previous articles of this series damage to timber caused by auger beetles, pinhole borers and the Lyctus borer has been described, and control measures indicated. It has been emphasised that in Australia, auger beetle and pinhole borer attack does not constitute a major problem in seasoned timber and that Lyctus damage being restricted entirely to the sapwood, is of limited extent in many timbers, and of real consequence only in special cases, *i.e.*, in timbers with a wide sapwood or in decorative woodwork.

By contrast, the Anobium or "furniture borer" is a more serious pest though fortunately it is not as common in Australia as the Lyctus borer. Anobium infestation occurs typically in old woodwork and though slow in spreading it may cause extensive damage since both sapwood and truewood may be attacked. It is similar in general appearance to Lyctus attack, the wood being honeycombed with small tunnels filled with "frass" or borer dust which is coarser and more granular than the fine flour-like dust typical of Lyctus attack. Exit or flight holes in the surface of the wood are also similar in appearance being normally about 1/16th inch in diameter.

2. Essential Facts Concerning Attack.

(i) *Anobium borer attack is usually found in softwoods although a few hardwoods are also attacked.*

The principal timbers in which attack has been reported in Australia are blackwood, Queensland kauri pine, hoop pine, and New Zealand white pine. In addition certain imported timbers are susceptible to attack. These include *imported* oaks, beech, birch, walnut, etc., and also various pines, firs and spruces.

Except for a very few Australian hardwood timbers and some imported hardwoods, attack is most commonly seen in Australia in true softwoods such as New Zealand white pine, which is particularly liable to attack. There is no record of attack in any of the eucalypts.

(ii) *Freshly seasoned timber is seldom attacked, preference being shown for old dry woodwork.*

As a result of this preference for old timber and the immunity of eucalypts from attack, most damage in Australia is seen in private homes, halls, churches, museums, etc., where old timber exists, and in furniture and other warehouses where wooden articles or antique furniture is retained over a considerable number of years. Thus attack is commonly seen in old Baltic pine floors and in old New Zealand white pine shelving or kitchen fittings, etc. The precise reason for the high incidence of attack in old timber is not known but it is thought to be associated with slow changes in the starch and other substances in the wood.

(iii) *Both sapwood and truewood of susceptible timbers are liable to attack*, which usually occurs in the sapwood first but may spread later to the truewood, causing extensive damage. In most cases however the rate and extent of Anobium attack is relatively greater in the sapwood than in the truewood.

(iv) *Attack may continue in the same piece of furniture or timber for many years, as re-infestation of the wood by each successive generation of beetles occurs, unless remedial measures are taken.*

Generally, Anobium attack is more serious than that caused by Lyctus, which, as mentioned previously, is confined to the sapwood of some hardwoods. If unchecked, Anobium attack may proceed until the whole of the timber is destroyed or rendered worthless.

3. The Life History of the Anobium Borer.

The life history of the Anobium borer is completed in four distinct stages, namely, egg, larva, (or grub), pupa and finally mature beetle. The actual length of the period from the laying of the egg to the emergence of the mature beetle has been the subject of considerable research but recent work by J. M. Kelsey and associates in New Zealand strongly suggests that the life-cycle occupies three years.

During the spring and summer the adult female beetle, after mating, lays her eggs *on the surface* of suitable timber in cracks, crevices, joints and exit holes—practically never on smooth surfaces. The New Zealand work indicates that in egg-laying the physical nature of the wood surface is as important as the timber species—rough surfaces favouring egg-laying. The eggs are often wedged into spaces between adjacent pieces of timber especially on the end grain and are attached to the surface by an adhesive secreted by the female beetle.

After about one to four weeks the larvae (grubs) hatch out, bore into the surface of the wood and commence tunnelling a network of galleries which may eventually reduce the inside of the wood to a honeycombed structure loosely packed with a fine gritty dust.

As with Lyctus the chief damage to infested timber is due to the grub or larva and the presence of a few flight holes on the surface may mean extensive attack below. The grub may work in and destroy the wood for a period of over two years before it pupates and finally changes to the mature beetle which cuts a flight or exit hole, about 1/32nd inch to 1/16th inch in diameter, to escape from the wood.

The beetle is small, usually from 1/10th inch to 1/4 inch in length and is reddish to dark-brown in colour. The head is enclosed in a hood-shaped segment, and looking from above, the head proper is almost invisible. The wing covers appear finely furrowed due to rows of small pits or punctures which are well defined. The beetles mate soon after emergence, and the females then seek suitable places for egg laying.

4. Recognition of Anobium Attack.

It is important to distinguish carefully between Anobium and Lyctus attack, because of the much more extensive damage which may be caused by Anobium. With Anobium attack very thorough treatment is always necessary for eradication ; with Lyctus attack treatment, if necessary at all, is usually simplified by the small percentage of susceptible wood present. The following differences should enable certain identification of these borers in almost all cases.

Eucalypt timbers not attacked.	Eucalypt timbers commonly attacked.
Attack more frequently found in true softwood timbers and in some imported hardwoods.	True softwoods never attacked.
Attack usually commences only after woodwork is many years old.	Attack usually commences rapidly in new timber or woodwork.
Damage not restricted to sapwood.	Damage restricted to sapwood usually on the edges of occasional pieces of timber.
Borer dust when rubbed between the fingers feels coarse and gritty.	Borer dust very fine, smooth and flour-like.

5. Control and Remedial Measures.

It is important to remember that when the first signs of Anobium infestation are discovered active attack may have been in progress for as long as two years inside the piece of timber. Therefore control or remedial measures should be taken as soon as possible after attack is detected. Fortunately in Australia, Anobium attack is rarely found in building frame timbers as the majority of such timbers are eucalypt hardwoods which, as previously noted, are immune from attack by this borer. In New Zealand, on the other hand, where large quantities of softwoods are used in building frames, Anobium is a major pest.

Considerations of methods of control and eradication are restricted mainly to flooring, linings, interior trim, joinery and furniture in Australia, and a number of effective preservatives and treatments have been investigated by workers in New Zealand. The recommendations which follow are based on these investigations.

(*a*) **Treatment with Insecticides.**

In general, treatment with insecticidal solutions should be made as for Lyctus borer damage (see Forest Products News Letter No. 154), *i.e.*, with the object of obtaining good penetration of the preservative into the flight holes. This may be achieved by dipping, by liberal brush application, by flood spraying (the usual commercial method), or by injecting holes with a pressure syringe, eye dropper, etc. All woodwork to be treated should be well dusted before treatment, and, if possible, a vacuum cleaner used to remove all dust and dirt from cracks and joints to provide a clean surface for treatment.

The following preservative solutions are effective if correctly used although several applications may be necessary for complete eradication. They do not readily affect painted, varnished or polished surfaces and treated timber may be subsequently finished as desired. However, some caution in their use is advised where highly polished surfaces are involved. The pressure-syringe method is preferable wherever there is a risk of affecting the finish of decorative woodwork.

(i) *Pentachlorphenol or trichlorphenol.* These chemicals are crystalline solids and should be dissolved in kerosene or mineral turpentine at the rate of 1 oz. to the pint of solvent. It will be necessary to add a small amount of methylated spirits or somewhat greater quantity of linseed oil to the kerosene or mineral turpentine to obtain complete solution of the chemical. The amount of spirit added should be kept to a minimum to prevent marring polished surfaces. Both pentachlorphenol and trichlorphenol are now available in Australia, and the names of suppliers may be obtained on application to this Division.

(ii) *Zinc or copper napthenate.* Both chemicals are readily available as prepared 20 per cent. solutions in kerosene or mineral turpentine. They may be diluted to half strength with either of the above solvents. Zinc napthenate is colourless, but copper napthenate stains woodwork a deep green and its indoor use is therefore limited to articles which are to be subsequently painted over.

(iii) *Paradichlorbenzene or orthodichlorbenzene.* Paradichlorbenzene is a solid while orthodichlorbenzene is a liquid. Both chemicals may be purchased cheaply at most large chemical warehouses, and should be used at the rate of 1 oz. to a pint of kerosene.

These chemicals are highly effective initially for the control of Anobium but their effect in not permanent and *subsequent re-infestation may occur after treatment.* Since the more permanent types of preservatives such as pentachlorphenol and zinc napthenate are no more difficult to apply and are only slightly more expensive, it is recommended that paradichlorbenzene and orthodichlorbenzene be used against Anobium only where the preservatives mentioned in (i) and (ii) are not available.

(iv) *Other insecticides.* Creosote and creosote mixtures are very satisfactory for killing Anobium beetles and larvae, but as they stain woodwork and adversely affect subsequent finishing with polish or paint they are not suitable for flooring or furniture and should be restricted to applications in outhouses, sheds, etc.

Kerosene, mineral turpentine or kerosene-turpentine mixtures may be used if other preservatives are not available, but while giving good control of insects already present in timber, their effect is only temporary, and their general use is not recommended.

(*b*) **Fumigation.**

Fumigation by reputable firms is an effective treatment for furniture, etc., but should not be attempted by private individuals. Correct treatment with a suitable gas will destroy all infestation but it is emphasised that *fumigation does not prevent re-infestation.* All woodwork which has been fumigated for the eradication of Anobium attack should be treated with one of the permanent preservatives mentioned earlier if it is desired to avoid all risk of subsequent attack.

Further advice and information may be obtained from the Division of Forests Products, 69–77 Yarra Bank Road, South Melbourne, S.C.4.

BREVITIES

Dr. H. E. Dadswell, Assistant to Chief of Division and Officer-in-Charge of the Wood Structure Section returned to Australia on August 6th from Great Britain where he, together with Mr. S. A. Clarke, Chief of the Division, represented C.S.I.R. at the 5th British Empire Forestry Conference.

The Conference, which commenced its deliberations on 16th June and continued to 19th July, was attended by forestry and forest products representatives from all the Dominions and from the various Colonies as well as by representatives of the home country. From the forest products angle, the Conference was a decided success because it provided an opportunity for the meeting of forest products representatives from all the Empire Products Laboratories and Research Institutes. In addition, Mr. G. M. Hunt, Director of the U.S. Forests Product Laboratory, Madison, Wisconsin was a guest of the Conference.

