C.S.I.R.O.

Forest Products Newsletter

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Fundamental Research in Wood Cutting

By W. M. McKENZIE, Utilization Section

ONE OF THE most important features of wood is that it is relatively easily worked or cut. However, since a high proportion of the time and money involved in converting trees to forest products is absorbed by cutting operations of various kinds, their efficiency is vital to the economics of wood conversion. Also, cutting operations affect many subsequent operations such as gluing and finishing, and in this way poor machining may increase costs or impair final quality. Further, cutting operations are responsible for much of the waste generated in the production of wood items. Hence, improvement of the efficiency and precision of wood cutting operations should result in the manufacture of cheaper products of higher quality, with less waste of the nation's forest resources.

Wood cutting (of all kinds) is still largely an art, based on tradition and recipe. It is only a few years since it was subjected to scientific study, beginning with systematic study of machine operation variables. This led to the study of the problems basic to particular processes e.g. sawing, planing, veneering, and, more recently, to the study of problems basic to wood cutting in general. It is logical to expect that study of fundamental problems should produce results of widest possible application and hence be most efficient in the use of limited resources for research. Also, it may be expected to reveal new principles leading eventually to new, more efficient, processes.

The most basic situation of wood cutting, common to all types, is the action of the tooth or cutter edge on adjacent wood. The cutting actions of the various operations can be reduced to a very simple situation comprising a wedge-shaped cutter moving in a straight line and in a plane parallel to the surface of a wooden work-piece (see Fig. 1). This situation has its parallel in the cutting of any material, but is distinguished in this case by the peculiar properties of wood, particularly its cellular and anisotropic nature. It still embodies a large number of factors which influence cutting—wood species, moisture content and grain direction, cutter geometry, edge condition, and orientation.

It has been shown that this situation is not greatly affected by cutting velocity, so that cutting can be studied at slow speed, which is a great convenience. Then the two

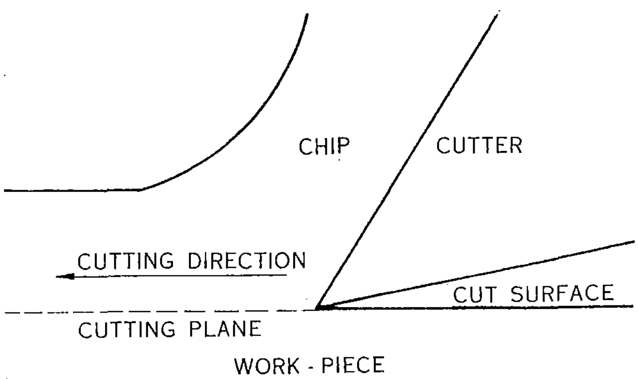
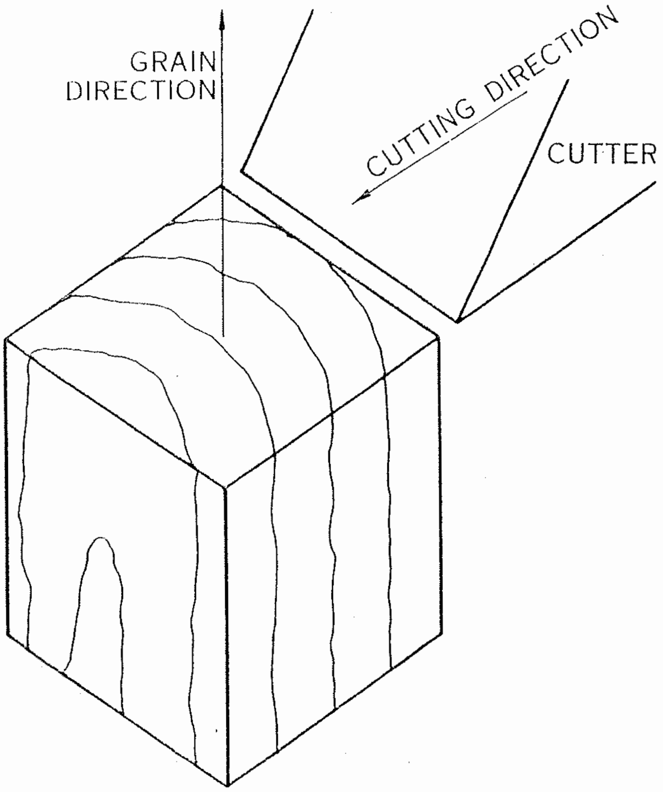


Fig. 1.—The basic cutting situation.



***Left* (*Fig.* 2)**—*"End-grain" cutting, typical of sawing.*

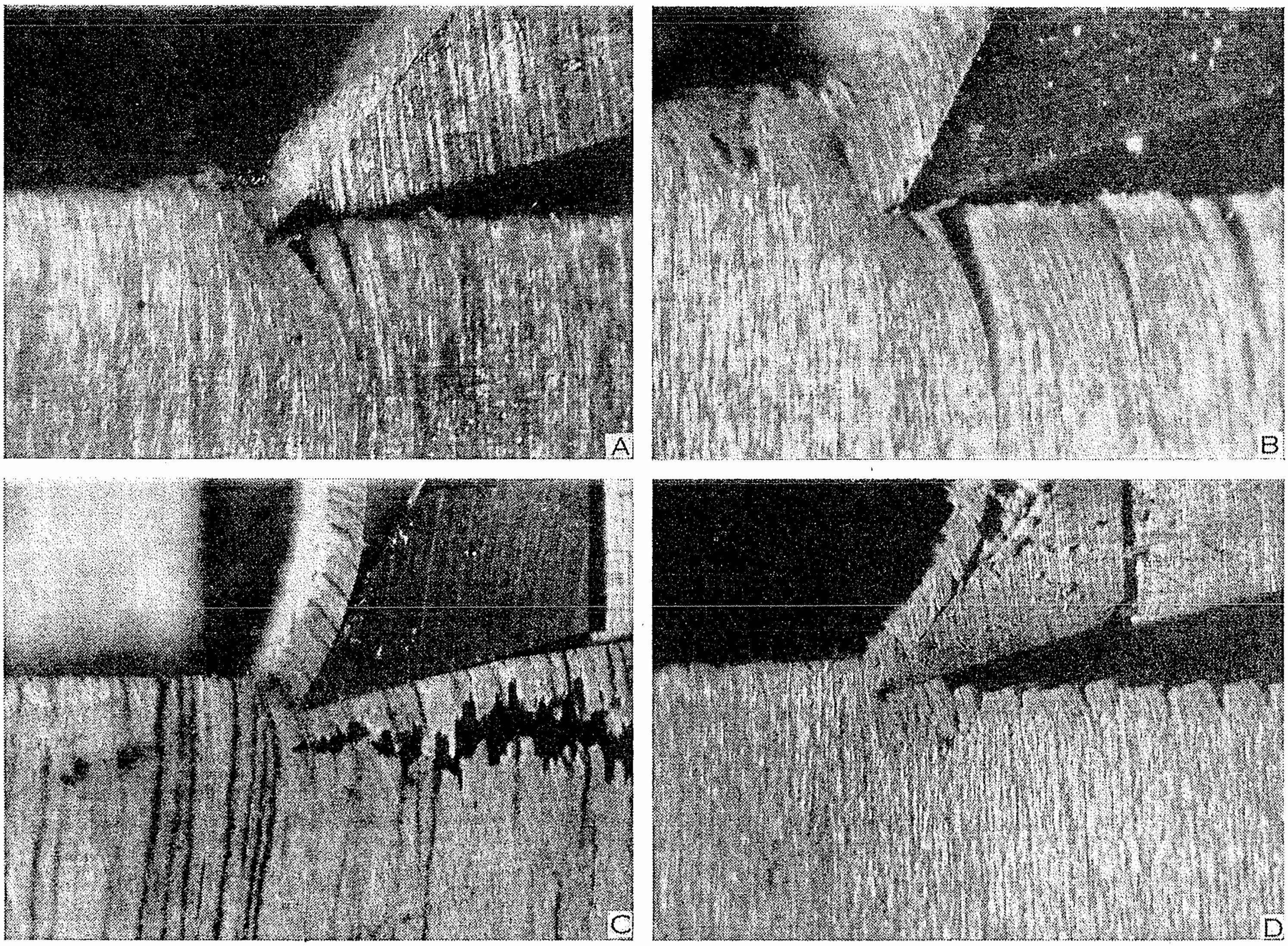
***Below* (*Fig.* 3)**—

A: *Type I(a) failure in saturated eastern white pine* (Pinus strobus); *chip thickness 0·010 in.*

B: *Type I(b) failure in eastern white pine at 5% moisture content; chip thickness 0·030 in.*

C: *Type II(b) failure in persimmon* (Diospyros virginiana) *at 5% moisture content; chip thickness 0·030 in.*

D: *Type II(a) failure in yellow poplar* (Liriodendron tulipifera) *at 5% moisture content; chip thickness 0·030 in.*



types of information obtained from such studies are, firstly, the way in which various cutting variables affect the formation of the chip and resulting surface, and secondly, the related forces between cutter and wood. It is evident that these two matters affect important problems in any machining process such as surface quality and accuracy, power requirements, machine design, wear of cutters or teeth, and operating variations required for different wood species.

The anisotropy of wood is such that the effects vary greatly with direction of cutting and to date it has been necessary to choose a particular cutting direction for intensive study. The author has studied the situation basic to sawing or any other end-grain cutting operation, where the cutting edge is in a plane perpendicular to the grain, and moves in a direction perpendicular to the edge (Fig. 2). The four main types of chip formation are illustrated in Figure 3. They show that even with sharp cutters, the resulting surface is damaged by splitting, or even tearing out of the wood below the cutting plane. These failure types are associated with characteristic oscillation in the cutting force, and in case of types II(*a*) and II(*b*), variation with successive cuts. These results emphasize that the cutter cannot be considered to be ideally sharp. It has a radius at the edge which is comparable to the thickness of a fibre wall, and indents the wood causing considerable deflections in cell walls before building up sufficient stress to incise the wood. On the assumption the incision requires failure in tension along the fibres at the cutter edge, it has been possible to arrive theoretically at an estimate of the cutting force which can be used to predict power requirements for sawing wood species of which certain properties are known.

In addition to edge bluntness, moisture content is an important factor in determining failure type and hence surface quality, which is better at high moisture contents. Figure 4 illustrates the different results of cutting hard maple at two moisture contents, one above, and one below a critical value. This effect appears to be due to changes in mechanical and frictional properties with change in moisture content.

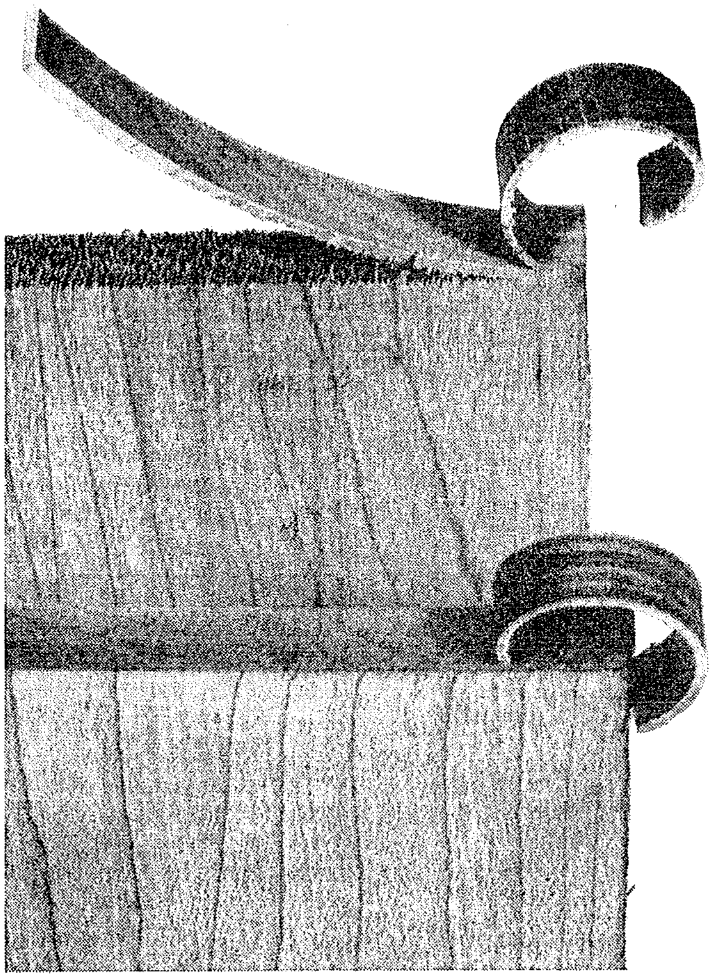


Fig. 4.—The effect of moisture content on failure type in sugar maple (Acer saccharum). *Top, 5% moisture content; bottom, 14% moisture content. Chip thickness 0·030 in.*

Study of the factors affecting the indentation process mentioned above has led to possible methods for improving surface quality, and these will be discussed in a later article.

Edge bluntness, moisture content, and frictional effects have thus been established as important factors in cutting, but, to fully account for their effects, further work of a fundamental nature is required.

The Fire Resistance of Timber

PART III. FIRE ENDURANCE OF BUILDING MATERIALS

BECAUSE ALL STRUCTURAL MATERIALS are affected by fire, the important consideration is their fire endurance, which may be defined as the period for which structural components will sustain their load when subjected to intense fire. For high fire endurance the materials used must, of course, be resistant to fire damage, but the construction details play a major part. Thus a timber structure with a few members of large cross section would endure longer than one with many members of small cross section.

A recent paper* discusses the times to failure for small structural elements of several materials in a fire in which a temperature of about 900°C is reached in 35 minutes, the temperature being above 600°C after 5 minutes.

The author assumed that failure occurred when the strength was reduced to 25% of its original value. For timber the rate of charring was assumed to be 1 in. per 40 minutes.

The calculated times to failure were:

Aluminium Alloy	:	about 3 minutes
Mild Steel	:	about 6½ minutes
4 by 2 in. Softwood	:	about 25 minutes

In addition, the rate at which the strength of the metal structures decreased with rising temperature far exceeded that for wood.

These figures make it apparent that even a light timber truss would be expected to have advantages over a steel truss as far as fire endurance is concerned.

The direct effect of heat on the strength of the material is not the only consideration. The high coefficient of expansion of steel causes steel girders and trusses to expand markedly in a fire. The resulting push outwards on their supports is often sufficient to collapse masonry walls and so bring down the entire structure. Such expansion does not occur with timber and this hazard therefore does not exist.

Many who prefer steel structures to timber overlook this tendency to early collapse with possible serious danger to human life. Where this hazard exists, firemen cannot risk entering the building to fight the fire. In a fire of like intensity, a timber structure composed of members of large cross section will not collapse in the early stages, if at all. Slow-burning, and therefore strength-retaining, timber structures allow firemen to fight the fire with safety, and thus reduce its ultimate spread and destructive effect. Water does not damage heated timber but is absorbed by the charcoal and so increases its resistance to burning. Very frequently the remaining strength of such timbers will enable the structure to continue in effective service with minor repairs. If required, the resistance of timber to fire can be considerably increased by coating or impregnation with suitable chemicals. A relatively cheap means of increasing the fire endurance of critical parts of a timber structure is to nail on 1 in. thick boards, preferably but not necessarily impregnated with fire-retardant chemicals.

Timber rigid frames of 150-ft span were chosen for a new hangar at Gatwick Airport, England, not only because they led to a cheaper building than alternative designs with no maintenance requirements, but because they provided better fire endurance.

Part IV will consider the use of timber treated with fire-retardant chemicals.

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* Richardson, H. (1960).—"Fire Endurance of Timber Structures." The Dock & Harbour Authority. Vol. 61, No. 475.

Five types of wooden fence in a Melbourne suburb. The type of paling fence referred to is in the centre.

Thoughts on Domestic Fencing

By F. A. DALE, Preservation Section

IT IS A PARADOX that in Australia the fences around a luxury home are often little different from those around a cottage, except that they may be in better repair.

Tradition and most lending authorities require that a suburban building block be fenced to a given standard before the final payment for the building of a house on the block is made, but the type of fence erected is usually the ordinary paling fence which has changed very little in 40 years, while the quality of timber used has declined considerably.

This lack of change should cause the timber industry to ask whether it will always monopolize the fencing market. Already steel and prestressed concrete are taking their share, and if timber cannot match their claims it must inevitably give way to them.

Timber has a number of advantages for domestic fencing such as low cost, ease of erection and repair, and not the least important, flexibility to accommodate soil movement. Its disadvantages are its relatively short life and its often poor appearance with increasing age.

The life of wood fencing can be increased in two ways:

- By using better methods with existing materials
- By using better materials.

The traditional domestic fence in Victoria employs 3 by 2 in. and 3 by $1\frac{1}{2}$ in. non-durable hardwood rails let into 5 by 3 in. red gum (*E. rostrata*) posts and carrying sawn hardwood palings resting on a 6 by 1 in. hardwood plinth. Failure usually occurs in the plinth (often in less than 10 years), followed by rotting of the rail ends in the posts, then by general decay of the rails and palings, particularly in gardens with plenty of vegetation and water. Post failure often occurs last of all. The usual course of events is that minor repairs are needed after 10 years and major repairs or even replacement in as short a time as 25 years. These intervals will vary according to locality, but nowhere does the life of the fence even approach that of the house.

The interval before the major repairs are needed and probably the overall life of the fence could be substantially increased by:

- Turning the 5 by 3 in. posts at right angles, i.e. with the 5-in. face in line with the fence and bolting the rails to this face without checking out the posts. This practice, common in South Australia, gives a stronger fence, is quicker to erect and gives the posts better bearing in the soil.

- Greasing the ends of the rails and the joints with 50/50 creosote/petrolatum or similar preservative.

These measures, by preventing the trapping and absorption of water, should greatly reduce decay at the joints.

Regular spraying or brushing with a preservative oil, such as 1 part of creosote and 3 parts of clean sump oil, can prolong the life of a fence substantially, but it must be done on both sides of the fence to be really worthwhile. This and the difficulty of preventing damage to plants usually means that it is not repeated after the first time, consequently this treatment is not often recommended.

The better way of extending the life of a fence is by the use of more-durable materials. These are available in most places at prices which enable their *annual* cost, i.e. their true cost per year of service, to compare favourably with that of orthodox materials. The following points should be considered:

- **Posts.** Ideally only the most durable timber should be used for posts. However, river red gum gives good service in Victoria and jarrah is standard in Western Australia, despite the fact that they are not of class 1 durability, and it is unlikely that they will be displaced from this field while they are available in quantity. Unfortunately the quality of timber sold for fencing varies widely and the sale of timber with sapwood, wane, and even adhering bark has done discredit to the industry.

Only full-sawn timber free of gross defects should be used for posts, and if highly durable timbers such as wandoo, grey box, or ironbark can be obtained, so much the better. The use of timbers of only moderate durability is short-sighted economy.

Where pressure-treated timber (e.g. radiata pine treated with either creosote or a waterborne preservative) is available, it is usually cheaper than the durable species and just as reliable. If the design of the fence is altered to use round posts, or round posts flattened on one or two faces, these should be cheaper than sawn posts. Fixing such posts in the ground can often be done more cheaply and more effectively by setting them in a bored hole and ramming with stabilized soil (1 bag of cement to 6 posts) than with orthodox struts and sole plates. A Melbourne fencer has been using this method successfully with sawn red gum posts for several years.

