Western Australia.

FORESTS DEPARTMENT.

Notes on the Forests and Forest Products and Industries

OF WESTERN AUSTRALIA.

Issued under the Authority of
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FOREWORD.

The purpose of this pamphlet is to present in popular form a series of short pen pictures of forestry objects. The forests of Western Australia beyond a shadow of doubt form the State's largest and most valuable visible asset, and this asset has a quality which belongs to few of its other natural sources of wealth. The forests are inexhaustible if properly managed. The gold from the mining field cannot be replaced, and, once exhausted, what has been at one time a scene of busy industry, lapses into waste. The forests, however, under capable management may continue to yield their riches in perpetuity. In the past our forests have been treated with a recklessness almost wanton; they have been destroyed, and no attempt has been made to replace the lost wealth.

In these pages many phases of forest problems are touched upon, the whole object being to inform the people of the State exactly regarding the extent and nature of their forest heritage, to point out that, as the forests have been of inestimable economic value in the State's progress, so they deserve kindly consideration at the hands of the people. If these pages assist in arousing in the minds of the Western Australian public a consciousness of the intimate relationship that exists between the State's economic progress and its forests, they will have served their purpose. The Forests Department is now engaged in the work of regenerating cut-out areas and repairing the havoc of the past, and its work will be infinitely assisted if those at the head of affairs know that behind them they have the strong support of an united public opinion. That this support will be given I do not doubt. The facts for forming such opinion will be found in these pages, and those who read them will, I feel certain, be impressed not only with the supreme value of the forests to the State, but interested in the romance that has attended one of the State's great primary industries.

J. SCADDAN,
Minister for Forests.

June, 1920.

The Significance of Forests.

Of the many forms which a nation's national heritage may take, there is none so valuable as forests. Precious stones and metals may bring riches, but, exhausted, they cannot be replaced. No art of man can induce nature to reproduce mineral wealth that has been removed. But forests, unless wantonly destroyed, may go on reproducing themselves for ever—a never failing source of wealth and an ever present asset to the community possessing them. In the forest, for the mere trouble of reaping, we find a material which fills more human requirements, meets more human necessities than any other. Nature has been generous to Western Australia, and in the great jarrah and karri forests the pioneer white men found stored the accumulated wealth of centuries. Natural forest resources possess an important element which is absent from other of nature's gifts. They are capable of yielding increased returns to increased activity. In other words, man by the exercise of care and skill can induce a natural forest to produce more abundantly than it does in a virgin and uncultivated state. Upon this provision of bountiful Nature, the science of forestry is founded. Look all around, form judgments on all that is seen, and ask is there any material which is more often and more intimately connected with man's welfare than wood? There can be one answer only. There is no such material. Wood is more than necessary for men's comfortable existence through life. Without it life would be unendurable. Without forests man could never have emerged from primitive barbarism. He must have for ever remained a cave-dweller. Without timber he could have crossed no great stream, nor traversed the ocean. He would have been condemned for ever to entire ignorance of the lands and peoples beyond the seas which washed his own shores.

But the significance of forests as factors in human development is not limited to the raw timber derived from them, and the numberless functions it is capable of fulfilling. With the advance of civilisation and the increasing demands for suitable materials for meeting new wants, the latent possibilities of wood began to be tested, and the results of these tests have been as marvellous as they have been satisfactory. Under distillation new products of wood have been brought to light, all of them of value in arts and manufactures. To-day many avenues of employment and of wealth are dependent wholly upon substances derived from wood. Under distillation wood yields pyroligenous acid, charcoal, gas, tar, and many other substances of prime value to man in his commercial relations. From this it is possible to form some conception of the importance of the part played by wood in all industries dependent, wholly or partly, on chemical products.

The following eloquent tribute to the value of trees is taken from the "Forest Club Annual" of the University of Washington:—

"Trees are the arms of Mother Earth lifted up in worship of her Maker. Where they are, Beauty dwells; where they are not, the land is ugly, though it be rich, for its richness is but greasy fatness and its gaudy raiment is but cheap imitation of forest finery.

"Trees are the shelter of men and beast and bird; they furnish the roof above us, the shade about us, and the nesting places of love and song. They call children out to play; they entice sweethearts into leafy coverts to seal their vows with fond caresses; they console and gratefully reward old age. They are the fittest ornaments of wealth and the inalienable possessions of the poor who can enjoy them without having title to them. They are the masts that fly the flags of all nations and the sails of all the seas; they are the timbers that bridge forbidding streams; they bear the wires of the world's intelligence; they hold the rails that carry the traffic of the continents; they are the carved and polished furnishings of the home; they cradle the young and coffin the dead.

"Trees are nature's prime sources of food; their fruits and nuts gave sustenance to the first tribes of men and are the sweetest and most nourishing of the earth's products.

"Trees herald the spring with glorious banners of leaf and bloom; they clothe the autumn in garments of gold and royal purple; bared to the winter's cold, they are the harp of the winds, and they whisper the music of the infinite spaces.

"Before the earth could be peopled it was set thick with trees; and when man has run his course and the race we know has disappeared in the completeness of its mission or perishes in the destruction of its trees, the earth will spring up again with new forests to shelter and sustain a new race of

men and beasts and birds to work out a greater destiny. Perhaps if we are wise enough to replenish our wasting forests and to make ourselves worthy of the gift of trees, we may be permitted to accomplish that greater destiny which the Mighty Forester, the Perfect Orchardist, the Loving Father requires in the fulfilment of His sublime purpose."

FORESTRY A SCIENCE.

Forestry is a science and, without unduly straining language, it may be asserted that it is a science that, so far as the British Empire is concerned, has been lost and rediscovered. When England was dependent wholly upon her own forests for the timber with which to build her ships and, in great part, her houses, and to fill the many uses in industry to which wood is put, her forests were managed with skill. Their protection against unwise destruction, the cutting of the timber, the replanting of cut-over areas were among the duties of those who followed the craft of forestry. The forester in England in those days was a person of some importance, and the value of his services to the community was fully recognised and fittingly rewarded. But, when England became a commercial nation and her ships traded in every sea, foreign timbers gradually began to be introduced, and the time came when almost the whole of the timber used was imported from abroad. With the rise in importations, the national forests were neglected, much of the best woodland was denuded of timber, and the land given over to agricultural and other purposes, and forestry lore was neglected, and the ancient and honourable craft of forestry fell on evil days.

For something like two centuries England has depended upon foreign countries for her timber supplies, but the disastrous experiences arising out of the war have demonstrated the folly of such a course, and to-day the British Government is actively engaged in fostering the reforesting of every suitable acre that is not required for food-raising or other essential purpose. In other words, scientific and economic forestry is being reborn in England. In these days the significance of the word "forest" has come to mean any woodland area that has become an object of care, with a view to its protection against wanton destruction and its protection, so that its productive capacity may be maintained and increased. The treatment of forests on sound rational and

scientific principles so that the best financial and economic results may be got from them, constitutes the science of forestry.

The Science of Forestry covers the Art of Sylviculture and the Art of Arboriculture. Sylviculture, or forest crop production in its widest sense, may be defined as the application of knowledge regarding the life history of trees to the practical task of growing them. And the forester must not only know the general features of the biology of the species, their development from seed to maturity, and their requirements as to soil and moisture, but, as he is producing something for revenue, he must also take cognisance of the amount of production and the rate at which that production takes place. Arboriculture may be said to be the growing of trees for any purpose not primarily financial or economic. The arboriculturist considers the aesthetic value of trees in city gardens or streets or pleasure reserves, or as game coverts, or for any other purpose in which timber production for sale is not the main element. The differences between sylviculture and arboriculture are analogous to those existing between agriculture and horticulture. The forester— the man engaged in the work of scientific forestry—must of necessity have a wide knowledge not only of sylviculture and arboriculture, but of those sciences which deal with the physical properties of soils and forest botany, geology, and entomology. He must be familiar with the principles controlling the relationship between forest climate and production, and he must have made a study of the physical properties of timber. A forester's scientific training and his assimilation of the basic principles of sound forestry enable him to develop positive methods in the treatment and preparation of forests. And to the technical capabilities necessary to the successful application of the science of forestry, a forester must add the business knowledge requisite to administer the financial and economic interests involved in his calling.

FOREST CAPITAL AND FOREST INTEREST.

The "capital" of a forest may be defined as the total amount of marketable timber it contains; the "interest" is the total annual growth of the trees, in other words the percentage by which they increase in volume. In a forest in

which a large proportion of the trees are mature or over-mature, the ratio of annual growth is relatively small; in the case of a forest which contains a large proportion of young and immature trees, the ratio of annual growth is relatively large. In a "natural" forest, that is a forest which has received little or no attention at the hands of a skilled forester, the annual growth is much less than is the case in a "cultivated" forest. In a "natural" forest there are to be found many imperfect trees—mis-shapen, fire-damaged, or otherwise defective and incapable of developing into trees suitable for milling purposes. In a "cultivated" forest all these imperfect trees would have been removed, and the space they occupied filled with trees capable of developing into marketable timber. Forest cultivation, therefore, increases the yield of timber, in other words increases the annual interest on the forest capital.

Eucalypts native to Australia have been introduced with remarkable success into other countries, and in all of these countries the annual rate of growth is greater than in Australia. The reason for this lies on the surface. Wherever the eucalypt has been planted abroad it has been carefully "cultivated." Imperfect trees have been weeded out as soon as their imperfections have become visible, and nothing that does not give promise of yielding first-class timber on maturity has been allowed to remain. In India, South Africa, and California great attention has been paid to the growing of eucalypts. Writing of eucalypt cultivation in its report for the year 1912-13, the Board of Scientific Advice for India says:—

"The figures collected in the plantations of the Nilgiris show some astonishing results in the rate of growth of *eucalyptus globulus* (blue-gum). Many annual increments of 527 cubic feet per acre and of 815 cubic feet in the case of seven-year old coppice show that this species uses the productive qualities of the soil to the extent of forming, in the case of coppice, over 16 tons avoirdupois of wood in one year per acre."

In South Africa karri has shown a yield of 400 to 500 cubic feet per acre per annum, and that country is now taking £26,000 annually out of the thinnings of her plantations. Speaking on this subject in the Legislative Council on the 5th of December, 1919, the Hon. John Nicholson said:—

"It has been demonstrated that karri land without any expenditure of money whatever, with no care or forestry treatment, will grow this valuable timber at the rate of 100 cubic feet per acre per year. The age of maturity of the species has not yet been ascertained, but it may be put down at a maximum of 100 years. We may, therefore, expect without any expense of

sylvicultural operation 100 x 100, or 10,000 cubic feet of timber (200 loads) to the acre at maturity. Much more than this has actually been cut from an acre by the State saw mills at Pemberton on virgin forests, so that 10,000 cubic feet may be regarded as a moderate estimate for an even stand of karri. This is the country that has been given to the settler at £1 8s. per acre. With proper forest management the rate of growth will be far higher than 100 cubic feet per acre."

Sir. D. E. Hutchins, a forester of world-wide reputation, and author of "A Discussion on Australian Forestry," writes:—

"Yields Compared—Cultivated and Wild Forest.—The wild forest is usually characterised by very heavy yields of timber over certain areas, but with a much lower useful and general yield. Some of the record yields of timber from virgin forests are astonishing—up to 100,000 cubic feet per acre in the case of Redwood and certain patches of heavily stocked Coniferous forest. The Douglas-pine (*Pseudotsuga douglassii*) has perhaps the heaviest stock over any large area; but the general position is that the cultivated forest is much more productive than the wild forest. It is the main part of the science of modern forestry to so regulate the cuttings that the forest undergoes a gradual and continual improvement. Statistics show that the yield from many of the cultivated forests of Europe has doubled during the last half-century. Careful statistics showed that the Prussian forest doubled in value between the years 1850 and 1890."

FOREST POLICY.

From what has been said about the scope and objects of forestry and the work of a forester, it becomes evident that the management of woodland resources must be carried on in accordance with a mixed plan if the best is to be made of them. In every large business or undertaking method must be evolved and prevail throughout the whole of the operations. The work of the forester from its very nature calls for a system, the continuity of which must not be disturbed. The forester has to take long views, for a century may elapse between the sowing of the seed and the reaping of the mature tree. Briefly put, the object of laying down a fixed system of forest management and exploitation—a forest policy—is to conduct the business of the forest in a way that will ensure to future generations a sufficient supply of timber. In conducting their operations the sawmiller and others have a definite object in view—that of getting as much timber as they can in the shortest possible time. They remove the best and most desirable trees, leaving the inferior, badly grown or mis-shapen trees still standing. Such a course, if continued, leads to a change in the composition and quality of

the trees, the forest is deteriorated in value, and its future productiveness impaired. Improvident misuse of any natural resource is a matter which calls for interference or regulation by the State in the interests alike of its present revenue and of the future. In every civilised country this interference takes the form of a department whose duty it is to see that wise measures of exploitation are adopted and carried out. There are several ways in which the State can beneficially exercise its regulating and protecting powers for the public good. In a country such as Australia, where the people are the real rulers, the Government—the people's representatives and executive—must find its most effective aid to protecting national wealth in such educative measures as shall convince all that ill-advised use of a natural resource must inevitably lead to its destruction. When once a free community has become seized of the fact that its own interests are intimately bound up in the conservation of a natural resource, that resource will not longer be misused, for the people themselves will insist upon the adoption of adequate measures for the safeguarding of their property.

Such a policy of conservation is an urgent necessity for Western Australia, for ever since the foundation of the Colony the forests have been cut down, with no thought for future requirements. The timber industry has always held a foremost place in the State's activities. It gives employment to thousands, and is the solid basis of a comfortable existence for tens of thousands. If the forests are to continue to be a national asset of the first rank, work in them must be conducted in such a way that only the crop they annually yield must be annually reaped. And the only effective way for the attainment of the condition aimed at by the administration is the adoption of a policy of conservation with a regulated exploitation, and the single object of getting the best out of the forests for the welfare of the people of the State now and to come. Such a policy would necessarily include:—

The classification of the land with a view to the demarkation and survey of the forest estate.

The permanent reservation of this estate.

The appointment of a certain number of highly-trained officers to draw up the plans necessary for the management of the forests.

The establishment of one sound forest school for the training of the professional staff.

The training of a subordinate staff in the practice of forestry.

The establishment of a Forest Products Laboratory to investigate the commercial possibilities of our wealth of forest produce.

The initiation of a wide publicity campaign in order to awake a forest conscience in the minds of the people.

Generations ago the increase in the cutting of the native forests created some public alarm, and a gallant effort was made to stem the tide of destruction and to introduce a policy which would conserve the forests. Speaking on this matter in the House in September, 1918, Mr. R. T. Robinson, K.C., Minister for Forests, said:—

"The Government of that day appointed a skilled and expert forester, Mr. Ednie Brown, to advise as to what course should be adopted. Unfortunately for Western Australia, Mr. Brown died very soon after his arrival in the State, and the Government that appointed him went out of office. Before Mr. Brown died, however, he managed to awaken in the public a sense of their duty, and he drafted a Forests Bill, a Bill which differed very little from the one now placed before hon. members. Had that Bill become law I feel sure that the management of the forests of the State would have been placed on a sound foundation. Alas! with Mr. Brown's death died also the Forests Bill, and the country once more threatened to sink back into a slough of apathy regarding forestry. A small band of men who had been associated with Mr. Brown in his work and had learned from him something of his ideals, and of the theory and practice of forestry, strove hard to keep alive the spark of enthusiasm which he had kindled, and they so far succeeded that in 1903 a Royal Commission on Forestry was appointed to investigate the whole subject. I will have occasion to read many recommendations from that Commission. This is what the Commission had to say about the appointment of an expert forester:—'Evidence afforded by the experience of other countries, as well as that of this State (as indicated by evidence given before the Commission) seems to prove most emphatically that no forest conservation worthy of the name is practicable until the forest lands shall have been placed by Statute under the control of a well-manned and properly equipped Forests Department.' And later, in the second portion of their report, the Commissioners say:—'The evidence attached hereto supplies much information on the questions raised in this second reference to the Commission, all of which has strengthened the opinion of the Commission as to the utter impossibility of making adequate provision for conserving the forest interests until they shall have been placed under the administration of an Inspector General qualified by experience and scientific training.' This is what the Commission recommended regarding the Advisory Board:—'Realising, however, a possible delay in obtaining an officer qualified to fill the important position of Inspector General, the Commission is of opinion that no time should be lost in securing the legislation necessary to put the administration under the effective control of a board as suggested. Such a Board would find ample occupation in establishing some degree of order out of the present destructive chaos, preparatory to the appointment of an Inspector General.'"

Nothing came of the Commission's recommendations, and the position gradually got worse and worse until public opinion again forced the hand of the Administration, with the result that a skilled forester, Mr. C. E. Lane-Poole, was appointed to take care of the national forest resources. The task in front of him is one that might well daunt most men, but Mr. Lane-Poole is throwing himself into it with characteristic energy and enthusiasm, and is gradually evolving forestry order out of forestry chaos. "The Forests Act of 1918," referred to elsewhere, provides him with certain powers, and these he is exercising to the fullest extent. It will be years before the effect of Mr. Lane-Poole's administration can be seen, for the forester pre-eminently has to take long views, but with public opinion behind the Forests Department, there can be no doubt as to the result. There must inevitably arise a period during which there will be partial stagnation of forestry activity. There are still in existence old contracts covering hundreds of thousands of acres, and many permits also covering large areas. When these contracts have expired the export trade in jarrah will practically die, until a new crop has grown. Western Australia has been a timber spendthrift and, like all spendthrifts, a time must arise when there must be a cessation of spending and a husbanding of resources in creation of fresh wealth.

FOREST ADMINISTRATION.

The world of the present day is widely and deeply deploring the short-sightedness and apathy of past generations in respect of forestry matters. A world-shortage of timber is threatened, and those nations which have not already done so are hastening to adopt measures for the protection of what remains of their forest, for the regeneration of despoiled areas and for planting new ones. From the inauguration of Western Australia in 1829 until the end of 1918, the vast forest heritage of the State was, to all intents and purposes, at the disposal of any who cared to make use of it. For many years no restrictions at all were placed upon cutting. After the lapse of more than a generation certain regulations were brought into force, but these had reference only to revenue, and no attempt was made to reforest cut-out areas nor to regulate exploitation. It was not till the year named that

the forests were administered under certain clauses attached to the Land Act. In December, 1918, a Forests Act was put upon the Statute Book "to provide for the better management and protection of forests." The following is a brief summary of its provisions:—

Part I. is preliminary, and deals with interpretation, repeal of previous authority, preservation of existing rights, and powers to extend.

Part II. incorporates the Forests Department and the appointment of officers, the Conservator being declared to be a corporate body. The qualifications, training, and duties of officers are also defined.

Part III. deals with State forests and timber reserves. It provides for classification and dedication of forests, the purchase and resumption and exchange of land, reservation of timber reserves.

Part IV. deals with permits, licenses, and forest leases and royalty.

Part V. has reference to financial provisions. Three-fifths of the net revenue of the department, to be certified by the Under Treasurer, is in every financial year to be placed to the credit of a special account at the Treasury, and is to form a fund for the improvement and reforestation of State forests and the development of forestry.

Part VI. deals with regulations, which may be made by the Governor on the recommendation of the Conservator.

Part VII. is devoted to offences, penalties, and general provisions. In this part it is provided "a day shall be set apart in every year for the planting of trees in the several land divisions of the State, and such day shall be called 'Arbor Day.'"

The forest "Working Plans," on which the continuity, and, incidentally, the whole future of the forests depend, are laid down by the Conservator, and, having been approved, cannot be altered except on the recommendation of the Conservator. Under the planting provisions of the Forest Act the Parliament of Western Australia has wisely introduced clauses designed at once to assist the farmer, and by so doing to extend the State's production of timber on alienated land.

It is provided that—"On the disposal of land under the conditional purchase provisions of 'The Land Act, 1898,' it shall be a condition that the purchaser shall use an area of not less than two per centum of the acreage of the holding acquired by him for the growth of timber or other forest produce," and in a subsequent subsection it is declared that "the planting of trees on not less than five acres of any such land shall be deemd an improvement within the meaning of the Act."

FORESTRY AND EMPLOYMENT.

The forests of Western Australia in normal times give employment to over 5,000 men working in various capacities in the mills and in the bush on behalf of the mills. Outside of this there are employed directly in the forests only the officers attached to the Forests Department, but under a scientific system of forestry the woodlands of the State would find constant employment for a very much larger number of men. According to a return prepared in South Australia from official reports, the number of persons employed by the Forestry Departments of the various States in the Commonwealth in 1910 was 220, and this figure includes office staffs. It does not strike one as extravagant, and even if it has increased by 50 per cent. since 1910—which is very doubtful—the total is still absurdly small compared with the interests involved. But the extremely attentuated numbers forming Australia's official forest workers are in keeping with the general public attitude in the Commonwealth in regard to forestry questions. They reflect the common apathy which exists in the matter of the care and preservation of the national forest wealth. We have to look around in order to acquire some knowledge of the part that properly managed forests may play in the economics of labour.