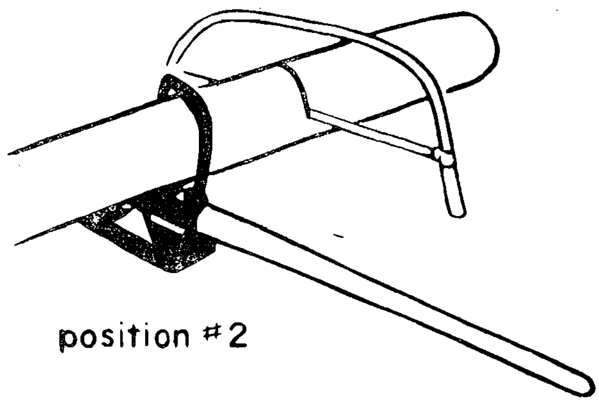
One important recommendation passed by the Conference was in connection with the need for an all-round and immediate effort in timber production by all members of the British Commonwealth if the Commonwealth is to play its part in restoring the general level of world prosperity. In this connection, emphasis was laid on the great need for forest products research by the various Forest Products Laboratories and it was stressed that attention should be paid to the possible increase in the use of timber derived from tree species now considered of secondary importance.

A NEW TYPE OF LOG JACK

The following description and illustration of a type of log jack may be of interest to those handling small plantation grown coniferous logs. It is claimed to be of assistance in lifting and holding the log off the ground while being sawn into shorter lengths.

"The 'U' shaped metal strap bolted on the stock opposite the dog forms a support for the log when it is rolled over. This raises the log several inches off the ground and provides a convenient block to hold a small log while it is being bucked."

This information was contained in an article on cant hooks and pulp hooks which was published in the "Southern Lumberman" v. 174, No. 2179, Jan. 5th, 1947 and is reproduced by permission of the Editor of that journal.



Victorian Railways Print.

C. S. I. R.

FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

No. 156 1947##156 September 1947

SECTION OF WOOD PRESERVATION

(This is the eighth article in the series describing the work of the various sections of the Division of Forest Products.)

Wood preservation is a subject of wide scope which may be defined broadly as embracing all practices designed to increase the service life of timber and of various other wood products. The subject includes a study of the main biological enemies of timber—fungi causing decay or other degrade, borers, termites (white ants) and marine organisms—and also of agencies of mechanical deterioration such as fire and weathering. It includes a study of wood preservatives, their chemistry, toxicity and permanence and their testing in the laboratory and the field. It includes methods of preservative application for such diverse purposes as prevention of fungal staining of timber during seasoning, preservation of poles, piles, rail sleepers, etc., prevention or eradication of termite or borer attack in buildings or other woodwork, prevention of mould growth in cool stores and the fire-proofing of timber. It also involves such important practical aspects as the design and operation of treatment plants, the use of constructional methods to reduce the deterioration hazard or to obviate the necessity for preservative treatment and the careful consideration of economic aspects and the relation between first cost, annual charge and service life.

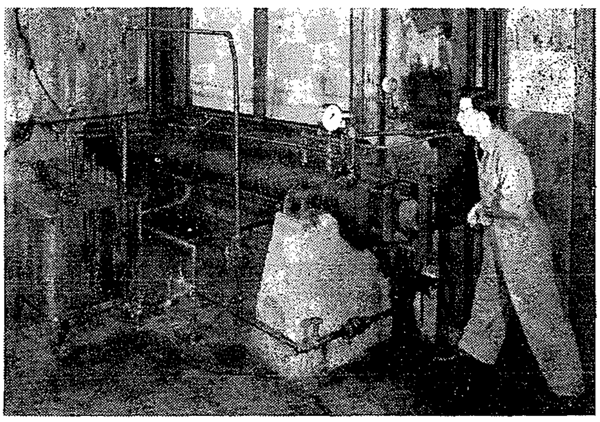
The organization of the Wood Preservation Section is similar to that described for other Sections, the present personnel consisting of an officer-in-charge, three research officers, three technical officers and a number of technical and laboratory assistants.

The work of the Section in the broad field defined can perhaps be illustrated best by selecting typical activities for more detailed discussion.

(1) **Field Tests:**—An important part of the Section's work is the testing of various preservatives and methods of treatment. To accomplish this, extensive service and "graveyard" tests have been installed in many different localities selected to include high levels of decay and termite hazard or other rigorous conditions of service. The extent of these tests may be judged from the fact that during the period 1929-1941 approximately 12,000 "test pieces" were installed in all mainland States except the Northern Territory. These included service tests of treated fence posts, poles, rail and tram sleepers, etc., and many "graveyard" tests in which small specimens treated with various proprietary and standard preservatives were compared. In most cases these tests were installed in co-operation with State Forest Services, pole-using authorities, State Railways, etc., so that the practical results obtained could be demonstrated to as wide an audience as possible.

Installation of variously treated pole stubs at a testing site or "graveyard" in New South Wales

Each specimen in test is individually numbered and the method of treatment, absorption and depth of penetration of the preservative recorded together with the results of periodic inspections. The majority of these tests are still proceeding and many are only now reaching the stage where the final result is becoming apparent. The results being obtained after such long-term testing are however of the greatest practical importance as their application will enable the better utilization of lower durability timbers, the improvement of existing practices and the very considerable saving of labour, material and money.



The high-pressure pilot plant for the experimental preservative treatment of timber at pressures up to 1000 lb./sq. inch

To illustrate further the type of test installed and the results being obtained, two tests may be taken as examples. In the period 1930-1936, fence post tests were installed in Western Australia, Victoria and New South Wales to determine whether small **round** fence posts of non-durable timbers could be treated satisfactorily and economically. In the Western Australian tests approximately 1900 fence posts representing 11 different timbers and 6 different preservative treatments, were installed in three widely separated localities. At the latest inspection, round posts of 8 different species treated with creosote oil were in excellent condition and only 1 per cent. had failed compared with 67 per cent. of untreated posts. Similar tests in New South Wales and Victoria have confirmed this result. The tests are still proceeding to determine the degree of superiority of creosote oil over the other preservatives used.

As a second example a rail sleeper test in South Australia may be cited. In 1936 approximately 1300 sleepers were installed in a service test in six localities ranging from Mount Gambier in the south to Peterborough in the

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north. In this test preservative-treated *P. radiata* sleepers were compared with untreated red gum and jarrah sleepers. Preservative treatment was made with 4 different preservatives using the Division's experimental pressure treating plant at Melbourne. The interim results of the test after 9 years' exposure have shown that *P. radiata* sleepers pressure-treated with an oil preservative should give entirely satisfactory results except possibly under very severe conditions of high traffic density and heavy axle loads. This test has also demonstrated the necessity of using rail plates with softwood sleepers and has incorporated in its design a secondary test to compare the effectiveness of different types of plates. With increasing yields of *P. radiata* in South Australia and New Zealand, the practical importance of this test is obvious.

(2) Borer Investigations:—For many years the Preservation Section has worked systematically at the problem of developing treatments to prevent powder post borer (*Lyctus*) attack in the sapwood of Australian hardwood (pored) timbers. It was early realized that treatment of the very wide, borer-susceptible, sapwood of many New South Wales and Queensland "scrub timbers" presented a problem which could not be solved by the spraying or dipping practised to some extent in other countries. Preliminary work was confined to the testing of many different chemicals. Small blocks of wood were treated, placed in glass containers and inoculated with Lyctus beetles. Results demonstrated that both sodium fluosilicate and boric (boracic) acid when present in even very small quantities conferred complete immunity to Lyctus attack. Boric acid was selected as the more desirable preservative because use of fluorine-containing chemicals involved a health hazard. Consideration was then given to methods of treating veneer with boric acid so that complete penetration of the wood could be obtained. After extensive tests a process was released to the Australian plywood industry which provided a safe, practical and inexpensive method of treating borer-susceptible veneer. This method has now become firmly established in New South Wales and Queensland and since its introduction approximately 10 years ago, no case of Lyctus attack in boric acid treated veneer has been reported to the Division.

Following the development of a process for treating veneer, attention was turned to the more difficult problem of treating sawn timber with boric acid so as to obtain complete penetration of the wood. Preliminary work which was completed during the war demonstrated the practicability of treating green timber up to 2 in. in thickness. From this point the further development of the method was undertaken by the New South Wales and Queensland State Forest Services who have implemented its commercial use in their respective States.

As continued progress and improvement is the keynote of scientific research, the Preservation Section is now investigating the possibility of improving and simplifying existing methods of treatment. Two extensive tests have been commenced recently to determine firstly whether introduction of toxic chemicals into the glue will prevent borer attack in plywood, and secondly to what extent the present boric acid process for treating veneer can be simplified. In this latter work, 1/16 in. and 1/8 in. green veneers from six different New South Wales and Queensland "scrub timbers" were treated by momentary dipping in cold boric acid solutions of varying strength, and then block-stacked for varying periods to permit diffusion of the chemical into the veneer. In all, from this treated veneer, 1560 small plywood panels were made and set up in 312 insect-proof cages for inoculation with Lyctus beetles. Inoculation is now proceeding in a constant temperature "warm" room where conditions are ideal for Lyctus attack. The breeding of many thousands of Lyctus beetles for inoculation in this and similar tests has proved not the least of the difficulties involved.

(3) The Pressure Treatment of Timber:—In countries where softwoods (non-pored or coniferous timbers) predominate, the preservative treatment of external structural timbers by pressure processes is well established. Officers of the Section who in the past investigated wood preservation practices in the U.S.A. and in Europe, found that methods suitable for softwood timbers failed to give satisfactory penetration in the truewood of many Australian hardwoods including almost all eucalypt timbers. Thus, except for natural round timbers, such as poles and posts which can be treated readily by impregnation of the sapwood, the main problem in wood preservation in Australia has been to develop methods of treating truewood timbers (i.e. rail sleepers, cross arms, bridge timbers, etc.) to obtain deep penetration. This problem has been under constant investigation for many years and various methods have been tried in the laboratory and tested in the field. It is only recently, however, that any promise of real success has been obtained. Preliminary tests of many different eucalypts have shown that treatment at very high pressures may achieve the desired result in the majority of cases. A high pressure pilot cylinder has been installed for extensive testing of this new method using pressures in the vicinity of 1000 lb./sq. inch. Interim results now being obtained confirm the promise of earlier tests, but much experimental work is necessary and will be done before the method can be released for commercial use. In this connection the many years spent in patient testing and ultimate rejection of various methods of treatment, provide a typical example of the long-term research projects undertaken in every phase of the Division's work. Success, when achieved, is seldom the result of short-term work or of "lucky guesses". If the high pressure treatment method is not finally successful or has practical disadvantages, work will be continued until the problem is ultimately solved.