- **Plinth.** There are valid arguments for using a non-durable plinth, i.e. it is cheap and easily replaced, but if the fence is meant to last, then a durable or pressure-treated timber should be used, as the decay and termite hazards at ground level are often very high.

- **Rails.** There is a very good case for using a durable timber such as jarrah for rails to prevent premature failure. Treated pine of structural grade or pressure-treated alpine ash or mountain ash, which species treat at normal pressures, could also be used. Even with a durable timber, dressing of the joints with preservative is desirable. Treatment of timber with preservative oils also inhibits the rusting of fastenings.

- **Palings.** Unfortunately it is often the poorest material that is sawn for palings. However, this material, if it will dry flat, will usually make satisfactory palings with a moderate life. Pine or "ash" when pressure-treated with preservatives will make virtually everlasting palings.

- **Fastenings.** Ordinary iron nails cannot be expected to last indefinitely in wet wood, especially if the fence is in a seaside locality, and when they rust they contribute to the breakdown of the wood around them. The use of hot-dip galvanized nails, particularly in the above conditions, is very desirable and adds little to the cost. Flat-head nails are preferable to bullet-head for fixing palings. Bolts as used in South Australia should last longer than nails in rail fastening, particularly if greased beforehand, when they can be more easily replaced.

- **Ornamental Fences.** Most of the points mentioned above can also be applied to front or other ornamental fences. In these cases cost is not such a critical factor. The use of treated and highly durable timbers in such locations will ensure that the fence will retain its appearance for a long period.

Summing up, if timber users and suppliers use their imagination, available knowledge, and materials to the best advantage, timber will undoubtedly remain the major all-purpose fencing material in Australia.

Plastic Soles for Snow Skis

—WIDER RANGE OF TIMBERS MADE POSSIBLE

By D. S. JONES, Utilization Section

In recent years two significant changes have taken place in the ski industry. The first was the widespread adoption by manufacturers of the laminating technique, which tremendously improves the quality of skis by eliminating any undesirable features and by making the most of the desirable properties of wood for this purpose. The second was the introduction of plastic soles.

The first experiments on the use of plastic soles for snow skis were probably carried out in France, where in 1932 nitrocellulose films were glued to ash and hickory skis. In spite of several technical difficulties, the most serious of which was obtaining good adhesion of the plastic film, a practical low-friction plastic sole was eventually developed. However, only in recent years have plastic soles become widely accepted and this is probably due, not only to the development of the plastics industry, which now offers a variety of suitable plastic materials, but also to the wider introduction of ski tows and lifts. The fast plastic soles were very difficult to manage when up-hill trudging was a necessary part of down-hill running.

Laminated skis have for some time been within the reach of the amateur ski maker (see "Laminated Skis—How to make them", Newsletter No. 230), but plastic soles have only recently become available to skiers keen to sole their own skis. Several plastic preparations are now available which can be simply painted on the wooden sole until a reasonably thick layer is developed between the steel edges.

It may at first sight be difficult to understand why an article on plastics should appear in a Forest Products publication. However, the subject is appropriate, since the introduction of plastic preparations into the manufacture and maintenance of skis has a considerable influence on the choice of wood species for skis. Hitherto, the species chosen for solid skis required high mechanical strength and abrasion resistance, and as low a density as possible consistent with these requirements. For laminated skis, these properties were required of the outer laminations. Hickory was ideal, since it combines exceptionally high abrasion resistance and toughness with moderate density. A number of Australian timbers equal hickory in mechanical properties, and although they are rather heavy, the laminating technique allows this to be offset by combining them with lighter species in low-stressed regions.

An essential requirement of the material used for skis is that it be high-quality kiln-dried stock, but unfortunately the dense species are not always easily obtained in this form. This sets a problem which is aggravated by the fact that virtually all of these species react sensitively to changes of moisture content. Thus, cracking, warping, or glue-line failure in the finished ski is a real danger.

Furthermore, in all but abrasion resistance, the mechanical value of many high-strength species is offset because their stiffness requires thinner skis to be used to give reasonable flexibility.

However, when abrasion resistance is eliminated from the list of requirements by the use of plastic soles, a much larger selection of suitable timbers is available, and fortunately, several of these are commonly marketed in high-quality kiln-dried form ideally suited to ski making. Examples are mountain ash (*Eucalyptus regnans*) and alpine ash (*E. gigantea*) which are available in Tasmania, Victoria, and New South Wales in kiln-dried furniture- or flooring-quality boards. The suitability of other species, which may be more readily available in specific localities, can be checked by contacting the Division of Forest Products.

The density of these two ash eucalypts approximates very closely to that of hickory, and, while several of their strength values are inferior, they give skis of adequate quality for all but the most ambitious skiers, provided plastic soles are applied.

Material for the lightly stressed core of laminated skis can be selected from almost any lightweight species available in good quality such as kauri, radiata pine, meranti, Douglas fir, etc.

The technique of application of the plastic soles is simple. Instead of fitting the steel edges in rebates to make them flush with the surface, they are screwed directly to the sole of the ski and the depth between the edges is filled with successive brushed-on coatings of plastic. The plastic layers follow the shape of the centre groove. Each coat is sanded smooth before the application of the next, and the sole is finally built up a little full and is sanded back to the level of the steel edges.

This process can be applied to old skis without removing the steel edges, by removing the wood between the edges with a scraper and replacing it with plastic.

An even more recent development is the use of plastic strips cemented along the top edges of skis to prevent the scuffing that takes place when skis are accidentally crossed. These strips are of a much harder and tougher plastic than is necessary for the soles, and will probably become increasingly available in ski stores.

Thus, by using plastic soles and top edges on well-made solid or laminated skis, ski-making enthusiasts and professional manufacturers now have it in their power to produce skis at least equal to some of the higher priced imported skis. Furthermore, by introducing a little trial and error into the design and dimensioning of their skis, amateur enthusiasts have the advantage of being able to produce almost any charactersitics of flexibility or strength to suit their own particular demands.

Lyctus Susceptibility of Red Meranti

IN THE Division's publication, "Properties of Timbers Imported into Australia", issued last year, the red merantis (*Shorea* spp.), as a group, are listed as being commercially non-susceptible, i.e. either immune to attack or rarely attacked by *Lyctus*. This rating was based on a table published by the Malayan Forest Service of the susceptibility of Malayan timbers to powder-post borer attack. This table states that most species of meranti (both dark and light red) are non-susceptible to attack and, in a footnote, 11 species of *Shorea* in this group are specifically mentioned as being immune.

However, it has become evident that some red meranti being imported into Australia is in fact not immune to *Lyctus* attack. Because any parcel of this timber is likely to contain a mixture of species of *Shorea*, and because the separation of those that are susceptible from those that are not is generally impracticable, it is considered safer to regard all red meranti as being liable to *Lyctus* attack.

It is for this reason that Shorea *species are scheduled as requiring treatment against* Lyctus *under legislation in New South Wales and Queensland.*

DONATIONS

THE following donations were received by the Division during November:

Celcure (Aust.) Pty. Ltd. . .	£7 0 0
Alstergrens Pty. Ltd.	£7 0 0
Sydney & Suburban Timber Merchants Association	£100 0 0
Wilson Hart & Co. Ltd. (Maryborough, Qld.)	£150 0 0

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Selective Kiln Charging May Cut Your Drying Costs

By R. M. LIVERSIDGE and R. FINIGHAN, Seasoning Section

IN AN IDEAL air drying yard all the packs in any given stack will dry at the same rate—the actual moisture content, of course, depending on the elapsed drying time, species, thickness, season, etc. However, in most air drying yards the stacks do not dry uniformly but show a marked gradient, the bottom pack drying slowest. In fact, it is not uncommon in poor yards to find a moisture content gradient between the top and bottom packs of 25–30%, depending on the length of drying and the season. This condition is usually caused by uneven circulation, crowded stacks, poor foundations, bad drainage, etc. Many of these individual problems are being investigated and will be discussed in the present series of articles on air drying, as results become available.

Obviously, the best way of overcoming the moisture gradient problem is to improve the air drying conditions in the yard, but in some instances, for reasons of finance or space, no large-scale improvements in production practices are possible, and here it becomes imperative that the very best use be made of the air drying potential which is available. In such instances the breaking down of stacks and the grouping of packs into kiln charges of reasonably uniform moisture content is worthy of consideration. It is well known that the drying times of kiln charges are often extended unnecessarily, with a resultant increase in kiln drying costs, simply because one pack is at a much higher moisture content than the others.

At first sight it might appear that any reduction in kiln drying times brought about by the selection of packs may be offset by the possible extra handling involved. However in most cases it should be possible to reduce the extra handling to a minimum either by modification to the existing kiln loading bays and/or by the provision of a separate segregation and holding area.

As an example of the reduction in kiln drying times which should be possible by pack selection, consider the drying times of the four kiln charges shown in Figure 1. These are figures obtained from an actual drying plant and show the variation in moisture content between packs making up the kiln charges. Assuming that the timber follows the kiln drying curve shown in Figure 2, then the drying time for each kiln charge to reach 12% moisture content, as

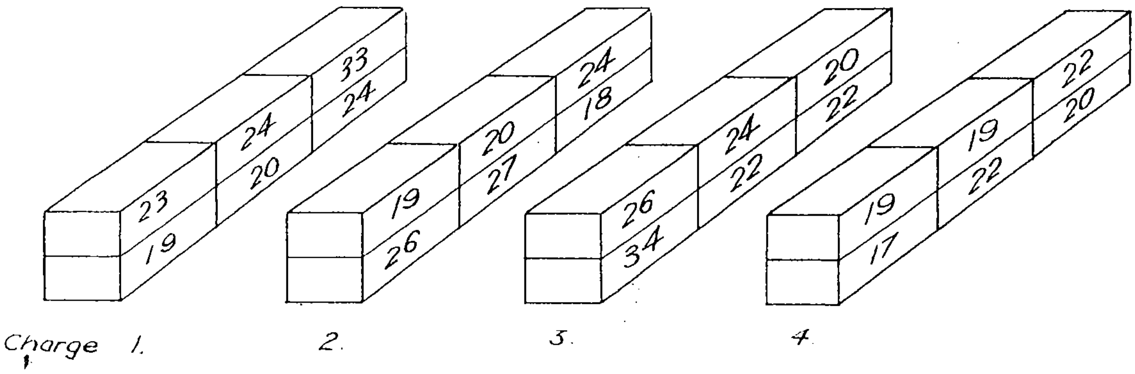
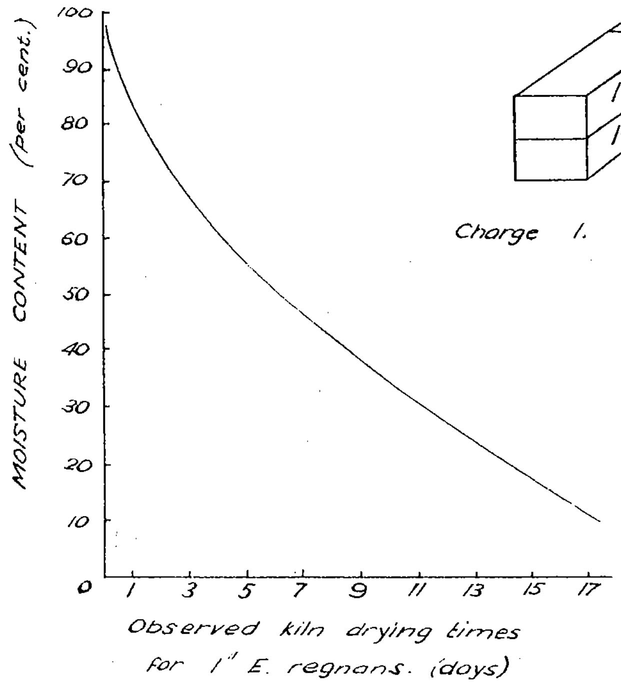
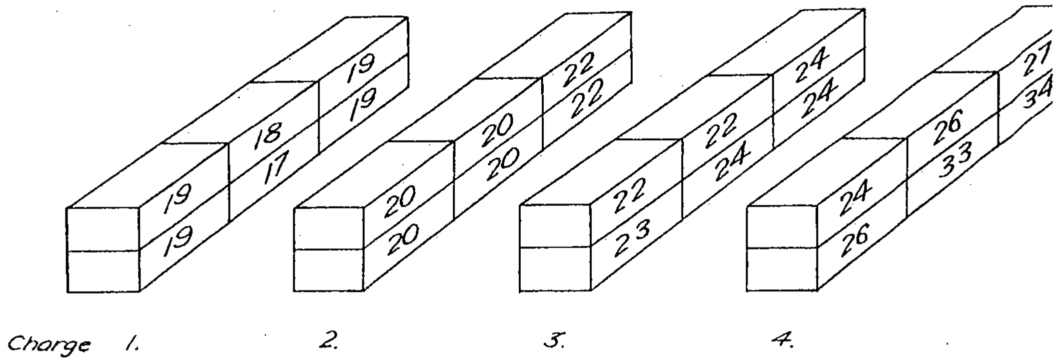
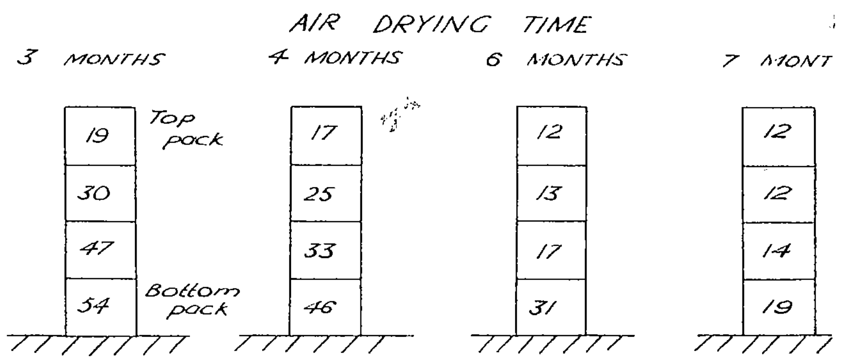


Fig. 1

Below: Figure 2
Top right: Figure 3
Bottom right: Figure 4







Air Drying Time	Kiln Drying Time	
	Unselected Charges	Selected Charges
3 Months	46 days (4 charges at 11½ days)	29 days (1 charge each at 2, 5½, 10, and 11½ days)
4 Months	40 days (4 charges at 10 days)	22 days (1 charge each at 1½, 4, 6½, and 10 days)
6 Months	24 days (4 charges at 6 days)	9½ days* (2 charges at 1 day, 1 at 1½ days, and 1 at 6 days)
7 Months	8 days (4 charges at 2 days)	5 days* (3 charges at 1 day and 1 at 2 days)

* A 1-day conditioning period in the kiln has been assumed in these cases for charges air dried to 14% or below.

dictated by the wettest pack in the charge, is as follows:

	%	*Days*
Charge 1	(33–12)	6½
Charge 2	(27–12)	4½
Charge 3	(34–12)	7
Charge 4	(22–12)	3
Total kiln drying time for the 4 charges		21 days

If, instead of being dried as above, the packs had been selected and regrouped as shown in Figure 3, the kiln drying time is reduced considerably:

	%	*Days*
Charge 1	(19–12)	2
Charge 2	(22–12)	3
Charge 3	(24–12)	4
Charge 4	(34–12)	7
Total kiln drying time for the 4 charges		16 days

Hence, in this case, pack selection would result in a 20% reduction in drying time or a reduction of 1 in 5 in the number of kilns required to give the same output.

Alternatively, using the same number of kilns, the selection of packs should enable the stacks to be kiln dried from higher moisture contents, thereby reducing air drying stocks.

As a further example of comparative kiln drying times of selected and unselected charges, consider a typical stack from a Melbourne air drying yard. For convenience the pack moisture contents are shown at four different stages of air drying (Fig. 4).

If at any of the above stages it was decided to kiln dry a group of say four such stacks, the drying times of selected and unselected charges would have been as shown in the table on page 2.

It can be readily seen that in this particular case for the same kiln capacity stacks could have been kiln dried much earlier by selecting the charges for minimum moisture content variation.

While the above discussion shows in theory the savings possible by selective kiln charging it should be pointed out that no data have been obtained on how the system works in practice. The authors would appreciate any information from persons using such a selective kiln-charging system.

The Fire Resistance of Timber

PART IV. FIRE RETARDANT TREATED TIMBER

Effect of Treatment

Although no chemical treatments are known which will render timber incombustible, there are treatments which will considerably improve its behaviour in a fire. Their main effect is generally to reduce the flammability of the timber, with a consequential reduction in the normal increase in temperature and a big decrease in the rate of flame spread. There is also a significant increase in the resistance to penetration of the fire through the timber. Timber treated with fire-retardant chemicals will char under continuous exposure to intense heat, but will not continue to burn once the igniting source is removed.

The progress of the char into the treated wood is delayed, and so a structural component made from such timber will support its load long before it collapses. Tests on wooden walls and stressed-skin panels have indicated an increase in time to failure of 20 to 33% by treatment with fire-retardant chemicals.

Solid timber and sheet materials such as plywood, chipboard, and insulating board may be readily treated to achieve class 1 rating ("surfaces of very low flame spread") in terms of British Standards Specification No. 476. Hardboard may be treated to achieve class 2 rating ("surfaces of low flame spread").

Effectiveness of Treatment

The chemicals may be forced into the cells of the wood by a pressure-impregnation treatment or may be applied as a surface coating. Suitable impregnation treatments are generally more dependable than paint coatings, but for controlling the spread of fires of short duration, a good fire-retarding paint can be as effective as an impregnation treatment. The ultimate fire performance of a wooden structure is more likely to be affected by details of design when a paint is used than when the timber is impregnated. Often paint cannot be applied to all surfaces of the structure, and, if sparks or heat can penetrate to unpainted surfaces, then the fire may get out of control. Also glowing, once established by the fire, is more apt to persist in the untreated wood beneath the painted surfaces than in well-impregnated wood. However, properly applied, continuous coatings offer worthwhile protection. If the burning fuel is limited in quantity, then they may permit the fire to burn out unattended, and have been known to be effective against incendiary bombs. In any case, they will retard the spread of fire in the structure and allow more time for the blaze to be detected and fought. Furthermore, surface coating is the only means of applying the chemicals to an existing structure.

The performance of impregnated timber under fire is related to the amount of dry fire-retarding chemical retained in the wood. With surface treatments, the performance depends on the thickness of the coating, and this should be greater than with ordinary paint.

An indication of the effectiveness of treated timber is shown by the following results of comparative fire tests on two "sentry-boxes", one built with timber impregnated with fire-retardant chemicals and the other with untreated timber. In each box, which was the standard size and shape of sentry-boxes with the open front, was placed 5 lb of wood wool (shavings), 3 lb of light kindling, and ¼ gallon of petrol. This fuel was ignited and pyrometer readings of the internal temperatures in the boxes were as follows:

Time	*Treated Structure*	*Untreated Structure*
3.00	65°F	65°F
3.01	415	1505
3.02	615	1635
3.02½	485	1655
3.05	255	1975
3.07	165	1975
3.10	90	1875

The untreated box was completely consumed in 15 min. The treated box was charred to a depth of ⅛ in. to half its height but did not support flaming. The temperature readings show that the treated timber made a negligible contribution to the fire.