In Belgium, prior to the war, the total area of State forests was only 430,000 acres, yet employment was given to 32,000 workers in winter and to 750 all the year round. In Germany, in the winter months, the average labour employed in the Bavarian forests is one man to 40 acres, and, taking all the year round, one man to 130 acres. The whole State forests of Germany total 35,000,000 acres, on which 1,250,000 people live directly, and 3,750,000 live on industries dependent on the products of the forests.

Such instances might be multiplied, but sufficient have been adduced to support the contention that properly managed forest areas absorb a very large amount of labour. An expert, who examined the forests of Australia two or three years ago, in his report on the labour question put the matter thus:—"Perhaps the worst error in the history of Australian colonisation has been allowing good forests to be destroyed for sheep-grazing. A reliable estimate of the employment on a sheep station gives one man for every 7,500 sheep, or, perhaps, as an average for forest lands, one man for every 7,500 acres; while ordinary forestry, when systematically practised, gives employment throughout the year at the rate of one man per 800 acres. So that, approximately, forestry gives ten times the employment that sheep do. And yet this squandering of the public estate, this reckless loss of rural employment still continues!" Most public work must be done when it is wanted, but there is always a store of forest work that can be hastened or postponed with little inconvenience. That is a question for the forest "working plans" and the forest officers who are carrying them out.

Outside the question of the vast regular employment which a forest, under proper control, can provide, and beyond the rural population attracted by dependent industries, there is the unemployed problem, which becomes more or less acute from time to time. Australia has its unemployed. Says the *Age* (Melbourne) on 29th March, 1915, in an article on State forestry:—"Thousands of pounds have been spent to provide the unemployed with work of such little value that they might almost as well have been engaged carrying bricks up a ladder in order to carry them down again, yet here is profitable work for thousands. In this fine undertaking (forestry), as well as for the planting of exotic timbers, the State wants, first of all, direct and independent control, a Forestry Department free from political influence, managed by an expert who has the knowledge of a skilled forester."

Another difficult problem which an intelligent system of forest management would go a long way to solve is that of rural depopulation. This is admittedly one of the great social problems of the day, and one which is yearly increasing in intensity. It is not confined to any one country, but seems to be common to most where industrial undertakings are conducted on a large scale. Those countries without forests, or with only woodlands of small extent, do not possess a potential means of relief which exists in those more bountifully

supplied with natural timber resources. Australia is happily endowed in this respect. In every one of the States, forestry places it in the power of the Government to do something definite towards keeping people in the rural district. The opening up of the country, by the organisation of the forests, and the considerable expenditure in so doing, would also be a powerful assistance to many of the struggling agriculturists in the forest regions.

It is evident, therefore, that from the standpoint of national economy, every productive employment of labour, directly or indirectly concerned, is of great moment. Forestry is the twin-sister of agriculture, and it is often attempted to make comparisons between them in national economic value. Such comparisons must always be in the nature of doubtful estimates. Everything depends on the degree of intensity which has been applied to the particular industry. It would be unfair to compare, for labour-absorbing statistics, an area of agricultural land, intensely cultivated with a like area of virgin forest. Agriculture certainly directly employs more labour than forestry, but economically the forest still more than holds its own. An American forestry professor crystallises the point thus:—"If forest affords only one dollar per acre in labour earnings, it also gives rise to a labour-earning of over three dollars per acre in wood-working industries."

Scientifically organised, forestry pays the State in every way. It yields a handsome profit on the annual output, and it goes a long way to check abnormal concentration of population in the capitals, and in it the unemployed may find productive labour.

FORESTS AND CLIMATE.

The question of the influence of forests upon climate has engaged attention from the earliest times. Even as early as the Roman days it was recognised that too great a clearing of woodland areas brought undesirable changes in the physical conditions of Italy, and affected the welfare of the inhabitants adversely. The time was when Sicily was well-wooded. It was then the granary of Rome. Its woods were

cut down, and its productiveness was so seriously reduced that it scarcely produced enough for the use of its own inhabitants. Cyprus is another instance of the evils which follow unwise deforestation. Early in the 19th century vast woods in the French Alps in the southern portion of France were cut down. The results were disastrous. A few years after their destruction the Agricultural Society of Marseilles reported that, in consequence of the reckless destruction of the forests after the Revolution—"the winters are colder, the summers hotter, and the beneficial spring and autumn showers no longer fall. The Uveaune, flowing from east to west, rushes down in flood with the least rain, carrying away its banks and flooding the richest pastures, while for nine months of the year its bed lies dry owing to the drying up of the stream."

The deductions from these facts are obvious. Authorities of the highest order give the conclusions that they have arrived at in no uncertain manner. De Humboldt, in his great work "Kosmos" refers to the influence of forests in lowering the temperature of the whole surrounding region. He ascribes the reason to the following:—

1. The canopy formed by the crowns prevents the heating of the soil by direct sun's rays.
2. The evaporation of moisture by the leaves.
3. Night radiation resulting from the wide extent of surface made up by the foliage.

Investigation by competent observers has shown that the total quantity of moisture returned into the atmosphere from a forest by transpiration and evaporation from the trees and the soil is about 75 per cent. of the precipitation. For other forms of vegetation it is about the same, or sometimes larger, varying between 70 per cent. and 90 per cent. Scientific investigation into the question has received greater attention in France than in any other country, and the results arrived at point unmistakably to the fact that forests not only equalise temperature and increase precipitation, but by holding up a large percentage of the rainfall and giving it off gradually, cause rivers and streams to flow with a nearly equal volume at all seasons of the year, whereas, in a country that has been devastated rainfall, as was the case in the Landes, would take the form of rushing and destructive streams followed by long periods of dry watercourses.

The temperature of the air in a forest being lower than the surrounding country, it is natural that more condensation takes place. To prove this, M. Mathieu in 1866 established three research meteorological stations—

1. In the centre of Foret de Haye, area 14,000 acres, there is a clearing known as "Cinq Tranchue," where the forester's house is situated. Here one rain gauge was erected. Adjacent to this, but in a 40-year old dense stand of beech and hornbeam a second rain gauge was erected. Now, in a dense forest, the amount of water reaching the gauge depends on the amount of opening in the leaves above it. To eliminate all errors a gauge was made having the same large surface as the crown of a selected tree, and this was built around the tree itself.

2. The second station was chosen at Bellefontein on the edge of the Foret de Haye. Here another rain gauge of ordinary construction, but of very large dimensions, was established.

3. Finally a third station was established at Amance in purely agricultural country.

All three stations were within 10 kilometers of Nancy and at the same altitude.

Records were kept from 1866 to 1882, when it was found necessary, for some reason, to move the Amance station to Champenaux. The following table explains itself:—

Total rain recorded from 1867-1899 in mm.—
Station 1—28006.1 mm.
Station 2—26295.4 mm.
Station 3—21470.3 mm.

Average fall per year—
Station 1—848.7 mm.
Station 2—796.8 mm.
Station 3—650.6 mm.

Expressed as a percentage—
Station 1—100.
Station 2—93.9
Station 3—76.7.

It will be seen that more rain falls within and in the neighbourhood of a forest than in bare country. The records for each year bear this out. M. Mathieu's experiments at Nancy have been repeated in pine forests, oak forests, in Germany, and in Switzerland, and they have all resulted in the same conclusions.

Springs are affected by the infiltration of rain. Rain falls on the earth, percolates through, and either finds its way out as in hilly regions in the form of springs, or dams itself up in subterranean lakes. Do forests increase the flow of springs? From time immemorial the answer has been "Yes." Buffon, writing in 1730, said—"The more a country is denuded of timber, the poorer does it get in water." The French Forest Law of 1827 lays it down that the forest officials must oppose the destruction of forests so that the springs and rivers may be protected. A wide study of the question points to the following conclusions:—First, that where forests exist larger quantities of water reach the soil than in places that are bare; and second, that the proportion of water which, having reached the soil, is allowed to reach the subterranean water level is greatest in forested country.

The conclusions on the whole matter which have been reached by investigators may be summed up as follows:—

1. Forests increase the rainfall. This is proved beyond doubt, in spite of the fact that many persons still continue to deny it. It amounts to 23 per cent. increase, and this is a mean of 33 years records at Nancy.
2. The forests retain some of the rain in the branches and leaves. Against this, however, the crowns condense more water, being colder. So that the forest soil receives more water than bare country.
3. Forests diminish the evaporation from the surface of the soil to an enormous extent, and also hold up the run off. So that in hilly and mountainous country the forests increase the subterranean waters enormously.
4. As far as we know at present forests do not, however, increase the supply of subterranean water in plain or level country. In fact it would seem that the trees, as opposed to grass or other shallow-rooted crops, take up more water from the soil, and so

lower the general level of subterranean waters. The question is not finally settled, and many contradictory results have been arrived at.

5. We must remember that springs are only numerous and big in the hills, and that the forest most certainly increases and maintains them through the dry season. In plain country springs are rare and of little importance, so that we may say as the old French foresters did, that forests are the mothers of rivers.

In the South-West of Western Australia the whole water supply depends on the springs in the Darling Range, and the conservation of the forests in the catchment areas is the duty of every good citizen. If this is not done the run off from the hills during the winter will increase the torrential characteristics of the streams, and in the summer the streams will become detached pools. People visit Mundaring Weir to see what has been calculated at 300,000,000 gallons of water going to waste. Were the catchment area under dense forests that immense run-off would be held up late into the summer, so that the weir would remain full all the year. A past and foolish Government destroyed the forests of the catchment area. They argued that what happens in the plains will happen in the hills. Let us hope they have learnt a lesson.

Summing up a discussion on the co-relation of forests and moisture precipitation, Dr. James Brown in his work, "The Forester," says:—

"From a consideration of these facts it appears evident that, within certain limits, of course, by the distribution of plantations of such extent as may be suited to the particular circumstances of each case, it may be in the power of man to modify certain local climatic conditions so as best to suit the various kinds of crops he cultivates in different localities."

From what has been said it is evident that Western Australia, in the interest of her farmers, as well as of forest workers, must preserve every acre possible of forested country, and must regenerate cut-over areas as well as engage in planting of suitable areas with other varieties of trees than those indigenous to the country.

Western Australian Forests.

HISTORICAL.

It is a plain statement of fact to say that Western Australia owes its inclusion in the British Empire almost wholly because it possessed immense forests of valuable hardwoods. The Western portion of Australia 120 years ago was a "No-man's Land." The British Government had not made up its mind whether it should annex it or not, and by way of finding out whether the territory was worth anything at all a small settlement, composed mainly of a military detachment from Sydney, was quartered on King George's Sound. This settlement was given the name of Fredericktown, and Albany now occupies its site. After a while it was decided to withdraw the settlement, but, before doing so, the New South Wales Government informed the Home authorities that there were immense forests of magnificent timber in the Southern portion of the territory, and extending, as far as could be gathered, over many miles northward and westward. This information reached the Admiralty in London and, as timber suitable for shipbuilding was an item of prime importance in the naval dockyards, it was decided that the Western portion of New Holland after all ought to be occupied, and formally annexed to the British Crown. The result of all this was the establishment in 1829 of the Swan River Settlement.

The first buildings in Perth, Fremantle, Guildford, York, Bunbury, Busselton, and throughout the districts occupied by settlers were all of timber found on the land. The necessities of the settlers early made them acquainted with the value of jarrah as a building material, and within 10 years of the foundation of Perth, the question of exporting jarrah—then known universally as "mahogany"—began to attract attention. It is difficult for present-day citizens of Western Australia to realise the obstacles which beset those pioneer exporters. They were without appliances for handling heavy weights. There were no railways; there were no jetties, and at Fremantle every ounce of cargo had to be lightered to and from the vessel lying in Gage Roads. But these early men

were stout of heart, and were not discouraged by difficulties and disappointments. By slow stages and with the help of bullocks and horses they managed to get the sawn timber to the beach. It must be recollected also that there was no such thing as a steam sawmill in those days. Everything was done by hand. A very common method of converting a tree was, after it had been felled, to dig a sawpit close by the trunk as it lay, and then laboriously by hand cut it into the sizes wanted. In a local paper printed in 1845 there is a curious account given of the difficulties attending the transport of a log that weighed seven tons from the Canning to Fremantle. We read that "after great labour the log was slung in chains and then transported for a quarter of a mile, when the chains broke like bundles of twine." Then the writer of the paragraph goes on to say, "it will be a matter of great difficulty to get this huge log to the beach, and we confess that we do not see how it is to be got on board any vessel."

The first steam sawmill in the Colony was erected in Guildford, and the day it was opened was held as high holiday, and the Governor and many of the principal residents in Perth journeyed to Guildford by water to see the marvellous process of cutting jarrah into boards by a circular saw driven by steam. The next sawmill was close to Mt. Eliza, Perth, and was in Mr. Monger's timberyard. Mr. Monger seems to have been the first to open a regular yard for the sale of sawn local timbers.

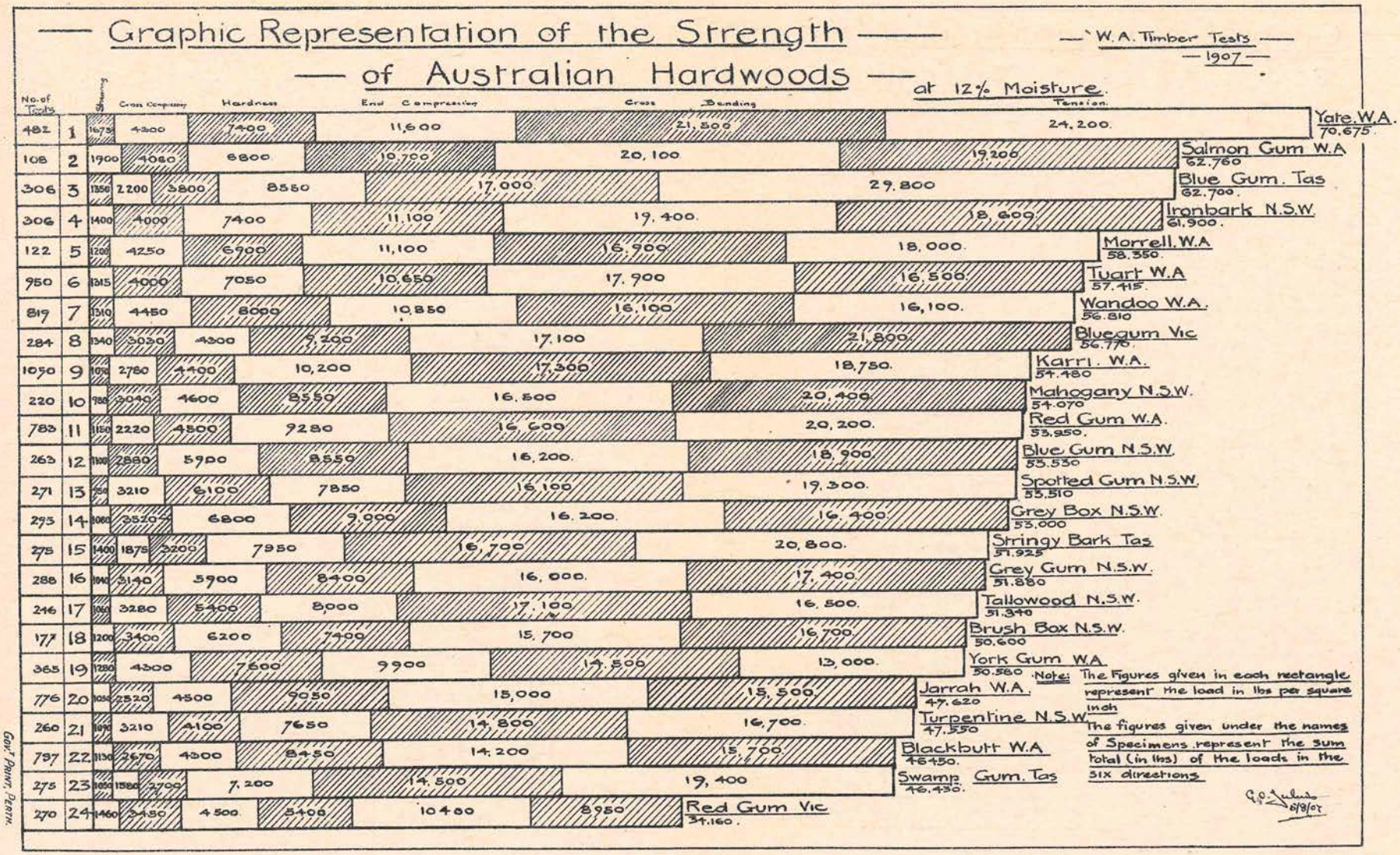
It should be mentioned here that for half a century after the foundation of the Colony, all the boats and barges plying on the River Swan and the Murray River and at Albany were built of jarrah. Ocean-going vessels were also constructed at the places named, some of these making voyages to India, the Cape, and to England. The suitability of jarrah as a shipbuilding material was early recognised by the British authorities, and it was put upon the Admiralty list and upon Lloyd's list as a timber suitable for shipbuilding.

Necessity, they say, is the mother of invention. Those who pioneered the West Australian forests were hard put to by reason of the distance from the centres of civilisation. Shipping was erratic, and there were often long intervals between the arrival of ships from England. The settlers, therefore, were thrown upon their own resources, and they

Graphic Representation of the Strength of Australian Hardwoods

W.A. Timber Tests — 1907 —

at 12% Moisture.



Note: The Figures given in each rectangle represent the load in lbs per square inch

The figures given under the names of Specimens represent the sum total (in lbs) of the loads in the six directions

C.O. Jules 6/8/07

GOV'T PRINT. PERTH.

put the materials that they found at hand to purposes which to us in these later days would seem curious in the extreme. For instance, when iron rails for bush tramways could not be had, rails made of such timbers as wandoo and tuart were used, and over these, trucks with logs and timber travelled. In the earlier flour mills of the Colony the whole of the machinery was of local timber, different varieties being used in different parts of the outfit. The wheels were usually made of jarrah, the cogs were very often of tuart. All bearings were of native woods also, and answered the purpose marvellously well. The first "safe" of the Colony was built of jarrah, and placed in the Treasury at Perth, and for many years this wooden box contained the Government's hard cash. On farms the jarrah plough 60 or 70 years ago was as common as the steel one of to-day, and in many other matters in which metal is now used on farms, local timber was made to serve similar purposes. The first jetty in Western Australia was built at Arthur's Head, Fremantle. It was, of course, wholly of jarrah cut within a mile of its site. It was a private concern, and belonged to one of the whaling companies then established at the port.

EXTENT OF THE FORESTS.

From the very foundation of the Colony curious misconceptions have existed as to the extent of the forests of Western Australia. The fact that good timber was found growing in and around Perth and extending southwards indefinitely seems to have given rise to the notion that the whole country to the south of Perth and over 100 miles back from the Indian Ocean was one vast prime forest, and in the earlier estimates this whole area was generally set down as capable of producing marketable timber. One early authority puts it in this way:—

"The forest area is included within the parallels of south latitude 31 degrees to 35 degrees, and is estimated to cover an area of at least 30,000 square miles. It may be stated that a belt of forest land exists between the latitudes above-mentioned, in some places extending inland for 100 miles,

but the best jarrah wood is found in the hill ranges, and not nearer than 15 or 20 miles from the coast, and of this the areas occupied by the principal eucalypti are:—

	Square miles.
White gum (*eucalyptus redunca*)	10,000
Jarrah (*eucalyptus marginata*)	14,000
Karri (*eucalyptus diversicolor*)	2,300
Tuart (*eucalyptus gomphocephala*)	500
Red gum (*eucalyptus calophylla*)	800
York gum (*eucalyptus loxophleba*)	2,400

"The white gum grows generally in all forests, excepting in that part of the colony where karri abounds. It is, however, found in the greatest profusion eastward of the Darling Range. The wood is used for many purposes in the colony, but it does not appear as an article of export."

A more recent authority stated:—

The area under prime forests in Western Australia is not yet accurately known. At the present moment the work of classification is being pushed on, and until this is completed the acreage carrying trees of commercial importance and value will not be available. Mr, Ednie Brown in 1906 made a rough estimate:—

	Acres.
Jarrah, chiefly (with Blackbutt and Marri) ..	8,000,000
Karri	1,200,000
Tuart	200,000
Wandoo	7,000,000
York Gum, Yate, Sandalwood, and Jam ..	4,000,000
Total area of the principal forest surface of Western Australia	20,400,000

These figures probably are an approximation of the areas in which the timber named may be found, but they certainly do not represent the facts so far as forests of commercial timbers are concerned. Wandoo, for instance, is placed at 7,000,000 acres, but this tree is seldom to be found in masses deserving to be called forests. It is scattered over immense areas as "Savannah Forest." The same may be said of the figures regarding jarrah and some of the other woods named. At the present time it may be estimated that the existing area of prime forests in Western Australia does not exceed 3,000,000 acres, AND THE BULK OF THIS AREA HAS BEEN CUT OVER.