(4) Advisory Service:—In addition to fundamental investigations such as the above, the section deals with many requests for technical assistance from industry and the public on all aspects of wood preservation. These requests which come from all States and from abroad total approximately 1000 per year and are given individual and careful attention.

BIBLIOGRAPHIES AND SUMMARIES OF INFORMATION.

The following are available for distribution to those interested:—

"Glue Drying Practice", prepared February, 1946.

"Fireproofing of Paper"—Bibliography of Recent Developments, prepared May, 1947.

"Kinos from the Australian Myrtaceae", prepared May, 1947.

BREVITIES.

Mr. S. A. Clarke, Chief of the Division, has just returned to Australia after a 5 months' trip overseas. During his travels he visited New Zealand, United States of America, Great Britain and Sweden, and while in Great Britain attended the Fifth British Empire Forestry Conference as one of the Australian delegates.

He spent considerable time in both the United States and Sweden on matters relating to the production of pulp and paper and insulating and hardboard.

Two research officers who have recently joined the staff of the Division of Forest Products are Mr. D. H. Foster, M.Sc. and Mr. G. L. Amos, M.Sc. Mr. Foster has joined the Section of Wood Chemistry and Mr. Amos the Section of Wood Structure.

Mr. R. F. Turnbull, Officer-in-Charge, Utilisation Section, Division of Forest Products, at present seconded to Associated Pulp and Paper Mills Ltd., manufacturers of fine printing papers in Burnie, Tasmania, has recently returned from the U.S.A. and Canada where he spent seven months investigating, on behalf of the Company, modern methods of de-barking, cutting up and chipping of pulpwood.

WHAT IS A SOFTWOOD?

The question of the difference between hardwoods and softwoods has again arisen, mainly in relation to the statement made by officers of this Division that the powder post borer (Lyctus sp.) does not attack softwoods. A correspondent has written querying this statement and pointing out that milky pine, a "softwood", is badly attacked by the powder post borer. The answer is, of course, that milky pine is wrongly named and is, in fact, a hardwood and not a softwood. It is most unfortunate that this species, botanically known as *Alstonia scholaris* was ever given the name "milky pine". According to the Australian Standards Association list the standard name, which should be used, is "white cheesewood". Mr. E. H. F. Swain in his book on "The Timbers and Forest Products of Queensland" has stated that the bush vernacular name of "milkwood" or "milky pine" arose from the fact that there was an abundant exudation of latex from the bark of the tree when injured. This exudation is rather common for all the species of the family to which *Alstonia scholaris* belongs, namely the Apocynaceae. The timber from the so-called "milky pine" is very soft and easy to work and on this basis could probably be considered to be a "soft" wood. However, structurally and technically it is a hardwood.

The question may well be asked "just how do we say that a timber is a hardwood when obviously to the naked eye it is soft and easy to work?" The definitions of softwood and hardwood refer to the structure of the wood. All hardwoods are derived from the botanical group named the Angiosperms. This group is commonly known as the broad leaved group of trees. The wood structure of the Angiosperms shows typical comparatively large cells, termed "vessels", which appear on the cleanly cut cross section of the wood as holes or pores. On the longitudinal section these vessels appear as long fine lines. On the other hand, the softwoods or Gymnosperms, derived from the coniferous trees, have a very uniform wood structure with none of the characteristic vessels or pores of the hardwoods. Now in technical literature for many years it has been the custom to call the Angiosperms, or broad leaved trees, "hardwoods" and the Gymnosperms, or coniferous trees, "softwoods". That this terminology is not strictly correct is shown at once when we think of the so-called milky pine—*Alstonia scholaris*—which is a broad leaved tree and which gives timber showing the characteristic vessels or pores of all "hardwoods" although it is not a hard wood. On the other hand, we find species like Douglas fir and celery-top pine from Tasmania, technically softwoods, being far harder and denser than many of the so-called hardwoods.

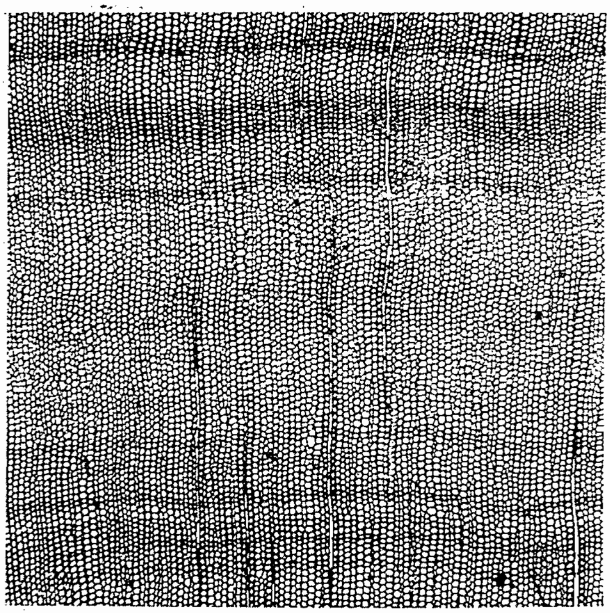

Figure I

In Australia these difficulties were realised very early and for this reason it was decided to standardise different names for the two main groups of timbers. As the timbers from the broad leaved group of trees, the so-called hardwoods, have vessels or pores, it was decided to call these timbers **pored timbers.** As the timbers from the Gymnosperms, or so-called group of "softwoods", never showed the characteristic vessels or pores, it was decided to call this group **non-pored timbers.** On this basis there would be little difficulty in classifying the so-called milky pine. It has pores and therefore it falls within that group called pored timbers and synonomous technically with hardwoods. As a pored timber or hardwood with sufficient starch in the cells of the sapwood, it is very susceptible to the attack of the powder post borer. The non-pored timbers, or softwoods, on the other hand, are not susceptible to the attack of the powder post borer. The reason for this non-susceptibility is that such timbers contain none of the pores or vessels in which the Lyctus beetle must lay its eggs before the timber can be infested. It is unfortunate that a number of the timbers from the rain forests of New South Wales, Queensland and various tropical areas should have become known collectively as "softwoods". Examples of these are Putt's pine, Leichhardt pine, Carrobean, crabapple, etc.* These are all pored timbers and are thus definitely "hardwoods". Certain of these are highly susceptible to attack by the powder post borer.

Fig. I is a cross section of a piece of Queensland hoop pine, a non-pored timber or softwood which is not susceptible to the attack of the powder post borer. It will be noted that there are no very large cells, the structure is even and all the cells shown are small in diameter and of uniform size.

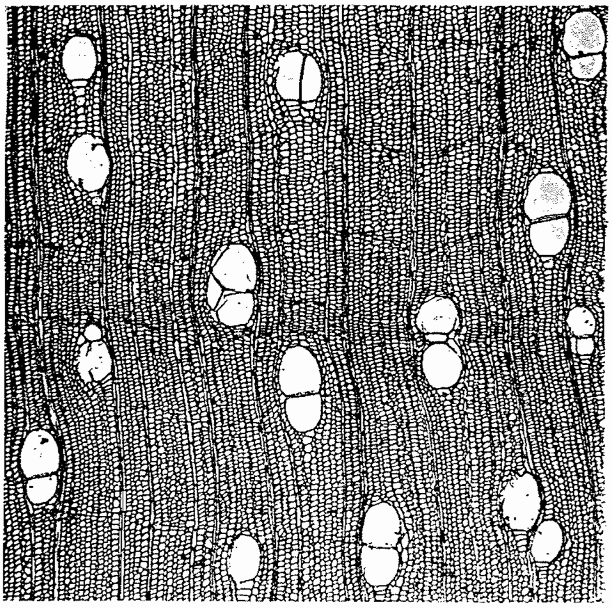

Figure 2

Fig. II is a cross section taken at the same magnification of a piece of *Alstonia scholaris* (white cheesewood or milky pine) and it will be noted that there are a number of fairly large vessels. These are much larger than the fibrous tissue which forms the main bulk of the wood. It is in these vessels that the eggs of the powder post borer are deposited.

Australian non-pored timbers, or softwoods, include hoop pine, bunya pine, kauri, cypress pine, brown pine, celery-top pine, huon pine, King William pine. None of these is susceptible to attack by the powder post borer. Common imported non-pored timbers or softwoods include Douglas fir, N.Z. white pine, N.Z. kauri, rimu, the various true pines including southern yellow pine and Baltic pine, hemlock, fir, Western red cedar. These again are not susceptible to attack by the powder post borer. The plantation grown pines in Australia, namely *Pinus radiata* and others, are also not susceptible. It would be wrong to assume that all the pored timbers or hardwoods are susceptible to powder post borer attack. Their susceptibility depends on several factors, mainly on the presence of sapwood, in which sufficient starch must be present to feed the developing larvae, and secondly on the size of the pores or vessels which must be large enough to accommodate the egg of the female Lyctus beetle.

It will be seen then that this matter of distinction between the two groups of timbers is dependent on fundamental differences in structure, and the question "When is a soft wood not a softwood?" can now be answered—"When it has pores".

* These names, needless to say, have not been standardised, the Standard Common names being silver silkwood, cheesewood, yellow carabeen, white birch.

PROPERTIES OF AUSTRALIAN TIMBERS

Queensland Maple

(This species has been previously described in News Letter No. 80, but in the light of more complete information the description has been modified and enlarged.)

Queensland maple is the standard trade common name for the timbers known botanically as *Flindersia brayleyana* F.v.M.; (Syn. *Flindersia chatawaiana* F.M. Bail.) and *Flindersia pimenteliana* F.v.M. (Syn. *Flindersia mazlini* F.M. Bail.). These two distinct botanical identities are included under the one trade name as their timbers are very similar with regard to colour, figure and working qualities.