Methods of Treatment

The procedures and facilities for impregnating timber with fire-retarding chemicals are similar to those required for impregnating timber preservatives. Consequently, there is now no difficulty in obtaining fire-retardant impregnated timber. As with preservative-impregnated timber, not all species treat equally well and advice may need to be sought on suitable species to be used.

Fire-retardant chemicals may be sprayed or brushed on to any species with no more skill than is needed for ordinary painting. Inadequate application can be corrected readily and the coatings may be renewed when this becomes necessary.

Sheet materials such as plywood, hardboard, etc. may be either impregnated or painted. Plywood is preferably impregnated in the sheet form, as impregnation of the veneers before gluing is likely to adversely affect the glued joints.

Fire-Retardant Process

Fire-retardant chemicals used for coatings usually act either by forming a glaze which prevents oxygen reaching the underlying material or by swelling the paint film to form an insulating layer.

Chemicals used for impregnating the timber act in one or more of the following ways:

- The fire retardant decomposes at a temperature rather below that at which decomposition of the material itself begins, and it then gives off non-inflammable gases, which mix with the inflammable gases produced a little later from the heated material. The non-inflammable gas mixture so formed provides a protective blanket against the attacking flame and inhibits its propagation at the surface of the material.
- The decomposition of the fire retardant is accompanied by absorption of heat. This cools, and may even extinguish, the igniting flame.
- The fire retardant, on heating, melts at a temperature below that at which the wood alone would take fire, and covers it with a glaze impervious to the air essential to smouldering and burning. The glaze also facilitates the adherence of charcoal on the surface of the wood, and the charcoal so formed acts as an insulator to the wood behind it.
- Rapid formation of a heavy layer of charcoal is induced (at the expense of the volatile gases) by such fire retardants as ammonium phosphate when the timber is exposed to high temperatures. The carbon also excludes the air from the surface of the timber and prevents combustion.
- A denser and modified charcoal is formed, which does not smoulder to any dangerous extent.

In the concluding part of this series, the chemicals used as fire retardants will be listed and discussed.

DONATIONS

THE following donation was received by the Division during January:

M. & D. Richardson Ltd.,
Adelaide £3 3 0

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C.S.I.R.O.

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, C.S.I.R.O., P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

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NUMBER 284 APRIL 1962

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Flush Doors

By J. J. MACK, Timber Mechanics Section

A NUMBER OF years ago, an article on flush doors was published in this Newsletter (No. 178, October 1949).

Numerous enquiries on doors continue to reach the Division, however, and it is felt that another review of important factors in their manufacture would be of interest to door manufacturers and users.

A good quality flush door should have the following characteristics:

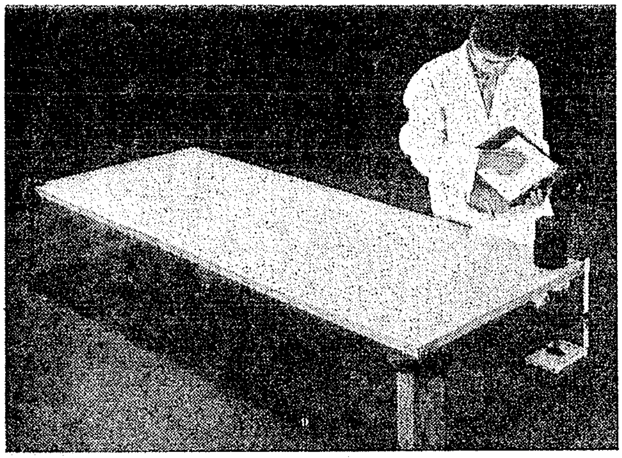
- Accuracy and stability in dimensions.
- Freedom from warping when subjected to changes in atmospheric conditions.
- Sufficient stiffness in a vertical plane to prevent sagging under its own weight or the weight of any object likely to be carried by it.
- Sufficient stiffness in a horizontal plane to prevent undue distortion if one corner sticks and the handle is pulled violently.
- Sufficient strength in both vertical and horizontal directions to prevent damage to the door when loaded as above.
- Adequate provision for housing the lock and securing the hinges.
- Sufficient strength in sheathing material to resist normal knocks and blows.

There are many differences of opinion as to the most suitable method of constructing the internal framework of the door. However, it must be realized that in this type of door the sheathing material carries most of the load, the strength and stiffness of the frame being relatively unimportant.

Tests have shown that corrugated fasteners are sufficient to join end rails to stiles. No fastening is necessary between intermediate rails and stiles.

Although standard specifications for the general construction of flush doors have been prepared by some housing authorities, no general standard exists in Australia. However, from past experience of doors which have proved satisfactory in service, it seems that a minimum value of lateral stiffness can be set. The simple test of lateral stiffness is illustrated on p. 2, and can be performed by anyone possessing a few weights and a rule. The door is supported horizontally at three corners and loaded at the fourth corner. The increase in the vertical deflection of this corner under the applied load is measured, and it appears that for satisfactory performance, this should not be greater than about $\frac{1}{10}$ in. for a load of 20 lb. This stiffness is largely affected by the species and thickness of the sheathing plywood and the thickness of the core, but not to any great extent by the details of the door framing.

In attempting to reduce the cost and weight of the door, manufacturers commonly make the mistake of using too thin a plywood or core or both, thus severely reducing lateral stiffness. Another disadvantage of thin plywood is that the resistance to puncture is low, but this may be overcome to some extent by the choice of a suitable core construction, such as closely spaced intermediate rails, or the type of infill.



Test of lateral stiffness.

The manufacture of good quality hollow core flush doors requires consideration of the following:

(i) *Balanced Construction.*—Differential movement of the two faces with different atmospheric conditions on the two sides of a door may give rise to warping, and such movement is kept to a minimum by ensuring that the sheathing on both faces is of similar material and construction, i.e. balanced.

(ii) *Sinkage of Plywood.*—In the early stages of development of the hollow core door, trouble was experienced owing to sinkage of the plywood facing between the rails. This spoilt the appearance of the door, the effect being accentuated if the door was highly polished. The problem of overcoming this defect is primarily one of technique in gluing, although it may be minimized by modifications to the internal framework and the number and positioning of internal rails. If the glue is applied in such a manner that there is no "squeeze out" of surplus glue over the sides of the internal rails, and if gluing pressures are kept near the minimum satisfactory pressures required, then sinkage can be greatly reduced or entirely eliminated. Under a given set of conditions, if plywood sheathing $\frac{3}{16}$ in. or thicker is used, sinkage will be less than with thinner plywood.

(iii) *Moisture Content.*—All frame members, including internal rails, should be properly seasoned before dressing and thicknessing. Unsatisfactory seasoning results in variations in moisture content of individual components in the construction and will almost certainly produce faults affecting the appearance of the finished door. There will inevitably be some change in the moisture content of the frame or core, due to moisture absorption from the glue line and from any glue "squeeze-out" which occurs. Consequently it is advisable to have a holding period between pressing and final sanding to allow this moisture to distribute itself or dry out.

(iv) *Spacing and Positioning of Internal Rails.*—This is important since it affects the resistance of the door to puncturing and the sinkage tendency. Tests were carried out at the Division of Forest Products, in which the spacing of the internal rails was varied. These rails were $1\frac{1}{4}$ in. by $\frac{1}{4}$ in. and in one case were at 6 in. centres, whereas in the second case, using very thin plywood facing, they were at $1\frac{3}{4}$ in. centres. These tests demonstrated that the closer spacing of the intermediate rails gave improved resistance to puncture but had no significant effect on strength or stiffness. Closer rail spacing also reduces sinkage of the sheathing material. If the intermediate rails are placed at an angle to the stiles rather than horizontally, sinkage is less obvious. It is not necessary that intermediate rails be connected to the stiles, providing that the gap between the end of the intermediate rail and the stile is small—approximately $\frac{1}{16}$ in.

(v) *Lock Housing and Hinge Securement.*—It frequently happens that the stiles are narrower than the depth of conventional locks, and in this case a lock block should be added. Similarly with narrow stiles it is desirable to provide additional blocks to facilitate the fixing of hinges.

(vi) *Ventilation.*—Hollow core flush doors are usually ventilated on the inside. This may be achieved by one of several methods, such as by saw cuts or holes in all rails, or by grooving the stiles along their inner edges.

In conclusion, although individual manufacturers may vary the internal construction considerably, the same principles of design apply to all types of flush doors. By observing these, the industry can ensure the production of doors that will satisfy all consumer requirements.

The Fire Resistance of Timber

PART V (Conclusion). CHEMICALS USED

SOME 30 chemicals and combinations of chemicals have been demonstrated to have some value in rendering timber fire retardant. Their efficiency varies considerably, as does the cost. Ammonium salts and boric acid are amongst the most important. It should be borne in mind, however, that some fire retardant agents are highly corrosive, and may also be very hygroscopic, and affect paints and varnishes, so that a judicious selection of retardant is necessary.

Another point worth noting is that most fire retardants are water-soluble, and unless thoroughly impregnated into the timber and given some protection against subsequent wetting, they are likely to be leached out by weather or washed out of floors. Most retardants also tend to have a dulling effect on the cutting edges of wood-working tools, so that it is desirable to treat the timber in the finished sizes whenever possible.

The American Wood Preservers' Association, after extensive research, concluded that monoammonium phosphate and diammonium phosphate at reasonable concentrations are extremely effective in stopping both flame propagation and smouldering. Ammonium chloride is good in mixtures with other fire retardants, but poor when used alone. Only monoammonium phosphate can be regarded as substantially without corrosive effect, and it has the least tendency of all to become damp in comparatively humid atmospheres. More detailed notes on the most effective salts follow.

(i) Chemicals for Impregnation

Monoammonium and diammonium phosphates, even at low concentrations (1 lb of dry retardant per cu. ft. of dry timber) are good retardants for stopping flame and in both low and high concentration (5 lb per cu. ft.) they prevent smouldering. Tri-ammonium phosphate is inferior to the other two, and monoammonium phosphate is chemically the most stable. These salts can be leached out, but the monoammonium phosphate tends to be held best. Generally they will not pick up sufficient moisture from the atmosphere to become damp.

Ammonium sulphate has little effect on smouldering or on controlling flame propagation if in low concentration, but has marked effect in very high concentrations (6 lb per cu. ft.). It is more corrosive to metals than the phosphates, but less so than ammonium chloride or magnesium chloride. It may be leached out of the timber, and as it is rather more hygroscopic than the phosphates it tends to cause moisture collections on the timber surface.

Boric acid in low concentrations has small effect on flame spread, but it has a good retarding effect at high concentrations. It inhibits smouldering even at low concentrations. It has very little corrosive effect on metals, and because of its low solubility boric acid is practically non-hygroscopic. It is toxic to wood-destroying fungi, and is often used combined with monoammonium phosphate as a fire retardant.

Ammonium chloride at low concentrations has a noticeable effect of suppressing flame propagation, but it does not prevent smouldering. At high concentrations flame suppression is good and prevention of smouldering is quite effective. However, it is highly corrosive to most metals, particularly iron and steel, and it tends to become damp with high relative humidities.

Proprietary compounds: a number of proprietary fire retardants have been proved effective. Many combine fungicides and insecticides with fire retardants, and also are specially designed to reduce corrosion of metals to a minimum.

(ii) Surface Coatings

Fire retardant paints and similar compounds may be quite effective, and usually they are less expensive than impregnation. In choosing a paint or coating, consideration should be given to properties other than fire retardance, including adherence, chemical stability, resistance to high relative humidities, and appearance. The principal types of coatings are:

Sodium silicate ("water glass") is a good fire retardant when freshly applied but loses its effectiveness if relative humidities are high.

Ammonium phosphate in strong solutions (30–35%) gives good protection. Two or three coats of hot solution should be applied. However, it is not suitable for outdoor work.

Synthetic resin phosphate is one of the most successful coatings. It is based on a combination of urea formaldehyde resin and ammonium phosphate.

Calcium sulphate is very resistant to fire, but is not suitable for outdoor use.

Whitewash on its own is of very little value, but when mixed with cement gives moderate protection.

Insulating materials such as mineral wool and asbestos in layers of ½–1 in. are effective against fire, but are not resistant to wear or weather.

Borax–linseed oil coatings are moderately effective, but are not suitable for outdoor use.

Casein paints are moderately fire resistant, and their effectiveness is increased by the addition of borax.

Proprietary finishes: a number of these of a high standard of effectiveness are available.

CONCLUSION

Protection against fire depends on many aspects of building design. Good warning systems, means to prevent a fire from spreading from its source, provision for venting hot gases, ample exits, and automatic sprinklers are some of the requirements for minimizing fire damage. Whether the material used for the structure is combustible or incombustible is not usually a critical consideration. What is important is that the structure should be capable of maintaining its load for sufficient time for the fire to be extinguished without risk to the firemen. Timber structures can fulfil this requirement, and are much better in this regard than unprotected metal structures. Furthermore, chemical treatments considerably reducing inflammability of timber are now available.

Novel Timber Laboratory Building

RECENTLY the opportunity arose to overcome a handicap to the Division's research effort by relieving the cramped conditions in laboratories. An adjacent site has been acquired, and developmental plans are being made, but the very poor foundation conditions present a considerable difficulty.

A conventional structural design involving piling of the foundation and using brick walls and concrete floors in multi-storey construction would be comparatively costly, and an alternative design, which is structurally dependent on timber, has now been proposed by the Division. Because of the relatively light weight, it is possible to build to the same height without piling, as was proposed with the alternative construction. Further, there is no great difficulty in providing large unobstructed floor areas to enable flexible laboratory space development. Perhaps most important of all, in view of limited funds, is that estimates made on preliminary designs indicate approximately twice the floor area can be provided, in the timber construction, for the same cost as the alternative conventional building.

It is believed that the timber building could be so designed as to provide an adequate fire rating, comparable to that which would normally be available with the heavier construction.

Because of the novelty of the design and the limitations on large timber buildings imposed by existing building regulations, a number of difficulties must be overcome before the proposals are finally accepted, and detailed designs prepared. However, it is confidently hoped that these problems will be solved. The type of timber building being considered would draw attention not only to structural advantages and potentials of timber which are generally overlooked, but also to many other advantageous uses of timber in its various forms. It is hoped to feature these, not just in the form of displays, but by utilization of the material to the best advantage in essential elements of construction and decoration.

If the building design does proceed in this manner, it is felt that it will be in keeping with the Division's association with the industry. Also it is hoped that the industry may feel some pride in the venture, and that it may see its way clear to assist with the supply of materials. Further information on this project will be made available as progress is made.

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Storage of Logs under Water Sprays

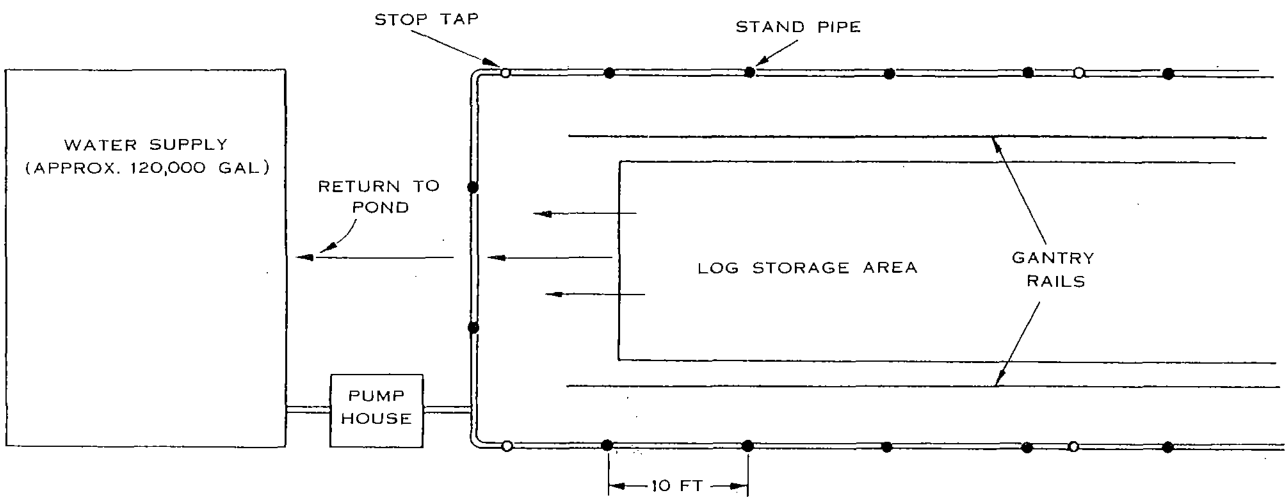
By R. FINIGHAN and R. M. LIVERSIDGE, Seasoning Section

ALTHOUGH end coating of logs with various materials to reduce degrade has long been practised with reasonable success, it must be realized this only affords protection for a limited period, generally up to about six months. In most cases this is sufficient to enable the miller to work through his stock pile before serious end splitting begins. However, a more serious problem often exists owing to the checking which occurs on the surface of the logs, causing considerable losses where quality cutting is practised. Since it is obvious that this checking is largely caused by the drying of the logs, it follows that any method which helps to keep the logs in the green condition should reduce degrade.

This problem is often solved in the U.S.A. and many other overseas countries by storing the logs in ponds, thereby eliminating the possibility of drying. However, in Australia this method has not been practised to any extent for various reasons, including the lack of adequate water supply and the fact that a large proportion of our timbers are "sinkers" (i.e. their green density is greater than that of water).

Although the log pond is probably the ideal solution, a practicable approximation to this is the use of continuous water sprays. As mentioned in Newsletter No. 281, the usefulness of water sprays is at present being examined, as are also a complete plastic cover and an overall spray coat of end

Diagram of spray system.



Spray system showing jet arrangement.

coating material, as part of our current studies on log degrade prevention.

While this study is only partly completed it is already quite apparent that the water sprays are proving very effective.

The spray installation used in these studies is located at Licola Sawmilling Co. Pty. Ltd., Heyfield, Vic., and as the system has a number of interesting features, a description of the installation might be of interest to other millers who are considering wet stack storage.

The details below were kindly supplied by Mr. Edgar Brown, Manager of Licola Sawmilling Co. and are published with permission of C. H. Tutton Pty. Ltd.

The spray system (shown in the diagram) works in conjunction with a 10-ton gantry crane which stacks the logs to a height of about 20 ft. Log storage capacity covered by the spray system is approximately $1\frac{1}{2}$ million super feet (Hoppus). Stand pipes 5 ft 6 in. high are set up at intervals of 10 ft on either side of the pile, each pipe having two nozzles, one being a mist or geyser type, and the other a jet. It is found that this arrangement gives a complete spray cover over the ends and tops of the logs even on fairly windy days. The water is supplied by a pump which delivers a maximum of 430 gal per minute, and is driven by a 30 h.p. motor. The water supply is a recirculating system using a pond of 120,000 gal capacity constructed for this purpose. During normal years it is expected that this will be adequate but during this present dry season (the summer of 1961–62) a small supplement has been required from the town water supply.