EXPLOITATION.

So long as the forests were only called upon to supply the local demand for timber no special regulations were put in force by the Government, but, when an export trade developed, the authorities considered that for revenue purposes it was necessary that those who cut down timber should pay for the privilege of doing so. All over the South-West there are scattered deserted sites of sawmills, which at one time furnished material for export. The earliest mills were in the Canning district, amongst them being Jarrahdale, using Rockingham as a port, and connected with it by a private railway. The Canning district was worked by the Canning Jarrah Company and others, and gradually, as the export trade increased, other plants were put down at suitable places, such as Quindalup and Geographe Bay.

In the karri country the earliest mills were at Karridale and at Torbay, and later at Denmark. A generation ago the regulations governing the conversion of timber were vastly different from what they are to-day. At that time licenses to cut and remove timber on Crown lands were issued by the Commissioner for Lands, the Collector, or any Sub-collector of Revenue, or any Resident Magistrate, on the following terms:—

1. To fell and hew timber to be used locally or exported as piles or balks, for each man—£3 per month; or, in case of a pair being employed—£5 per month (such licenses included all men employed in removing timber).

2. To fell, cut, and remove timber, or split and remove fencing, firewood, or shingles, for each man—5s. per month.

3. To cut sandalwood outside proclaimed areas, or to gather zamia wool, gums, or other such substances, for each man—2s. 6d. per month.

No license was granted for a period less than one month or more than 12 months.

Special licenses were also granted for one year at the following rates:—

For any quantity not exceeding 640 acres of land—£20.

For any quantity exceeding 640 acres, but not exceeding 1,280 acres of land—£40;

but such licenses did not permit the cutting, hewing, and removing of logs and piles.

In addition to the above, there were also granted to certain large companies concessions and special leases on terms approved by Her Majesty's Secretary of the State for the Colonies. The maximum term for which such licenses were granted is 42 years.

On the 13th February, 1891, in the Legislative Council, the Colonial Secretary laid upon the table the following return showing the timber concessions and special timber leases in existence at the end of 1889. This table reads as follows:—

Name.	Number.	Acres.	District.	Annual Rent.
				£ s. d.
1. Western Australian Timber Company, Lockeville ...	...	About 200,000	Sussex ...	Free.
2. Rockingham Jarrah Timber Co.	...	250,000	Cockburn Sound	50 0 0
3. Keane, E. V. H.	12/1	100,000	Canning ...	200 0 0
4. Davies, M. C.	12/2	46,000	Sussex ...	150 0 0
5. Gill & Co.	12/3	2,880	Swan	133 6 8
6. Honey, R.	12/4	1,920	do.	100 0 0
7. Yelverton H. J.	12/5	51,840	Sussex ...	75 0 0
Total	...	652,640		£708 6 8

This table is a vivid illustration of the recklessness with which valuable timber rights were granted. Most of the concessions and special timber leases mentioned above have expired, or ownership has been altered.

The following return shows the concessions and leases in existence up to the 30th June, 1919. No concessions or

leases are now granted, exploitation being carried on solely under sawmill permits, hewing permits, and firewood permits.

CONCESSIONS.

Concessionaire.	No.	Locality.	Term.	Original Area.	Present Area.
Millar's T. & T. Co., Ltd	12/0	Cockburn Sound	1-1-1899 to 31-12-1901 1-1-1902 to 31-12-1915 1-1-1916 to 31-12-1929	250,000	250,000
Millar's T. & T. Co., Ltd	12-1	Canning ...	1-1-1893 to 31-12-1924	100,000	82,750
Millar's T. & T. Co., Ltd	12/2	Sussex ...	15-1-1883 to 14-1-1925	46,000	45,289
			Total	396,000	378,139

LEASES.

Leases.	No.	Locality.	Term.	Original Area.	Present Area.
Ainslie, James	145/113	Nelson ...	1-1-1899 to 31-12-1923	4,480	4,389
Ainslie, James	149/113	Nelson ...	1-1-1899 to 31-12-1923	4,480	4,092
Ainslie, James	150/113	Nelson ...	1-1-1890 to 31-12-1923	4,480	3,524
Millar's T. & T. Co., Ltd.	186/113	Wellington ...	1-1-1899 to 31-12-1923	27,000	16,012
Millar's T. & T. Co., Ltd.	227/113	Wellington ...	1-1-1901 to 31-12-1925	4,480	4,743
Millar's T. & T. Co., Ltd.	228/113	Wellington ...	1-1-1901 to 31-12-1925	4,480	4,130
Millar's T. & T. Co., Ltd.	229/113	Wellington ...	1-1-1901 to 30-12-1925	4,480	3,962
Millar's T. & T. Co., Ltd.	230/113	Wellington ...	1-1-1901 to 31-12-1925	4,480	4,480
Good, Frederick Daniel	244/113	Murray ...	1-7-1899 to 30-6-1924	17,280	13,259
Good, Frederick Daniel ...	257/113	Nelson ...	1-10-1899 to 30-9-1924	33,280	28,876
Millar's T. & T. Co., Ltd.	261/113	Murray ...	1-10-1899 to 30-9-1924	58,270	22,937
The Timber Corporation, Ltd.	268/113	Nelson ...	1-10-1899 to 30-9-1924	49,920	33,938
Wittenoom, Edward Horne	269/113	Wellington ...	1-10-1899 to 30-9-1924	5,000	2,080
Macmurtrie, Wm. ...	288/113	Wellington ...	1-7-1900 to 30-6-1925	36,960	12,637
Ainslie, James	291/113	Wellington ...	1-1-1901 to 31-12-1925	17,920	17,308
Millar's T. & T. Co., Ltd.	296/113	Wellington ...	1-1-1900 to 31-12-1924	11,520	4,146
Millar's T. & T. Co., Ltd.	297/113	Wellington ...	1-1-1900 to 31-12-1924	13,440	12,771
Ainslie, James	299/113	Murray ...	1-7-1900 to 30-6-1925	19,840	18,795
McNeil, Alexander James	309/113	Wellington ...	1-4-1901 to 31-3-1926	21,310	793
Wittenoom, Edward Horne	322/113	Murray and Wellington	1-4-1902 to 31-3-1927	44,800	20,000
Wittenoom, Edward Horne	225/113	Wellington ...	1-4-1902 to 31-3-1927	1,280	1,205
Smith, Henry Teesdale ...	330/113	Murray ...	1-7-1902 to 30-6-1927	10,240	7,781
Smith, Henry Teesdale ...	331/113	Murray ...	1-1-1903 to 31-12-1927	9,600	7,194
			Total	409,020	247,047

In 1917 the royalty, which was formerly 1s. a load, was increased to 2s., and since then a system of sale by tender of the right to remove forest products was initiated, and by the system a royalty more in proportion to the value of the product is obtained. Under the term "permits" are included hewing permits, milling permits, and firewood permits.

Early Timber Industry.

In 1883, it is on record that 30 tons of "mahogany" in logs was lying at Cockburn Sound, and its owner was advertising it as available for exportation. In the same year "mahogany" was exported to the Cape, and is said to have realised good prices, but no details are to be had as to the quantity or the sums it brought. In July, also of that year a collection of samples of Western Australian woods, particularly those adapted for shipbuilding was sent to London. The value of the local timber for shingles does not seem, in the earlier years to have been too clearly realised. Thatch, we know, was pressed into service, and it is on record that in 1834 30,000 shingles were imported from Sydney. But even in these early years the desirability of cultivating the export market for "mahogany" was clearly understood, and several proposals were made to that end, including the formation of more than one company. The samples sent to London appear to have come under the notice of the Admiralty authorities, for in April, 1836, it is reported that 200 tons of timber, "the growth of the Colony" have been ordered by the British Admiralty. It seems also that at the date named there was in England a "Home Corresponding Committee," whose functions were to foster in every way possible the interests of the young Colony of Western Australia. Writing on the subject in April, 1837, the editor of the *Perth Gazette* says, "the white gum tree is pronounced by our millwrights to furnish a superior wood for machinery of every description, and if once introduced into England would obtain considerable consumption." With a fine optimism, he goes on to say that "English piano makers should be told about our mahogany, and he is sure that they would take payment for pianos, half in cash and half in mahogany," and he then suggests that mahogany should be included in the next shipment, and sent to London with our oil and wool. Incidentally it may be stated that the word "jarrah" seems first to have been suggested in place of the term "mahogany" for our principal timber in the beginning of 1843. A Mr. C. D. Ridley, of Perth, made the suggestion, and at the same time he proposed to form a company with a capital of £2,000 to carry on the export of "jarrah." In this gentleman's opinion the name "mahogany" is not suitable, "it is not mahogany, and it should be introduced into England under its proper name, as a wood eminently serviceable for many purposes." The

details of the 200 tons shipped to the order of the British Admiralty by the "Hero" are of some interest, and one may assume that part at least of the order was to be used in the construction of ships of war. The pieces were:—

Thick stuff, 10ft. 10in.—80 loads, 12 to 15 broad.
Thick stuff, 8in.—40 loads.
Thick stuff, 6in.—40 loads.
Planks, 4in—20 loads, 10 to 12 broad.
Planks, 3in.—20 loads, 10 to 12 broad.

That the Admiralty was pleased with the timber is very evident from the fact that in May of next year a Perth citizen secured a contract for a cargo of 400 tons of local timber for use in Royal Naval Dock Yards. Adelaide appreciated the timbers of the West, and many shipments were made, one of the earliest of these on record being that of 30 tons by the "Empress" schooner in 1847. The determination of the colonists to make the most of the magnificent heritage of timber finds another illustration in a proposition made in January, 1848, when the prospectus of the company for the export of Western Australian timbers was published. The capital of this concern was to be £50,000 of 2,000 shares of £25 each. The company was floated especially to push the export of jarrah, which the prospectus stated, resisted the teredo navalis. It was not the intention of this company to cut timber on its own account. Its purpose was to buy the timber from cutters and export it, and when it received foreign contracts it proposed to fill them by sub-letting the orders to hewers and cutters. But even in these early days the pessimist was in evidence in Western Australia, for in the local paper at the time a correspondent recommended that this company should ship only beams as "logs would through defective hearts give foreigners a bad impression." Next year, 1849, an enterprising citizen sent a small shipment of jarrah to India, and letters received intimated that the Government of India was much pleased with it, and it is stated further that there is a big market in India for Western Australian timber if it can be delivered there at about £7 a ton. In the early 50's the timber industry was quite busy, and a good deal of cutting took place in new districts. Particulars are in existence of 110 tons of timber, which was lying at the beach at Leschenault ready for shipment when an opportunity should occur. Mr. G. Shenton also at that period contracted for 100 tons to be cut at Augusta, about the same time 80 loads of

timber had been felled back from Bunbury, and 60 of these had been carted to the beach awaiting shipment. The fact that our timbers were appreciated for shipbuilding purposes finds further corroboration in the many exports of wooden trenails to England. In February, 1852, for instance, the "John Panter" sailed for London, and amongst her cargo were 101 loads of timber (kind unspecified, but most likely mahogany) and 14,700 trenails. The wood of which the trenails were made is not specifically mentioned, but from reports of these at other periods it seems that wandoo (white gum) was the tree which supplied them. In local shipbuilding right along the wandoo trenail was almost universally used. In 1854, vigorous efforts were made to increase the trade in timber with the Eastern Colonies, and early in the year the "Hamlet" sailed from Fremantle for Adelaide and Melbourne with a full cargo of timber, and the "Struan," which had arrived from London with general goods, loaded up with timber in Bunbury and took it across the Bight. These shipments seem to have been purely speculative, and not in response to definite orders, and one reads with some pain that the mahogany per the "Struan" to Melbourne failed to find a market. Towards the end of the same year, strangely enough, very good prices were obtained for a shipment of our timber which was taken there from Mangles Bay. In fact this sale was so heartening to the industry here, that it is on record that "the timber trade became busy and buoyant." By the early 60's the timber trade with India had become somewhat regular, and had assumed considerable dimensions. In February, 1861, two ships laden with timber left for India, one having Madras as a port of destination and the other Nagapatam.

Between 1870 and 1903 the sawmilling industry became thoroughly established, and the exports rose from 3,144 loads, valued at £17,551, to 154,969 loads, valued at £619,705. At the latter end of this period the rate of cutting so alarmed statesmen of the time that the Royal Commission already referred to was appointed to investigate the forestry question. Unfortunately its findings were disregarded and, instead of subsequent governments restricting the cutting of timber, they encouraged it. In 1906 the export was 176,614 loads, valued at £708,993, and in 1913-14, the year prior to the war, the export had grown to 272,397 loads, valued at £1,089,481.

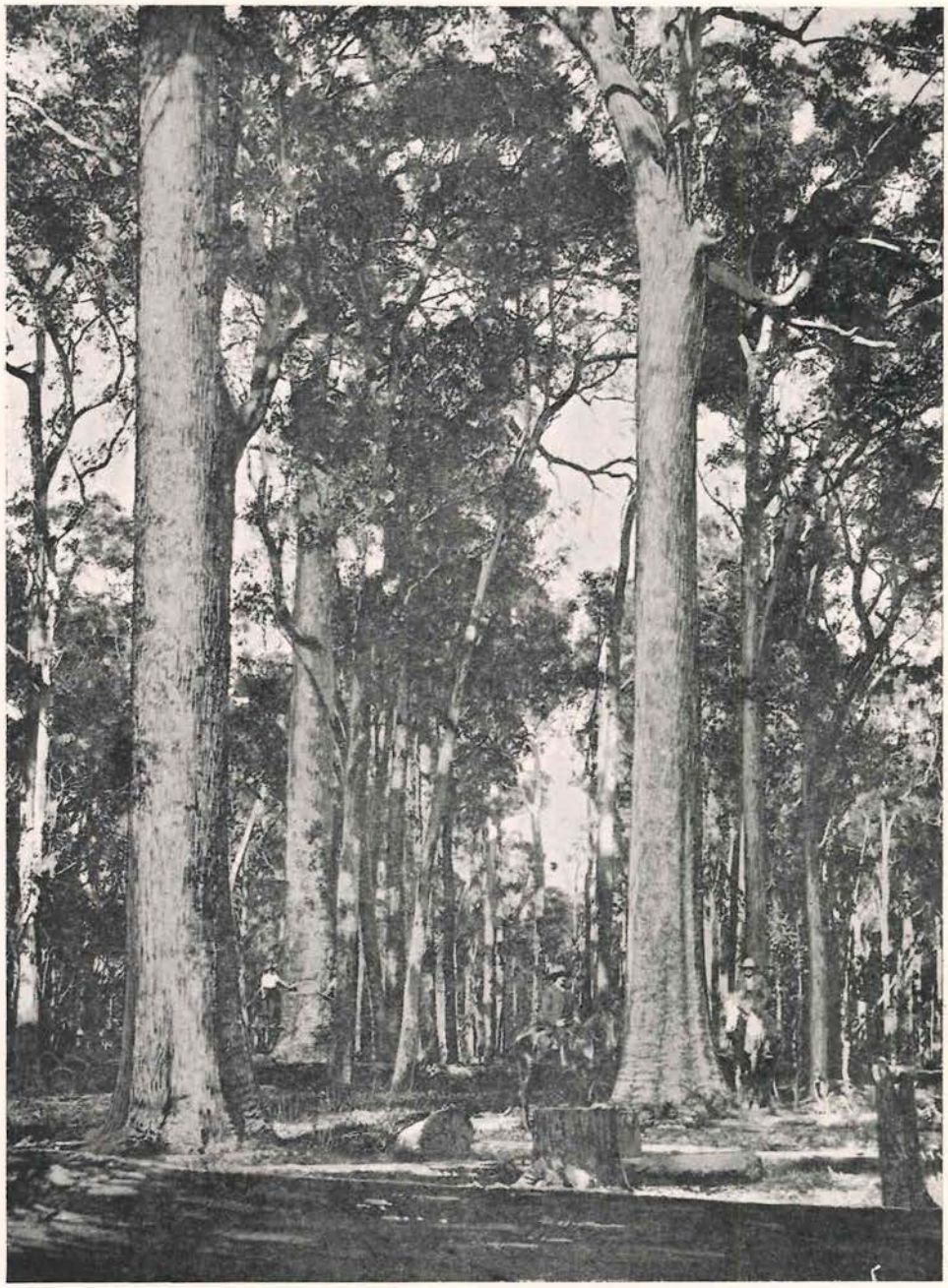
It is unfortunate that the bulk of the export trade in jarrah has been in the form of sleepers, and this has given

quite an erroneous impression in foreign countries as to the value and capabilities of our principal timber. The sleeper hewer is particularly wasteful of good timber in his methods. In the mills a recovery from logs of 45 per cent. is quite common, but it is seldom that the sleeper-cutter recovers more than 25 per cent. of the round log. Under the regulations of "The Forests Act, 1918," sleeper hewing is much restricted, and licenses are granted only to those who were engaged in the business before that date. One object of the Forests Department is to make jarrah known as a timber of the highest class and fit for the worthiest and best purposes, and when it is seen only in the form of sleepers, it is difficult to get outsiders to understand or appreciate its many admirable qualities.

Timbers of Western Australia.

The forests of the State are rich not only in the variety of the timbers they hold, but in the quality of these. It is curious as well as interesting to observe that the principal timbers of Western Australia are peculiar to the State, and are not to be found growing anywhere else. Jarrah, and some other of our eucalypts, it is true, have found a warm welcome in countries overseas, particularly in South Africa and California, and in some parts of Southern Europe, and Morocco and Algeria. But in every case these trees have been raised from seed or seedlings brought from their native home, the State of Western Australia.

Geologically speaking, Western Australia is the oldest part of our island continent. Time was when what is now known as Western Australia was the only part of Australia showing above the water, and at that time it was clothed with a rich and variegated tree life. Science has made it possible to determine the comparative ages of species of trees, and investigators have arrived at the conclusion that such trees as tuart, yate, karri, and jarrah are very much older than



Jarrah Forest.

Crosscutting Jarrah log.

any of the members of the eucalypt family to be found in what are known as the Eastern States. It seems probable that, when Central and Eastern Australia in course of time appeared above the surface, vegetation spread from the west to the east, undergoing in the course of myriad ages many modifications, but some members of the eucalypt family, such as tuart, jarrah and karri, do not appear to have spread eastward. It is likely that the conditions existing in those far-off ages were favourable to the spread and propagation of certain eucalypts, but that others, such as tuart, not finding the conditions they demanded in a new environment, did not spread, and can only be found in the habitat they have occupied for unknown ages—the limestone belt extending along the coast from 31 deg. 40 min. to 33 deg. 40 min. south.

A short description of the principal trees of the State will be of interest, as conveying not only some idea of the variety of the indigenous timbers, but of their value economically and industrially:—

JARRAH (*Euc. marginata*).

This tree is the principal timber of the State. In the early days it was called mahogany, owing to the resemblance it had to the Honduras timber. About 1860 the name was altered to jarrah, as it was generally recognised that this was a better timber than mahogany, and that it had so many fine qualities that it deserved a name of its own. Jarrah is the name given to the tree by the aborigines.

The tree grows to a height of about 100 to 120 feet, with a bole of 50 to 60 feet, and a diameter of 72 inches.

Weight per cubic foot (green)—68lbs.
At 12 per cent. moisture—55lbs.
Transverse strength—15,000lbs. per square inch.
Tensile strength—15,500lbs. per square inch.

A hard wood, but easily worked, and therefore used for almost every purpose. It is strong enough to be used for beams, and its colour and texture are such that it is daily becoming more and more prominent as a cabinet wood. One of its remarkable qualities is its durability when exposed to the worst conditions. The timbering in the first houses built when the Colony was established is still sound to-day, and the post-and-rail fences erected by the earliest settlers are still standing. Its extraordinary durability has, however, rather

cheapened it in the eyes of the outside world, where it has commanded a readier sale as sleeper or paving block wood than for purposes where more expensive wood is generally used. It is to be regretted that the exploitation of the jarrah forests has been conducted practically solely for the sleeper market. Since 1836, the export of timber from the State amounted to 3,559,954 loads, valued at £14,322,845, the bulk of which consisted of jarrah.

It is on Lloyd's list of shipbuilding woods, and jarrah ships in the early days plied between Western Australia, India, and other parts of the world. Its durability has made it renowned for bridge, wharf, and harbour work, while the telegraph service of the State is dependent upon supplies of jarrah poles.

It is to be found scattered throughout the South-West over some 13,000,000 acres of country within the 25 to 45 inch rainfall belt. The main belt of timber, however, stretches from Chidlow's Well in the North, along the Darling Range to the extreme South of the State, in the neighbourhood of Albany. The total area of prime jarrah forests is probably not more than 2,500,000 acres, and is all on this laterite capped range of hills.