As the species are not related to the widely known maple (Acer) genus of the Northern Hemisphere the distinctive name of silkwood was given to them in Queensland, where they are also known as maple silkwood and red beech. The wood has become so well known on Australian and overseas markets as Queensland maple that, in spite of the shortcomings of this name in describing the features of the timber, it has been accepted as the standard name.

Distribution.—The species are found associated in the mixed tropical jungles of the highlands of north-eastern Queensland, principally on the Atherton-Ravenshoe Tableland. In this area the mean temperature for the coldest month is in the vicinity of 60° F. and there is a heavy summer rainfall. The species are found on the deep red loam banks with *F. pimenteliana* extending to the yellow granitic clays.

Habit.—These species though not often exceeding a medium height of 100 ft. attain a massive trunk which may measure up to 4 ft. in diameter at the base. The bark is brown in colour and sub-fibrous.

Timber.—The timber of Queensland maple varies in colour from light brown, brownish pink to pink. In texture it is medium and uniform, with a grain that is often interlocked and sometimes wavy or curly. It displays a wide range of figure varying from plain to stripe, to waterwave, and the decorative value of these variations is greatly enhanced by the natural silken lustre of the wood.

Queensland maple is light in weight with an average density, before reconditioning, at 12 per cent. moisture content of 34.6 lb. per cubic foot. The density after reconditioning averages 33.9 lb. per cubic foot.

In drying from the green condition to 12 per cent. moisture content the average shrinkage in a tangential direction, including collapse, is 6.5 per cent. and the average shrinkage in a radial direction, again including collapse, is 3.0 per cent. After reconditioning these averages are reduced to 5.0 per cent. and 2.8 per cent. respectively.

Seasoning.—No particular difficulty should be found in satisfactorily air or kiln drying this timber from the green condition, in thicknesses up to 3 in. It does not readily check and, although evidence of fairly pronounced collapse has been observed on occasions in material from butt logs, this is usually not present to any appreciable extent.

Owing to the presence of an interlocked grain in some material, more especially in the denser stock, the timber frequently has a tendency to warp. Cupping of wide backsawn boards is also likely to occur and appropriate measures should be taken during drying to prevent the development of this and general warping. The time required to kiln dry this timber, green from the saw, to a moisture content of 12 per cent., varies from up to 10 days for 1 in. stock to about 30 to 35 days for 3 in. stock.

Mechanical Properties.—Although Queensland maple is not used structurally, its strength properties would place it in strength group D. Hoop pine falls in the same strength group and has approximately the same density as Queensland maple but due to the inherent characteristic of the latter, namely interlocked grain, maple is in many of its strength properties inferior to this species. In tensile strength, for instance, it has only 60 per cent. of the strength of hoop pine. However, the impact strength of Queensland maple is much greater than that of hoop pine although it is not as great as mountain ash. It has an Izod figure of approximately 10 ft.lb. compared with 4½ ft. lb. for hoop pine and 14 ft. lb for mountain ash.

General.—The sapwood of this species is not susceptible to the powder post borer (Lyctus); it is classified among those timbers immune to attack. The timber lacks durability in the ground and in damp places.

For veneering Queensland maple can be peeled or sliced satisfactorily and the timber glues easily. It works easily under hand or machine tools, but, when interlocked, its grain may be inclined to pick up in dressing. It takes stain readily, fumes successfully, and is held in high regard by cabinet makers. It polishes excellently and gives a high lustrous finish. It is also regarded as satisfactory for steam bending.

Uses.—Queensland maple has a very wide range of uses; it is not normally a structural timber but its use for fixed pitch airscrews is quite well known. It possesses a refinement and character equalled by few other timbers, is ranked among the best cabinet timbers in the world, and is the most favourable on the Australian market. Interior decorators use it to excellent advantage to produce very decorative effects in panelling, furniture, stairways and shop fittings. It is in good demand for reproductions of antique furniture, for presentation pieces, exhibition productions, high class furniture and cabinet work of many types. In stair pillars, handrails, doors, mouldings and household joinery, it is widely used to good effect.

Interior fittings of carriages, tramcars and pleasure boats are greatly enhanced when this timber is used. It is also used in railway carriage building for doors, inside framing, seat framing, outside sheathing, glass frames, louvres, partitions and mouldings. Besides its decorative uses in boat fittings, it is also suited for planking, outside joinery, and for rudders and stems of small craft.

It has proved very suitable for aeroplane propellors and construction and is used in considerable quantities for rifle stocks. As a general building timber, it is highly regarded locally as it holds nails well and does not rust them. It is used extensively for veneer and plywood manufacture.

Availability.—The timber is available in a wide range of board and joinery sizes, also as veneers and plywood.

Dr. W. E. Cohen, Officer-in-Charge, Section of Wood Chemistry and Dr. M. Margaret Chattaway, Section of Wood Structure attended the Meetings of the Australian and N.Z. Association for the Advancement of Science held in Perth during late August. Dr. Cohen presented a paper entitled "Some Recent Advances in the Chemistry of Australian Woods" and Dr. Chattaway one on "Sapwood-Truewood Transformation."

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C. S. I. R.

FOREST PRODUCTS NEWS LETTER

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No. 157 1947##157 October 1947

WOOD WOOL BUILDING BOARD

by

J. W. Gottstein, Seasoning Section.

The present requirements of the building industry for material for both exterior sheathing and interior lining has drawn attention to all possible sources of supply. Wood wool board has valuable properties for interior work, and may also be suitable for exterior sheathing, so that it is worthy of special attention.

The use of wood wool (known also as "Excelsior" when used for packing) to form the fibrous foundation of a light weight building board, bonded with a mineral cementing material, is not new. Wood wool is recorded as being marketed in Germany in 1926, and 25,000,000 square yards were used there in 1938.

Several attempts to place the product on the Australian market were made just prior to World War II but did not meet with success, perhaps because of the relatively free availability of building materials at that period, and perhaps because of a lack of understanding of the special properties of the material.

In the present critical shortage of building boards it is apparent that wood wool board deserves special attention: investigation of its properties, its manufacture with Australian raw materials, and a study of its suitability for application to Australian conditions and constructional methods is necessary. Investigational work along these lines is proceeding at the laboratory of the Division of Forest Products, C.S.I.R.

The basic material requirements for the production of the boards are simple, and comprise the following:—

(a) **Wood Wool.** This material is produced from small billets of wood in a special planing machine built for this purpose. A number of the lighter weight, straight-grained timber species are suitable, and the small billets required may be obtained from small logs not suited to the production of sawn timber. Only about one pound of wood wool is used in producing a square foot of board one inch in thickness. This represents a saving of nearly 75% when compared with solid timber of the same thickness.

(b) **Cement.** The binding agents used overseas include Portland cement, magnesite (magnesium oxychloride) and plaster of Paris. The several cementing materials produce boards with different qualities, and also affect the manufacturing methods.

Some pre-treatment is usually given the wood wool to ensure proper bonding with the cement. Milk of lime and calcium chloride have both given good results as bonding agents.

In the simplest manufacturing methods, a measured quantity of the dried wood wool is dipped in a water bath containing the bonding agent, and then thoroughly mixed with a measured amount of the cement. This cement may be used wet or dry according to the process and the type of cement. After mixing, the uniformly cement coated wood wool is spread evenly on to forms, and pressure is applied to bring the board to the correct thickness and density: the pressure is retained until setting has occurred. The boards are then removed from the frames and dried, or given a special treatment to ensure the development of maximum strength.

The relative proportions of wood wool and cement, and the pressure used to form the board to its required thickness can be varied over fairly wide limits with the different bonding materials used, and the final purpose for which the board is intended. Present indications are that a board using Portland cement as a binder will be most suitable for conditions in Australia. Portland cement is reasonable in cost, little affected by water, and produces a board suited to a wide range of working conditions.

When wood wool is bonded with Portland cement, the proportions vary from one part by weight of dry wood wool to from two to four parts of dry cement, but most boards use between two and three parts of cement by weight. There is some indication that rapid setting cements of the finely milled type are specially suited to wood wool board manufacture.

The pressures used to form the board vary from less than 10 to more than 20 lbs. to a square inch, according to manufacturing requirements. The changes in proportions of ingredients and variations in forming pressures naturally affect appearance, density, conductivity and other physical properties of the board.

Wood wool board has many useful properties as a building material: these include light weight (commercial boards usually range between 2 to 4 lbs. per square foot of 1 in. board), good affinity for plaster finishes and rendering, adequate strength and good nailing properties. It can be sawn with ordinary hand saws, and has very good acoustical and thermal properties. Published results of tests on 1 in. thick board show a heat transmission of only about 0.6 B.T.U's per square foot, per hour, per degree F. temperature difference. These properties make it highly suited for interior partitions, ceilings, etc., but the extension of its uses in this field must take into consideration its cost in relation to its special merits. The board is subject to some movement when moisture is absorbed or lost, but this is not likely to be sufficient to be of any importance in interior work provided sound constructional methods and properly dried boards are used.

Most of the board made overseas has been applied to interior work, and apparently given every satisfaction. The information available on the application of this material as an exterior sheathing is much more limited and the conditions of service are far more severe. In this field several Australian manufacturers are claiming complete satisfaction, but it must be recognised that here the wood wool board is used in conjunction with a waterproof rendering, and represents only one component of the exterior sheathing. The degree of satisfaction which can be obtained in this application will depend on the stability of the frame work to which the wood wool is attached, the method of fastening, method of jointing and the quality of the rendering. Since a properly rendered exterior should behave as a concrete veneer, expansion joints at approximately 10-feet intervals are considered advisable. The rendering adjacent to the joint should be reinforced with expanded metal.

Service tests under Australian conditions are too limited to be able to guarantee results completely for all conditions, but there is no evidence that any failure will necessarily occur provided the work is carried out carefully. A reinforcing hessian scrim overlapping all joints (except expansion joints) by approximately 4 in. is usually applied before rendering. Vertical joints between sheets over the corners of openings for door and window frames should be avoided. Chicken wire can be used as an alternative joint reinforcement.

The relative proportions of wood wool and cement, the density of the board, the species and grade of wood wool, the method of manufacture and the setting technique used, all have their effect on the properties of the board, and affect its suitability for the applications referred to above.