The plant was installed by Mr. Brown at an estimated cost of £800 for materials and equipment. Prior to the use of the sprays at the mill, log degrade losses from end and surface checking, averaged over a number of years, were conservatively estimated at 10%. At 34*s.* per 100 super ft (Hoppus) this represents a loss of over £2600 per annum. During last season (the summer of 1960–61) the spray system was not operated continuously during the daytime, and some surface checking occurred. Even so, Mr. Brown estimated that the degrade loss due to end splitting was very small, and the overall loss was certainly reduced to less than 5%, thereby reducing the expected losses by £1300, or almost twice the capital cost of the spraying system.

Assuming that the unit operates for 6 months per year (10 hours per day for 7 days a week during the dry period) the annual operating charges, depreciation, and maintenance are estimated at £600. This charge could, of course, be greatly reduced by using an intermittent spraying system, as it is obviously only necessary to keep the surface of the logs sufficiently wet to prevent cracking. Some overseas workers have estimated this to commence at a moisture content of about 70%, and this question may be examined in a future study.

Various systems of controlled spraying using moisture content indicators connected to automatic pumps and sprays have been described, and some investigators have claimed that a spraying time of 10 min per hour is adequate.

The Heyfield spraying installation is ideally suited for use with a gantry crane, but if it was

View of pile showing complete log wetting.

used with a fork lift truck the area would require considerable consolidation and surfacing at the log storage site.

The gantry used in the above system was built at the mill for approximately £6000, and from the savings indicated above it can be seen that this capital cost should recovered in a short time.

In addition to the savings brought about by reduced log degrade, Mr. Brown considers that logs stored in a wet stack saw much easier than unprotected logs and yield a better-quality sawn product. This aspect will be examined when test logs in the stack are milled at the conclusion of the current studies.

Gum Veins and Marketing Problems

VICTORIAN ACTION

IN THE PAST the problem of gum veins in eucalypt timber required for an exposed unpainted finish has been met adequately by specification limitation of their size and frequency of occurrence. For unexposed timbers such as scantling, and where the timber was to be painted, there has in general been acceptance of gum veins unless they were excessive.

Recently, however, Victoria has been faced on the one hand with the use of species in which gum veins are more common, reducing the proportion of timber suitable for exposed unpainted surfaces, and on the other hand with opposition to acceptance of gum veins in painting grade mouldings and joinery stock.

Representatives of the Kiln-Drying Division of the Victorian Sawmillers' Association have discussed the situation with officers of the Division of Forest Products and the following course of action has been decided upon:

(1) Because sawing on the back instead of on the quarter as is the common practice in Victoria would result in boards showing fewer gum veins on both surfaces, it has been decided to investigate the possibility of reducing degrade during the drying of backsawn stock. The Division of Forest Products is to cooperate with one of the member companies which is already carrying out salt seasoning investigations towards this end.

(2) The Association is to take steps in an endeavour to obtain acceptance by the State Public Works Department of the use of eucalypt timbers including gum veins where

these do not detract from the value of the timber for the purpose for which it is to be used.

(3) The Association is to endeavour to obtain acceptance by the State Public Works Department and other large users of pre-primed material for uses which involve ultimate painting.

(4) The Association is to look into the question of conducting an educational campaign to prove to users that in some circumstances the presence of gum veins is of no significance.

(5) The Association is to investigate the question of conducting a survey of present usage of timber containing gum veins and of possible advantageous modifications in the allocation of such timber.

(6) With regard to gum pockets as distinct from veins, the study of patching equipment available is to be made and the economics of patching investigated.

While the bulk of the work involved in the above decisions will fall on the Association, the Division of Forest Products will continue to make available technical advice, and information relating to equipment.

Information on Diving Boards

SEVERAL YEARS AGO, an article on the manufacture of wooden diving boards was prepared by officers of the Division for the Australian Timber Journal. Since then, there has been a small but steady demand for reprints of it. Supplies are now nearing exhaustion, so the article has been reprinted in the Division's Technical Note series.

Although little change has been made to the original text, the opportunity has been taken to enlarge on certain aspects, particularly those relating to the repair of diving boards.

Forests Products Technical Note No. 2, "Manufacture, Maintenance and Repair of Diving Boards" has now been issued, and is available to those concerned in their manufacture or use on application to the Chief, Division of Forest Products, P.O. Box 310, South Melbourne, S.C.5.

Visits by Divisional Officers to Western Australia

DURING late February and early March, Mr. R. G. Pearson of the Timber Mechanics Section delivered a series of twelve post-graduate lectures on timber engineering to some 80 engineers, architects, and members of the timber trade in Perth.

This course had previously been presented in Melbourne, Sydney, and Brisbane. In Perth it was sponsored by the Timber Development Association of Western Australia in conjunction with the Adult Education Board of the University of Western Australia.

Through the courtesy of Professor K. L. Cooper, a lecture theatre in the University's new Engineering School building was made available. The lectures were received with considerable interest and enthusiasm by those attending.

Another officer of the same Section, Mr. N. H. Kloot, who was in Perth at the same time, took the opportunity of delivering four lectures to timber trade personnel. These lectures were organized by the Associated Sawmillers and Timber Merchants of Western Australia and were designed to be complementary to those given by Mr. Pearson. The purpose of these lectures was to acquaint the timber trade with background information concerning the structural use of timber, some of the problems involved and some modern developments in timber engineering. These lectures were also well received by an audience of more than 80.

Mr. M. W. Page of the Utilization Section also spent some time in Western Australia during March and April.

The purpose of his visit was to make a general survey of sawmilling practice in the State and to indicate, where possible, the application of modern developments.

This survey was requested by the Associated Sawmillers and Timber Merchants of the State and covered a cross-section of the industry.

DONATIONS

THE following donations have been received by the Division during April and May:

Tasmanian Timber Association	£300
Celcure Ltd., London	£100

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The Behaviour of Pressure-Creosoted Poles in Bushfires

By W. G. KEATING, Wood Technologist, P.M.G.'s Department

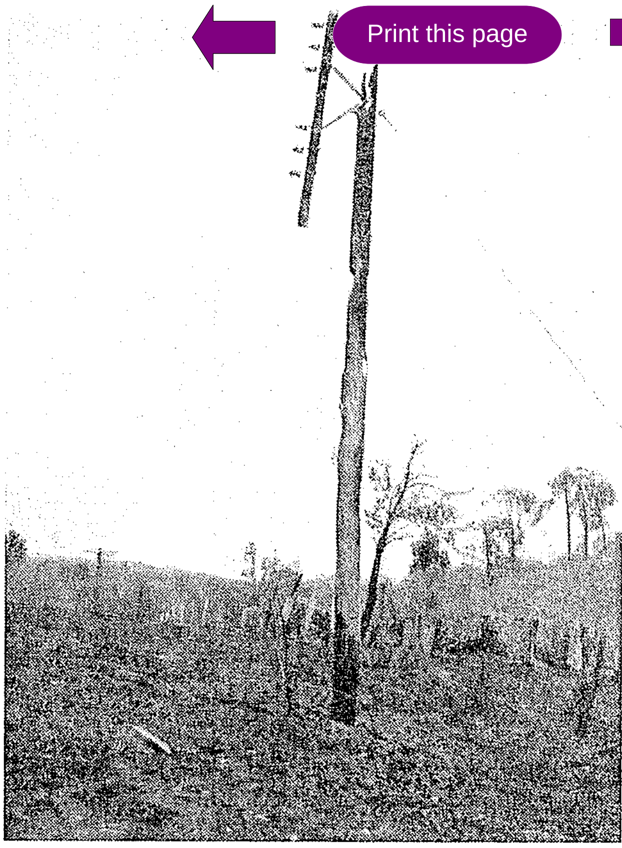
THE VICTORIAN bushfires of January 1962 provided the opportunity to study the performance of hardwood telephone poles, pressure-treated with creosote, under these rather severe conditions.

The hills area around Melbourne, where the fires occurred, is thickly timbered and for scenic reasons strenuous efforts have been made in the past by local authorities to retain as much of the natural vegetation as possible. As a result, clearing along pole routes was kept to a minimum, a fact that seriously increased the fire hazard. Although a rural area, its pleasing situation has attracted a comparatively large population so that there is an intensive network of telephone services. The majority of the aerial routes concerned have been in existence for some time and in recent years pole replacements, which have been numerous, were with pressure-treated poles. This then enabled a direct comparison to be made of the behaviour of treated and untreated poles in the fires.

Over 200 poles were destroyed but not one pressure-treated pole was lost or even severely damaged, although it is estimated that an equivalent number were subjected to similar conditions. This phenomenon has been reported on several occasions from overseas countries, in particular the United States, Germany, and South Africa, but nevertheless there has been a natural reluctance in Australia to use creosoted poles in potential bush fire areas. The explanation put forward is that on exposure to fire the creosote in the outer layers of the pole volatilizes and ignites at a temperature lower than that necessary to cause damage to the timber, and that the thick smoke created shuts off the oxygen supply and the flames are soon extinguished. The deposit of free carbon formed on the pole serves as an insulator against further damage. In these fires it was noticed that a thin outer layer of charred wood was formed on the pole, a fact which supports the above theory. Also the firm outer surfaces of the treated poles (compared with those of the untreated poles, many of which would have had loose and partly decayed sapwood) assisted materially in preventing their loss. It was noted that many of the poles had been treated less than 12 months earlier.

These fires provided the first major test of the fire resistance of pressure-creosoted eucalypt poles in Australia since treatment

Pressure-treated pole still intact.



Typical damage to an untreated pole.

was started in 1957. The financial loss and interruption to communication which was prevented by their use should not be forgotten in assessing the overall benefit, including substantially longer life, that can be expected from their use.

Testing Treated Timber with Electrical Moisture Meters

By N. C. EDWARDS, Timber Physics Section

TO OBTAIN accurate determinations of the moisture content of wood using an electrical moisture meter, the precautions listed on page 14 of Trade Circular 50, "Testing Timber for Moisture Content", must be observed. One of these precautions precludes the use of electrical moisture meters for the testing of timber suspected of being chemically treated. In such cases the use of the oven-drying method is recommended instead. This limitation on the use of electrical moisture meters sometimes places that section of the timber industry engaged in timber preservation at a considerable disadvantage. With the increasing use of water-borne preservatives and the frequent need for redrying the treated timber, the measurement of moisture content becomes necessary and in the absence of a reliable rapid means of measurement, serious delays can occur while sections are being oven-dried.

The above precaution may now be modified as a result of recent tests carried out at this Division. These tests were made to determine the magnitude of the errors produced in readings obtained on electrical resistance-type moisture meters when testing timber treated with one of three commonly used

Table 1: Retention Ranges

Preservative	Range of Retention
Boliden "S25" (Zinc–copper–chrome arsenate)	$0{\cdot}20$–$0{\cdot}70$ lb/ft^3 of paste
Celcure "A" (Copper–chrome arsenate)	$0{\cdot}20$–$0{\cdot}66$ lb/ft^3 of dry salt
Tanalith "C" (Copper–chrome arsenate)	$0{\cdot}20$–$0{\cdot}66$ lb/ft^3 of dry salt

water-borne preservatives. The preservatives used, and the range of retention obtained with each, are set out in Table 1.

The species selected for these tests was radiata pine, this being one of the sawn timbers most commonly treated in this country. The results of the tests indicate that, within the above range, variations of retention of the preservative salts have little effect on the errors produced in the meter readings. In addition, the similarity between the results for the two copper–chrome arsenate preservatives suggests that the correction data for these could be combined. Table 2 gives the corrected moisture contents for meter readings in the range 8–24%, when testing radiata pine treated with one of the three preservatives and having a retention within the range given in Table 1.

The moisture meter used in the test was calibrated for Douglas fir, this being the calibration commonly used in Australia, and the correction data listed must not be used with meters calibrated for a different reference species.

Table 2: List of Corrections
(Radiata pine from South Australia and Victoria)

Meter Reading of Moisture Content (%)	Corrected Moisture Content (%)	
	Celcure "A" or Tanalith "C" Treatment	Boliden "S25" Treatment
8	9	11
9	10	12
10	11	13
11	12	14
12	13	15
13	14	16
14	14	17
15	15	18
16	16	19
17	17	20
18	18	21
19	19	22
20	20	24
21	20	25
22	21	26
23	22	27
24	23	28

PROPERTIES OF AUSTRALIAN TIMBERS

Messmate Stringybark

MESSMATE STRINGYBARK is the standard trade common name for the timber known to botanists as *Eucalyptus obliqua* L'Hérit.; the timber also being known as brown top stringybark (Tasmania), stringybark (Tasmania, South Australia), messmate (Victoria), Tasmanian oak, and Australian oak.

Distribution

The species is widely distributed in Eastern Australia, being found in New South Wales, Victoria, Tasmania, and to some extent in South Australia. In Tasmania it is found throughout the whole forest area except parts of the west coast, being specially well developed in the south. In New South Wales it occurs on the eastern side of the southern tableland and on the eastern edge of the northern tableland near the Queensland border. In Victoria it is well developed on the lower elevations of the highlands.

Habit

Messmate stringybark is often a large tree 150–225 ft in height with a butt diameter of 5–12 ft. However, the tree is generally much smaller; at felling height the diameter is 2½–3½ ft. The tree possesses a stringybark which extends to the branchlets. The bark of the trunk is thick and fibrous.

Timber

The wood of messmate stringybark is generally pale brown to brown although some samples show a reddish tinge. The sapwood (1–1½ in. in width) is many shades lighter.

It is of open texture, usually straight-grained although sometimes interlocked, and its growth rings are fairly well defined, but there is no tendency to ring porosity. Figure is not prominent but may sometimes be fiddle-backed.

The timber is one of the lighter eucalypts with an average air-dry density before reconditioning of 48·0 lb/ft^3, and after reconditioning is 44·5 lb/ft^3, while the average green weight of the timber is 70 lb/ft³. The difference in density 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 11·3% (tangential shrinkage) and the average shrinkage of a quartersawn board (including collapse) is 5·1% (radial shrinkage). Reconditioning reduces these values to 6·3 and 3·3% respectively.

Seasoning

Although similar in many properties to mountain ash, this timber is somewhat slower in drying and tends to check more readily, particularly in the case of 2-in. material from Tasmania.

Kiln-drying from green condition (except with thin case stock) is generally not recommended. However, some 1-in. material is predried from green condition in Tasmania. This takes about 3–4 weeks to reach approximately 20%. It appears to be almost impossible to kiln-dry 1-in. backsawn stock within a reasonable time and free from face checks, and in kiln-drying green quartersawn stock edge checking may be pronounced in material from certain areas if drying conditions are too severe.

Kiln-drying after air-drying to a moisture content of 30% or less can be satisfactorily accomplished. Little trouble from warping is experienced except perhaps in material from "top" logs.

There is evidence available to suggest that some variation in seasoning characteristics exists in this species, dependent on the location in which the timber is grown.

Pronounced collapse occurs but good recovery is obtained by reconditioning.

Approximately 15–21 days are required to kiln-dry green 1-in. quartersawn stock and about 6–8 days are needed for similar stock that has been air-dried to 30% moisture content. Recommended drying schedules are available on application to the Division of Forest Products.

Mechanical Properties

Messmate stringybark has been included in strength group C together with mountain ash, but it is superior in mechanical properties to the latter species. At 12% moisture content its modulus of rupture is 17,100 lb/in.² compared with 16,000 for mountain ash and 12,500 lb/in.² for Douglas fir; and its hardness is 1,700 lb as against 1,100 lb for mountain ash and 760 lb for Douglas fir. Impact strength is comparable to mountain ash.

General

The sapwood of messmate stringybark is highly susceptible to lyctus. The pinhole borer also attacks this species, but it should be realized that the attack will not continue after it has been converted.

The timber is not durable, and if it is used in contact with the ground, preservative treatment is necessary. It is considered more resistant than mountain ash or alpine ash.

It is a relatively good bending timber at 6 in. radius, fair to good at 4 in. radius, and fair at 3 in. radius. Care must be taken in selecting bending timber.

The timber is readily worked with hand or machine tools, is glued easily, stains well, and takes a good polish. It splits readily.

Uses

Messmate stringybark is suited to a wide range of uses in both construction and manufacturing fields. In general building practice it is used for studs, bearers, rafters, and joists. In its higher qualities it is valued for flooring, weatherboards, interior trim, panelling, cabinet work, motor bodies, and furniture. In Tasmania it is popular for posts, poles, and piles, for wharf construction and railway sleepers. It is also used as a fencing and mining timber. Considerable quantities are used for case stock and export wine casks have been made from it. It makes excellent wood wool, and has been successfully used in the manufacture of newsprint paper.

Availability

The timber is available in a wide range of scantlings, boards, joinery sizes, and milled products. The annual cut is in excess of 100,000,000 super ft sawn.

Additional information is available from forest authorities in New South Wales, Tasmania, and Victoria and from the Chief, Division of Forest Products, C.S.I.R.O., Box 310 P.O., South Melbourne.

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Forest Products Newsletter

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Pole Drying and Degrade Control Investigations

By F. J. CHRISTENSEN, Seasoning Section

A COMPREHENSIVE series of studies on various aspects of pole drying, and the alleviation of drying degrade in poles, have recently been commenced at this Division. Experiments have been planned (i) to determine the drying behaviour and relative air-drying rates for hardwood and softwood poles, and how the effects of seasonal conditions and a number of other drying variables influence them; (ii) to investigate methods of reducing forms of drying degrade which prevent the utilization of poles cut from some straight-grained, fissile species, and (iii) to test methods of accelerating pole drying times from the present 6–9 months required under air-drying to, perhaps, as little as 24 hours.

This research has been put in hand because inadequate supplies of naturally durable pole timbers in most Australian States have led to the need for utilizing less durable species. Good supplies of these, of adequate strength and suitable form, are generally available, and it has been shown that some of them give good service performance following a suitable preservative treatment.

Drying Problems

The advent of pressure impregnation treatments in Australia and the use of these naturally less durable species have introduced their own special problems. Instead of being installed green, poles must now be dried until the average sapwood moisture content is 25–30% in order to ensure specified preservative retentions during treatment. With the usual air-drying method, extensive stock-piling of poles therefore becomes necessary to ensure continuous treating plant operation, and this can lead to considerable capital expenditure. In addition, drying degrade can become extensive, and cause large losses due to rejections and cut-backs.

For example, in some States, particularly Western Australia, New South Wales, and Victoria, there are large quantities of pole timber available in a number of species which are suitable for use as poles except for their tendency to develop end and barrel splits during air-drying and after treatment, owing to the effects of growth and seasoning stresses. This applies to species such as *Eucalyptus diversicolor* (karri), *E. regnans* (mountain ash), *E. goniocalyx* (mountain grey gum), and *E. viminalis* (manna gum), all of which are straight-grained timbers with high shrinkage values (averages of 11·8% tangentially and 5·3% radially before reconditioning). Clearly, if an economic method can be found to prevent this form of drying degrade in these species it will be very greatly to the benefit of both the forest utilization and the operations of the large public authorities which require pole timbers in quantity.

Studies in Air-Drying

As indicated, the purpose of these studies is to determine the drying behaviour of pole timbers at different times during the year, and the influence of the season when drying is commenced. Initially, the drying behaviour of 10 ft long, end-coated pole sections of *E. obliqua* and *P. radiata*, not less than 8 in. or greater than 12 in. in diameter at either end, will be investigated.