It regenerates itself well, but the constant firing of forests has resulted in the destruction of the young growth in many parts of the forests. The recovery in milling operations is from 45 to 50 per cent. of the round log.

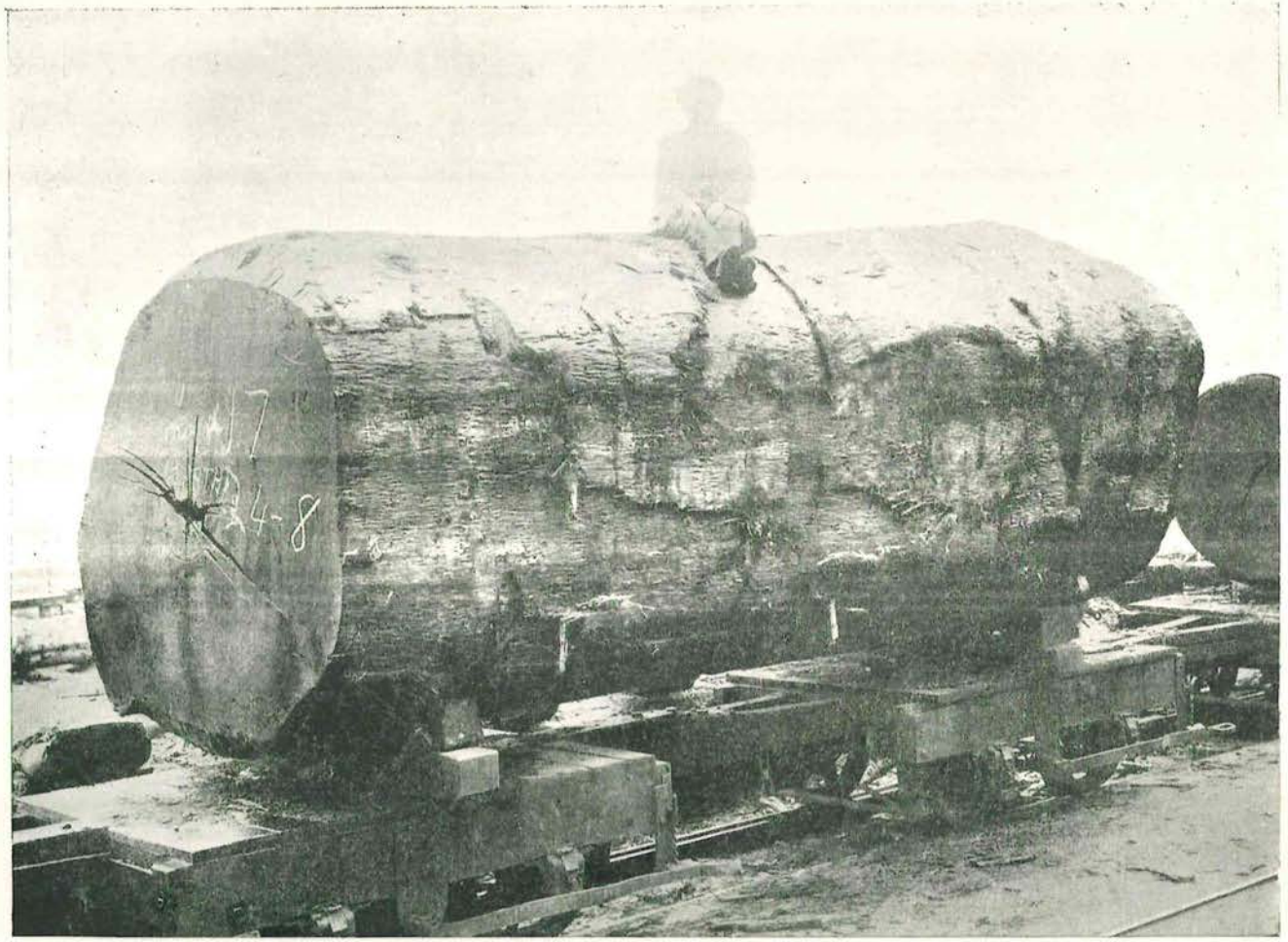
Karri (*Euc. diversicolor*).

The second most important tree of the State; it grows to a great height (trees of 280 feet having been measured), with a bole of 100 to 140 feet, and diameter of eight to 10 feet.

Weight per cubic foot (green)—72lbs.
At 12 per cent. moisture—58lbs.
Transverse strength—17,300lbs. per square inch.
Tensile strength—18,750lbs. per square inch.

A hard, strong wood. It closely resembles jarrah timber, but the grain is longer, and it is a much stronger wood. It is beyond doubt a splendid super structural timber, and is strongly to be recommended for heavy beams, roof purposes, etc. *It is not durable in the ground, and does not resist white ants.*

Karri Forest.



Karri log at Mill.

It is on Lloyd's list of shipbuilding timbers, and is suitable for all purposes where large sections of great strength are necessary. It has been found very satisfactory for wooden pipes, and it makes a good wagon spoke, but its main use up to now has been for railway wagon-scantling, and telegraph arms. The English Railway Companies and the London Post Office authorities are strong in their praise of the timber for these purposes. It has suffered very much through its being so easily confounded with jarrah. As in all young countries, timber in Western Australia has in the past been valued according to its durability as a fence post or a sleeper, and karri, though immeasurably superior in other respects, has been condemned owing to its failure when put to such uses. It is confined to the wettest portion of the South-West of the State, and its northern limit is Nannup and the upper waters of the Donnolly, whence it spreads southwards and south-eastwards to Denmark. There is then a gap in the belt, and it is to be met with again near the Porongorup Range; another isolated patch occurs on the extreme south-west near the Leeuwin; this was the place whence the first karri was exported from the State, and is more commonly known under the name of Karridale. In all it is doubtful whether more than 500,000 acres of prime karri forest can be reserved. It regenerates itself well, and it forms the only forest of the State that carries a dense undergrowth of shade-bearing species.

The sawmiller recovers from 38 to 40 per cent. of the round log.

Wandoo (*Euc. redunca var elata*).

A tree attaining a height up to 100 feet, with a bole of 30 to 40 feet, and diameter of four feet.

Weight per cubic foot (green)—79lbs.
At 12 per cent. moisture—71lbs.
Transverse strength—16,100lbs. per square inch.
Tensile strength—16,100lbs. per square inch.

This wood is hard, strong, and durable. It is used for bridge construction, wharf planking, wheelwright, millwright, knees of boats and shipbuilding generally. It makes an excellent trenail. It is very satisfactory for all turnery work, such as jute and cotton bobbins, telegraph insulator pins, etc. Its main use, however, is for wagon scantling for the

railway stock of the Government Railways of the State. It gives a life of 25 years in under-carriages of trucks. The top plank of these trucks is always made of wandoo, which stands the wear of the unloading and loading better than steel, also the stanchions of the trucks are of wandoo. A remarkable quality which this timber possesses is that when used in conjunction with steel there is no chemical action between the wood and the metal. Bolts have been taken from underframes of trucks after 20 years' use and been found to be quite as clean as when put there, while the auger marks were still visible in the holes. The value of this timber is so well recognised by the Government of this State, that permits for cutting it can only be obtained if the timber is to be used by State Departments; in other words, the timber may not be exported. (*See* Tuart.)

It is to be found growing in the South-West portion of the State on the edges of the jarrah belt. It does not grow in close forests, but in open savannah forests, and is to be found mixed with jarrah and red gum. The soil is usually a clay sub-soil, though occasionally it is to be met with on the sand-plain country.

Marri: Red Gum (*Euc. calophylla*).

A tree attaining a height of 90 to 100 feet, with a bole of 40 to 50 feet, and diameter of six to seven feet.

Weight per cubic foot (green)—72lbs.
At 12 per cent. moisture—56lbs.
Transverse strength—16,600lbs. per square inch.
Tensile strength—20,200lbs. per square inch.

This tree yields a light-coloured strong wood. It is easily worked, and were it not for the presence of gum veins would be among the most valuable timber in Western Australia. Unfortunately, the gum or kino occurs in such quantities that it is difficult to find a tree free enough from gum to make it profitable to saw it up. It is used for all purposes where strength and elasticity are required. Timber hewers always take out the hickory shafts from their carts and replace them by red gum shafts. Heavy poles used in the large whims which carry the great jarrah and karri logs to the mills are of red gum. In the whim itself the fetchels, which are trusses to connect the pole with the axle bed, are also of red gum. It makes a good axe and tool handle, and there would seem to be a future for it for all small turnery work. It must not

be confounded with the red gum of Victoria and New South Wales, which grows along the Murray, and which is far better growing timber, but is not nearly so strong as the Western Australian red gum. The gum or kino yielded by this species contains a heavy percentage of tanin. Hide powder analysis shows that it contains up to 68 per cent. From earliest settlement it has been used by settlers to convert hides into leather, but unfortunately it has not been possible to use it to the extent that it should, owing to the fact that it imparts to the leather a red colour. It is hoped that investigations by leather chemists will discover the means of decolourising this valuable product, the source of which is inexhaustible.

It occurs throughout the jarrah belt, but like blackbutt, is to be found generally on the better alluvial soils in the valleys between the laterite capped ridges. Red gum soil is generally considered from an agricultural point of view a degree better than jarrah soil, which from an agricultural standpoint is of little use.

Tuart (*Euc. gomphocephala*).

A tree attaining a height up to 100 feet, with a bole 35 to 45 feet, and a diameter seven to eight feet.

Weight per cubic foot (green)—78lbs.
At 12 per cent. moisture—68lbs.
Transverse strength—17,900lbs. per square inch.
Tensile strength—16,500lbs. per square inch.

The timber is hard and dense with an interlocked grain, its colour is yellow. It vies with wandoo in strength and toughness. The timber is used for wheelwright work, especially the large naves required for the 9ft. wheels of the timber whims. Its main use, along with wandoo, is for railway wagon and truck construction. The late Chief Mechanical Engineer in Western Australia, Mr. E. S. Hume, reduced the maintenance of his trucks from £3 7s. 6d. to 10s. per year per truck by substituting for steel tuart and wandoo in the under carriages. Like wandoo, the cutting of tuart except for departmental purposes is forbidden, and its export prohibited.

It is confined to the limestone formation, and on this formation it stretches in scattered lines from Lake Pinjar southward along the coast as far as Sabina River, some 12 miles north of Busselton. Curiously enough it is not to be

found anywhere else in the State, although limestone occurs all round the coast line. The best tuart is to be found between Sabina River and Capel, and it is doubtful whether it will be possible to reserve more than 5,000 acres of first-class tuart country. Between Sabina River and Capel River the distance is about 12 miles.

Sandalwood (*Santalum cygnorum*).

A small tree attaining a height of 12 to 16 feet, with a diameter of six to eight inches. Until some few years ago it was used solely by the Chinese for ceremonial purposes. It may be said that the development in Western Australia in the early days was to a large extent dependent on the sandalwood trade. Since 1845 there have been exported 292,367 tons, valued at £2,494,079. The supply close to the seaboard has long since been exhausted, and the source is now away back in the goldfields district. It thrives in as low a rainfall as eight inches per annum. Lately there has been a development in the distillation of sandalwood oil. The yield of oil from the Western Australian wood is not so heavy as that obtained from *Santalum album*, and the content in essential oil is lower. It is, however, used in Australia for medical purposes, and found to be as efficacious.

Native Pear (*Xylomelum occidentale*).

A small tree, attaining a height of 20 to 25 feet, with a short bole, and a diameter of about 12 inches.

Weight per cubic foot (green)—56lbs.
At 12 per cent. moisture—46lbs.
Transverse strength—7,669lbs. per square inch.
Tensile strength—7,000lbs. per square inch.

A tree yielding a most ornamental and dark brown wood, with a beautiful figure. It is light, and makes up into very fine furniture wood; finished with a wax surface it resembles moiré silk.

It is to be found growing all along the sand-plain country, between the Darling Range and the sea coast. Like shea-oak, it suffers very badly from fire, and it is therefore very hard to get in sizes greater than 12 inches in diameter. It is important that thorough fire-protection measures be taken in order to prevent the extinction of this beautiful furniture wood.

Tuart.

Salmon Gum (*Euc. salmonophloia*).

A tree ranging from 80 to 100 feet in height, with a bole of 40 to 50 feet, and about 2½ to 3 feet in diameter.

Weight per cubic foot (green)—70lbs.
At 12 per cent. moisture—66lbs.
Transverse strength—20,100lbs. per square inch.
Tensile strength—19,200lbs. per square inch.

An exceedingly dense wood, the second strongest in Australia. It has up to now been used for mining purposes only. It is questionable whether the goldfields of Western Australia, which have up to date yielded £80,000,000 of gold, would have been developed had it not been for this tree and its sisters Mulga (*Acacia aneura* and *steresophylla*) and Gimlet (*Euc. salubris*). The region in which it thrives has an average rainfall of 12 inches. Its gleaming salmon-coloured bark makes it the most conspicuous tree of the savannah forest.

Blackbutt (*Euc. patens*).

A tree attaining a height up to 100 feet, with a bole 40 to 50 feet, and up to six feet in diameter.

Weight per cubic foot (green)—69lbs.
At 12 per cent. moisture—54lbs.
Transverse strength—14,200lbs. per square inch.
Tensile strength—15,700lbs. per square inch.

About the same weight and strength as jarrah, but a pale yellow-coloured wood. It is not plentiful, but it is to be found in small patches in the gullies and pockets of alluvial soils, between laterite crests of hills. It is useful for many purposes, and particularly for farm implements and railway truck building.

Raspberry Jam (*Acacia acuminata*).

A small tree 15 to 25 feet high, with a short bole, and up to 12 inches in diameter.

Weight per cubic foot (green)—73lbs.
At 12 per cent. moisture—62lbs.
Transverse strength—15,300lbs. per square inch.
Tensile strength—12,000lbs. per square inch.

A fairly heavy wood possessing a remarkably heavy scent, resembling that of pressed raspberries. It is very durable indeed; fence posts 70 years in the ground show no signs of decay. The grain, like its Victorian sister, the Blackwood, is very beautiful, and it is therefore much prized for cabinet work. It is regarded by farmers as an indication of good wheat-growing and sheep-grazing land, and is being rapidly destroyed.

Yate (*Euc. cornuta*).

A tree attaining a height of 50 to 60 feet, with a bole of 25 to 35 feet, and diameter of three feet.

Weight per cubic foot (green)—79lbs.
At 12 per cent. moisture—71lbs.
Transverse strength—16,700lbs. per square inch.
Tensile strength—24,200lbs. per square inch.

This species yields a light-coloured timber of exceptional strength. It is probably the strongest timber in the world, and in one test for tensile strength the breaking load was 17½ tons per square inch, 3½ tons less than that usually specified for wrought iron of ordinary quality. It is used for wheelwright work generally, and is preferred where the strongest shafts for frames of carts are required. It occurs at Busselton, Donnolly River coast, Lake Muir and Mount Barker district. That it is not used more generally is due to the fact that it is found in open savannah forests at a distance from centres of population.

York Gum (*Euc. loxophleba*).

A tree which attains a height of 40 to 60 feet, and a length of bole of 10 to 15 feet, and a diameter of 18 to 24 inches.

Weight per cubic foot (green)—77lbs.
At 12 per cent. moisture—67lbs.
Transverse strength—14,500lbs. per square inch.
Tensile strength—13,000lbs. per square inch.

A dense, hard, heavy wood, with very interlocked grain. The wood is by far the best nave, maul, and mallet wood in Australia, while it may be used very successfully for felloes and other wheelwright and wagon-building purposes. The

River Banksia Timber.

wood is of a yellow-brown colour, and carries a beautiful figure. It grows in open or savannah forests, and is to be found in the 20-inch rainfall belt. It is most common about Bolgart, Toodyay, Northam, York, Narrogin to Broomehill. Its presence is regarded by farmers as an indication of good agricultural soil for wheat-growing, and also good grazing country for sheep.

River Banksia (*Banksia verticillata*).

A tree attaining a height of 50 to 60 feet, with a bole of 15 to 20 feet, and a diameter of two feet six inches.

Weight per cubic foot (green)—59lbs.
At 12 per cent. moisture—35lbs.
Transverse strength—10,300lbs. per square inch.
Tensile strength—8,000lbs. per square inch.

This tree yields a light-coloured timber with a particularly beautiful grain. The medullary rays are wide, so that when cut on the quarter it shows a beautiful oak-like figure, and is much prized for furniture work. It is the lightest of all timbers of the State. It occurs along the side of the larger rivers and streams in the South-West, and is rarely to be found growing far away from running water.

Sheaoak (*Casuarina Fraseriana*).

A tree attaining a height of 40 to 45 feet, with a bole 10 to 15 feet, and a diameter of two feet six inches.

Weight per cubic foot (green)—60lbs.
At 12 per cent. moisture—52lbs.
Transverse strength—12,000lbs. per square inch.
Tensile strength—9,000lbs. per square inch.

A sound wood with broad medullary rays, which show up and make the timber particularly beautiful when cut on the quarter. It takes a good polish and stands up well, and therefore makes an excellent cabinet wood. It makes a good ox yoke. It splits well, and was used almost exclusively in the early days of the colony for roofing shingles. A shingle taken from one of the first-erected houses in Perth (after 83 years' use) was found to be in a splendid state of preservation. Bush fires have played havoc with this species, and

it will only be by a sound system of fire control that the future supplies of this valuable timber can be assured. It grows scattered through the length and breadth of the jarrah belt, but is not to be found in the drier regions.

Morrell (*Euc. longicornis*).

This tree attains a height of 60 to 90 feet, with a bole of 30 to 40 feet, and diameter up to four feet.

Weight per cubic foot (green)—73lbs.
At 12 per cent. moisture—64lbs.
Transverse strength—16,900lbs. per square inch.
Tensile strength—18,000lbs. per square inch.

It is a strong, hard, dense wood, and has an interlocked grain. It is of a dark-brown colour, and is used for wheelwright work, tool handles, etc. It is also used for mining timber. It occurs in the dry country in the rainfall belt of about 10 to 20 inches, and is scattered throughout the length and breadth of country between Three Springs on the north, Katanning on the south, and Southern Cross on the east. It does not grow in dense forests, but occurs in savannah forest formation.

Yellow Tingle Tingle (*Euc. Jacksoni*).

A very large tree, only second to karri in height and as large in girth. The timber has not been tested, but from an examination that has been made it appears to be suitable for all purposes for which karri is now used. It is confined to a very small area of forest country in the neighbourhood of Nornalup Estuary, and along the three rivers flowing into that estuary, viz., the Deep, the Walpole, and the Frankland Rivers. Communication with this part of the State has been so difficult that only small samples of timber have been obtained. It is brownish-yellow in colour, planes up well, and takes a good polish. Unlike most of our other Eucalypts, it appears to split readily on the quarter. Little is known as to its qualities, so far as durability is concerned, but there is no doubt that for general purposes and particularly for furniture work it is to be thoroughly recommended.

RED TINGLE TINGLE (*Euc. Guilfoylii*).

This tree only grows mixed with the yellow tingle tingle, and is easily recognised by its much smaller size and more widely branching crown.

Weight per cubic foot (green)—73lbs.
At 12 per cent. moisture—62lbs.
Transverse strength—14,780lbs. per square inch.
Tensile strength—15,680lbs. per square inch.

The wood is of a reddish colour and, so far as the tests have gone, it should prove a most valuable wood, as soon as railway communication permits the opening of the forests in the locality.

Strength of Western Australian Timbers.

Early in the history of the timber export trade of Western Australia, questions as to the strength of the native woods as compared with the product of other countries competing in the British market came up for consideration. It may be premised that within certain limits moisture is an important factor in the strength of wood. Generally speaking, strength increases with the degree of seasoning. Freshly cut or green timber, in consequence, should be seasoned before being used for any purpose in which strength is an essential element. Defects in timber such as knots, shakes, or surface cracks, influence strength to a considerable degree. The character and position of these, however, are of importance. For instance, in cross bending stresses defects on the upper surface do not detract from the strength nearly so much as those on the lower surface.

The methods adopted in order to ascertain tne strength of our woods in those earlier times were somewhat primitive. An early official report on the subject was that written in January, 1871, by Mr. James Manning, Clerk of Works, at the Convict Department, Fremantle. It was largely due to Mr. Manning's inquiries and experiments that in the end of 1871 jarrah was placed on Lloyd's list as a timber suitable for shipbuilding. A little later the strength and durability of jarrah won for it a place on the Admiralty list of timbers that might be used in the Royal dockyards. The most complete and exhaustive tests into the strengths of our native timbers were made in 1906 at the Midland Junction Railway Workshops by Mr. C. A. Julius. The investigations of Mr. Julius have reference in particular to timbers used for constructional purposes, in which it may be subjected to any of the following stresses:—

(a) "Transverse" or "cross bending" stresses, as in beams which give rise to tensile, compression, and shearing stresses in the material.