Where manufacture is contemplated, the cost of production must be considered carefully because, while raw materials are fairly cheap, labour costs are high and mechanization may be expensive. A careful analysis of probable production costs should be made before manufacture is undertaken. Several firms in both Melbourne and Sydney have undertaken production successfully on a small scale.

THE COMPARATIVE DURABILITY OF EMPIRE TIMBERS

Note on a Proposal to Establish Inter-Empire Tests made at the Empire Forestry Conference, London, 1947.

Many Empire timbers available for export, or potentially so, have a high reputation for durability in their country of origin but are less well known on the overseas market. In some cases, timbers which have been exported for many years have established such a reputation that buyers are not persuaded easily to accept alternative timbers less well known but probably of similar or even superior durability. This position has arisen in Australia where Western Australian jarrah has achieved an overseas reputation while other eucalypt hardwoods of equal durability are not readily accepted abroad because of unfamiliarity with their properties.

It is suggested that in order to obtain a comparative picture of the durability of less well known timbers an inter-Empire durability test might be laid down. This will provide a basis for reasonable comparison and will assist both buyers and sellers to select suitable timbers where durability is a main criterion. Such a test is considered desirable as a reputation in the country of origin is not sufficient to convince overseas buyers and is actually no guarantee that performance will be satisfactory in other countries where the biological hazard may be very different. The best index of durability is satisfactory performance under varying conditions of decay and termite hazard.

If such a test is undertaken a list should be made of 30–50 Empire timbers which are available or potentially available for export. Included in this list should be reference timbers such as jarrah, teak, iroko, etc., which will serve as a yardstick for comparison of other timbers. A suitable specimen size would be sticks approximately 2″ x 2″ x 24″ and testing sites should be selected in at least six different countries. Where possible sites should represent a combined decay and termite hazard. Each timber species to be tested should be represented by a suitable number of trees and the specimens divided into matched sets for testing.

In each country where a testing site was established other local timbers could be included for comparison with the standard set. This would permit a much more extensive test without expanding the international test beyond practical limits. It is suggested that the test might be run similarly to the "International Termite Test" with the Princes Risborough Forest Products Laboratory acting as the co-ordinating body and issuing the combined periodical inspection report.

A further extension of the above test which would prove very interesting would be for some of the co-operating laboratories to run accelerated laboratory durability tests on material matched with the field test specimens. This would permit correlation between laboratory and field tests and show to what extent laboratory tests can be used to predict field test results.

If the above test is accepted in principle it may then be wise to consider whether any foreign timbers should be included and how far the number of species can be increased without exceeding practical limits.

THINNER FLOORS

by K. L. Cooper and J. J. Mack, Timber Mechanics Section.

A previous article (Forest Products News Letter No. 140) briefly described the timber flooring tests which were being carried out in the Timber Mechanics Section of the Division of Forest Products, C.S.I.R. As these tests are now nearing completion it is possible to summarize the work that has been done and the conclusions which may be drawn.

When the working plan for the experiment was originally drawn up the object was firstly to determine the strength of flooring, secondly to compare various Australian species, and thirdly to compare ordinary T. & G. strip flooring with plywood flooring and with end-matched material. To this end strip floor sections 7 ft. 6 in. long x 3 ft. 0 in. wide were made up of ordinary commercial flooring boards on 4 in. x 1½ in. joists at 18 in. centres and plywood floor sections were constructed of single 6 ft. 0 in. x 3 ft. 0 in. sheets of ⅝ in. ply also on joists at 18 in. centres. It had been decided that the load should be applied to the test floors through a steel tool of relatively small area, and some preliminary tests were carried out to investigate the effects of different sizes of loading face on the strength and stiffness of the floor. It did not appear however, that the size of the tool tip was at all critical. In the meantime, as a result of an investigation of floor loads, the Commonwealth Experimental Building Station had recommended that concentrated loads should be considered as applied uniformly over a circle of 0.5 sq. in. area, and so a suitable loading tool of that size was developed. The Building Station also put forward certain proof loads which it was considered desirable floors for use in domestic buildings should be able to sustain. Although not part of the original plan, proof load testing was incorporated into the experiment and used as a guide in determining whether the floors under test were structurally sufficient.

The plywood floor sections were made up either without nogging pieces between the joists or with noggings at 18in. or 36in. centres, in the latter case being under only the long edges of the ply sheets. Floors made of ⅝in. thick plywood, similar to that used in these tests, are sufficiently strong and stiff for ordinary domestic use. Also the floors do not require transverse support except at the edges, so that a small saving in noggings would result from laying the length of the plywood sheets in the direction of the joists instead of across them.

For the strip flooring tests nine species were tested, jarrah from Western Australia, radiata pine from South Australia, mountain ash from Victoria, and tallowwood, Sydney blue gum, blackbutt, spotted gum, brush box and cypress pine from New South Wales. All the material was tongued and grooved and an additional batch of jarrah was end matched. The nominal thickness of the flooring was 13/16 in. except the mountain ash which was ¾ in., and the width of the boards a nominal 3⅞ in. except in mountain ash where three widths, 2½ in., 4¼in. and 5¼in. were tested and radiata pine where 4 in. and 6 in. were used. The first species tested were jarrah and mountain ash and it was early seen that the floors were much more than sufficient to fulfil the Building Station's requirements for domestic floors. The question was no longer whether economies could be effected, but how much saving could be made.

Two alternatives presented themselves, either the thickness of the flooring could be reduced or the spacing of the joists could be increased. The latter is the simpler thing to do, and could and should be done where the other alternative is not available; but the former is potentially much the more important economy. Accordingly it was decided to investigate the strength and stiffness of thinner floors and 9/16 in. was chosen as a finished thickness which could be obtained from ¾ in. green stock, a size which is normally cut. The tests were then extended to 9/16 in. material on joists at both 15 in. and 18 in. centres. Cypress pine and radiata pine were not included, however, as while they amply met requirements there was not the same margin of strength and stiffness which the jarrah and mountain ash possessed. End-matched jarrah too was not tested in a reduced thickness as, while the 13/16 in. material on joists at 18 in. centres was adequate, there was no great reserve. It is considered that all the hardwood species tested would give satisfactory service in a domestic floor if only 9/16 in. thick and on joists at 18 in. centres. Where it is not possible to use thinner material, standard material (3/4 in. or 13/16 in. thickness) can be used on joists up to 24 in. spacing for hardwoods of C strength group or better, and up to 21 in. centres for radiata pine and group D timbers.

It is interesting to note that a British economy memorandum on the use of timber in building work (Ministry of Works, 1947) specifies that 5/8 in. T. & G. flooring boards are to be used on joists at 14 in. spacing, and 7/8 in. boards on joists at 21 in. spacing. Taking into account the difference in the stiffness of the materials the recommendations are quite comparable with those resulting from the Division's tests.

The recommendations for flooring for ordinary domestic purposes may be summarized in a table:—

Recommended Sizes of Flooring

Strength Group	Minimum Finished Thickness (in.)	Maximum Joist Spacing (in.)
A, B and C	9/16 T. & G. 3/4 T. & G. 3/4 end-matched	18 24 18
D and radiata pine	3/4 T. & G. 13/16 T. & G.	18 21

COMMERCIAL TIMBERS OF AUSTRALIA.

An account of the principal commercial timbers of Australia, covering their properties, uses, and treatment, has just been published by the Council for Scientific and Industrial Research.

The book is divided into two parts. The first deals with the general technology of the timbers and discusses wood structure, including various forms of timber defect, the mechanical and physical properties of timbers, methods of seasoning, preservative treatment and durability, the bending of wood, grading, veneer and plywood, improved wood, the manufacture of paper from Australian hardwoods, and Australian essential oils.

The second part of the book lists the individual timbers and gives the characteristics of each, including their density, the amount of shrinkage that can be expected, their durability, the seasoning required, main uses, and the availability of the timber. To aid in the selection of suitable timbers for specific purposes, the articles for which wood is commonly used are listed and the timbers that can be employed for each are given. A comprehensive bibliography dealing with Australian timbers is included, and the whole book has been carefully indexed.

("The Commercial Timbers of Australia: Their Properties and Uses," by I. H. Boas, M.Sc., 1947, viii plus 344 pp., 20 plates. Price: 12/6, postage 8d. Copies obtainable from Tait Book Co. Pty. Ltd., 349 Collins Street, Melbourne.)

SAPWOOD AND TRUEWOOD

by M. Margaret Chattaway, Wood Structure Section

On looking at cross sections of many trees one sees a distinct difference between the inner and outer layers of the wood, a difference of colour, or of moisture content, which persists through the whole length of the mature trunk and in old trees right up into the primary and secondary branches. The inner is the truewood, the outer the sapwood, and the differences between these two zones give rise to many of the problems that confront people who use wood, whether they use hard and heavy constructional timbers or the more elegant figured woods for cabinet work and decorative panelling.

These problems have led many investigators to study the development of truewood, but we are still far from a full knowledge of the fundamental details of its formation. An investigation has recently been undertaken at the Division of Forest Products to get further knowledge of this matter, especially as it affects Australian timbers.

There are certain differences between sapwood and truewood that are well marked in the majority of trees and that are considered as criteria on which to distinguish between the two types of wood. These criteria are, however, not infallible, and may be misleading if taken alone, though together they usually help one to a correct decision. **Colour** is often a good guide, but there are many woods that do not have coloured truewood, and of those that do, the colour change may be gradual, giving a zone of intermediate wood with some, but not all the attributes of the truewood. In others the truewood will be one colour in a freshly cut log and a different colour in timber that has been exposed to the air for some time. The blocking of pores by **tyloses** often accompanies this colour change; in many trees it is indeed a very conspicuous feature of the wood, and a clear line of **demarcation** can be traced, with empty pores on one side and blocked ones on the other. (Fig. 1). Unfortunately this too is a feature that may be very variable, and tyloses may be absent from some trees and be found in considerable numbers in the sapwood of others. It is possible that their formation depends on the minute structure of the wood, the important factor being the size of the pits between the vessels and the adjacent parenchymatous elements. It has been stated that tyloses may occur in the sapwood of all species in which they occur in the truewood, and though it is possible that when this occurs it is an artificial formation resulting from alterations of tension due to the felling of the timber, it cannot be ignored.