A drying frame to hold 78 pole sections has been erected in the Melbourne area and this will enable an examination of the effects of such variables as methods of stacking, orientation, and position in stack. The frame has been designed to permit the ready withdrawal of any pole for periodic inspection and moisture content measurement. The first series of tests is scheduled to commence in June of this year: all poles in the stack will be replaced by a new batch of green poles at 9-monthly intervals over the next 3 years.

Drying rates will be determined by removing two $1\frac{3}{8}$ in. diameter by $1\frac{1}{2}$ in. long "plugs" from each pole fortnightly for measurement of sap- and heartwood moisture content values. This technique, which will be described in a forthcoming issue of this Newsletter, has proved satisfactory and reliable in recent laboratory and field studies.

Studies to Reduce Drying Degrade

In these experiments, the effects of a number of pre-treatments considered likely to alleviate or prevent end- and barrel-splitting in fissile pole timbers will be examined. They will be aimed, in general, at reducing the rate of drying and shrinkage and, hence, the severity of drying stresses.

In a study made jointly by the Forests Commission of Victoria and the State Electricity Commission of Victoria at a commercial preservative treating plant near Melbourne in 1959–60, the seriousness of drying degrade in regrowth *E. regnans* poles 30–40 ft long was dramatically demonstrated. Out of 438 poles stacked in June and air-dried for 6–7 months before treatment, 212 were rejected outright without possibility of utilization, mostly because of barrel splitting. Of the 226 poles accepted only two were classified as first grade, and 95 were cut back either 5 or 10 ft.

For this series, *E. regnans* pole sections will be used initially in experiments designed to study the effects of end- and barrel-treatments separately. The former will consist of independent tests with (i) a brushable wax type end-coating and quickly removable plastic end covering, (ii) end restraint provided by C-irons, and (iii) peripheral restraint provided by circumferential banding near the ends. The barrels of all these log sections will be sprayed with a wax emulsion to minimize confounding of results due to the influence of barrel checking.

Chemical seasoning of log sections, end coated at one end, in solutions of sodium chloride, urea, and invert sugar will also be carried out on both plain and incised material to determine their effectiveness in reducing drying degrade.

Scout tests with *E. regnans* pole material to determine (i) optimum soaking times and extent of radial penetration of the three chosen chemicals into green specimens, and (ii) strains developed in restraint applied near the end of a pole section as a result of drying stresses, are already in progress.

In cooperation with the Forestry School, University of Melbourne, an experiment is also in progress to determine how slow and rapid methods of killing *E. regnans* pole-size trees, left standing after treatment, influence sap- and heartwood moisture content, the development of growth stress shakes, and the extent of drying degrade after felling. Further work is planned along these lines, and will include an investigation of the drying which occurs through transpiration, when the crown is not lopped for some time after felling. This method, referred to as "biological drying" in the literature, is stated to provide rapid drying rates.

Studies to Accelerate Drying Rates

Earlier work of this Division has shown that it is possible to reduce some of the degrade development which accompanies the air-drying of poles by using accelerated drying methods, in which a drying medium other than air or superheated steam is used. For example, it has been shown that degrade resembling that which normally occurs in air-dried sleepers (generally a few deep, long checks) usually develops when relatively mild drying conditions of low to moderate dry bulb temperature (D.B.T.) and high equilibrium moisture content (e.m.c.) are used, but that with very severe drying conditions, in which D.B.T.'s exceeded 212°F, and e.m.c.'s are extremely low, drying degrade is often less severe, both at the conclusion of accelerated drying and during further subsequent air-drying. Although more numerous, the checks are shorter, narrower, and shallower, with a greater tendency to occur on tangential surfaces. An important value of this type of checking is that it permits some surface penetration of preservative. Later, these checks tend to close up as additional drying occurs.

The approach to research in this area has already been described (Newsletter No. 264). In brief, the accelerated methods for examination include:

(i) *Boultonizing or boiling-in-oil under vacuum.*—Poles are immersed in hot oil (e.g. creosote) in a closed vessel operated at less than atmospheric pressure.

(ii) *Steam and vacuum drying.*—Poles are subjected to alternate cycles of heating with low pressure steam, followed by a period under vacuum when moisture is evaporated.

(iii) *Superheated steam drying.*—Poles are dried in steam at atmospheric pressure heated above 212°F; wet bulb temperatures are either maintained at 212°F or allowed to drop below this temperature by the admission of air.

The effects of treatments (i) and (ii) on the strength of specimens cut from green and treated poles are being investigated in cooperation with the Timber Mechanics Section.

While most of the work completed under this heading has been carried out on *E. obliqua*, some attention has been given recently to studies on pole sections of *Pinus radiata*, and its redrying after treatment with a waterborne preservative, particularly in view of its potentialities for utilization in hot, dry climates, where splitting of treated poles may occur after installation. After 10–12 days kiln-drying at a D.B.T. of 110°F, and a self-modulated wet bulb depression of 28–32°F, average pole moisture content values fell to 30% from initial values exceeding 100%. Redrying after treatment to an average moisture content of 45% was achieved in a further 16 days under similar drying conditions. Even after redrying, barrel checking and end splitting were classified as slight.

Assessment of Degrade

Assessment of the effectiveness or otherwise of a particular treatment in reducing degrade frequently presents a considerable problem. For the above cases, it was considered that a subjective rating system would not provide a consistent standard of assessment, since arbitrary standards set by an observer are subject to fluctuation, and this is worse when several observers are involved. Further, statistical analysis of results is not possible with such a system. For these reasons, an objective rating system has been developed.

This consists of two series of photographs, one for end- and the other for barrel-checking, showing an extensive gradation of typical degrade. Numerical values have been allotted to each example of degrade illustrated, and range from 0 for near perfect material to 8 or 10 for reject material. This system has been evolved so that it is related to currently practised, commercial standards of acceptance or rejection for air-dried poles prior to preservative treatment. It will be used to assess degrade in all current pole drying investigations.

Future Work

Exploratory work has also been planned to determine the effects of soaking in polyethylene glycol, a shrinkage stabilizer, and it is also planned at a further later stage to investigate the effectiveness of the vapour-drying process.

Reporting of Results

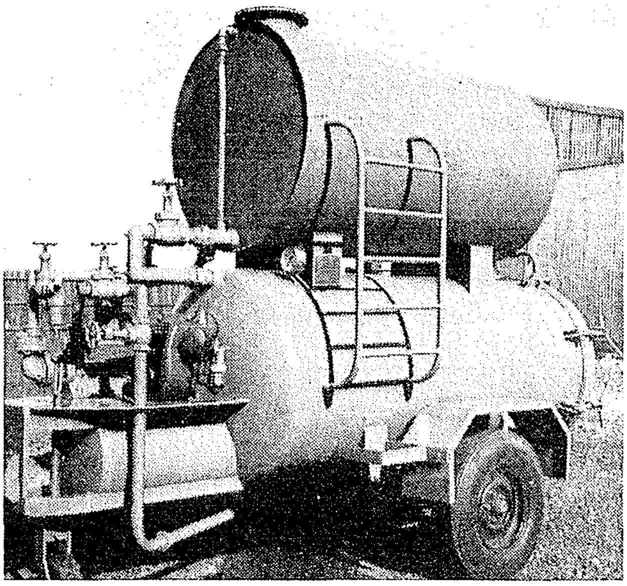
The investigations described are expected to yield results which will have both immediate and future application in a rapidly expanding field of activity. As sections of work are completed, these will be reported on, and others will be commenced with other species.

DONATIONS

THE following donations were received by the Division during May:

Atel Ltd., Oberon, N.S.W. ..	£50	0	0
J. & T. Gunn Pty. Ltd., Tas.	£250	0	0

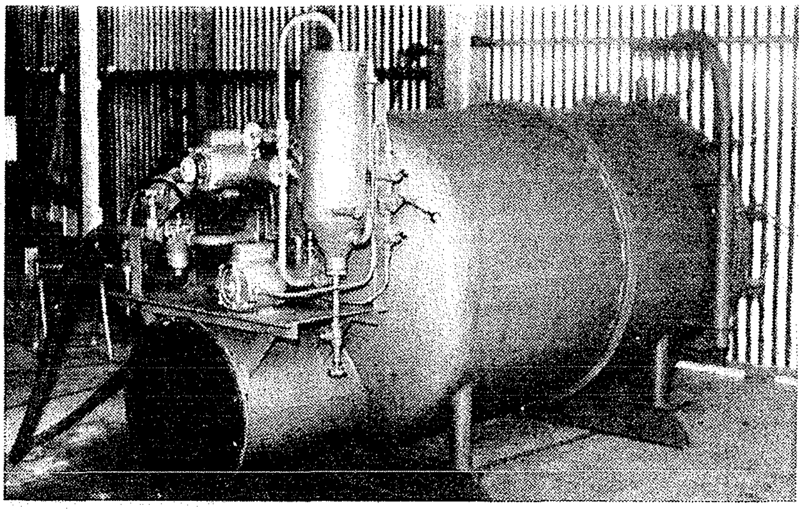
Equipment for Low-Pressure Fence Post Treatment



Portable low-pressure fence post treatment plant.

SINCE C.S.I.R.O. Leaflet No. 12 was first published, preservative treatment of round fence posts has become firmly established, particularly in south-eastern Australia where durable fence post timbers are relatively scarce and expensive. Along with the development of commercial post treatment, there has been a steady growth of "do-it-yourself" treatment, ranging from sap replacement to low-pressure treatment.

In the field of low-pressure treatment the Division has answered many enquiries for details of the plant required and at least a dozen of these plants are now in operation. To permit those planning to build or acquire a low-pressure treatment plant to decide which type suits them best, and to provide sufficient detailed information for the average engineer to build such a plant, it was found necessary to summarize the available information.



Fixed vacuum-operated low-pressure plant.

Amongst the items covered in the summary are the types of plant that can be installed, details of the pressure cylinder, pressure pumps, vacuum pumps, valves, and other ancillary equipment. In general the summary sets out to answer the many queries that arise when such a plant is under consideration.

The summary, entitled "Equipment for Low Pressure Fence Post Treatment", is available on request to the Division, as also is the revised edition (1961) of Leaflet No. 12 "Round Fence Posts: Their Preservative Treatment".

The Third Predrying Conference

What proved to be one of the most useful and interesting of the series of Predrying Conferences now established as part of the liaison between industry in Tasmania and the Division of Forest Products, was held in Launceston during May, under the alternate Chairmanship of Mr. C. Sibley Elliot, Assistant Chief of Division, and Mr. Colin Gibson of the Tasmanian Timber Association. The Conference was opened by Mr. David Gunn, Deputy Chairman of the Tasmanian Timber Association.

Discussion proved so lively that the full agenda could not be completed in the time provided. Conference agreed, therefore, on the need for a second session in September on a date to be arranged.

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Points from the Division's Annual Report

THE Annual Report of the Division of Forest Products for 1961-62 was issued early in July, and as it can be distributed only on a restricted mailing list the following brief extracts are published here for Newsletter readers.

General

The greatly increased number of enquiries received by the Division for 1961–62 is a reflection of the difficulties experienced by the timber industry generally during this period. The number of requests for assistance totalled just over 13,000, an increase of nearly 2,000 over any previous year. In addition, officers of the Division spent considerable time assisting industry in the various States. Particular examples of this are the survey of sawmilling practices in Western Australia and the sawmill studies in north Queensland; both of these projects have been referred to previously in the Newsletter.

Financial support by industry for specific sections of the Division's work has come from the Australian Plywood Board and the pulp and paper industry, together with donations of both money and material from the industry in general.

Two major research conferences were held in the Division: the 10th Forest Products Research Conference in July 1961 and the 18th Pulp and Paper Research Conference in October. The Division was represented at various oversea conferences including the 18th International Congress of Pure and Applied Chemistry, a conference on "The Formation and Structure of Paper" at Oxford, the 10th Pacific Science Congress at Honolulu, and the 2nd World Eucalyptus Conference in Sao Paulo, Brazil.

As reported previously in the Newsletter, a series of post-graduate lectures was well received by engineers, architects, and members of the timber trade at the University of Western Australia.

During the year the Division provided training for seven students under either Colombo Plan, F.A.O., or similar fellowships. Mr. F. W. Addo Ashong, of the Ghana National Research Council, commenced a two-year period with the Division under the Special Commonwealth African Assistance Programme.

Wood and Fibre Structure Section

During the year the standard wood collection expanded to over 8,100 species in 2,000 genera by acquisition from the Smithsonian Institute, Washington, U.S.A. The new material is being examined in order to revise data for the card sorting key based on microscopic features. Fundamental investigations have continued in many fields, notably the structure of plant cells, morphological changes associated with the beating of wood fibres, lignin and lignification, wood and bark extractives, and assessment of wood qualities for tree breeding.

Wood Chemistry

Much of the fundamental work of this Section is of direct interest to the pulp and paper industry, and covers such fields as chemistry of the cambium, infrared spectroscopy of carbohydrates and wood, properties of holocellulose pulps, pulping and papermaking properties of various species, semi-chemical pulps, the beating process, retention of pulp strength after drying, and others. Of interest is a new project on plant gums, which aims to determine the physical and chemical properties of the gum exudates of Australian woods and to find suitable substitutes for common plant gums in commercial use.

Timber Physics

Fundamental studies have been carried out on dimensional changes of wood and the effect of high stresses and moisture content changes on the rheological characteristics of wood. Further work has been completed on electrical moisture meters, particularly in the design of an improved electrode and a meter which may have applications at very high moisture contents on untreated timber and at very low moisture contents on both treated and untreated timber.

Timber Mechanics

Here the emphasis has been on the timber engineering side, covering such aspects as structural design, nailed joints, columns, scantlings, poles, and plywood. The increasing interest in timber as a structural material was shown by the number (over 400) of requests received for assistance in this field.

The Division's interest in erecting a two-storey laboratory building in which timber is the structural material has already been indicated in the Newsletter, and detailed designs of individual members and joints for this structure have been made. Some full-scale sections of the proposed structure have already been tested.

Thirty-eight roof trusses of various designs are currently under long-duration loading at the Division's field test site for structures. Glued laminated and finger-jointed radiata pine for structural members in cooling towers are also under test in towers in various States.

The mechanical testing of four Western Australian and 54 New Guinea species has been carried out and tests have confirmed that there is little difference in the strength properties of mature and immature hoop pine.

Timber Preservation

The number of requests from industry and the public for assistance and advice on various aspects of wood preservation has increased considerably and is an indication of the growing importance of the wood preservation industry in Australia.

Many thousands of specimens treated with various preservatives are now installed in field tests throughout Australia, and inspecting and reporting on these tests is an important project.

Investigations of new preservatives are continuing, and both water-soluble and oil-type preservatives are under constant review with the object of improving their performance. The natural durability of fast-grown compared with slow-grown timber is often queried, and durability tests have shown that while in the case of jarrah there is little difference, in fast-grown cypress pine and teak the durability tends to be lower than in slower grown material.

Studies of the important species of wood-destroying fungi have continued. Service tests on various species of timber used in cooling towers where soft rot is a hazard have indicated that, although the order of durability is not constant between towers, in general, softwoods are more resistant than hardwoods.

Timber Seasoning

Investigations into air seasoning and the drying of round timbers have occupied a great deal of the Section's time for the past year. As a result of the work to improve the efficiency of air drying, measures which should result in a saving to the industry have been established.

Further work has been carried out on predrying and improvements made to predrier design. A successful Predrying Conference was held in Launceston during May.

The rapid growth of the pole preservation industry has high-lighted the need for some method of controlling end splitting and barrel checks in poles of the more fissile species, and experiments are in progress with this object in mind.

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Further work was done on the cause, effects, and removal of collapse, and field investigations have been completed to make possible the prediction of equilibrium moisture contents of wood under protected outdoor conditions.

Work on dimensional stabilization has continued and it is felt that one or more of the treatments developed may prove of importance to the timber and allied industries.

Plywood Investigations

Work on various aspects of veneer production, drying, glue spreading, and hot pressing were continued during the year, and experimental work accenting plywood utilization was extended. Factory trials carried out in three States have confirmed results of laboratory experimental work indicating the suitability of wattle tannin adhesives for bonding a number of rotary peeled veneer species.

The effect of wood preservatives and insecticides on glue behaviour has been under consideration for some time, and some of the earlier difficulties have been overcome, although there are still a number of problems.

Utilization

Sawmill studies conducted in 26 sawmills in north Queensland constituted a major project of the Section for the year under review, and reports on this work are now going out to the mills concerned. Surveys of sawmilling were also carried out in 14 mills in Western Australia.

Studies of the thickness and rim speed of saws have been carried out in the laboratory, and work is progressing in the study of the fundamentals of wood cutting.

Utilization of small dimension timber by finger-jointing and laminating has also been studied and satisfactory results achieved.

Special Investigations

Fundamental aspects of dimensional stabilization of paper and veneer were studied, and papermaking properties of some dense eucalypt woods were established. Physical and chemical aspects of the wood-glue joint are under investigation.

The Division acknowledges the help and cooperation of various organizations, including the State Forest Services and the Forestry and Timber Bureau, and all other branches of the timber and allied industries.

Trade Circular No. 50 — Testing Timber for Moisture Content

A completely revised edition of this important publication is now in stock and is available on request to The Chief of the Division.

Besides bringing up to date the general information on the methods of moisture content determination and on moisture meters, the new edition of Trade Circular No. 50 includes the latest species correction figures for meters calibrated on Douglas fir.

Kiln operators and others who use this publication frequently are advised to write for this edition.

Personal

Mr. G. W. Wright, Officer-in-Charge of the Timber Seasoning Section of the Division, has been one of the two Australian representatives at the 8th British Commonwealth Forestry Conference in East Africa.

On his return journey Mr. Wright is spending one week in Bangkok to inspect and test a predrier plant installed to the design developed by this Division. This plant, built by the Bhanasit Timber Impregnating Company, has used all Australian equipment and is expected to be the forerunner of a number of similar plants throughout South-east Asia.

DONATIONS

The following donations were received by the Division during June:

Oxley Plywood Co. Pty. Ltd., Brisbane £50

A. A. Swallow Pty. Ltd., Melbourne £100

½-In. electric drill and vertical drill stand from Black & Decker (Aust.) Pty. Ltd., Croydon, Vic., value £53

Preservative-treated timber for bridge decking to the value of approx. £450
- Timber: Penola Timbers Ltd., Mt. Gambier, S.A.
- Preservative: Celcure (Aust.) Pty. Ltd., Melbourne
- Treatment: H. Beecham & Co., Melbourne

Treated Timber Bridge Decking

Most visitors to the Division have seen the timber decking over the open storm-water drain beside the main building. This carries timber trucks, oil tankers, and other heavy vehicles, and is very similar to the decking used on many road bridges in Australia. It consists of 8 in. × 4 in. boards of non-durable Victorian hardwoods spiked to massive round ironbark beams at 4 ft centres.

In recent years failure of the decking has been accelerated, mainly because of decay at the ends of the boards. Treatment *in situ* with creosote has been tried without much success and replacement has become increasingly costly, as it is relatively difficult to get durable hardwood in the sizes and lengths required.