(b) Direct "tensional" stresses occurring in the tension members of framed structures.

(c) Direct "end" compression stresses, occurring in the compression members of "struts" of framed structures and in columns, etc.

(d) "Cross" compression stresses occurring wherever a "loaded beam" is supported by a column, or upon a second beam, and also in the case of sleepers where they carry the rails.

(e) "Shearing" stresses along the fibres occurring frequently where timber is used for joints or "keys" in framed structures, and also along the "neutral" axis of beams.

(f) "Combined shearing" and "compression" stresses set up in timber when subjected to blows on end, such as occur in the case of "piles" when being driven, and in "mall" heads, etc., as also to a lesser extent in the case of columns carrying a live load, such as railway bridges, piers, etc.

The following table of transverse strengths of Western Australian timbers and of some foreign woods brings into prominence the superior qualities of the native produce:—

TRANSVERSE STRENGTH OF BEAMS OF W.A. TIMBERS COMPARED WEIGHT FOR WEIGHT.

Name of Timber.	Weight in lbs. per cubic foot at 12 per cent. moisture.	Extreme fibre stress in lbs. per square inch at apparent elastic limit.	Comparison with Yate.		
			Strength.	Weight.	Strength. / Weight for weight.
W.A. TIMBERS.					
			%	%	%
Yate	71	17,000	100	100	100
Red Tingle Tingle ...	62	14,776	86·9	87·3	99·6
Karri	58	13,550	79·7	81·7	97·6
Tuart	68	15,900	93·5	95·8	97·6
Rasbperry Jam ...	62	14,200	83·5	87·3	95·6
Salmon Gum	66	15,030	88·2	92·9	94·9
Red Gum	56	12,600	74·1	78·9	93·9
Sheaoak	52	11,100	65·3	73·2	89·2
Banksia	35	7,290	42·9	49·3	87
Blackbutt	54	11,000	64·7	76	85·1
Wandoo	71	13,650	80	100	80
Morrell	64	12,250	72	90·1	79·9
Jarrah	55	10,300	60·6	77·4	78·3
Coolabah (*a*)	82	14,461	85·1	115·2	73·8
York Gum	67	11,000	64·7	94·3	68·6
Native Pear	46	6,500	38·2	64·8	58·9
Karri-Sheaoak* (*Casuarina decussata*)	44	5,000	29·6	62	47·7
FOREIGN TIMBERS.					
Padouk (*c*)	50	11,539	67·9	70·4	96·4
Teak (*b*)	49	10,583	62	69·6	89·2
Oregon, select ...	34·4	4,690	27·6	48·4	57
Oregon, merchantable	42·4	4,625	27·2	45·6	59·6
Oregon, 2nd quality ...	33·9	3,740	22	47·7	46·1

* The corky-barked Casuarina from the Karri country. (*a*) At 16 per cent. of moisture. (*b*) At 21 per cent. of moisture. (*c*) At 17 per cent of moisture.

These figures too may be regarded as a cogent argument in favour of the use of home timbers in preference to the imported article. The native article is cheaper, it is stronger, and is more durable than the imported product. Further, when the home wood is used, encouragement is given to local industry and employment to Western Australian citizens.

A further demonstration illustrating the comparative strengths of seven Western Australian timbers and of oregon is to be found in the graph included here. It becomes evident from these figures and from the illustrative graph that in building construction indigenous timbers of a much smaller section than would be necessary if foreign timbers were employed may be safely used. Before the war, when huge importations of foreign timbers were made to Australia comparatively little native wood was used in building construction. The reason for this is not difficult to find. Those interested in the sale of foreign timber were keen and active, pushing their goods upon the market with great energy. Again, it must be admitted that the native timber is harder to work than the foreign article, and this was made an excuse for employing the latter. But with the war came a shortage of foreign timbers, and the indigenous product was turned to, and it was to the surprise of many, found able to do all that the foreign article did, and moreover do it better, inasmuch as native hardwoods are more durable than the imported softwoods.

SOME PHYSICAL PROPERTIES OF THE PRINCIPAL WEST AUSTRALIAN TIMBERS.

Name.	Weight per cubic foot green.	Weight per cubic foot at 10 per cent. moisture.*	Transverse strength per sq. inch.	Tensile strength per sq. inch.	Remarks.
Jarrah (*Euc. marginata*)	68	55	15,000	15,500	The principal commercial timbers of the State.
Karri (*Euc. diversicolor*)	72	68	17,300	18,750	
Wandoo (*Euc. redunca var elata*)	79	71	16,100	16,100	General construction work.
Red Gum (marri) (*Euc. calophylla*)	72	56	16,600	20,200	Yields a kino of high tanning value.
Tuart (*Euc. gomphocephala*)	78	68	17,900	16,500	Very dense and hard. Valuable in rolling stock construction.
Native Pear (*Xylomelum occidentale*)	56	46	7,660	7,000	A "figured" wood of great beauty.
Salmon Gum (*Euc. salmonophloia*)	70	66	20,100	19,200	A very strong wood with many uses found over a very large area, including the Eastern Goldfields.
Blackbutt (*Euc. patens*)	69	54	14,200	15,700	A strong timber, not abundant. Wood pale yellow.
Raspberry Jam (*Acacia acuminata*)	73	62	15,300	12,000	Remarkably durable in and out of ground. Strong odour as of raspberries.
Yate (*Euc. cornuta*) ...	79	71	16,700	24,200	Of exceptional strength, probably the strongest timber in the world. Many uses, including railway rolling stock.
River Banksia (*Banksia verticillata*)	59	35	10,300	8,000	Light in colour, with a beautiful grain.
Sheaoak (*Casuarina Fraseriana*)	60	52	12,000	9,000	When cut on the quarter exhibits an unusually fine and effective figure. Valuable furniture wood.
Morrell (*Euc. longicornis*)	73	64	16,000	18,000	Many uses, including wheelwrighting and tool handle.
York Gum (*Euc. loxophleba*)	77	67	14,500	13,000	Dense, hard with very interlocked grain. Unequalled for naves, maul-heads, etc.

* Wood dried to a 12 per cent. moisture content is "dry" for commercial purposes.

Production.

EXPORTS AND DOMESTIC CONSUMPTION.

It is only when one comes to examine the figures relating to the timber and other products already taken out of the State's forests that some notion of the supreme part which the woodlands have played in the country's development may be obtained. The growth of the export trade was slow. Shipping was scarce and intermittent, and for many years the means of getting timber to the places of shipment were primitive and ineffective, as well as those for loading the timber into vessels. The first shipment officially noted was in 1836, when a couple of hundred loads, valued at £2,500, were sent to Great Britain. From 1846 onward the export trade became more regular, but it was not till 1865 that the export exceeded 2,000 loads a year. Up till 1877 the growth was comparatively small; in 1878 over 11,000 loads were sent away, and from that date the increase was regular and continuous. In 1897 47,866 loads were exported, and two years later the volume suddenly expanded to 138,274 loads. The 200,000 mark was reached in 1909, and in 1913 the largest quantity ever sent abroad in one year, 272,397 loads, was reached. The value of the shipments in that year was over £1,000,000. Up to the middle of 1919 a total of 3,897,849 loads, valued at £15,693,989 had been exported from the State. But large additions must be made to these huge figures if the wealth that the forests have brought to the State is to be ascertained. Sandalwood has to be taken into account. For three quarters of a century sandalwood has been regularly exported, principally to the East. Up to the middle of 1919 the total sent away amounted to 321,360 tons, valued at £2,827,035.

Then there are tanbarks. The whole of the eucalypt family contain in their bark, leaves, or wood a certain proportion of tannin, the active agent in the process of tanning. In most of the species, however, the proportion is so small that under present conditions the barks of most of them cannot be used economically for commercial purposes. One noteworthy exception is the mallet (*Eucalyptus occidentalis var. astringens*). The percentage of tannin in this tree runs as high as 45 per cent. The bark has been largely exported,

particularly to Germany in pre-war days. The first shipment sent away was in 1903, when mallet bark to the value of £859 was shipped. Next year the value of the export rose to over £32,000, and in the following year the phenomenal figure of £154,087 was reached. That was high water mark. Since then exports have gradually diminished until in the year ending June, 1919, the value of the bark sent away was only £18,875.

It is to be regretted that no sufficient steps were taken at the time that the value of mallet bark as a tanning agent was discovered to protect the tree. The result was that it was recklessly and wantonly exploited. The total value of the mallet bark sent away between 1903 and 1919 was £929,808.

What the forests have yielded and the part they have played in the development of Western Australia becomes strikingly apparent when the figures relating to forest exploitation are gathered together and summarised. The totals are as follows:—

	£
The total value of timber, sandalwood, and mallet bark exports amount to	19,450,832
Total value of timber products used locally	8,700,000
Mining timber, estimated at	25,900,000
Total	£54,050,832

The forests of the State have, therefore, already yielded products to the enormous amount of over £50,000,000, and to this must still be added the value of gums, resins, and fibres, industrial and domestic firewood, regarding which no official statistics are available.

Finance and Output of the Forests.

The figures which tell of the operations of the Forests Department are of the greatest value. A study of them reveals several outstanding features. The first of these it that viewed as a commercial proposition the Department has shown a handsome profit every year since its foundation. The following table discloses the fact that between 1895 and 1919 the Department contributed £514,989 to Consolidated Revenue. Under "The Forests Act, 1918," three-fifths of the net revenue is earmarked for forestry purposes. Under this wise provision the Department will be enabled to undertake the big and urgent task of repairing the forest wastage of the past.

REVENUE AND EXPENDITURE.

The following statement shows the Revenue and Expenditure of the Department since its inception in 1895 :—

Year.	Revenue.	Expenditure.
	£ s. d.	£ s. d.
1st Jan. to 31st Dec., 1895	3,175 5 2	1,108 5 5
1st Jan. to 31st Dec., 1896	4,838 11 2	2,020 11 5
1st Jan. to 31st Dec., 1897	12,320 6 4	3,489 14 4
1st Jan. to 31st Dec., 1898	30,150 6 3	3,356 5 7
1st Jan. to 31st Dec., 1899	16,999 11 3	2,438 7 5
1st Jan. to 31st Dec., 1900	15,525 19 2	2,648 11 10
1st Jan. to 31st Dec., 1901	18,477 16 2	2,747 6 3
1st Jan. to 31st Dec., 1902	18,752 11 7	4,301 6 1
1st Jan. to 31st Dec., 1903	20,478 9 1	3,789 3 4
1st Jan. to 31st Dec., 1904	20,018 19 4	4,192 16 9
1st Jan. to 31st Dec., 1905	18,479 18 6	5,089 18 6
6 months, 1st Jan. to 30th June, 1906 ...	10,973 18 4	3,385 1 9
1st July, 1906, to 30th June, 1907 ...	22,783 1 5	6,207 15 2
1st July, 1907, to 30th June, 1908 ...	23,498 13 3	8,801 14 3
1st July, 1908, to 30th June, 1909 ...	29,484 3 8	9,030 12 6
1st July, 1909, to 30th June, 1910 ...	31,549 6 11	8,531 0 9
1st July, 1910, to 30th June, 1911 ...	37,477 3 5	8,862 16 8
1st July 1911, to 30th June 1912 ...	44 560 10 10	10,469 4 10
1st July, 1912, to 30th June, 1913 ...	48,236 14 0	11,463 2 11
1st July, 1913, to 30th June, 1914 ...	53,038 16 0	12,092 15 3
6 months, 30th June, to 31st Dec., 1914 ...	22,906 0 0	5,468 14 0
1st Jan. to 31st Dec., 1915	45,725 13 9	8,869 15 11
1st Jan. to 31st Dec., 1916	29,820 12 10	9,575 3 2
1st Jan. to 31st Dec., 1917	36,128 17 11	10,263 2 5
6 months, 1st Jan. to 30th June, 1918 ...	22,113 1 8	6,199 1 11
1st July, 1918, to 30th June, 1919 ...	42,059 12 4	10,872 18 3
	£679,565 0 4	£165,275 6 8

It will be seen from the above statement that to the 30th June, 1919, the revenue exceeded the expenditure by the large sum of £514,289 13s. 8d.

What the forests have yielded in the way of timber, etc., for export is shown in the table which follows. It must be borne in mind that these figures take no cognisance of timber used locally, nor of domestic firewood nor of mining timber.

SUMMARY OF EXPORTS OF FOREST PRODUCE SINCE 1836.

Year.	Timber.		Sandalwood.		Mallet Bark.
	Loads.	Value.	Tons.	Value.	Value.
		£		£	£
1836*a*	200	2,500	...	...	...
1837	...	...	...	...	...
1838	...	...	...	...	...
1839	...	...	...	...	...
1840	...	...	...	...	...
1841	...	...	...	...	...
1842	...	...	...	...	...
1843	...	...	...	...	...
1844	*b*	163	...	...	...
1845	...	...	4	40	...
1846	51	255	32	320	...
1847	244	1,120	370	4,444	...
1848	67	333	1,335	13,353	...
1849	...	...	...	...	...
1850	210	1,048	...	...	...
1851	25	268	219	1,593	...
1852	141	806	...	...	...
1853	1,044	5,220	...	...	...
1854	1,170	7,023	...	...	...
1855	1,538	12,076	...	...	...
1856	1,410	9,671	...	...	...
1857	1,384	9,449	280	2,524	...
1858	585	2,340	745	7,455	...
1859	1,345	6,051	1,278	17,259	...
1860	1,096	4,932	1,687	16,360	...
1861	555	2,497	2,558	24,945	...
1862	1,376	7,151	2,393	21,541	...
1863	658	2,963	2,807	25,265	...
1864	1,166	5,508	2,724	24,520	...
1865	3,679	15,693	1,686	13,490	...
1866	1,713	6,849	2,965	23,722	...
1867	1,135	4,541	2,305	18,442	...
1868	160	638	3,256	26,045	...
1869	3,598	14,273	4,124	32,998	...
1870	3,144	17,551	6,112	48,890	...
1871	4,370	15,034	3,366	26,926	...
1872	740	2,590	3,942	31,536	...
1873	1,363	4,771	6,290	62,916	...
1874	6,912	24,192	7,057	70,572	...
1875	6,847	23,965	6,646	66,465	...
1876	4,381	23,743	6,577	65,772	...
1877	6,723	36,979	4,247	31,851	...
1878	11,618	63,902	4,675	35,064	...
1879	12,545	69,742	4,667	35,001	...
1880	13,251	66,252	5,097	51,970	...

a The exports up to the year 1834 consisted only of supplies to shipping of which no record is kept.
b Not available.

SUMMARY OF EXPORTS OF FOREST PRODUCE, ETC.—*continued.*

Year.	Timber.		Sandalwood.		Mallet Bark.
	Loads.	Value.	Tons.	Value.	Value.
		£		£	£
1881	15,855	79,277	7,716	77,165	...
1882	18,730	93,650	9,605	96,050	...
1883	19,940	79,760	7,031	56,250	...
1884	17,234	68,936	2,620	20,960	...
1885	16,963	67,850	4,527	36,216	...
1886	12,523	50,092	3,431	27,450	...
1887	7,096	28,384	4,317	34,533	...
1888	10,515	42,060	4,470	33,525	...
1889	15,770	63,080	6,385	57,465	...
1890	23,444	82,052	5,136	51,355	...
1891	25,479	89,179	3,760	37,600	...
1892	21,653	78,419	5,716	42,870	...
1893	10,259	33,888	3,893	32,160	...
1894	21,274	74,804	2,784	23,430	...
1895	25,105	88,146	3,851	30,863	...
1896	30,912	116,420	6,848	65,800	...
1897	47,866	192,451	5,852	49,480	...
1898	81,723	326,195	4,349	31,812	...
1899	138,271	553,198	4,084	29,719	...
1900	114,508	458,461	5,095	39,038	...
1901	143,012	572,354	8,864	73,931	...
1902	125,135	500,533	7,995	61,771	...
1903	154,969	619,705	4,406	37,913	859
1904	161,446	654,949	4,510	25,417	32,876
1905	174,190	689,943	5,521	38,817	154,087
1906	*c* 176,614	708,993	8,848	70,958	140,720
1907	*c* 128,091	511,923	9,212	65,999	98,773
1908	*c* 197,390	813,591	9,564	77,668	79,934
1909	*c* 216,609	867,419	4,805	37,456	59,633
1910	*c* 241,482	972,698	8,228	70,775	93,733
1911	*c* 248,990	986,341	6,907	65,506	83,470
1912	*c* 225,942	903,396	3,154	27,533	49,094
1913	*c* 272,397	1,089,481	6,260	47,589	47,377
1914*d*	*c* 125,595	502,153	4,702	39,800	18,197
1915*e*	*c* 190,370	808,392	8,375	78,926	6,127
1916*e*	108,642	441,991	6,271	61,381	10,208
1917*e*	77,813	310,893	7,230	72,669	18,959
1918*e*	68,725	274,141	6,494	81,834	16,886
1919*e*	82,715	344,119	8,998	117,072	18,875
Total ...	3,897,849	15,693,989	321,360	2,827,035	929,808

c Approximate figures only.
d Six months ended 30th June.
e Year ended 30th June.

The amount of timber taken yearly from the forests and its value enable some idea to be formed as to the highly important part the woodlands play in the State's economy. The figures given in the following tables cannot be maintained, and if the forests are to continue to furnish employment for workers, it can readily be understood that a policy

of regeneration must accompany exploitation. Systematic cultivation of cut-over regions and the planting of new areas alone can assure continuity and permanence to the forests as producers of wealth and avenues of employment. The first table gives the total timber production (sawn and hewn) for the year ending 30th June, 1919.

TOTAL TIMBER PRODUCTION.

——	In the Log.		In the Square.	
	Loads.	Cub. feet.	Loads.	Cub. feet.
Total Milling Timber ...	283,865	14,193,250	123,612	6,180,600
Total Hewing Timber ...	78,332	3,916,600	19,583	436,450
Total Sawn Timber from Private Property	5,018	250,900	2,258	112,900
	367,215	18,360,750	145,453	6,729,950

Round Piles and Poles ... ... 81,050 running feet.
Heart-in Beams ... ... 12,975 „ „

There is further taken from the forests timber for mining purposes and for firewood. The volume under these heads is represented below:—

MINING TIMBER AND FIREWOOD CONSUMED DURING THE YEAR ENDED 30TH JUNE, 1919.

	Tons.
Wood fuel consumed on Greenbushes Mining Fields	15,120
Mining Timber consumed on Collie Coal Fields	3,464
Wood fuel consumed in Metropolitan Area	154,500
Wood fuel consumed on Golden Mile, Coolgardie, and Norseman Mines	333,565
Mining timber consumed on Golden Mile, Coolgardie, and Norseman Mines	8,700
Wood fuel consumed on Northern Goldfields, Lancefield, Gwalia, Menzies, and Ora Banda	76,605
Mining timber consumed on Northern Goldfields	2,072
Wood fuel consumed in Southern Cross Areas, Westonia, Bullfinch, and Golden Valley	35,779
Mining timber consumed in Southern Cross Areas	18,087
Pumping Stations, Goldfields Water Supply, Nos. 5, 6, 7, 8, plus other small pumping plants	7,599
Household wood, Goldfields	35,059
Bakers' wood, Goldfields	16,181
Breweries, Cordial Factories, Electric Light Plants, Batteries (State and Private outside Golden Mile Batteries)	6,781
Engine wood consumed on Tramways	14,909
Electric Power and Light	50,976
Wood fuel used as charcoal on Eastern Goldfields	300
Sleepers	3,300
	*782,997

* Exclusive of mining timber and firewood consumed on the Murchison and other distant Goldfields not mentioned above.

Cutting operations in the forests are carried on under various forms of authorisation. These and the areas respectively covered appear in the following table:—

	Total Areas.	
	Original.	Present.
	acres.	acres.
Concessions	396,000	378,139
Leases	409,020	247,047
Sawmill Permits	814,346	722,892
Hewing Permits	28,840	18,439
Sawmilling Permits	43,945	43,225
Firewood Permits	20,464	19,924
Miscellaneous Permits	18,479	15,040
Grand Total	1,731,094	1,444,706

The concessions and leases are of old standing, and all of them will expire before 1928. At the end of the terms for which they were granted, the areas included in them will be exploited under the permit system as laid down in the Forests Act.

State Nursery.

An important branch of every Forest Department is the raising of young trees for use by the Department itself in afforestation work and also for the convenience of private citizens, particularly farmers, who desire to grow timber for shade purposes, for use on the farm, or for sale at maturity. The Western Australian Nursery is situated at Hamel, and there hundreds of thousands of trees of many varieties are raised. In some of the farming districts of the State, the original holders of the land, with an eye only to the present and the immediate future, practically denuded their holdings of all timber, thus depriving themselves and their successors of the countless advantages following the

presence of timber on the farm. The value of what in America and Canada is called the "farmer's wood-lot" is not yet sufficiently recognised in Australia, although in some of the older settled districts the errors of earlier times are being repaired by vigorous planting of trees. There are few farms that do not possess more or less land unsuited for the raising of wheat and other crops, but perfectly adapted for growing of such timbers as may suit the soil and the rainfall of the particular district. These areas, when planted with trees, form very valuable assets and, when the "wood-lot" has been well established and is yielding its yearly crop of mature timber, the area of ground which was once regarded as of little or no value at all becomes one of the most profitable on the holding.