Deposits of gum and resin are also common features of truewood, for the colour of which they are often responsible, and yet they too—as the gum veins of *Eucalyptus* sp. show—are found frequently in the sapwood, in connection with wounds, and commonly also in woods which have a zone of intermediate wood. These deposits are responsible for the greater resistance of truewood to decay. Both fungi and insects are, however, selective in their attack and conditions of resistance differ between living trees and felled timber. The impregnating deposits found in the truewood of many timbers render it relatively immune to attack by fungi, though there are certain specific truewood fungi which attack the truewood but not the sapwood of living trees. In this case the immunity of the sapwood is probably due to its high water and low air content, for in most living trees the moisture content of the sapwood is much higher than that of the truewood. After felling however, owing to its quick drying properties the sapwood succumbs to these fungi more readily than the truewood.

Owing to its greater penetrability, sapwood is more easily impregnated than truewood, and for this reason can be made resistant to decay, so that there need be no objection to the use of properly impregnated sapwood, as its strength is very similar to that of truewood.

There are, however, many fundamental questions that remain unanswered when all the available literature on the subject has been studied. One of these is at what age trees start to make truewood. It has been stated that a warm climate favours early formation of truewood in softwoods, and figures have been given of 30-35 years for pines in the Black Forest. A series of figures given for pines by another writer is from 20 years in Alsace, through 30 and 50 years in South and Middle Sweden to 70 years in the colder regions of North Sweden.

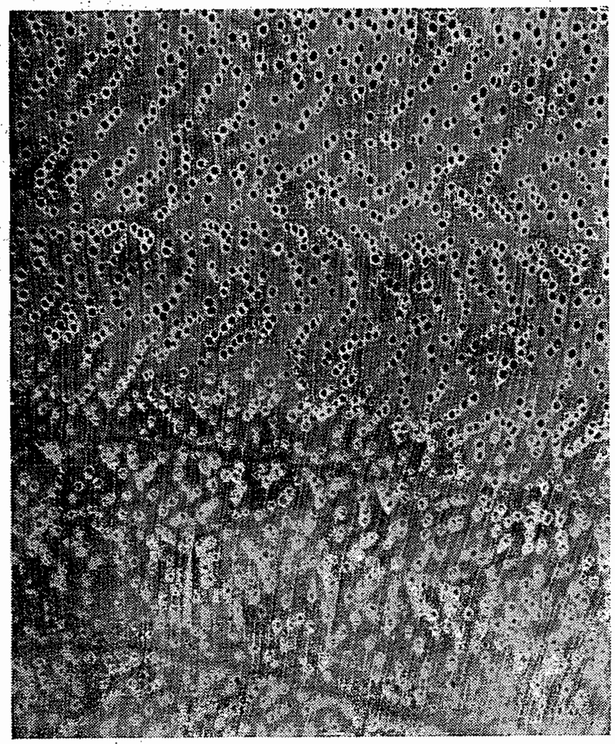

Figure 1. E. paniculata showing empty pores in sapwood and their occlusion by tyloses in the truewood.

Species of Eucalyptus in Victoria seem to mature earlier than this, and *E. regnans* on the dividing range, which has grown since the 1939 fires, has already made a considerable amount of truewood (Fig. 2), extending to within two growth zones of the bark, and up the tree as far as the crown, usually ceasing just below half height. In several cases truewood was present in large trees of this age at 30 ft. from the base.

Suppressed and normal trees of the same age have been compared in *E. regnans* and *E. gigantea*; the presence of truewood in both suggests that its formation is a function of age rather than of girth.

A further type of tree is of considerable importance in the sub-tropical areas of Australia. Here the sapwood is moderately wide, but the bulk of the log is made up of so-called intermediate wood, in colour more like the truewood, but still having some of the essential properties of sapwood, including unfortunately its susceptibility to insect attack. *Tarrietia* is an example of this and in logs sent to the laboratory for examination there was no sharp line of separation of sapwood and truewood. It is possible that in these timbers the process of truewood formation is stayed before completion, giving the wide zone of less durable intermediate timber.

Another point on which there is very little information in the literature is when the tree makes truewood, and study of the timber does not help much in this. In most trees it seems that truewood formation is quite independent of the periodic growth by which annual or seasonal rings are formed. There is often great variation within a stem, and the limit of the truewood may be in one growth zone on one side of the stem and in another one either a short way above or below, or on the other side of the stem at the same level.

This inability to correlate truewood formation with periodic growth suggests that there are two growth processes going on at the same time in the tree trunk. Increase in girth by division of the cambial cells is a continuous process, showing definite seasonal correlations both in the type and the quantity of the tissue produced; truewood formation appears to be a process that, once started, is continued throughout the life of the tree; it is roughly correlated with increase in girth of the tree, but is apparently unrelated to the periodic growth by which that girth is accomplished. Koehler has stated that "sapwood is wider in open grown timbers with large crowns than in trees of the same species and same diameter with smaller crowns." One can speculate a lot on this statement, and build an hypothesis on the fact that the wider sapwood seems to be correlated with a greater supply of food from the larger crown. This suggests that truewood formation is a starvation product, which fits the fact that when truewood is formed the parenchyma cells are dead and the vessels have ceased conducting. The whole hypothesis is a pleasant speculation, but still leaves unexplained the variation from part to part of the trunk.

It has also been stated that truewood formation is due to cessation of active conduction within the tree as direct contact with the leaves is lost. This suggests that although investigation of the truewood of a tree shows a cone of truewood, wider at the base and tapering to an apex in the crown, the actual stimulus for the formation of truewood travels from the apex of such a cone to the base.

Figure 2. E. regnans about 7 years old. The dark central disc of truewood has reacted with Mallo to give a blue-black stain.

Recent experiments at the Division of Forest Products on truewood formation in species of *Eucalyptus* have shown that truewood is formed at the base of the branches, at a level above that of the truewood in the main trunk. The pattern of truewood formation in the branches appears similar to that in the stem, and in almost every sample examined patches of truewood were found in the first and somtimes also in the second or third branches above the truewood level of the stem, or, in secondary branches, above the level in the primary branch. The full significance of these basal patches of truewood is not yet appreciated, and further work is being carried out.

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C. S. I. R.

FOREST PRODUCTS NEWS LETTER

This monthly bulletin is prepared for general circulation by the Division of Forest Products, C.S.I.R., 69-77 Yarra Bank Road, South Melbourne, S.C.4., and will be supplied free on request to members of the timber trade and timber users who wish to keep abreast with current developments in the field of forest products.

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SECOND AUSTRALIAN FOREST PRODUCTS CONFERENCE

In March 1946 at the first Australian Forest Products Conference representatives of the State Forest Services and of the Division of Forest Products, C.S.I.R., met to discuss Programmes of Work and to arrange co-operation wherever possible. This Conference proved so successful that it was decided to make such meetings annual affairs and the second of these conferences was therefore held at the Division of Forest Products during the week commencing November 10th. All the State Forest Services sent representatives and there were also present the Secretary of the Forests Department of the Territory of New Guinea and Papua ; a representative of the Director General, Commonwealth Forestry and Timber Bureau ; an officer of the Plant Diseases Division of the New Zealand D.S.I.R. an officer of the Division of Economic Entomology, C.S.I.R., and representatives of the Munitions Supply Laboratories. The Division of Forest Products was represented by its senior officers. A few visitors were present for special sessions and in this connection two representatives of the southern section of the Standards' Association of Australia attended the discussions on standards work.

The Conference was addressed by Dr. A. E. V. Richardson, Chief Executive Officer, C.S.I.R., and by Dr. F. W. White a member of the Executive, C.S.I.R. Both spoke on the importance of forest products investigations to the community and the relationship of the work of the Division of Forest Products to other C.S.I.R. activities. They stressed the importance of co-operation in obtaining the maximum value from the effort and expenditure on forest products problems.

At the recent Fifth British Empire Forestry Conference it was decided that an Empire Standing Committee on Forest Products should be set up and preliminary arrangements were made for Australian representatives on this. The formation of corresponding committees on specialized subjects was also recommended and steps have been taken to organize some of these. It was essential therefore, that effective steps should be taken in Australia to maintain the necessary contact between research workers on forest products problems and these committees of the Empire Forestry Conference. Suitable arrangements were made and full advantage was taken by delegates of the opportunity to discuss the development of these activities.

There can be no doubt that the present demands for information and for new investigations far exceed the capacity of the existing forest products organizations. It is essential therefore, that the closest attention be given to all programmes of work to avoid overlapping and to select the most urgent matters for investigation. In this connection views were strongly expressed regarding the desirability of all States developing their own trade contact activities. Such a step would markedly lighten the burden for the research staff of the Division of Forest Products and enable them to devote more time to research projects. The States, on their part, fully appreciated the desirability of keeping the Division as closely in touch as possible with the industry and with research problems in the field.

One of the most important problems which came up for discussion was the effect of silvicultural treatment on the properties of timber. As the virgin forests are cut over the timber from managed forests becomes more and more important, and it is therefore necessary to know the effect of different silvicultural treatments so that the best methods can be applied. Preliminary tests in co-operation with the States have already been commenced, but a revision and an extension of these is considered to be of importance.

All State Departments and most of the timber trade are interested in the possibilities of using forest and sawmill waste for the manufacturing of building boards. The recent developments overseas indicate that there are possibilities for small plants in this regard. The desirability of a concerted attack on this problem in Australia was stressed.

Co-operative investigations in connection with borer attack in timber have been proceeding for some two years. The progress to date was reviewed and a programme of work for the next year drawn up. The Forest Products Branch of the Queensland Department of Forestry ; the Division of Wood Technology of the New South Wales Forestry Commission ; and the Division of Forest Products now have a closely co-ordinated programme in this field and excellent progress has been made in the commercial adoption of the boric acid process. Sodium fluoride as an alternative to boric acid for certain applications was discussed and will be given greater attention in future work.

Mill studies, which are of great importance to the sawmilling industry generally, were considered and it was proposed that there should be some extention of this work. It is hoped that some of the State Forest Services will train their own team for this work, after initial assistance has been given by the Division of Forest Products. This will then leave the officers of the Division free to pursue some of the more fundamental problems associated with the sawing and machining of timber.