Thanks to the generosity of several firms who supplied the materials, a start has been made on replacing the decking with a permanent cover of preservative-treated timber. The street end of the deck, roughly 60 ft × 20 ft, has been replaced with laminated slabs of pressure-treated radiata pine. These slabs are made up of 5 in. × 2 in. structural grade pine laid on edge and nailed together to form units 28 in. wide of lengths varying from 8 ft to 16 ft.

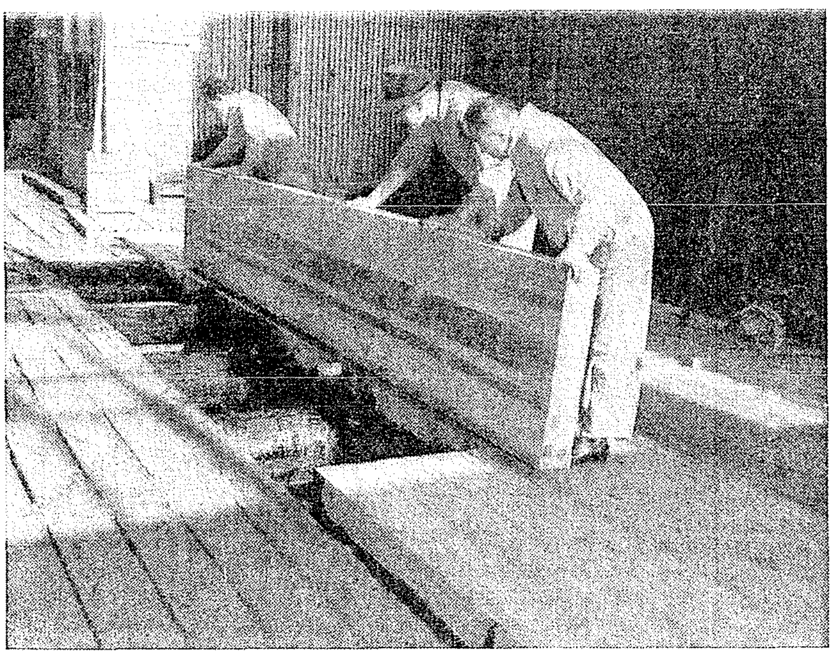
Ideally, to prevent movement of the finished deck under traffic, this type of decking should be laid in one piece, but considerations of ease of assembly and access to the drain beneath precluded this.

Galvanized spikes 8 in. × $\frac{3}{8}$ in. were used at approximately 10 in. centres to fasten the laminations together. This heavy nailing was used to ensure substantial transfer of load between laminations without significant individual movement to enable the completed slabs to withstand wheel loads of 2 tons per tyre, i.e. 4 tons for dual wheels.

The timber was treated with a waterborne preservative to a loading of 0·75 lb/cu.ft., which should ensure protection against decay in this location for at least 40 years.

It is intended to continue the replacement of the rest of the decking with creosote-treated pine and treated hardwood to compare their wearing qualities with the new section. Various surfacing materials such as epoxy resins will also be tested.

Laminated decking is used in New Zealand and the U.S.A. for road bridges and it is hoped that its use by the Division will stimulate interest in this country.



Laminated slab of treated radiata pine being put into position.

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Brown Coal Tar Creosote as a Wood Preservative

By R. JOHANSON, Timber Preservation Section

CREOSOTE OILS in the main are produced by distilling the tar obtained as a by-product in the manufacture of town-gas from bituminous (or black) coal. The production of town-gas involves high temperature carbonization of coal resulting in the formation of coke and numerous gaseous substances, some of which condense on cooling into tars or tar oils. These condensates were found to be good preservatives and the fractions distilling between about 200 and 400°C have been used extensively as coal tar creosote throughout the world for over a century in preservation of poles, piles, rail sleepers, heavy constructional timbers, farm buildings, fence posts, and the like.

In Australia black coal tar creosote has been used for preservation for the last 30 years, but only in the last 5 years with the introduction of pressure plants for impregnation of poles and posts has there been an extensive demand for this oil type preservative. As consumption of creosote increases with the growth of the timber preservation industry it is anticipated that there will be a shortage unless positive steps are taken to increase production of these oils or to find suitable alternatives.

The manufacture of town-gas from brown coal has opened up the possibility of a new source of creosote oil.

Production from Brown Coal

Brown coal tar creosote (BCTC) is a product obtained from condensed tar oils by the Gas and Fuel Corporation at Morwell, Vic. It represents higher boiling fractions of by-products of the modified Lurgi high temperature gasification of brown coal. For the present the output is likely to be about half to one million gallons per annum.

During the last few years investigations in this Division have shown that this new material has considerable promise as a wood preservative, and unlike the established black coal tar creosotes (known as K.55* creosotes) it possesses the useful property of producing a "dry", non-oily treated surface when treated timber is subjected to hot air drying or dried in hot summer months. The high phenol content of BCTC may amount to 25–30% of the total constituents and it is well balanced with respect to other components. The composition on the whole is fairly similar to that of K.55 creosotes, but BCTC contains a comparatively large group of undistillable compounds which may contribute to this property of producing a non-oily surface on drying.

In developing BCTC it was considered desirable to incorporate as much as possible of the high boiling (or "heavy") tar oils.

*Australian Standard Specification No. K.55–1936.

However, these oils are too viscous to be used by themselves for pressure impregnation of poles and it was found necessary to add some lower boiling (or "lighter") middle oils to reduce viscosity of the blend. The present BCTC is thus sufficiently "thin" to ensure penetration into the wood, but it is well supplied with higher boiling fractions which extend beyond 315°C, the minimum limit required by the Standards Association of Australia, into the region above 360°C. The heavy fractions are designed to impart lasting protection to treated timber. By comparison with good quality K.55 creosote, as can be seen from the accompanying table, BCTC appears to be superior as far as these fractions are concerned.

Distillation Ranges of Creosote Oils

Temperature Range (°C)	K.55 Standard Not To Exceed (%)	Good Quality K.55 Creosote (%)	BCTC (%)	BCT Heavy Oils (%)	Lurgi Middle Oils (%)
0–205	6	6	5	0	9
0–230	40	20	19	0	51
0–315	85	75	54	25	94
0–335	—	85	62	41	—
0–350	—	—	70	58	—
0–380	—	—	81	69	—

Incidentally, it is regarded that in the current Standard Australian specification for creosote, K.55–1936, the content of lighter fractions is too high at corresponding temperatures and at present these are under consideration by the Standards Association of Australia with a view to improving the quality of K.55 creosote by increasing the proportion of heavier fractions.

Toxicity of BCTC

Laboratory evaluation of BCTC has shown that it has satisfactory toxicity and lasting qualities (or permanence) which are so important if a preservative is to provide protection for many years. The decay test procedure used was an adaptation of the standard method of the American Society for Testing Materials, and it is capable of giving rapid results. In this procedure small blocks of wood are impregnated with creosote to required loadings and subjected to accelerated severe weathering representing many years of service. From the information obtained from decay tests to date, there appears to be no difference in preserving powers between the two creosote materials originating from bituminous and brown coals. The weathering tests indicate that BCTC might be more permanent than K.55 creosote. It appears that the heavy fractions in BCTC are capable of holding the lighter oil and of reducing the overall weight loss by more than 50% compared to that normally found with K.55 creosotes.

Treating Properties

BCTC has been used extensively in the last 5 months in the Division's experimental high pressure plant for treatment of various timbers, and during this time it has been subjected to numerous heating and cooling cycles. The treating behaviour of the material has been found to be satisfactory and absorption and penetration were similar to that usually obtained with K.55 bituminous coal tar creosote. No evidence of sludging, sedimentation, or other undesirable effects has been observed and the BCTC showed no signs of deterioration.

Wood treated with BCTC, unlike that treated with K.55 black coal tar creosote, tends to become "dry" within a few days at room temperature and this phenomenon is sufficiently pronounced to allow separation of timbers treated with these two creosotes. It was found possible to accelerate this "drying" process, on a laboratory scale, and to obtain material ready for handling 48 hours after treatment. There is a prospect that, if fully developed, this "drying", which is probably a reversible thermoplastic polymerization, could be of particular value in production of clean non-oily creosoted material.

BCTC also possesses thixotropic properties, causing it to "set", and this could reduce the losses through drainage and bleeding commonly experienced in creosoted poles under service conditions.

On the evidence of the results obtained to date the BCTC material as produced at present gives promise. At this stage limited commercial scale assessment of this product with accelerated drying is fully justified.

Novel Timber Laboratory Building

PROGRESS IN DESIGN

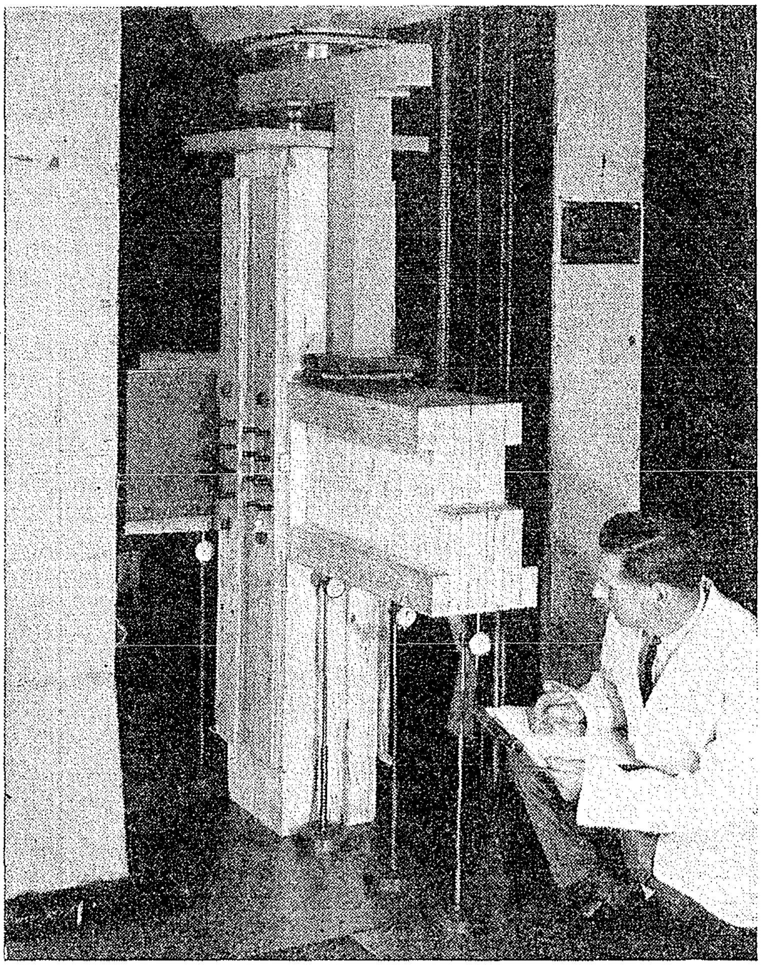
By R. N. BOURNON, Timber Mechanics Section

A NUMBER of alternative features have been considered, and extensive-detail design studies have been made in connexion with the new timber laboratory referred to in this News-letter (No. 284, April 1962). It is proposed that the structural framework should consist of built-up timber columns at 22 by 24 ft centres linked by heavy fabricated timber beams supporting light but stiff built-up floor joists. It is designed to carry a floor load of 60 lb per sq. ft. and half of this is considered to be permanently applied.

It is proposed that the columns should be of 12 by 10 in. solid section laminated from 10 by 2 in. radiata pine. Each column unit would be of a length equal to the height of the room and cut square at the ends. The main beams pass between the ends of the columns on the upper and lower floors and canti-levered sections support the ends of other main beams. It is anticipated that these beams will be 10 in. wide and 18 in. deep and in the form of a double I section. The flange members of the beams consist of four pieces of 4 by 2 in. radiata pine. The two webs of radiata pine plywood each have a maximum thickness of $1\frac{1}{4}$ in. made up from $\frac{1}{2}$ and $\frac{3}{4}$ in. thick sheets. The plywood sheets would be scarf jointed to form continuous lengths.

The stiffness of the framework will depend largely on the joints between beams and columns. The design requires these joints to develop and maintain a high degree of rigidity under load. To determine the rigidity characteristics of the proposed joint and to establish whether it is practical to fabricate the novel type of joint which has been proposed, at a reasonable cost, the full size joint shown in the photograph was built and tested in the laboratory.

To achieve integral action of the column and beam system, the forces and moments may be transferred from member to member at the joint by two separate paths, namely, direct bearing between the columns and the beam and by dowelled side plates. These paths will share the forces and moments according to their relative stiffness. The stiffness of the direct bearing is, of course, very dependent on the precision of fit obtained between the beams and the column. Initial effort to control this, using conventional wood-working methods, were not successful, owing to the difficulty of accurately machining members of the sizes required. As an alternative approach, the faces of the joint were kept slightly apart until the beams and columns were secured in position; the edges of the joint were then sealed and an epoxy resin was pumped in under pressure until the joint was completely filled. Care was taken to use a formulation with the required strength and flexibility, and the meeting faces of timber were pretreated with a primer to



Full size prototype of joint between column and beam under test.

prevent the resin from sinking into the wood before it set.

The side plates of 6 by 1 in. kiln-dried hardwood were secured by $\frac{5}{8}$ in. diameter mild steel dowels penetrating $2\frac{1}{2}$ in. into the columns and beam. It is proposed that when the structure is erected, the dowels should be fitted in the columns as late as practicable, so as to allow the previous settlement of the joint under the weight of the building and thus ensure that most of the forces are carried in direct contact between the columns and beams.

In the tests, loads were applied to the short length of beam so as to give the shears and moments corresponding to full dead plus live loads in one bay of the building and dead load only in the other. In addition, an axial load was applied to the upper columns corresponding to roof loads only in one case, and to the roof plus floor loads in the other. Total proof loads of up to 100 tons were applied without distress of the joint and with an acceptable degree of stiffness. At working loads the side plates were carrying approximately one quarter of the bending moment in the beams, and this reduced the bearing pressures on the beam to a satisfactory figure.

Timber Engineering Design Handbook—Second Edition

THE DEMAND for the Timber Engineering Design Handbook, prepared by officers of the Division's Timber Mechanics Section, has been so great since its publication four years ago that a second edition has been found necessary. Extensive revision after such a short period was not considered warranted, but the section on the design of beams has been rewritten to clarify the meaning of the tabulated factors with respect to various loading and support conditions.

For the benefit of those who prefer tables rather than charts, safe loads for beams and columns are given in tabulated form in appendices to this edition. Further, in the Appendix containing the column tables, a simplified formula for the design of eccentrically loaded columns has been included as an alternative to that given in the main text.

Copies of this second edition, published by Jacaranda Press Pty. Ltd., are obtainable from technical bookshops and recognized booksellers in all States at 35/- a copy, plus postage.

Visit of American Expert on Timber Fastenings

PROFESSOR E. George Stern of the Virginia Polytechnic Institute is well known amongst timber engineers in many countries for his expert knowledge on nails and other timber fastenings. Under arrangements with the United States Department of State, Professor Stern is being brought to Australia under a Specialist Grant to lecture on modern developments in U.S.A. and elsewhere, and generally to advise on problems relating to the use of fastenings in home building, pallets, boxes, and other forms of timber construction. These talks will be to engineers, architects, students, and trade groups. He will also take part in discussions of research at the Division of Forest Products.

Although the general coördinating of plans for his visit is being handled by the Division of Forest Products, the Timber Development Association or the equivalent in each State is making arrangements for Professor Stern's lectures, visits, and discussions.

As at present planned, Professor Stern will arrive in Australia on September 30 and will spend in this country approximately 3 weeks, during which he will visit all six States before going on to New Zealand. Unfortunately it will not be possible for Professor Stern to spend more than about 2 week days in each State, and in practically every case, this time will be spent in the capital city. However, present proposed arrangements should make it relatively easy for members of all interested groups to learn of the most efficient modern developments through Professor Stern's lectures and discussions.

Further details of Professor Stern's visit will be given in the next Newsletter.

DONATIONS

THE following donations were received by the Division during July:

Murray Valley Sawmills Pty. Ltd., Nathalia, Vic.	£15
Bright Pine Mills Pty. Ltd., Bright, Vic.	£100
Cairns Timber Ltd., Qld.	£15

ERRATUM

Newsletter No. 284, April 1962

"Flush Doors" by J. J. Mack, page 1, col. 2, line 21 should read: ". . ., this should not be greater than about 1 in. for a load of 20 lb."

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C.S.I.R.O.

Forest Products Newsletter

DIVISION OF FOREST PRODUCTS, C.S.I.R.O., P.O. BOX 310, SOUTH MELBOURNE, S.C.5, VICTORIA

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1962##290

Some Methods of Improving the Basic Cutting Action in Wood

By W. M. McKENZIE, Utilization Section

ALL WOOD CUTTING processes rely on the action of a sharp edge to separate a chip or divide the work-piece. An ideally sharp edge would do this, leaving a perfect surface without distortion and damage, and producing a continuous ribbon-like chip, with very low expenditure of energy. Unfortunately, as anyone knows who is familiar with any wood cutting process, whether it be hand working, machine planing, sawing, veneering, or microtome sectioning, the cutting edge is not ideally sharp, even after the best preparation, and gradually blunts in use. Thus, in spite of constant effort to keep cutting edges sharp, many practical procedures have developed around the need for minimizing the effects of edges not being ideally sharp.

For instance, in sawing or planing, a feed speed which is too low in relation to cutter head (saw) speed leads to a rubbing rather than a cutting action, over-heating of cutters and wood, an excessive blunting rate, and raised or fuzzy grain. These difficulties become worse as blunting progresses. Practical precautions to minimize them are to ensure an adequate feed per cut (chip thickness), and to keep edges sharp by using wear resistant cutter materials or by frequent sharpening. Nevertheless, the costs of keeping cutters sharp and of avoiding or curing the effects of bluntness represent a considerable burden, and further, these effects impose a technical limit on what can be achieved while using a cutting process.

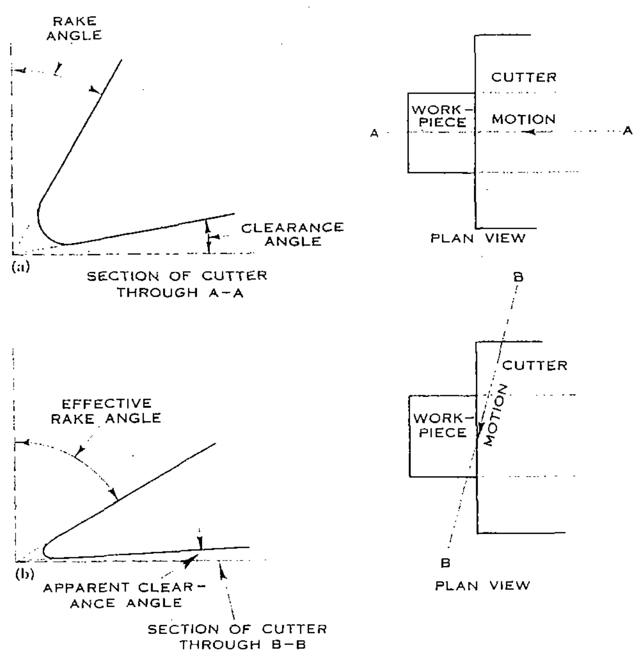

Fig. 1.—Effect of oblique cutting on effective rake angle and edge radius, i.e. as measured in a vertical plane in the direction of cutter motion. (a) Motion perpendicular to edge of cutter. (b) Motion oblique to edge of cutter.