The nursery at Hamel grows trees suitable for the temperate area of every part of the State, and seedlings of these may be had by farmers and others in quantities to suit them and at prices which cover only the cost of raising them.

Forests Products Laboratory.

There lingers in some quarters the belief that the value of forested country is limited to the raw timber that can be got out of it, and to its capabilities as an area on which stock may be depastured at certain seasons of the year. Such a conception is entirely at variance with the facts. Indeed in certain classes of forests the raw timber they produce is of comparatively small moment when set against the value of certain other materials that they yield; in other cases these products add materially to the amount derived from the forests, and in every instance investigation by skilled workers has never failed to discover many items of value hitherto unsuspected. The potentialities of the Western Australian forests in the direction of other products than timber are as yet but little known. It has been ascertained already

that the forests of the State yield oils, gums and resins, but to what extent is so far only a matter of conjecture. We know about sandalwood oil, blackboy gum, redgum kino, grasstree fibre, and of some other articles of value in commerce, but it is no exaggeration of language to say that the vast field has only been touched, but in no sense explored. Thorough exploration calls for the exercise of great skill allied to high scientific attainments. In other words, such works belongs to the province of a Forests Products Laboratory.

There is no subject more important in the economics of timber than research into timber waste. When a jarrah tree is felled half of the tree only is brought to the mill, viz., the log; the rest is wasted. When the miller converts it into sawn wood he recovers only 40 per cent. of the total cubic contents. The system of measurement—quarter girth—causes an under-measurement of 21½ per cent., so that a 50 per cent. recovery is really only about 40 per cent. The remainder is burnt. Every year we burn at our sawmills 500,000 tons of wood, exclusive of sawdust and rotten hearts—in other words, sound wood. Setting out these figures, we have:—

Crown, branches and twigs—50 per cent.;
Sawdust—5 per cent.;
Rotten hearts—10 per cent.;
Mill waste—15 per cent.;
Sawn timber—20 per cent.;
Tree in forest—100 per cent.

Eighty per cent. of the tree is destroyed and lost, and it is for a forest products laboratory to find uses for the various parts now wasted.

THE SCOPE AND PURPOSE OF SUCH AN INSTITUTION.

The general aims of this institution are as follows:—

1. To test all commercial woods with respect to their physical, mechanical, and chemical properties.
2. To study the causes of the decay of wood, and test methods for the preservation of wood.

3. To study the fundamental problems concerning the manufacture of wood-pulp, wood alcohol, acetic acid, essential oils, resins, and other products obtained from trees.
4. To find methods for the utilisation of wood waste.
5. To provide free information on the properties and utilisation of all forest products.

In order to conduct research in these directions the Forest Products Laboratory should be organised into divisions, each with its staff of technologists and quota of equipment. These divisions are as follow:—Timber Physics, Timber Tests, Pulp and Paper, Wood Preservation, Administration.

The work of administration will include the collection of information and management of the library, which will be a valuable up-to-date repository of technical information on the properties and utilisation of all forest products. This library will be, of course, of the greatest value to those engaged in the work of the laboratories, but may also be consulted by anyone interested in the characters, uses, and manufacture of all tree products.

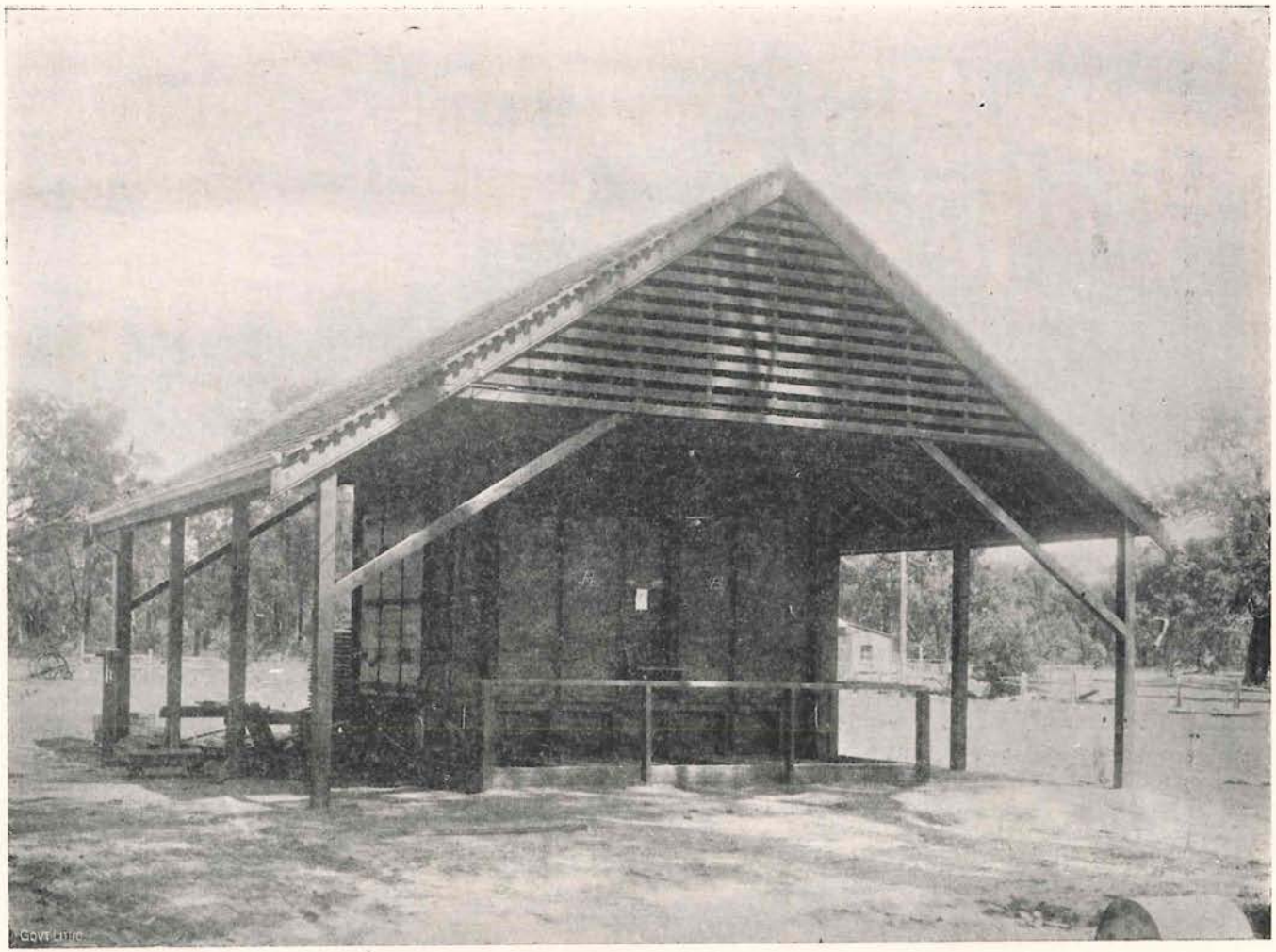
The Government of Western Australia and the Federal Government have arrived at a tentative arrangement for the establishment of a Forest Products Laboratory in Western Australia, and, if the arrangement be carried to finality, an institution will be at work within a reasonable period, greatly to the advantage of the State.

Kiln Drying of Timber.

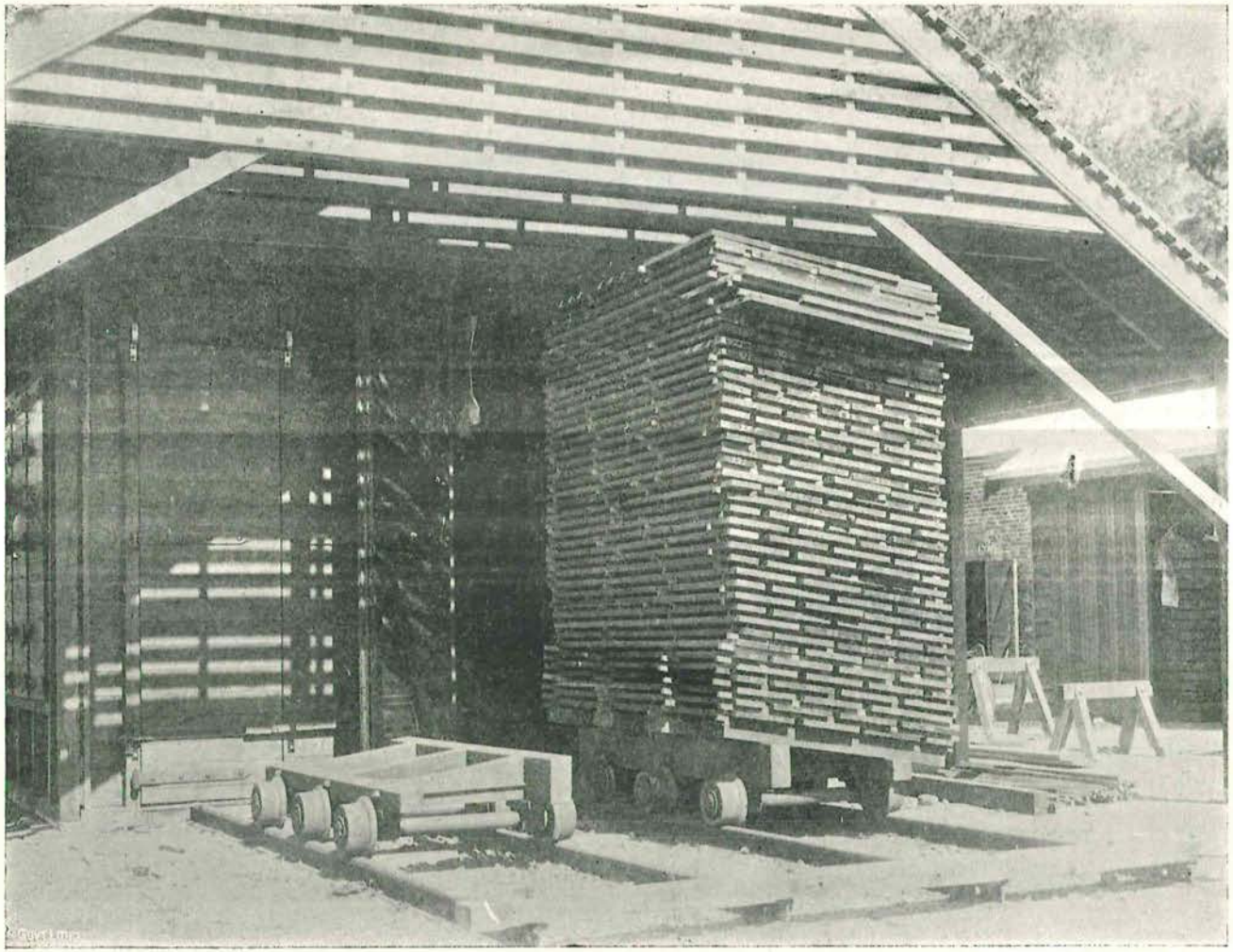
All over the world the increasing use of timber in arts and manufactures has given rise to a wide demand for steady supplies of perfectly dry wood. There are numberless purposes to which wood is applied whose success depends entirely on the use of material in a perfectly dry condition. The process of seasoning timber may be effected in two ways —either by stacking the wood in the open or in sheds in such

a way that the air may have free access to it, or by the use of kilns scientifically constructed and operated on principles which will bring about the desired result in the shortest possible time. Seasoning adds to the value and usefulness of timber in the following directions:—(1) it reduces the weight. Jarrah, for example, loses one-third of its weight in passing from a green state to a dry one; (2) it prevents warping; (3) it shrinks timber to a point at which working is reduced to a minimum: jarrah boards shrink 6.8 per cent. of their width in drying; (4) it increases the strength of the wood. This reason is not as generally known as it might be. Mr. Julius in his exhaustive tests of Western Australian timbers found that the transverse strength of green jarrah was 10,600lbs. per square inch, while that of dried jarrah was 15,000lbs. per square inch; (5) it renders timber less liable to fungus attacks. Rot is caused by the attacks of fungi, which require a moist medium in which to take root. Green timber, with its high moisture content, provides this favourable medium. How well dry timber resists rot is shown with karri, which, if seasoned before being used, is remarkably free from dry rot. (6) Drying makes it possible to paint and polish wood.

The seasoning of timber by other methods than air drying has engaged the attention of timber users for a long period. Many systems have been evolved, but most of them for one reason or another have failed to realise the expectations of their inventors. Kiln-drying has received attention to a greater degree in America than elsewhere. After careful study of the factors involved and long and exhaustive experiments, America has produced several types of kiln which give satisfactory results. The best of these probably is that constructed by Mr. H. D. Tiemann, an officer of the Forest Products Laboratory at Madison, Wisconsin. It is long since the notion that timber could be successfully dried by dry heat was exploited. Dry heat alone invariably exaggerates the imperfections which usually attend open air drying, and produces others equally disastrous. Dry hot air leads to warping, splitting, and checking, and "case-hardening," a condition which, owing to the difference in tension between the dry outside surfaces and the moist interior, produces serious warping and splitting. In modern kilns—including the Tiemann—drying is effected by moist or humid air. If success is to be achieved there must be kept up during the whole process of drying a certain relationship between



General view Crawley Kiln.



Jarrah charge after drying, Crawley Kiln.

humidity and temperature within the kiln, and, as this relationship varies according to the stage of the process, the determination of that varying relationship is a matter that calls for the exercise of much skill and care, and, at the same time, calls for intimate knowledge on the part of those carrying out the operations, of the physical properties of the woods being dried. Hardwood, such as our jarrah and karri, cannot be successfully dried under conditions exactly similar to those which succeed with American soft and medium woods. In adopting the Tiemann kiln, so far as its basic principles were concerned, the first investigators in Western Australia found it necessary to modify some of the conditions that prevail while soft and medium woods are being treated, and it was only after study and experiment that the conditions that would bring success with hardwoods were ascertained. The first experimental kiln was erected, jointly with Messrs. Millars' Timber and Trading Company, in that firm's yard in Nash Street, Perth. The work done at this kiln was of great value, as the experiments materially assisted in determining the variations from the Tiemann kiln, that were essential if hardwood was to be successfully dried.

A second kiln was erected in the grounds of the University at Crawley, and at it perfectly dried timber is turned out. The product of this kiln is eagerly sought after by furniture manufacturers and others whose business demands timber in a thoroughly dry condition. Messrs. Millars' Timber and Trading Company, at their sawmills at Yarloop, have erected a drying-kiln, on the principle of that at Crawley, and are turning out kiln-dried timber on a commercial scale. The times occupied in converting by kiln-drying green jarrah into commercially dry timber are approximately as follow:—1in. in thickness, 28 days; 1½in. in thickness, 40 days; 2in. in thickness, 56 days; and 3in. in thickness, 84 days. Karri takes longer to dry than jarrah, the approximate times being 1in., 35 days; and 1¾in., 70 days.

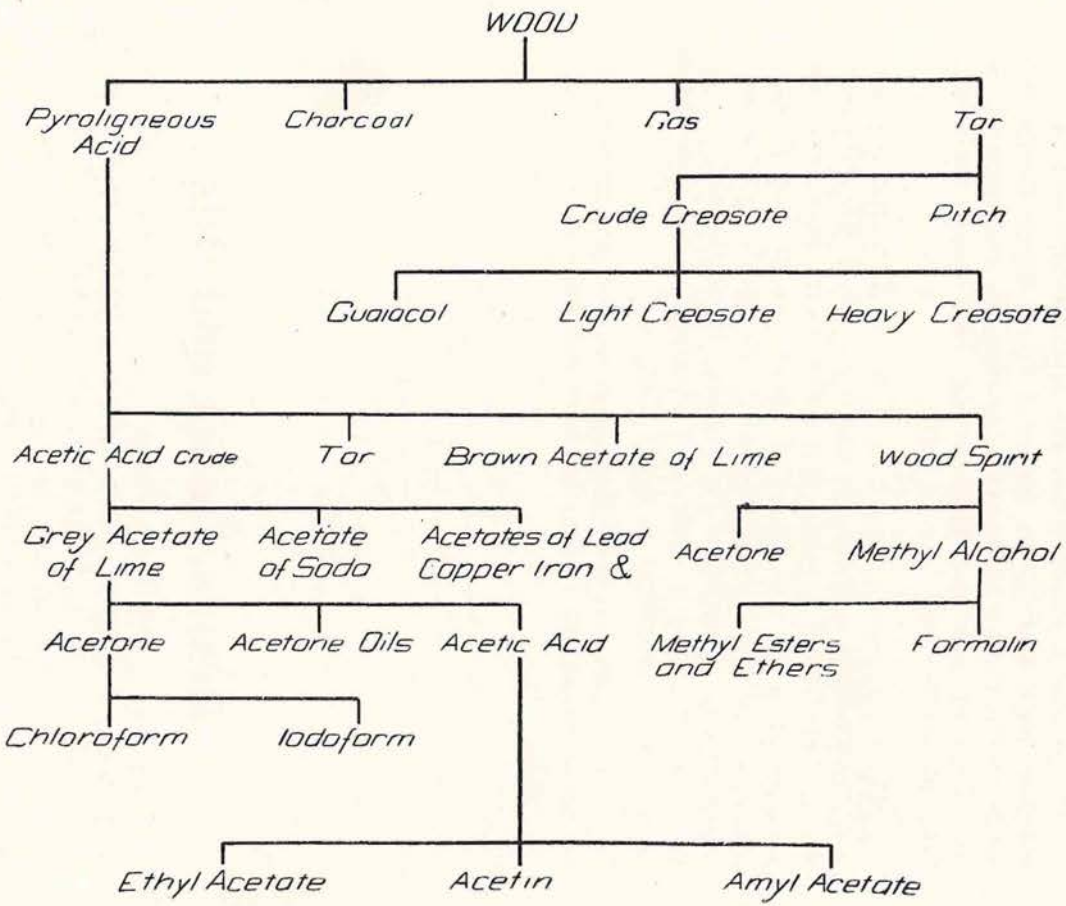
Distillation of Wood.

It has long been known that wood is capable of conversion into substances quite unlike their parent. It is many centuries since charcoal burners noticed the residuum of tar after their operations. This tar was believed to have high medicinal values and was used accordingly. It is only of recent years, however, that scientific principles have been applied and scientific methods adopted for the determination of the whole content of wood fibre. A systematic distillation of timber for the purpose of recovering its by-products has now developed into an industry of enormous dimensions. The development, of course, has been step by step. The first factories established for the purpose contented themselves with the production of such substances as crude pyroligneus acid and acetates in addition to the tar and charcoal. At the time these early plants were in operation no use had been found for the wood spirit, but to-day four main primary products are made, namely charcoal, grey acetate of lime, wood spirit and tar. In many cases plants for the production of pure acetic acid and acetone have been installed at the old distilleries, and other products derived from the primary woods are now manufactured on an ever-increasing scale.

According to an Indian authority, it is estimated that about three million tons of wood are distilled every year throughout the world for the sake of their by-products, producing approximately 150,000 tons of acetic acid and 15,000 tons of wood spirit. In the United States whole forests are cut down, and the production in that country is about half that of the total. The industry has also assumed large proportions in Canada, where half the remainder is distilled, while the remaining quarter is treated in Europe, mainly in Germany and Austria. The greater portion of the acetate of lime is converted into acetic acid. It is used in dye-making and for the production of salts and other secondary products, such as esters for which there is a large demand. Many of the salts are used in the dyeing industry, while the esters may be used for flavouring and perfumery purposes, or in the synthesis of more complicated chemicals.

Another most important product obtained by distillation of the grey acetate is acetone, which is largely used as a solvent particularly in the manufacture of cordite, as well as

Principal Products of Wood Distillation



being employed in the manufacture of chloroform and iodoform. Wood spirit is used in a partly refined form for the denaturing of alcohol and for the preparation of varnishes, and enormous quantities are consumed in this way. Many thousands of gallons are carefully purified, giving methyl alcohol, which is essential for the manufacture of many important dyes, and is the material from which formalin is made. From the tar, drugs such as creosote and guaiacol, can be separated, and even the charcoal dust is now worked up into briquettes to be used as fuel.

The distillation of wood in Western Australia is a matter which should seriously be taken up. Over 500,000 tons of wood, exclusive of sawdust and rotten heart wood, are every year burnt in the waste fires of various sawmilling plants in the bush. Wood thus destroyed is absolutely lost, while, if submitted to destructive distillation, it would at once produce many valuable articles of commerce, and provide an avenue of employment to many men.