A survey of Australian tanning materials and of the chemical composition of Australian timbers and barks was considered to be an urgent requirement and means whereby the necessary analytical work could be carried out were discussed.

All branches of Australian standard specifications as they affect the timber industry were reviewed. Proposals were made for intensifying the work in this respect, and it was agreed that one urgent requirement was the standardization of the trade names of more of the commercial Australian timber species.

A wide range of other matters came under consideration including methods of timber preservation ; seasoning co-operation ; underwater protection of wooden structures ; wood as an electrical insulating material ; dimension stock investigations ; timber for case purposes ; container design.

It was decided that the third of these Conferences will be held in Sydney during the latter part of 1948.

Mr. C. S. Elliot, Assistant to Chief, Division of Forest Products on a trip to South Australia at the end of October visited the Woods and Forests Department, Timber Development Association of Australia (S.A. Branch), various trade contacts in Adelaide, the Woods and Forests Department mills at Mt. Burr and Nangwarry, Cellulose Australia Ltd. at Snuggery, and Francis Kay Veneer Mill at Mt. Gambier.

Mr. K. M. Harrow, M.Agr.Sc. of the Plant Diseases Division, D.S.I.R., Auckland, N.Z., spent three months at the Division of Forest Products gaining an insight into the work of the Sections of Preservation, Wood Structure, Seasoning, Timber Mechanics and Veneer and Gluing. Mr. Harrow also attended the Forest Products Conference held at the Division during his visit.

SOME TROUBLES DUE TO CHANGES IN MOISTURE CONTENT

By

IAN J. W. BISSET.

How often have you struggled to get that window up, push open that door or pull out that drawer. Such happenings are most aggravating and no doubt you feel justified in blaming the joiner for all your troubles. Perhaps you are right sometimes, but, if he is a good joiner and you are a discerning person, you will have noticed that the sticking and jambing of drawers and windows generally occurs only in those seasons when the humidity is high. At other times of the year they are quite free, opening and closing easily. In fact windows may then become so loose that rattling with the wind becomes a source of annoyance. However, it is not always possible for the joiner who does the fitting, to anticipate completely the variation in conditions to which the timber in the windows will be exposed. Therefore provision should be made for adjustment of the windows after installation to cope with any unforseen movement.

Dry wood and even so-called " bone dry " wood always contains a certain amount of moisture. The amount of moisture depends on the particular type of wood and on the condition of the atmosphere surrounding it. During those seasons when the humidity is high and the atmosphere contains a larger quantity of water vapour than usual, wood absorbs moisture from the air and swells in proportion to the amount of moisture taken up. Likewise during the drier seasons some of the moisture in the wood escapes into the atmosphere and the wood shrinks. This shrinkage and swelling of wood is called " working," and is an inherent characteristic of all timbers.

All timbers are composed of long narrow fibres from one to seven millimeters in length, whose walls are composed of parallel, minute strands of cellulose, together with varying amounts of lignin and other substances which constitute wood. This ligno-cellulose complex is a hygroscopic substance, *i.e.*, it has an affinity for water. This affinity varies with changes in temperature and humidity of the surrounding air. Thus when wood absorbs moisture from the air, molecules of water become inserted between the cellulose strands and push them apart. When this effect is integrated for all fibres we have macroscopic swelling which, together with shrinkage upon loss of moisture, is referred to as the " working of wood."

However, for a given change of moisture content, the dimensional change of all timbers is not the same, that of softwoods being usually less than that of hardwoods. If it is required to have a closely fitting moveable piece of timber in a location where large variations of humidity are to be expected, then a low shrinkage timber should be chosen if jambing troubles are to be reduced. It should also be remembered that the movement of backsawn timber is one and a half to two times as great as the movement of quartersawn timber. Once a suitable timber has been selected it is then logical to ask at what moisture content it should be when being sawn and fitted. The timber should be dried to a moisture content which is compatible with the highest and lowest moisture contents it will experience during the year. This will ensure a minimum of swelling in the season of high humidity and correspondingly small shrinkage during the dry season. But how is a joiner to know what the most suitable moisture content is likely to be.

That is where the Division of Forest Products has been, and can be of considerable help. Some years ago a number of species was selected and samples of each located in various parts of Australia in which widely differing climatic conditions are experienced.

For more than a year these samples were periodically weighed and moisture contents calculated. From these observations it has been possible to make a chart indicating the range of moisture contents which a number of different species will experience in different parts of Australia for indoor and outdoor positions.

At this stage it is appropriate to introduce the term "equilibrium moisture content." It has been found that for any prescribed set of psychrometric conditions there are particular moisture contents known as equilibrium moisture contents to which each species of timber will tend if left exposed to these conditions for sufficient length of time. However in actual practice usually only thin veneer attains equilibrium with the surrounding atmosphere. In pieces of timber half an inch or thicker only the very outer layers will come rapidly into equilibrium with the atmosphere. This will cause a moisture gradient to be set up from the surface to the centre of the piece of timber due to the fact that water vapour does not rapidly move in or out of timber. However, this does not mean that a knowledge of equilibrium moisture contents is of no use.

In an air-conditioned building, for example, where the conditions of temperature and humidity may vary only between narrow limits, it is most useful to know what are the corresponding equilibrium moisture contents for a number of timbers. If this should be as low as 6 to 8 per cent. moisture content, which is not unusual, then obviously the installation of timber at more than a few per cent. higher than this will assuredly lead to disappointment ; the timber will lose moisture until it reaches the equilibrium moisture content for that species, and in practice nothing can be done to eliminate the ensuing shrinkage. Insufficiently dried skirting boards and architraves inevitably dry and shrink leaving an unsightly gap between edges and the original paint lines. It behoves all wood workers to have a knowledge of equilibrium moisture contents and to ensure that timber is sufficiently dried for the purposes for which it is required.

At this point it is pertinent to point out the usefulness of a knowledge of equilibrium moisture contents to kiln operators as they are responsible for the provision of adequately dried timber. It has been found that equilibrium moisture contents within the range of temperatures experienced in kiln drying, are proportional to the wet bulb depression, *i.e.*, the difference between the readings of wet and dry bulb thermometers placed in the kiln atmosphere. Thus the wet bulb depression is an indication of the severity of the drying conditions and enables the operator to know to what moisture content the timber would come if exposed to these conditions for sufficient length of time.

In this article only a few examples of trouble due to moisture content changes have been quoted. There are many others which could be cited. For example, consider insufficiently dried table tops and in particular kitchen tables. Here one of the main troubles is splitting, which may be often attributed to change of moisture content. The conditions in a kitchen are generally fairly warm and therefore probably drier than the conditions in the joinery shop where the table was manufactured. Immediately the table is installed the table top will commence to lose moisture from its surface and more rapidly from the end-grain exposed on the ends of the table. Shrinkage will tend to occur at the ends of the table and stresses will be set up due to restraint caused by the centre of the table top and the frame supporting it. The stresses set up by this tendency to shrink are large and may result in end-splitting occurring. Adequate drying of the timber before commencing manufacture of the table would have done much to avoid such a defect.

An instance of the importance of equilibrium moisture contents, stress conditions of timber and movement due to changes in moisture content, was encountered recently by an officer of this Division when he was hastily summoned by the alarmed management of a Melbourne furniture factory. A table with a hardwood top had been returned in a badly warped condition. Some material similar to that which had been used to construct the table was selected for testing. The material was found to be not entirely free from stresses. These should have been eliminated at the end of kiln drying by a suitable high humidity treatment. If timber such as this is planed on one face only or on both faces but an unequal thickness of timber is removed, then the balance of the stresses in the timber is upset and the timber must inevitably warp as it readjusts itself. However the stress condition of the timber did not appear sufficiently severe to account for the excessive distortion which had occurred. The table top had apparently shrunk to such an extent that the buttons holding it to the framework had become ineffective, yet a moisture content test of a similar timber showed it to possess only 14 per cent., which was a reasonable equilibrium moisture content for a Melbourne factory in the winter months. Then a chance remark by the management provided the remaining clue to explain the large amount of shrinkage. The table had been sent to a customer at Mildura and had arrived there in perfect condition yet, within a few months had developed the defects enumerated. It so happens that the equilibrium moisture content conditions at Mildura during the hot months are as low as 7 per cent. moisture content. The table top automatically began to adjust itself to the new equilibrium conditions, so different from those in the Melbourne factory, began to shrink, released the buttons and allowed the unbalanced stress conditions existing in the timber to distort the table top. Thus an annoying problem had a simple solution, but it was also a problem which need never have arisen if sufficient attention had been paid beforehand to moisture content changes, stress conditions of the timber and differences in equilibrium moisture contents.

Another bone of contention which can be attributed to moisture content changes is the buckling and squeaking of floors. If a house is constructed with inadequate ventilation beneath the floor the atmosphere below the floor may become very humid. The lower faces of the flooring boards pick up moisture from the air and in consequence swell, causing the individual boards to cup and on occasions where conditions have been very bad the entire floor has been known to buckle. On the other hand a floor may be laid with all boards tightly cramped and smoothly surfaced. If the moisture content of the flooring at the time of being laid down is higher than the surrounding moisture equilibrium conditions, the boards dry and shrink converting an apparently satisfactory floor into a cracked and squeaking nightmare.

A problem of a slightly different nature, yet still one involving a change of moisture content is the shrinkage of panels in solid framed doors. If the original moisture content of the panel has been unsuitable then either buckling may occur due to pick up of moisture or if the panel was at too high a moisture content originally, which is more likely to be the case, shrinkage will occur exposing an unsightly strip of unstained or unpainted wood around the edge of the panel where it has shrunk away from the framework.

These are just a few of the avoidable troubles which confront timber users due to moisture content changes. If you have any problems of this nature, further information may be obtained from the Chief, Division of Forest Products, 69-77 Yarra Bank Road, South Melbourne, S.C.4.

BREVITIES.

Mr. R. S. T. Kingston, Officer-in-Charge, Timber Physics Section, while in Sydney during September and October visited most of the firms manufacturing batteries or battery separators, the Standards Association, the Division of Wood Technology and the National Standards Laboratory.

Mr. I. W. Scott, Timber Physics Section, also visited the National Standards Laboratory recently in connection with problems relating to calibration equipment.