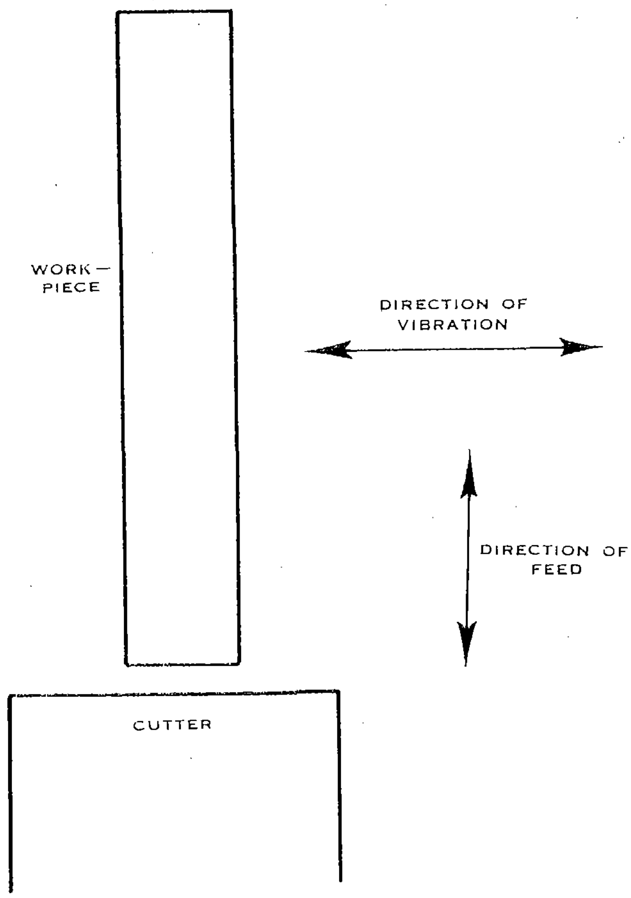

Fig. 2.—Lateral vibration superimposed on linear cutting; plan view.

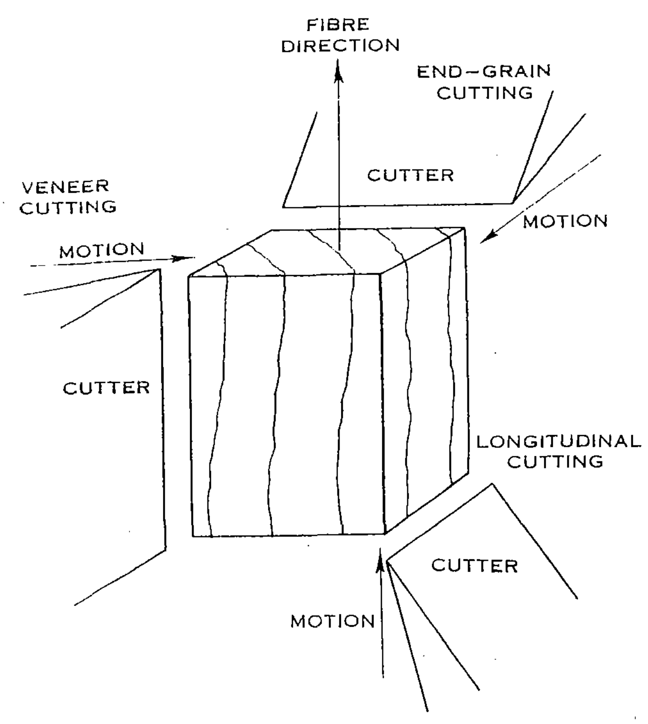

Fig. 3.—The three main cutting situations.

The basic effect of bluntness was discussed earlier in Newsletter No. 282, and is seen to be related to what is termed the indentation phase of chip formation. In this phase there is, under practical conditions, considerable deformation of the wood ahead of the cutter before the wood is separated as a chip, crumbles, or merely escapes beneath the edge in a rubbing action. This indentation phase occurs because stresses in the wood are not sufficiently concentrated at the edge of the cutter, but are spread to the front and back faces, where frictional forces come into play to oppose the forces tending to separate a chip. In considering ways of restoring this stress concentration at the edge, two possibilities will be discussed. Firstly, the edge may be given a pronounced slicing action; secondly, the coefficient of friction between the wood and the cutter face may be reduced.

Inclined Cutting or Slicing — Lateral Vibration

The effects of inclining the cutter at a large angle to its direction of motion are suggested in Figure 1. As viewed in a vertical plane in the direction of relative motion between cutter and wood, the radius of curvature of the edge appears to be less, and the effective rake angle of cutter is much greater. It appears that the combined effect is to increase the stress concentration in the wood at the edge. Another effect, more pronounced with newly sharpened edges, is that the minute serrations of an edge, moving in inclined fashion, tear the cell walls without deflecting them greatly. The benefits of inclining the cutter, or slice-cutting, are well established in cutting other cellular materials, such as meat, bread, and grass. In wood cutting, they are availed of in microtome sectioning, slicing, and veneer clipping.

A method of obtaining extreme inclination of a cutter to its direction of movement, with a very small increase in edge length, is to vibrate it rapidly in the direction of the edge (lateral direction), while feeding the work-piece in a direction perpendicular to this (Fig. 2). The average angle of inclination produced by lateral vibration depends on frequency and amplitude of the vibration in relation to the feed speed, and if they are sufficiently high a very high average inclination is obtained.

In experiments, a solenoid was used to apply such vibrations to the wood specimen at intervals during slow linear cutting, in the three main cutting situations, in which the cutting edge and direction of feed are either perpendicular or parallel to the grain, as indicated in Figure 3. These three cutting situations typify a large proportion of practical cutting processes. In all cases where the frequency and amplitude of the vibration were above a certain minimum, resistance to the cutter and deformation of the wood were greatly reduced, while chip and surface quality were greatly improved.

End-Grain Cutting

Referring to Figure 3, it may be seen that in end-grain cutting both the cutting edge and its direction of motion are perpendicular to the fibre direction, so that the fibres must be cut across. This is the case in band or frame sawing, while in circular sawing and most other processes such as turning, planing, and shaping there is some cutting across fibres. This is the most difficult cut to make in wood, because it tends to fail in some way other than by incision at the edge. The beneficial effects of lateral vibration in this cutting situation are illustrated in Figure 4. Apart from greatly improved quality of cut surface, cutting is more efficient, and since the load across the cutting edge is much lighter, less rapid blunting is to be expected.

In practice, the benefits of applied vibration are likely to be available only for processes where the cutting speed is low. In conventional sawing, or in turning, cutting velocities are such that the required frequency of vibration would be too high. This difficulty might be met by the introduction of radically different machines, such as that devised by Antoine, in which the work-piece is fed past a stationary saw.

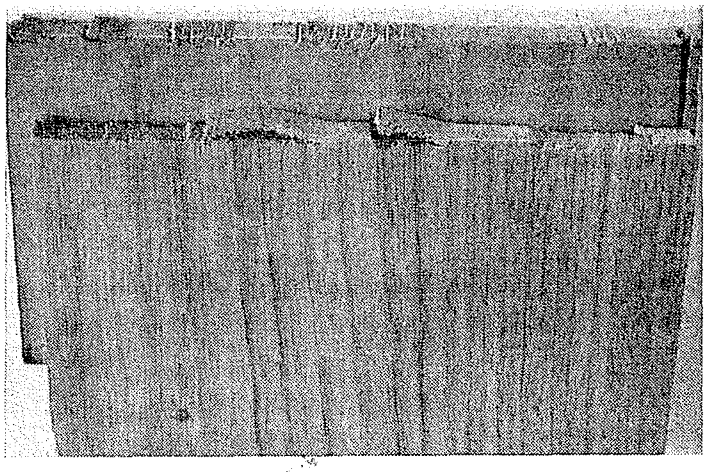

Fig. 4.—In the portions of these end-grain surfaces cut without vibration, there is extensive tear-out below the cutter, so that surface quality is very unsatisfactory. Note absence of damage below the cutting plane where vibration was applied.

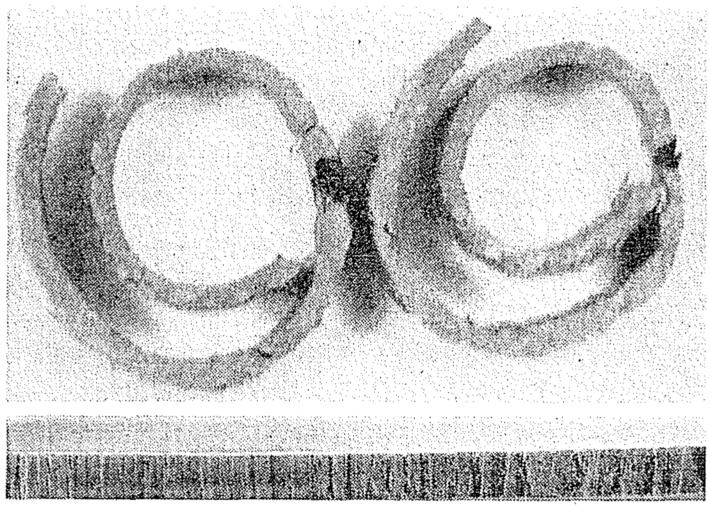

Fig. 5.—The left-hand half of this specimen (bottom) was cut with vibration, to produce the inner portions of the veneers shown above. With vibration, the cut surface is smoother, and the veneer is more uniform in thickness, stronger, and with shallower and more uniformly spaced checks.

Longitudinal Cutting *(Edge Perpendicular, Motion Parallel to the Fibres; See Fig. 3)*

This type of cutting is important in planing. Applied lateral vibration enables a lower rake angle to be introduced to avoid chipping out of the surface, while avoiding fuzzy and

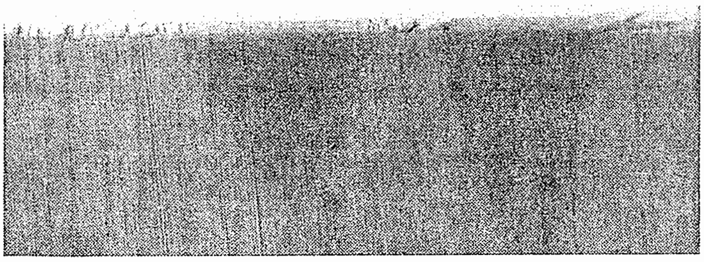

Fig. 6.—The effect of applying lubrication oil (dark stained areas) on quality of end-grain surface.

raised grain. Again, the principle seems to be inapplicable to normal rotary planing, but might be profitably applied to the scraper-type planer used in some European plants, to produce a high quality surface free of machining defects which contribute so much to costs of subsequent finishing.

Slicing and Veneer Cutting *(Edge Parallel, Motion Perpendicular to the Fibres; See Fig. 3)*

Figure 5 demonstrates that vibration in the direction of the edge improves the cut surface, reducing veneer roughness, and the chip or veneer is stronger and more uniform in thickness. These improvements were obtained using a cutter with a high wedge angle and no pressure bar.

A cutting process of this type, in which vibration has already been applied, at least to the patent stage, is in veneer trimming. Vibration enables a high quality cut to be made without a long horizontal travel of the knife. Another possibility is that of cutting high quality veneer with little or no cutter bar pressure, and with less exacting log preparation. In these processes the cutting speed is relatively low so that the knife need not be given a very high frequency, but the power required to vibrate the massive knife may be considerable.

Lubrication

The possible value of reducing friction is indicated by the results of a cutting experiment in which drops of SAE 30 lubricating oil were placed on the dry wood ahead of the cutter (Fig. 6). It may be seen that the oil practically eliminated damage below the cutting plane, the result being a high quality surface. It appears that lubrication had the effect of reducing the frictional support given by the face of the cutter to the wood, restoring the stress concentration to the edge, and reducing the deflections of the indentation phase. A fine spray of cutting fluid has been used in sawing, but there appears to be more scope for some pretreatment of cutters and saw teeth to reduce friction. Since the wood is constantly passing over the edge and face of the cutter or tooth, such a treatment must be highly resistant to abrasion. Successful lubrication would very probably result in a much slower blunting rate.

The possibilities discussed above are, of course, speculative but they are presented with the aim of stimulating wider interest in them, because it is apparent that much development, especially on machinery of industrial size, will be required to explore the field fully. Development of machines incorporating these principles could result in a big advance in efficiency and quality of production in the wood-working industries.

Personal

Mr. R. F. Turnbull, Officer-in-Charge of Utilization Section, left Melbourne on September 10 for Hong Kong, where he was an official Australian delegate at the sixth session of the F.A.O. Asia-Pacific Forestry Commission. He returned to Australia via Manila, where he visited the Philippines Forest Products Research Laboratory.

DONATIONS

The following donations were received by the Division during August:

Vermont Timber Kilns,
Vermont, Vic. £10 0 0

Smith Bros. Pty. Ltd.,
Rosebery, N.S.W. .. .. .. £ 2 2 0

Hearn Industries Ltd.,
Victoria Park, W.A. £25 0 0

Radiata Pine Association,
Adelaide: Poles to the value of £112 0 0

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Direct Drive Chain Saws

By H. F. HEATH, Utilization Section

IN RECENT YEARS there has been a rapid increase in the usage of direct drive chain saws in Australia and a number of problems associated with the chain performance has become apparent. The purpose of this article is to draw attention to the consequences of using high chain speed and to acquaint the operator with the measures necessary to obtain the maximum life from the chain, bar, and sprocket.

On the modern geared saw the sprocket is mounted on a shaft which is driven from the crankshaft through a centrifugal clutch and a train of reduction gears. The chain speed is about 1200 ft per min. On the other hand, the sprocket on the direct drive saw is mounted on the crankshaft and is driven through a centrifugal clutch at engine speed. The chain speed may be in excess of 3000 ft per min.

Direct drive saws are cheaper, lighter, and easier to operate than geared saws. The high chain speed results in the chain becoming partially self feeding and less effort is required of the operator to cut at maximum capacity. This results in less operator fatigue so that his work output is improved and he is less liable to suffer accidents resulting from fatigue. The direct saw does not suffer to the same degree from "kick-back" when commencing a boring cut, or when the chain suddenly becomes pinched, and so it is generally considered safer than the geared saw.

However, higher chain speeds result in greater wear of chains, bars, and sprockets, and therefore high replacement costs.

Blunt Chains Cause The Most Trouble

At least 80% of all chain saw trouble can be traced to incorrect sharpening and insufficient maintenance of the chain.

When the teeth become excessively blunt it is impossible to force the chain to cut by increasing the pressure on the bar as this will cause clutch slipping. Saws operated too long with a blunt chain have had the clutch drum burnt blue by overheating, with consequent damage to the bearings, and of course the clutch shoes may be burnt out.

With blunt teeth the heavy cutting loads cause the chain to wobble and result in severe chain and bar wear. The rivet heads become polished by the roughly severed wood fibres and lead the unwary operator to the conclusion that the chain has "lost its set". The operator is advised not to attempt to reset the teeth of a chipper chain.

Care Of The Chain

(*a*) *Sharpening the Teeth*

To avoid the effects described above, the cutting teeth must be kept sharp. Furthermore, it is a general rule that the faster a chain travels the greater will be the accuracy of sharpening required to give maximum performance. The teeth must be accurately filed to the same profile, length, and sharpness angle, and must have the same depth gauge clearance.

The sharpening of chipper chains has already been discussed in Forest Products Newsletter No. 256, September 1959.

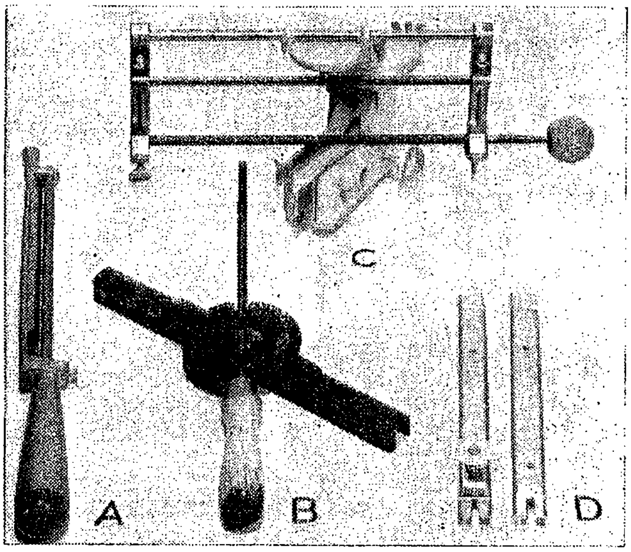

Fig. 1.—A *and* B, *Filing guides;* C, *File–N–Joint;* D, *depth gauge jointers.*

(*b*) *Depth Gauge Clearance*

The depth gauge (sometimes called a raker but incorrectly so, for the depth gauge does not remove wood) is a "stop" which precedes each tooth and limits the tooth bite. Accurate filing of the depth gauges is an essential part of sharpening a chain for use on a direct drive saw. Since the depth gauge has no cutting function it should not be bevelled, but filed horizontally to the desired clearance below the top of the tooth and have the leading edge rounded off to prevent penetration into the wood. This is important.

Some form of filing guide and a depth gauge jointer (see Fig. 1) are essential to enable the chain to be accurately filed. These accessories are not always included in the chain saw tool kit but are readily available from chain saw dealers.

(*c*) *Lubrication*

At all times the chain should receive adequate lubrication. The chain oiler should be continuously operated during heavy cutting but this is not always sufficient as a considerable quantity of the oil is thrown from the chain when it passes around the nose of the bar at high speed. The efficiency of lubrication will be greatly increased if, before making a cut, the chain is oiled whilst travelling at low speed. This may be accomplished by operating the oiler whilst "revving" the motor just sufficiently to engage the clutch and drive the chain at low speed. This will ensure that sufficient oil reaches the rivets and will help to reduce the incidence of chain stretch.

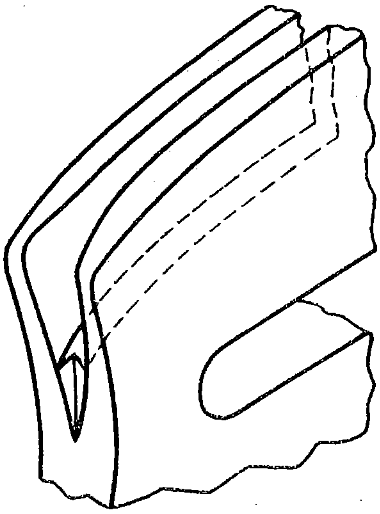

Fig. 2.—*Correct (funnelled) chain entry.*

(*d*) *Tension*

The chain should be tensioned so that it can be easily pulled around the bar by hand, but it should not sag from the underside of the cutter bar. The bar should be supported at the nose whilst the chain tension is being adjusted. If the chain is run too tightly the results may be excessive chain stretch, and excessive wear of such parts as the sprocket, the bearing surfaces of the chain which are supported by the bar rails, and the nose of the bar. Even the special hard alloy insert which is welded into the nose of most solid bars cannot resist this type of wear indefinitely. The nose of the bar may be burnt blue by overheating if the chain is run too tightly or without sufficient lubrication or both. If the chain is run too loosely, it may pound the bar at the point of entry after passing around the sprocket, and cause rapid wear of the bar, the bearing surfaces, and drive links of the chain. The end of the bar should be "funnelled" (Fig. 2) to guide the drive links smoothly into the bar and prevent damage.