The diagram on another page shows graphically the principal by-products that are derived from the distillation of timber.

Resins, Gums, and Oils.

In 1846 a Perth merchant made it known that he was a purchaser of gums, and mentioned that he had in stock, awaiting shipment, a parcel of about two tons of the very finest gum "derived from an acacia." It is probable that the gum collected by the merchant was that of the wattle (*Acacia cyclopis* or *Ac. canophylla*), a member of the acacia family indigenous to Western Australia. This gum is of great value in pharmacy, and in the manufacture of high-class mucilage. It is admirably adapted for many classes of confectionery work, but, owing to its high price, does not find much use in this direction. The Christmas tree (*Nuytsia floribunda*) whose floral magnificence adorns with a golden glory the

south-west forests about the Christmas period, also yields a gum of the finest quality. But the quantity available is so small that it is not likely ever to become a merchantable commodity.

The leaves of the whole of the eucalyptus family including the mallees and mallets as well, yield an essential oil, but this oil varies greatly in quality and quantity of yield. The possibilities of a number of the Western Australian eucalypts have been investigated in this direction, but, so far, the number examined is very small, and it is hoped when the Forests Products Laboratory investigates this subject, that it will discover among our numerous species more than one which will repay commercial oil distillation.

The scientific investigator who inquired into the properties of the oil distilled from the leaves of karri (*Euc. diversicolor*) says of it "the oil has apparently no commercial value, but is scientifically interesting, because the undetermined ester is evidently new, so far as eucalyptus oils are concerned, and if sufficient oil were supplied for the purpose, might be separated and determined. The oils derived from red gum or marri (*E. calophylla*), salmon gum (*E. salmonophloia*), wandoo (*E. redunca*), brown mallet (*E. occidentalis var. astringens*), the gimlet (*E. salubris*), jarrah (*E. marginata*), tuart (*E. gomphocephala*), and other native eucalypts have also been investigated, but in no case has the oil been found to be of sufficient commercial importance to justify its production industrially. The whole subject, however, is in need of further study, by experts such as those attached to a Forest Products Laboratory. The eucalyptus oil of commerce is derived principally from *E. amygdlaina* and other eucalypts indigenous to the Eastern States. The yield of oil varies greatly in the eucalyptus family. *E. amygdalina* and some others yield up to 33lbs. of oil from 1,000lbs. of leaves.

Jarrah and Karri and their Varied Uses.

It is often difficult to impress people with the immense possibilities latent in the principal commercial timbers of the State. Both karri and jarrah have been so long and so consistently put to second and third rate purposes that there has grown up in many quarters an opinion that they are suitable for none other. Never was a greater mistake made. There are few purposes in construction, in arts and decoration to which timber may be put that cannot be adequately filled by either karri or jarrah. Abroad jarrah has been seen almost exclusively in the form of railway sleepers. Timber experts, recognising the high qualities of the wood, have marvelled that such a magnificent timber should be put to a purpose which is filled in other countries by second and third rate timbers. Nowhere in the world except in Australia are railway sleepers made of the country's finest timbers. In Europe, and in America for that matter, they do not always insist even that the railway sleeper shall be strictly rectangular. The half-round sleeper is in common use, and in France engineers do not even demand that the sleeper shall be straight. So long as the requisite superficies is presented to the ground and the requisite thickness present, French engineers are satisfied. They do not call for a perfect piece of the highest class timber.

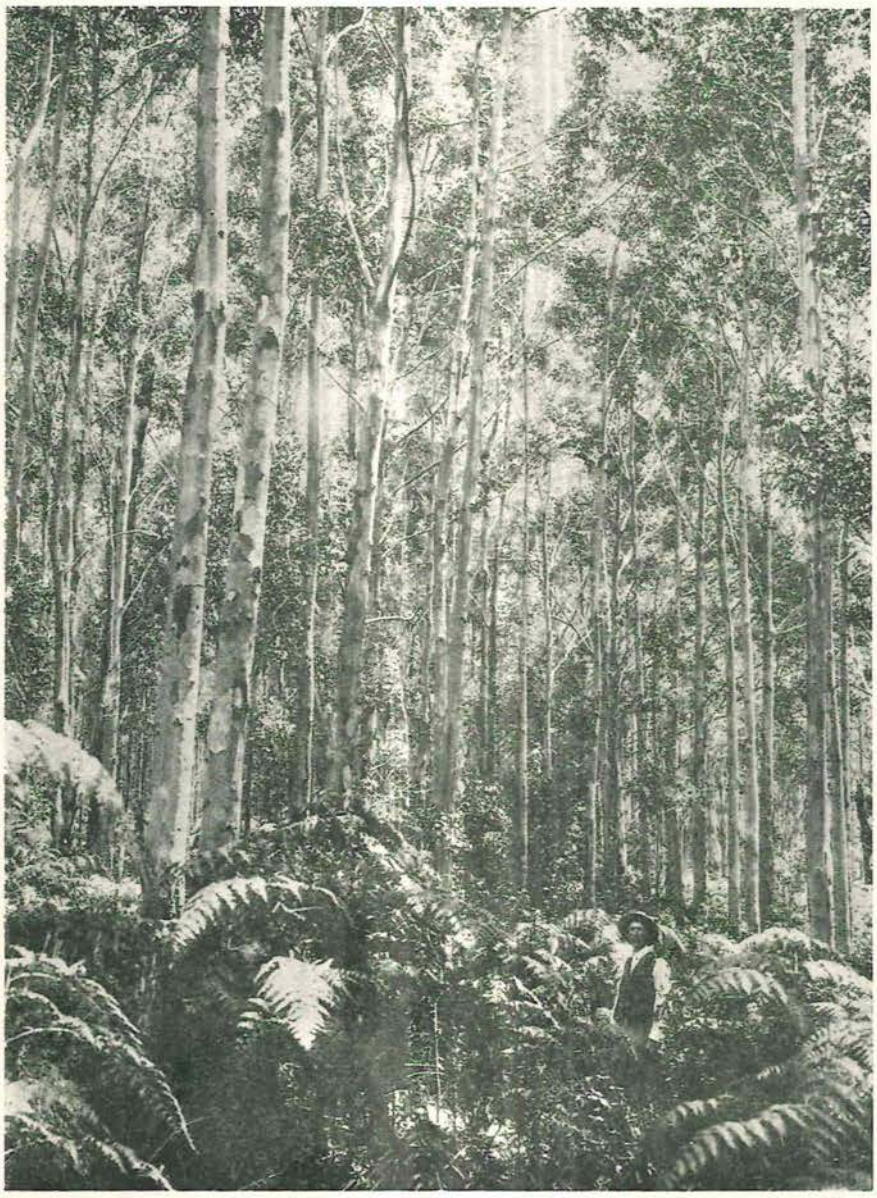
In Western Australia in the very first days of the Colony and for a couple of decades after, jarrah was to all intents and purposes the only building material used. Everyone of the first buildings in Perth was of jarrah. The first courthouse, the Government offices and Government house were all built of timber cut almost on their sites. The early buildings were roofed with rushes, and a little later the split sheaoak shingles came into vogue, and later on in the fifties sawn jarrah shingles were used. It followed, of course, that the pioneers used jarrah for furniture-making, and it continued to be so used until the cheaper but obviously inferior softwoods ousted it. The first bridges and jetties were built of jarrah, just as they are at the present day, and some of these earlier structures are quite as good as when they were opened. Western Australia had a splendid opportunity of following

in the wake of the United States and Canada and developing a local architecture, but it missed that opportunity, and took to the brick structure modelled on purely English style. In America and Canada whole cities are built of native woods. In others the residential quarters are entirely of timber, and in every case a special architecture has been developed, and the American wooden house of to-day is as commodious, ornamental and convenient as one built of stone or brick. Such a desirable state of affairs might have existed in Western Australia had it not been for an unreasoning adherence to British traditions. Again, municipal authorities in Western Australia have banned wood as a building material for outside walls and roofs on the alleged ground of fire danger. No sufficient proof that such a danger exists to an alarming extent has been adduced. Canada, for example, has given a scant reception to the fire bogey and, when one remembers that Canadian woods are all soft and many of them resinous and therefore readily inflammable, and that Western Australian timbers are all hardwoods with an unusual ability for resisting fire, the conclusion cannot be avoided that the civic authorities of the State framed their by-laws banning wood without due consideration.

In England the necessity for the rapid erection of a great number of houses for returned soldiers has led to a reconsideration of the question, with the result that the Board of Health has authorised the construction of buildings of wood. If the civic authorities of Western Australia will once more follow the lead of Great Britain, then we may hope to see here in the near future large numbers of fine residences built entirely of native timbers.

In building construction jarrah and karri are being employed in increasing degree where great strength is required. In many of the large buildings in the metropolitan area warehouses, and the like, native wood is being preferred to iron or steel for beams and supporting pillars. In the event of fire occurring in a warehouse fitted with metal beams and supports, it is more than likely that under the strain of an intense heat these will bend or break or buckle. With jarrah or karri the case is entirely different. The timbers char only to a limited extent and continue to do their work.

For internal fittings jarrah and karri are being recognised as eminently suitable timbers. In some of the new office blocks in the City of Perth they are used exclusively, in stair-



Regrowth of Karri.

Hauling Jarrah log.

cases, wainscoting, flooring, and panelling. Rooms so fitted present a remarkably handsome appearance, the rich tones of the timber enhancing the beauties of the pattern and design. For the manufacture of furniture of the highest class jarrah is now largely used.

In 1919 an *exhibition* of Western Australian timbers in a raw condition and manufactured was held in Sydney, and attracted a great deal of attention; more particularly was this the case as regards the furniture. Messrs. Millars' Timber and Trading Company exhibited a very fine pedestal reading table, an elaborately carved cabinet, a sideboard, a hall stand, and a mantelpiece, as well as some splendid wall panelling, all of jarrah. The Forests Department, in addition to raw products, showed a table of banksia and another of redgum; the Railway Department of the State sent some tramcar seats of banksia, a number of beautifully marked sheaoak panels, and a couple of wagon under-carriages of tuart and wandoo.

A notable feature of this exhibition was a panelled room of jarrah, containing a table and suite of furniture also of jarrah. The whole of the timber of this room and the furniture was made from wood which had been kiln dried. This room was a striking illustration of the capabilities of jarrah as a furniture and decorative wood.

The Sydney exhibits were sent to London, where they were shown at an exhibition of the woods of the British Empire, and attracted much attention; and in 1920 a somewhat similar collection was shown at the Peace Exhibition in Adelaide. Wherever jarrah and karri are shown in furniture or artistic form, they always command the admiration of the beholders.

The war has had this, among other effects, that while prior to 1914 few, if any, of the furniture makers in Perth used jarrah and karri in the trade to any extent worth mentioning, at the present time both these timbers are in active demand, and in every furniture warehouse suites and other articles of household furniture may be seen constructed of jarrah or of karri or other native timbers. Another result of the war is the discovery that karri is a first-class cooperage material. Casks of this timber are now beginning to be made, and it is hoped that the demand for it for cooperage purposes will steadily grow.

Boat and Shipbuilding in Western Australia.

A STORY FULL OF INTEREST.

The development of the Colony of Western Australia in its earlier decades was intimately associated with the building of boats and ships. The conditions were such that water carriage was not only the most economical, but was indeed the only method possible. The pioneers settled themselves in the districts watered by the Swan, the Canning, and the Murray, and it was only to be expected that the rivers became the highways. For years the Swan was, to all intents and purposes, the only "road" from Fremantle to Perth and Guildford, and the upper reaches of the river. Few ever thought in these early days of covering the distance between Perth and Fremantle by any other way than boat. The river was so well recognised as the best and most convenient highway that sailing boats plied regularly between the capital and the port, their hours of departure being fixed and duly advertised. And the colonist, finding that jarrah was a splendid wood for house construction, argued that it would be equally successful in boats and ships; they used it accordingly, and experience soon made it certain that, as a material for marine work, jarrah was an eminently suitable timber. Before the Colony had been ten years in existence boat and shipbuilding had become its principal secondary industry. There were building yards in Perth and Fremantle, and on the Canning and the Murray, and at Bunbury. Albany also had a busy yard, and there some of the finest vessels ever launched in Western Australia were turned out.

Necessity, if nothing else, compelled the early colonists to engage in big boat and ship building ventures. Ships from England arrived only at irregular intervals, and, as no foreign tonnage was available for local coasting trade, ships had to be built here. The fine part the early shipbuilders played in the development of the country deserves the lasting gratitude of all those who come after them.

Boat and ship building were among the earliest purposes for which local timbers were used. The circumstances of

the young Colony made it quite impracticable, even if it were desirable, to import foreign timber for the many purposes for which it was required. The demand for ships of various sizes for use on the river and around the coast was very urgent. But it is evident that the colonists in the opening years of Western Australia's history had not forgotten the English oak as a shipbuilding material, for very early it is announced that seedlings of English oak have been raised at the Botanic Gardens in Perth, and may be had by the settlers who desire to grow oak trees. The effort, however, seems to have died a natural death, for long before the seedlings could become trees from which shipping timbers were possible, the value of native timbers for shipbuilding purposes had been discovered, and the idea of growing exotics on an extensive scale was abandoned. The earliest printed reference to shipbuilding occurs in March, 1833, when a "craft" was said to be on the stocks in Perth for a Mr. Lukin, and was to be used as a whaler, with Albany as the centre of its operations. This year a "boat" was built at Perth by a Mr. Edwards for Moore & Hunt, and was fitted out for a sealing cruise around the islands in the neighbourhood of King George Sound. Albany in these early days seems to have been the headquarters of the whaling industry, although at a subsequent period Fremantle was the home of several very promising whaling enterprises. Albany in due time built its own vessels for whaling, and towards the end of 1834, a Mr. Dring launched two at King George Sound. The largest ship up to that date built on the Swan was the Lady Sterling. She was constructed wholly of native timbers, but, unfortunately, four months after her launching she was seriously damaged while trying to cross the bar at the entrance to the Swan, but was afterwards repaired. It should be mentioned that overseas ships did not enter the river to discharge their cargoes, but according to the report, any loading and unloading of cargo was done by the medium of boats. Cockburn Sound was in these days the principal export harbour of Western Australia.

The River Murray was also the scene of shipbuilding operations, and in 1846 a schooner of 150 tons with a keel of 75 feet was built there. Another vessel with an interesting history was the "Emma Sherrett," a schooner of over 90 tons, which left Fremantle for the Mauritius. No details of the cargo are available, but the vessel itself was built at King George Sound. In 1845 the "Thetis," schooner, was

launched at Fremantle, being the fifth vessel built up to that year; at the time of her launching two more were in course of construction. One of these, the "River Chief," was to be 220 tons burthen, and was intended to sail for London freighted with local products. Towards the end of the year she had sailed, taking amongst other cargo 50 tons of sawn timber and 21,000 shingles.

There were enterprising people in the Colony in the late 50's, and in the matter of shipbuilding they were not content with simply constructing vessels to carry away the natural resources of the Colony they felt their isolation in the matter of vessels from overseas, and in 1847 it was seriously considered whether it would not be well to extend the shipbuilding industry in order that imports might also be landed in the Colony from Western Australian bottoms. Bunbury, too, had its shipbuilding yard, and up to 1850 there had been built at Bunbury these vessels:—"Emu," schooner, 20 tons; "Gazelle," 18 tons, built a mile up Preston River; "Frolic," 16 tons; and one schooner of 50 tons then being built. In 1857 "The Pioneer" steamer was built wholly of local timbers, and commenced to make trips to Guildford; in the same year the "Lady Sterling" was engined for use on the river. The river, owing to the absence of roads for a generation after the Colony's foundation, was the great highway between the port and the capital. The whole of the barges and boats used for passengers and goods conveyance between Fremantle, Perth, and Guildford were built of local timbers, and many of these small vessels were very fine specimens of the naval constructors' work. Experience soon taught the early colonists the purposes for which the various woods were more particularly suited, and boat and ship specifications often bear evidences of this. For instance, in 1859 the Commissary General calls for tenders for two six-oared whale boats for service of water police to be of "Singapore pine" keel, stem, and stern post; gunwale, thwarts, rising keelson, and bottom boards to be made of mahogany; knees of seasoned banksia timbers, oak, or hickory. The Singapore pine here mentioned is presumably the pine now almost exclusively used on the North-West coast for the manufacture of cases for pearl shells.

With the coming of steam and with iron and steel replacing wood in the world's shipyards, the building of wooden vessels gradually declined. But the industry is by no means extinct. Most of the pearling schooners and luggers on the Nor'-West coast are built in the State of timber grown in

the State, and the same may be said of the hundreds of fishing boats at the various centres.

The revival of wooden shipbuilding is a matter which might well be seriously taken up in Western Australia. There is still work for wooden ships to do. Much of the carrying trade on the American coasts is done in wooden bottoms, and Scandinavia finds constant employment for large numbers of wooden vessels.

Fire-Resisting Qualities of Eucalyptus Timbers.

Many inquires have been made into the strengths of Australian timbers, and into those imported from outside, and the results have been tabulated on many occasions, but so far no comparative statistics have been compiled touching the fire-resisting qualities of Australian woods as compared with the softer timbers imported so largely into the Commonwealth.

The subject is topical at this moment, for the reason that large sums are now being spent throughout the Empire on homes for returned soldiers. One effect of this has been that, in England at last the old bogey about the danger of wood for building construction in towns has been laid, for the English Health Department has sanctioned timber as a building material for War Service homes.

In London of recent times several fire tests of Westralia's principal timbers have been made, and the reports upon these are of interest, and there can be no question that the behaviour of these timbers under fire does not materially differ from most of the other hardwoods of the Commonwealth. The following notes give particulars of these tests:—

Reports on the fire of September, 1902, at the Victoria Docks, London, E., on the premises of the Acme Wood Floor-

ing Company, Limited, in which large stacks of deal, pine, American redgum, and jarrah were involved; and tests made by the British Fire Prevention Committee on the 29th January, 1902, and the 9th July, 1903, clearly demonstrate the fire-resisting qualities of karri and jarrah timbers.

The Fire at Victoria Docks.

The British Fire Prevention Sub-committee in their report of the Committee of December, 1902, on this fire, said, though the jarrah bore the brunt of the fire, as what wind there was blew in this direction, comparatively little damage was done to this pile, and this was confined to the North and West faces, the fire failing to penetrate far into the interior. Your sub-committee are of opinion that but for the resistance offered to the fire by this stack of jarrah, the conflagration would have assumed much larger proportions, as in the rear were large quantities of deals, and had they ignited the task for the fire brigades would have been far larger and more difficult.

"The Street," in its issue of October-November, 1902, in an illustrated article on this fire, said "The fire swept all before it until it reached the stacks of Australian hardwood. The fierceness of the fire met an instant check, and failed to lay hold of the close-grained wood, thus giving the firemen the first chance of really tackling the flames and eventually extinguishing them; subsequent investigation showed that these wonderful West Australian woods were merely charred on the surface, and the large stacks remained intact. Inside the mill were several railway trucks loaded with hardwood blocks of the description used for public roads, ready for despatch to customers. The steel frames, springs, and wheels were all that remained of the trucks, but the contents were intact except for slight charring of the external layers of wood blocks. There can be little doubt that if the timber in the mill and in the yard had consisted wholly of Australian hardwood instead of deals and hardwood in juxtaposition, the fire would not have made much headway before being mastered by the brigade and the dock company's floating engines. "After all, an actual fire is the best fire test, even though an expensive one for the moment."

The Tests of the British Fire Prevention Committee on Jarrah and Karri Doors and Jarrah Floor, January, 1902, and Karri Floor, July, 1903.

The aim of the committee, as set out in their prospectus, is "to obtain reliable data as to the exact fire resistance of the various materials . . . . The tests are of entirely independent character, arranged on scientific lines, but with full consideration for the practical purpose in view . . . . All reports on tests solely state the bare facts and occurrences."

In their report of April, 1902, the committee give the following particulars of certain tests of jarrah and karri:—

Fire tests Nos. 35 and 36, 29th January, 1902.—A 2in. jarrah four-panel (bead flush both sides) door; a 2in. karri four-panel (bead flush both sides) door.

Objects of Tests.—To record the effect of a fire of one hour, gradually increasing to a temperature of 2,000 deg. F. (Note: 2,000deg. F. was attained in thirty minutes, and the temperature remained between 2,000 deg. F. and 2,200 deg. F. until the end of the test.) The fire was to be applied from one side, and the doors were to open inwards on to the fire side. The door openings were to be approximately 3ft. by 6ft. 9in.

Fire Test No. 37, 29th January, 1902.—A floor of jarrah wood, area 222ft. 6in., super in the clear (10ft. by 22ft.) loaded with 232lbs. per square foot in three separate loads of bricks, that in the middle covering an area of 47ft. 5in. super., and the two end ones 42ft. 8in. super.