Officers of the Division's Preservation Section have just completed inspections of the three Victorian pole test sites at Belgrave, Benalla and Ballarat. Visitors at the inspections, which were well attended by interested persons, included representatives of pole-using authorities, both in Victoria and other States, Government Departments and commercial firms interested in wood preservatives.

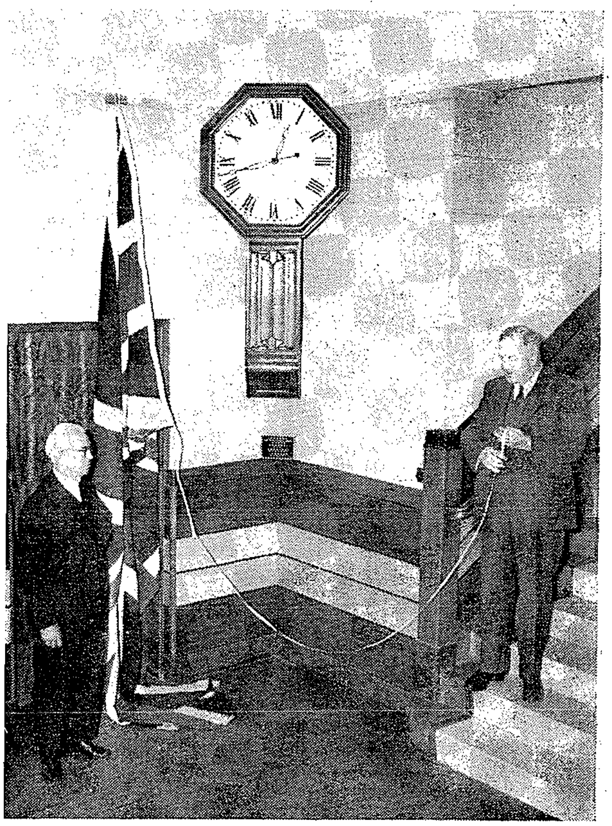
These tests, established between 1932 and 1936, present a variety of timbers, several types of treatment, and hazard from both decay and termite attack. The most efficient treatments are conferring excellent protection to all species in test, including messmate stringybark (*Euc. obliqua*), mountain ash (*E. regnans*) and silvertop ash (*E. sieberiana*).

The following interstate visitors attended the recent Forest Products Conference held at the Division : Messrs. H. R. Payne, Tasmania ; B. H. Bednall, South Australia ; D. Stewart, W.A. ; E. B. Huddleston, D. T. H. Hartigan, K. Taylor and G. Cannaway, N.S.W. ; C. Ellis and W. Young, Queensland ; and J. B. McAdam, New Guinea.

GIFT FROM PRINCES RISBOROUGH.

During the recent visit to England of Mr. S. A. Clarke, Chief of the Division of Forest Products, and Dr. H. E. Dadswell, Assistant to Chief, they were asked to accept on behalf of the staff of the Division a clock from the staff of the Forest Products Research Laboratory, Princes Risborough. For some time past the staff of Forest Products has been sending food parcels to their colleagues at the English laboratory, and the gift of the clock is a very sincere expression of their appreciation and friendship.

The clock was made by the staff of Princes Risborough from English oak taken from a bomb-damaged portion of the House of Commons. The linen fold panels on the front and side of the pendulum case are particularly fine examples of English wood craftsmanship. In style it is an "Act of Parliament" clock, with the typical large octagonal face unprotected by glass, and trunk long enough to take a seconds pendulum, of the year 1797, when because of a tax levied in England on all clocks and watches, tavern keepers and others, anticipating a scarcity of private clocks and watches, adopted a bold type of time piece for the convenience of their patrons. Although the Act relating to the tax was repealed the following year, many of these clocks are still to be found.



In the accompanying illustration Dr. A. E. V. Richardson, Chief Executive Officer, C.S.I.R., and Mr. Stanley A. Clarke, Chief, Division of Forest Products, are shown at the unveiling ceremony. The plaque underneath the clock reads as follows :

"This clock is sent by the staff of the
Forest Products Research Laboratory
Princes Risborough
to their friends in Australia as a
Token of Goodwill.

The case is of oak from the war-damaged House of Commons, and is copied from an "Act of Parliament" clock in the Hall of the Art Workers' Guild. London 1947."

PROPERTIES IN RELATION TO UTILIZATION

Many cases exist, where after centuries of wood ultilization in different countries it has become customary to use certain woods for particular purposes. This has not been a fortuitous happening, but one based on the behaviour of the wood when used for that purpose. In turn, behaviour, or the satisfactory manner in which the particular wood performs, is due greatly to its properties, some of the best known customary uses being willow for cricket bats, yew for archers' bows, teak for ship-building and briar for smokers' pipes, and in this country kauri for vats and churns. Many other examples could be included, but these should be sufficient to indicate that some timbers are particularly suited by their properties for certain uses. One may ask " What are these properties, and why are they so important " ?

Firstly, timber like metal, stone or any other material has numerous characteristic properties, the most outstanding of which is the ease with which it may be worked. In considering the properties of timber it must first be determined whether it is a softwood or hardwood, as there is a difference in structure between these types which has a definite influence on certain individual properties. Others are weight, shrinkage and seasoning properties, texture, colour, odour, durability, machining characteristics, bending qualities, porosity and mechanical properties.

The value of these properties is that when they have been determined they may be used in selecting woods for the purposes to which they are best suited. The advantage of this is immediately evident. Supposing that it is found that a timber is straight grained, fairly hard, has low shrinkage, machines well and possesses good strength properties ; would not its use as flooring be justified rather than for firewood ?

The inference should not be drawn that all that has to be done in choosing a timber for a certain use is to select on properties alone, as there also remains the actual selection of the material from the stack and the determination of its moisture content.

Many of these properties have been determined for Australian timbers by the appropriate sections of the Division of Forest Products, and this work is continuing as many yet remain to be investigated.

Now as to their application, this may be best illustrated by an example. Suppose it is necessary to select timbers for housing construction, the framework in particular. Here timbers must be strong enough to support the loads that will be imposed upon them, and in some cases stiffness is of prime importance.

Further, the timber selected must be one that grows free from major defects, dries without excessive warping, is immune to Lyctus attack in the truewood, and is not too hard for sawing and nailing. Examination of our available information reveals that numerous timbers possess these properties, some of the best known of which are the " ash " type and messmate timbers of Victoria, Tasmania and New South Wales, jarrah, karri, blackbutt, tallowwood, spotted gum, and the ironbarks.

Furniture timbers have more exacting requirements in some respects, depending where they are used in an article of furniture. Properties desirable in timbers for natural finish (solid construction) are decorative grain, attractive colour, strength, immunity to borer attack in truewood and sapwood, medium weight, hardness, good machining properties and gluing characteristics. In this case, appearance and machining properties are important, whereas strength is a lesser consideration.

The Division of Forest Products has dealt with many questions on utilization of timbers during its years of operation. Frequently requests are received for Australian alternatives for overseas species and unfortunately inadequate particulars are often given. It will be evident from remarks in preceding paragraphs that different properties of a timber are of importance in different uses and hence it is necessary, if proper advice is to be given, for inquirers to indicate not only the timber they wish to replace but to state the actual intended use. Some Australian timbers are superior in several of these characteristics to those of some overseas timbers and full use cannot be made of these advantages unless the adviser has the opportunity to determine where they will be most beneficial.

Thus it can be seen if this knowledge of properties of timbers is wisely used, much waste of material and time will be avoided. Further, it is of the greatest assistance in finding substitutes for timbers which have become associated with particular usages, and which are now in short supply.

THE PROPERTIES OF AUSTRALIAN TIMBERS

SUGAR GUM

Sugar gum is the standard trade common name for the timber known botanically as *Eucalyptus cladocalyx* F. v M. (syn. *Eucalyptus corynocalyx* F. v M).

The common name is derived from the rich flow of nectar in the flowers and the sweet leaves which are eaten by stock as fodder.

Distribution.

Sugar gum is widely scattered throughout South Australia, being found chiefly in the north on the Flinders Range, on Eyre Peninsula, and on Kangaroo Island. The species also occurs in the Wimmera district of Victoria. It is usually found on soils of a loamy nature in areas where the average rainfall is in the vicinity of 20 inches per year. The species has been extensively planted in South Australia, Northern and Western Victoria, and other areas of relatively low rainfall. The planting has been in plantations, shelter belts, parks and gardens.

Habit.

The tree grows vigorously in the first years of its life, and in the Flinders Range area attains a height of 100 feet and a diameter breast high of 3-5 feet, with a good bole, but generally it is much smaller. It forms a good canopy and has been noted to suppress ground vegetation. Sugar gum is regarded as a good nectar yielder, and is much sought after by apiarists. The honey is of excellent flavour and aroma, of a pale straw colour and good density. The flowers occur in January and February.

Timber.

The timber is yellowish brown in colour, is very dense and heavy and of a fine texture. The sapwood is highly susceptible to Lyctus attack, owing to the presence of starch.

The Division has not carried out extensive tests on the mechanical and physical properties of this species, however, the following properties are given although they were obtained from a comparatively small number of specimens. The air dry density before reconditioning averaged 68.3 lb. per cubic foot, and the radial toughness 144 inch lb.

The grain is commonly interlocked and consequently the wood is rather difficult to work. Reports as to the resistance to decay and termite attack vary considerably. It is generally considered to be fairly resistant to decay, but subject to termite damage in some areas. Its durability class would be 2 or 3.

The approximate shrinkage values would be in the vicinity of 3.5 per cent. in a radial direction (quartersawn) and 8.0 per cent. in a tangential direction (backsawn).

Very little information is available on the seasoning of this species.

Uses.

Sugar gum is used chiefly for heavy or rough construction work, and generally in the round or split form. The uses include fencing, poles, bridge poles, sleepers, mine timber and shed building. It is much favoured in some localities for firewood.

Availability.

The amount of timber available at present is rather limited, but during the war years quite a large quantity was sawn and sent to Broken Hill for mining purposes. The areas in South Australia from which this source was derived are now in process of being regenerated. Generally, however, the timber is not exported from the State of origin, being used almost invariably to supply local needs.

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