The Sprocket

Sprocket wear will be kept to a minimum if the chain is correctly filed, adequately lubricated, and run at the correct tension. A badly worn sprocket (see Fig. 3) will cause excessive chain stretch and severe damage to the driving links. A chain can be ruined by this type of damage long before the teeth have reached the end of their useful life. A new chain should never be fitted to a badly worn sprocket and the operator should therefore carefully check the condition of the sprocket before fitting a new chain. Under normal conditions the sprocket and chain should be replaced simultaneously.

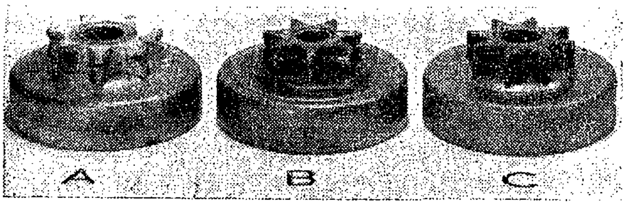

Fig. 3.—Badly worn and new sprockets. A shows extreme wear.

Running In a New Chain

Before a new chain is fitted on the saw it should be thoroughly soaked in lubricating oil (S.A.E. 30) to ensure adequate initial lubrication. The greasy substance on a new chain, used as a rust preventive, may not necessarily be a lubricant. When the new chain is on the saw and adjusted to the correct tension it should be "run in" for the first hour or so by making light cuts where possible and using plenty of oil. Initial chain stretch, which may be greater than the average chain stretch which will occur during the life of the chain, will occur during the running-in period and the tension must be checked frequently and adjusted when necessary. Some saw chain manufacturers also recommend running the chain slowly, without cutting, around the bar for at least 5 minutes while the saw is warming up, *not exceeding half throttle*. The motor should never be raced at full throttle without load. Careful attention to the chain during the running-in period can much prolong its life.

The Cutter Bar

The function of the bar is to guide and support the chain. The chain is guided by the driving links which ride in the bar groove, and the teeth and side links of the chain ride on the rails of the bar which thus supports the chain during cutting. If one rail of the bar is worn more than the other, the chain will lean to one side and it will be very difficult to achieve a straight cut. If the bar rails wear sufficiently to allow the chain driving links to ride on the bottom of the groove the chain will no longer be adequately supported and crooked cuts will result. A wide groove resulting from spreading of the rails allows the chain to wobble and should be corrected by inserting a spacer strip of the same thickness as a driving link into the groove and gently hammering the rails. Whenever a bar shows obvious signs of wear it should be sent to a competent service organization for repair. The rails and nose of the modern bar are specially hardened to resist wear and can be restored to shape only by grinding on equipment specially designed for this purpose.

One function of the chain drive links is to clear sawdust from the bar groove, and the bottom of the drive link is relatively sharp to achieve this. If the sprocket is worn and the drive links ride on the roots of the teeth, the links become rounded and no longer efficiently clear the sawdust from the groove. The drive links then ride on the sawdust compressed in the groove and the chain will no longer be supported by the rails. The groove should be cleaned out whenever the chain is removed and the bar should be turned over periodically to distribute the wear on the rails.

The chains on direct drive saws require more accurate sharpening and more careful maintenance than the chains on geared saws, and even under ideal conditions the replacement costs of chains, bars, and sprockets will be greater.

PROPERTIES OF AUSTRALIAN TIMBERS

Southern Blue Gum

SOUTHERN BLUE GUM is the standard trade common name for the timber of *Eucalyptus globulus* Labill. and *Eucalyptus bicostata* Maid., Blakely and Simmonds. *E. globulus* is also known as blue gum and Tasmanian blue gum. *E. bicostata* is sometimes considered to be a higher latitude variety of *E. globulus*.

Distribution

E. globulus occurs principally in Tasmania, particularly in the south-eastern portion of the State, but is endemic also to the southern coastal portions of Victoria, especially the Otway Ranges. *E. bicostata* is found in the higher tableland country of southern and central New South Wales and central Victoria. *E. globulus* (mainly of Tasmanian origin) has been planted extensively abroad and thrives in varying sites and climates. It has been used in plantations in South Africa, Egypt, Abyssinia, the more temperate parts of South America, New Zealand, and the U.S.A.

Habit

E. globulus in its native habitat is a medium to large tree (attaining a maximum height of up to 250 ft). In plantations height growth may be 7–8 ft a year in favourable circumstances and it may reach 150 ft and 4 ft girth in 30 years. Its bark is smooth and of a bluish or greenish grey colour, and it is deciduous except for the portion at the base of the trunk. *E. bicostata* is of similar form but not so tall and has more persistent rough bark at the base of the stem. Southern blue gum regenerates fairly readily both from seed and from coppice.

Timber

The heartwood of southern blue gum is light yellow brown in colour, with an open texture and commonly interlocked grain, and the growth rings are fairly distinct. The sapwood is somewhat paler in colour and rarely exceeds 1½ in. in width. The timber is moderately heavy, having a density ranging from 42 to 67 lb/cu. ft. at 12% moisture content, the mean being 53 lb/cu. ft. Tests carried out on material from trees less than 25 years of age indicate that the density of younger timber is very variable and is generally less than for mature timbers. Southern blue gum is regarded as being one of the more difficult of the Australian hardwoods to season satisfactorily as it tends to check fairly readily on backsawn faces, and is likely to warp appreciably unless measures are taken to restrain movement. Provided care is taken in the sawing and stacking of this timber, however, satisfactory results can be obtained. (Fairly good recovery in size of material with pronounced collapse can be obtained by the saturated steaming process known as reconditioning.) Advice is available on application to the Division of Forest Products, together with guides to air seasoning, kiln seasoning, and reconditioning.

The shrinkage involved in drying from the green condition to 12% moisture content is 10·8% in a backsawn (tangential) direction, and 5·9% in a quartersawn (radial) direction. In young material the shrinkage rates are higher, 14·4% in a tangential direction and 6·9% in a radial direction. The mechanical properties of southern blue gum justify its ranking in strength group "B" together with such timbers as silvertop ash, blackbutt, yellow box, karri, and turpentine. At 12% moisture content its modulus of rupture is 21,500 lb/sq. in. compared with 19,200 lb/sq. in. for karri, and its hardness 2340 lb as against 2030 lb for karri.

Selected southern blue gum is a good timber for steam bending. It bends very well at 8–6 in. radius but only fairly at 4 in. It is not generally regarded as a durable timber, being included in durability class 3. The sapwood is moderately susceptible to attack by the lyctus (powder post) borer. Some difficulty is experienced in the working of this timber when seasoned because of its fairly dense nature and the tendency for the grain to be interlocked. Nevertheless, with sharp tools good results may be obtained.

Uses

Some of the main uses in Australia are for telegraph and electric transmission poles, cross arms, heavy construction work, house framing, and flooring.

The timber has been used for marine piling in Victoria and Tasmania, and it has given good service in waters where there is little marine borer activity. It is not recommended for use in its untreated form in waters where teredo are prevalent.

It is suitable for poles though preservative treatment of the butt is desirable.

Southern blue gum is used for railway sleepers in Tasmania and to a minor extent in parts of Victoria.

The heartwood of this species is among the more difficult eucalypt timbers to impregnate and high pressures (up to 1000 lb/sq.in.) are necessary for satisfactory results. It is highly regarded for wheelwright work and wagon building because of its strength and good bending properties, being used for spokes, felloes, shafts, swingletrees, and framing. It is also used for boat-building and for pick, axe, and hammer handles.

Availability

Although southern blue gum occurs over a relatively wide range the annual cut is small and supplies are thus somewhat limited. The quality is usually high.

Additional information on this timber is available from the forestry authorities in New South Wales, Tasmania, and Victoria, and from the Chief, Division of Forest Products, 69–77 Yarra Bank Road, South Melbourne, Victoria.

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Sirex— A Threat to the Timber Industry?

By C. D. Howick, Timber Preservation Section

THE SIREX WOOD WASP, although originally a European timber pest, was introduced into New Zealand probably about 60 years ago, and into Tasmania about 10 years ago. Various *Sirex* species occur naturally or have been introduced in England, Europe, Canada, America, Japan, and parts of India. In January 1962, much publicity was given to the fact that *Sirex* had been discovered on the Australian mainland at Woori Yallock in Victoria. The insect would have been introduced into Tasmania and Victoria with timber imports from overseas, despite quarantine inspections and regulations. After its first discovery in Victoria, subsequent investigations over a period of some 5 months located *Sirex* infestations in five Victorian counties covering a wide area. Before this, it is doubtful whether the average timber merchant or builder had a very wide knowledge of *Sirex* and therefore he was not fully aware of its potential as a timber pest.

Timber Attacked

Sirex attack is limited to softwoods, predominantly pine. All trees attacked by the siricid wasps in Europe belong to the pine family, which includes the firs and spruces. In North America there are several species of *Sirex*, each attacking a range of pines and some attacking firs, including oregon. However, at present there is no indication that Australian native softwoods such as hoop, kauri, or cypress pine will be attacked, and in Victoria, infestation appears to be generally limited to radiata pine. Most ornamental garden conifers are also unlikely to be attacked.

As *Sirex* wood wasps attack living trees, freshly felled trees, and green logs, they are essentially a forest pest, and as such, are capable of killing trees in the forest before they reach maturity. Australia has *Pinus radiata* plantations valued at £65 million and therefore, if unchecked, *Sirex* can cause damage of great economic importance. It is, however, important to realize that this insect does not, and cannot, infest seasoned timber, although it is possible for emergence of wasps to occur for a short period after the timber already infested in the forest has dried.

Conditions for Attack

Experience in other countries has indicated that the most serious attack occurs on suppressed, damaged, and burnt trees. It was observed in New Zealand that infestation in a plantation of radiata pine was usually scattered and depended on the vigour of the trees and their moisture content. It was found that following periods of drought, trees with low moisture contents proved to be the most suitable hosts for the development of the *Sirex* larvae and the associated fungus. Once an attack became well established *Sirex* killed a proportion of healthy trees in addition to those which appeared to be sickly or of reduced vigour. Dead trees which have dried out do not appear to be a source of further infestation.

Damage

Tunnelling by the larvae and the emergence holes of the adults reduce the quality and lower the market value of the timber, although actual recovery from the tree may not be greatly affected. In addition, the female *Sirex* carries the spores of a wood-rotting fungus which is responsible for the death of heavily attacked trees. This fungus is injected into the timber at the time of egg-laying, probably to soften the wood around the egg.

Habits

Adult *Sirex* wood wasps do not feed. The males of the species congregate around the tops of suitable trees, but females, after mating, descend to the main trunk of the tree and spend much of their short lives boring tiny holes through the bark into the wood. A female under observation in New Zealand started from a position well down the trunk and worked upwards, ovipositing every few inches and then flying down to repeat the process. It has been noted that female *Sirex* prefer to operate on the more exposed parts of the trunk and limbs, particularly in sunny weather.

In the mature female, the instinct to bore is greater than her egg-laying capacity and thus as many as 10 times more "oviposition" holes may be made than eggs laid. However, when the ovipositor, which operates like a thin tubular drill, is inserted into the tree, it is believed that the fungal spores are always injected, whether an egg is laid or not. The exudation of resin from the punctures probably attracts other *Sirex*, resulting in a heavy infestation of the tree.

It is interesting to record that whereas the eggs of fertilized females develop into approximately equal numbers of males and females, an unmated female *Sirex* is able to lay "fertile" eggs, but these can only hatch into males.

Life History

After about 2 weeks the eggs hatch into larvae, which feed near the surface at first, and later bore into the tree towards the heart. The tunnels may be as much as 18 in. in length, and increase in width as the larvae grow. Towards the end of the life-cycle, the larva turns around and returns to a point near the surface, where it cuts a pupal chamber. After pupation, the adult wasp chews its way out of the timber leaving a characteristic emergence hole.

The life-cycle of most siricid species in Europe appears to take from 1 to 3 years, but the species found in Victoria, *Sirex noctilio*, is thought to take only about 12 months or a little longer to complete its life-cycle under local climatic conditions. It is possible, however, that some larvae which fail to pupate and emerge during the first season may not emerge until the following year. In Victoria, the emergence season may be expected to be in the warmer months of the year, probably from about November to May.

Recognition

Figure 1 shows a larva and pupa of a typical *Sirex noctilio*. The characteristic black spine at the tail end of the larva is present in both male and female.

Figure 2 shows an adult female, with the ovipositor—horn tail—protruding beyond the abdomen. Females tend to be larger than males and may grow to a length of 1½ in. Figure 3 shows an adult male. The adults of both sexes have two pairs of translucent brown-tinted wings. They are easily distinguished from ordinary wasps because of the fact that they do not have a "wasp waist", the body being almost straight-sided.

Evidence of Attack

One of the first indications of *Sirex* attack is the fact that some of the trees in a stand may have dead or dying top foliage. This occurs because the fungus reduces the flow of sap to the leaves and branches and possibly also produces some toxin. After the first season, emergence holes may be seen in the trunk or branches. These holes are almost perfectly round and up to ¼ in. in diameter.

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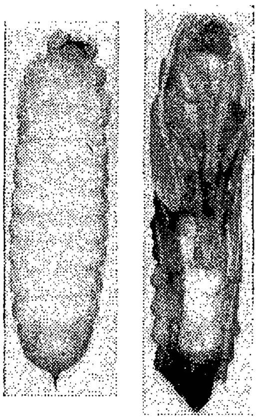

Fig. 1.—Left, larva; right, pupa.

Forest Control

This may be achieved by one or more of the following:

1. Systematic thinning to prevent suppression of trees in the forest, together with the prompt removal of unhealthy and infested trees.

2. The introduction of parasitic wasps (*Rhyssa* sp. and *Ibalia* sp.) which prey upon *Sirex* larvae and therefore help to control the *Sirex* population.

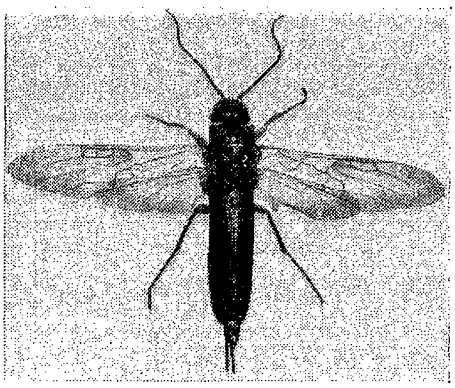

Fig. 2.—Female.

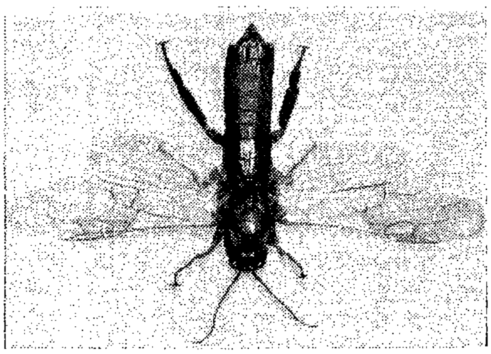

Fig. 3.—Male.

3. Forest spraying with contact and residual insecticides, usually during the emergence season, which will kill wasps actually on the wing and those on exposed portions of the tree.

Some research work is being directed towards the development of a systemic fungicide which, if introduced into the sap stream of the tree, would kill the fungus associated with *Sirex*. It is hoped that this might prevent trees from being killed by the fungus, and might well inhibit the early development of the larvae.

Treatment of Timber

Quarantine requirements state that timber from a *Sirex* infested tree must be treated to ensure destruction of any larvae present therein. This may be achieved by one of three methods.

1. *Kiln Drying.*—Normal commercial schedules are sufficient to kill all larvae in the timber and therefore to prevent any subsequent emergence.

2. *Fumigation with Methyl Bromide.*—The fumigation schedule is varied according to the thickness of the timber and the surface on which it stands during treatment. Ideally this surface should be concrete or plastic film. For example, case timber is fumigated at the rate of 3 lb of methyl bromide gas per 1000 cu. ft. of fumigation space for 36 hr at 70°F.

3. *Heat Sterilization.*—This schedule will also depend on the thickness of the timber; for example, 8 hr at 165°F after preliminary heating to achieve the 165°F at all points of stacks is required for case size timber.

Insecticides applied as a surface spray will not kill larvae below the surface and will not necessarily destroy emerging wasps, and therefore are permitted only as a temporary expedient. The aim of this treatment is more to reduce the likelihood of infestation spreading to other timber in the vicinity than to safeguard the infested timber itself.

What is Being Done

Soon after the outbreak of *Sirex* in Victoria, a National *Sirex* Fund was established. Under its auspices, the Forests Commission of Victoria has carried out numerous inspections in suspect areas. Forestry officers engaged in this work have been gazetted temporary quarantine officers and whenever an infestation is discovered, the area is declared a "quarantine area". When this occurs, any trees with active infestation must be felled and burned at the owner's expense, and restrictions are placed on the movement of any other pine timber from the area. The restrictions require that if any pine timber leaves the area to be milled, it must be either fumigated under quarantine supervision or kiln dried. The only exception to this rule is timber to be milled to a thickness of ¼ in. or less. As it is unlikely that any larvae would survive this milling process, no treatment is required. The Forests Commission of Victoria has further stipulated that all dead or dying pine trees and all pines with recently dead limbs must be destroyed before the beginning of the emergence season. Members of the timber industry can help in this regard by looking for such trees and reporting the location to their State Forest Department.

Quarantine inspection of imported timber as it arrives is aimed at avoiding any further introduction of *Sirex*, in addition to prevention of the spread of *Sirex* on the mainland. Packing cases of susceptible timber are inspected for signs of infestation and any suspect timber must either be destroyed, fumigated, or heat treated as indicated previously. Some countries in which *Sirex* is established treat susceptible timber before exporting to Australia, but unfortunately the reliability of such treatments is sometimes questionable.

Can *Sirex* Be Controlled?

The extent to which *Sirex* has become established in Victoria will not be fully known until the end of the 1962–63 summer. Precautions have been taken to eradicate existing *Sirex* infestations and to prevent any *Sirex*-infested timber finding its way on to the Australian timber market. Despite these precautions the control of *Sirex* is a formidable assignment, and the degree of its success depends largely on the cooperation of the public and the timber industry.

Personal

MR. H. G. HIGGINS, Senior Principal Research Officer, of the Division of Forest Products, has been advised that he has fulfilled the requirements for the degree of Doctor of Applied Science in the University of Melbourne. He will be the first recipient of this degree.

His thesis consisted of published papers collected under the general title "Studies on Cellulose and Paper, Properties of Wood, Casein Gels and Protein Reactions". These cover work carried out in the Division between 1945 and 1961.

DONATIONS

The following donations were received by the Division during September and October:

Boyne Valley Sawmilling (Builyan) Pty. Ltd., Qld.	£100
State Timber Board, Burma	£5
Hickson's Timber Impregnation Co. (Aust.) Pty. Ltd.	£100
P.G.H. Wood Products Pty. Ltd., N.S.W.	£25
Dunlop Rubber Australia Ltd.	£260

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