Object of Test.—To record the effect of a fire of two hours' duration at a temperature gradually increasing up to 2,000 deg. F.

Results.—In the hour test it took 60 minutes for the flames to break through the jarrah door, while, though at the end of 46 minutes a flame appeared at top of muntin of the karri door. It was not until the fire had been burning for 58 minutes that the top muntin fell out. In the two hours' test the fire had been burning for one hour and 24 minutes before it appeared through any part of the jarrah door.

"Transport," of July, 1903, in its report of the test made by the British Fire Prevention Committee the previous day, as to the behaviour of karri hardwood under intense heat, says, "The test formed part of the programme arranged

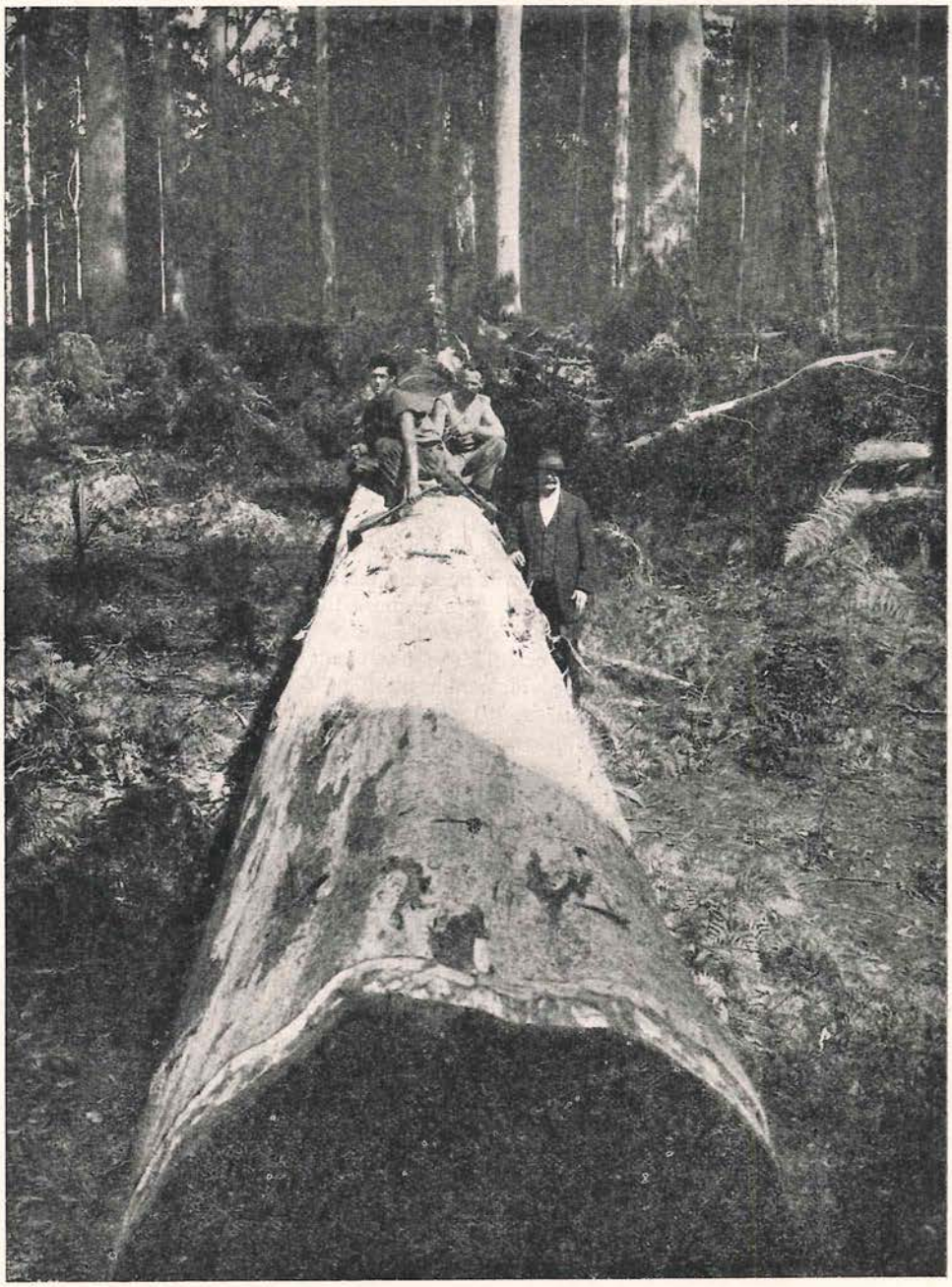
by the committee in connection with the Annual Congress (Fire), and representatives from the Continental fire brigades were present, besides many others. A large brick hut, 22ft. long by 10ft. wide, was arranged with several lengths of karri timber 2in. in thickness. These were placed so as to form a ceiling, and on top of these was a load of bricks weighing about 7 tons. Coal gas was then turned on from a generator in the grounds, and in a very short space of time the interior of the hut was red hot, the temperature at the end of two hours, the time fixed for the test, reaching close upon 2,000 deg. F. Notwithstanding this enormously high temperature, in no place did the fire burn through the wood, and the load of bricks remained undisturbed to the finish. The underpart of the planks—those in actual contact with the fire—were of course, considerably charred: otherwise the wood was unharmed. Everyone present expressed themselves well pleased with the astounding manner in which the timber withstood the test, and none more so than the foreign delegates, to whom the unrivalled strength and fire-resisting properties of karri wood came more or less as a revelation.

Fire Test of Karri Varillas.—A further proof of the fire-resisting character of karri is afforded by the following letter received from Mr. Hugh Wright, Los Mirasoles, Bahia Blanca, 17th April, 1901:—"Last December I had a camp fire pass through half a league of fencing hung with your varillas, and it left them practically uninjured; not one was burnt through or twisted, and those that suffered most were charred less than a centimetre in depth."

From these and other testimonials it is clear that structural works built of karri and jarrah timbers would be practically fireproof; for which reason, also, they are specially suited for underground railway work of every kind—sleepers, platforms, etc. The Underground Electric Railways Company, of London, Limited, have therefore ordered karri sleepers for their Baker Street and Waterloo Railway, specially on account of their fire-resisting qualities.

This is a subject of such importance, in view of the frequent and calamitous fires of recent years, that the company considers the above facts are worthy of the special attention of public authorities, architects, engineers, and builders.

Jarrah Forest.



Karri log (just fallen).

Mallet Bark.

The figures relating to the export of mallet bark have already been given. In the following article quoted from "Jarrah," is presented a view of the mallet bark question, which should not be lost sight of by the people of Western Australia:—

The history of the mallet bark industry in Western Australia is fairly well known. After the war there will be some mallet bark export trade, but it will be many years before the business assumes the proportion that it did a decade or less ago. The first official record of export is in 1903, when bark to the value of £859 was exported. The next year the trade jumped to £32,876, and in 1905 it reached highwater mark at £154,087, since when it has continuously dropped until in 1913 the value of the export was put at £6,127. From 1903 to 1913 inclusive the total value of mallet exported was £864,880. The cause of the drop, of course, was unwise exploitation. Regulations were made restricting the cutting of trees below a certain diameter, but these regulations were made too late, and were more honoured in the breach than in the observance.

Most of the mallet leaving Western Australia went to Germany, and some curious sidelights on the business are derived from the study of a paper read by Dr. Johannes Passler on 25th April, 1905, in Frankfort, before the General Meeting of the Central Association of General Leather Industry. One has no difficulty in gathering from this lecture that Dr. Passler is a skilled leather chemist attached to the Investigations Branch of the Technological Museum in Berlin. He does not appear to have visited Western Australia himself, but he mentions frequently the results of investigations by Dr. Diels, who spent some 18 months looking round the Commonwealth. It is gathered from Dr. Passler's paper that the earliest samples of mallet bark (he calls it malletto bark) arriving in Germany were received with grave suspicion. The mallet bark exudes under certain conditions a gum heavily charged with tannin, and this gum adheres to the dry surfaces of the bark and hardens, but in course of transit a good deal of it is found in the form of dust at the bottom of the bags containing the bark. This dust was regarded with serious doubts by the German importers, who seemed to think it was an entirely foreign substance introduced by the West Australian exporter for the sinister purpose of concealing the true nature of the bark by mixing with it the tannin-charged kino of some other tree. When the German importers were convinced that everything was right and in order they took

to the bark heartily. Dr. Passler's investigations led him to form the very highest opinion of the qualities of mallet bark. He writes:—

"It is safe to take the average of this tannin material as about 42 per cent., with an average of 14.5 of water. The average composition of mallet bark is about as follows:—

	per cent.		per cent.
Tanning substances	42.	variation ..	35.52
Non-tanning	7.	variation ..	5.10
Non-soluble	36.5		
Water	14.5		
	100		

"Thus it is seen that we have in mallet bark a tanning agent which, in regard to tanning property, equals those hitherto known as the richest in tanning substances."

Then he goes on to say that at the price paid for mallet bark it is the best and cheapest thing of the kind on the German market. He goes on to say:—

"A great advantage in the case of mallet bark lies in the fact that the tannic substances are easily dissolved in water of ordinary temperature."

In further trials of the bark at various temperature he got the following results:—

	Temperature of Solvent Waters.				
	20c.	40c.	60c.	80c.	100c. (boiling)
Tanning substances ..	39.	40.6	42.7	42.3	43.7
Non-tanning	9.3	9.3	8.9	7.3	7.7
Insoluble	37.2	35.6	33.9	35.9	34.1
Water	14.5	14.5	14.5	14.5	14.5
	100.	100.	100.	100.	100.

"In order to thoroughly test mallet bark with reference to practical use as tanning agent, and in order to ascertain whether it imbues the leather with any special characteristics, several tanning trials with whole hides have been carried on at the tannery attached to the institute. The tanning process occupied in all 38 days. After tanning, the skins were well washed and prepared in the usual manner for brown calf-skins. The greasing was done with a mixture of whale oil, tallow, and Degras. The leather is throughout of normal quality, the colour light and regular; the leather shows a fine and regular grain, a smooth fleshy side, and is very tough, the cut even and close and smooth; unfavourable qualities have not been observed in the leather. The result can therefore be qualified as thoroughly satisfactory."

Later on he says:—

"The manufacturers of tanning extracts have taken and utilised the mallet bark as soon as it appeared in the German mart to produce extracts for tanning purposes, that is regular ones, which are produced with the assistance of heat, and 'cold soluble ones,' which can be thinned (weakened) by the simple addition of cold water. We have repeatedly had oc-

casion to test mallet bark extracts at our institute. Their density varied between 22 to 24 per cent. Be. corresponding to an admixture of from 59-55 per cent. water. The tanning matter varied from 30 to 36 per cent., which is lower in these extracts than in mallet bark of average strength. All samples of extracts either contained no insolubles or only a fraction of one per cent. of insoluble matter. The leather tanned with these extracts all showed a little darker colour than those tanned with bouillon extracted from bark."

"All this points to the fact that in mallet bark we have a tanning agent which, owing to its qualities, deserves the highest consideration, and which may be expected to obtain a permanent footing in our industry. In some branches it has already established itself for regular use, which proves that the trial stage in these branches have been passed and have produced satisfactory results. Now the question arises whether the demand which is bound to increase can be met permanently and in satisfactory qualities, even if the restrictions imposed by the W.A. Government are observed strictly, after the first reckless exploitation of this bark, and even if provision is made for afforestation of denuded districts."

It is interesting to note that the German investigator seems to have anticipated what has happened in Western Australia. The tree was recklessly cut out, and the German saw that his country could not depend upon a steady future supply of the bark. Nor does he seem to have thought that the Government of Western Australia was to be relied upon to take the necessary measures for preserving mallet and for putting the industry there upon a permanent footing. So he goes on to discuss the question of acclimatising mallet in German colonies. He accordingly passes the whole of Germany's foreign possessions under review. Hereroland (German South-West Africa) he thinks an eminently suitable place for the cultivation of the tree, and certain portions of Togoland he thinks would do remarkably well, and he points to the success which has attended the acclimatisation of other eucalypts in South Africa as evidence that the Australian eucalypt is not averse to translation to foreign soil. German New Guinea and Samoa and the other former German possessions in the Pacific he considers to be quite unsuitable places for cultivating mallet, and he concludes a highly informative paper by urging upon the German Colonial Office the advisability of taking immediate steps for procuring mallet seeds.

Dr. Passler's lecture is of interest as showing the thoroughness with which Australia has been searched by the Germans for materials such as they wanted. But, so far as growing mallet in German Colonies is concerned, there is available no information. It is possible, of course, that the German Colonial Office acted on the suggestion of the lecturer and that mallet is now growing sturdily in several of what were formerly German possessions in Africa. The events of recent weeks, however, seem to indicate that even if mallet has been grown in Hereroland and elsewhere the German is not likely to be the one who will profit exclusively from the fact.

It is not comforting to the national self-respect to know that the foreigner discovered the value of one of the State's forest products, and profited by it at the expense of the people of the State.

Sandalwood.

(*Santalum cygnorum.*)

This tree played an important part in the development of the Colony of Western Australia in its earlier decades. In pioneer times the tree was found in the vicinity of Perth, extending over the Darling Ranges into and beyond the farming areas. When markets for agricultural farming produce were, owing to the want of regular communication by ships, few and far between, and ready money in consequence was scarce, sandalwood was of the greatest assistance to farmers in tiding them over difficulties. There was always a ready market for it in the East, and shipments from Fremantle were made with fair regularity in the first half century of the Colony's existence. At present the tree has ceased to exist on the Wheat Belt, and much of the supplies that still leave the State are drawn from the Eastern Goldfields. Sandalwood is found interspersed throughout the mulga belts from which the firewood supplies of the gold mines on the Eastern Goldfields are procured. In those portions of the Gascoyne of which Carnarvon is the port, sandalwood is fairly plentiful, and a considerable quantity is annually sent away.

It exists to-day as a small tree, attaining a height of from 12 feet to 16 feet, with a diameter of from six inches to eight inches. The building of the Great Western Railway brought to light the fact that very considerable belts of sandalwood exist north and south of the line, at points from 80 to 120 miles east of Kalgoorlie. Considerable quantities of the wood are now being obtained from this source, but the extent of the belts has not yet been ascertained. In the earlier decades of the sandalwood trade stems were often found of over a foot in diameter and 12 feet in length, some of these weighing from 3cwt. to 6cwt. In these early days trees were occasionally felled which yielded more than half a ton of marketable timber.

Sandalwood is not a social species, but is of parasitic habit, and is found interspersed among other forest trees. The wood is a light yellow in colour and is aromatic. Very little of the wood is used within Western Australia for

cabinet or decorative purposes. The bulk of that exported to the East is used for religious and ceremonial purposes, and for the manufacture of glove, jewel, and such-like boxes. The wood yields an oil, and a factory distilling the oil product is in operation in Western Australia. The Western Australian oil differs also from the Indian oil inasmuch as it has a positive refraction. It is extensively used in medical practice in Australia, and has given every satisfaction. The Council of Science and Industry is making therapeutic tests with a view to determining the relative values medicinally of the Indian and Western Australian oils. Up to the end of June, 1919, 32,360 tons of sandalwood of a value of £2,827,035 had been exported from Western Australia.

Blackboy and its Uses.

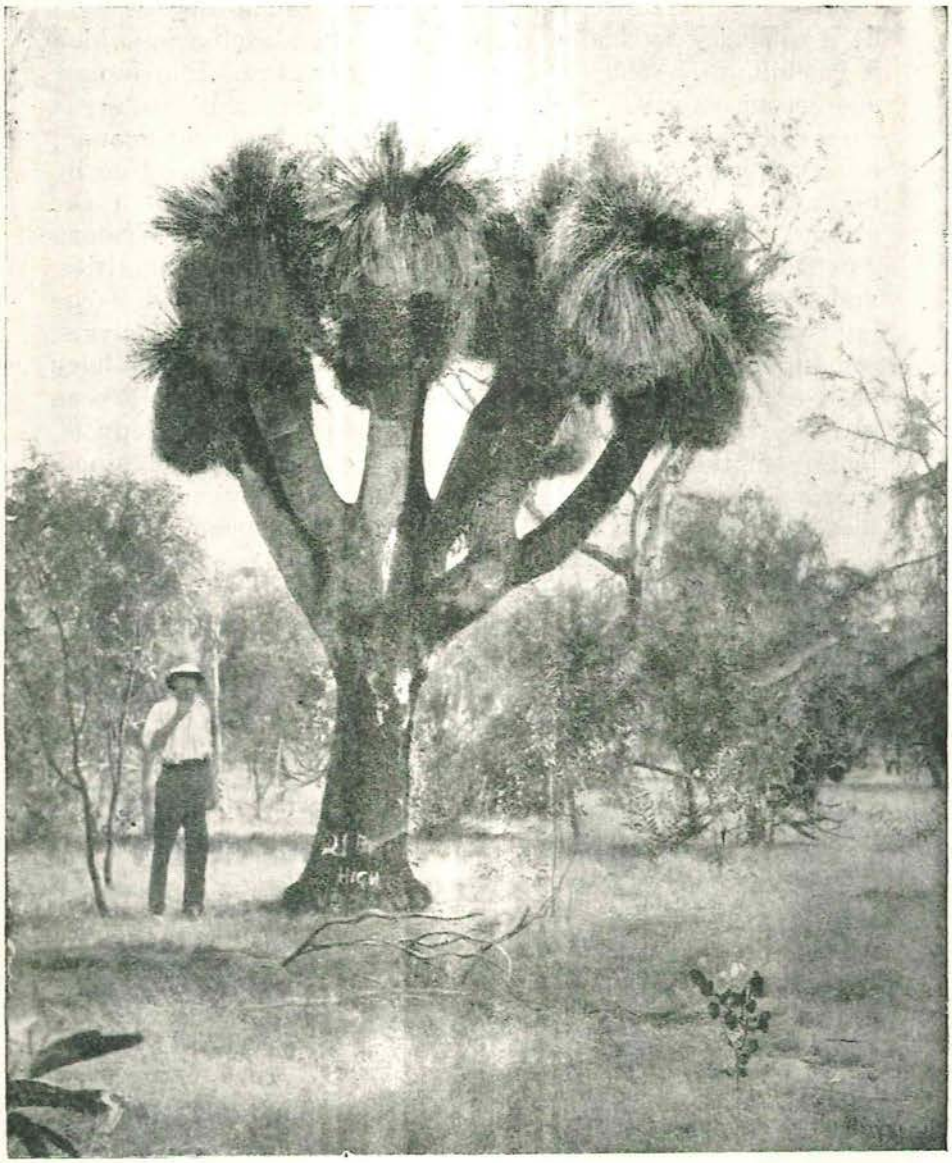
(*Xanthorrhoea preissii.*)

The Western Australian blackboy belongs to the same genus as the grass-tree of the Eastern portions of Australia. It is a familiar feature in the forest areas of Western Australia, and it is to be found in more or less abundance throughout the agricultural areas. The stems of the common Western Australian species are ordinarily from seven to eight feet in height, but often run up to 15 feet in height, and are very often branched. It may interest many to know that the blackboy belongs to the lily family, a botanical paradox more readily appreciated by the scientist than by the layman. It is constructed of a centre core and a very fibrous, somewhat spongy material sometimes hard enough to be termed wood, which contains a large amount of easily fermentable, sugary substance, surrounded by a thick coating of "husk," formed of the persistent bases of the old leaves lying very closely packed together, and more or less cemented by resin into a hard, coherent mass. When fire spreads through an area in which blackboy is found, it readily attacks this hard outside layer, burning and scorching it, and this

accounts for the fact that the barrel of the tree is always black, with all the appearance of having suffered from recent fire. When the "husk" is broken up and beaten the brittle resin is easily reduced to a fine powder, which may be with little difficulty separated from the fibrous skeleton on which it is built up. When heated this powder forms into lumps, and becomes a substance known as "blackboy gum." In areas covered by blackboy this gum is found in lumps in the ground, the gum having probably been separated from the tree by fire and coagulated where it reached the surface of the ground. As the blackboy covers very large tracts in Western Australia, its trunks can be obtained in enormous quantities, and the gum or resin might well form the basis of a large industry. From experiments made by competent analysts, something of the potentialities contained in the blackboy have been ascertained. Among the products obtained have been glucose, treacle, scents, alcohol, and certain tar products, and from these latter again two dyes have been obtained. Picric acid, so much used in explosives, is also yielded by the tree, the gum, on treatment, giving up to 50 per cent. of its weight in the form of picric acid. The Munitions Department in England during the war made experiments with blackboy gum as a producer of picric acid, and was highly satisfied with the result. There would seem to be a great future for blackboy by-products. The subject, although well investigated by competent authorities, has not yet been exhausted. In the early days of Western Australia the settlers obtained a form of alcohol from blackboy, which they used as a stimulant. This aspect of the question has been further treated by Mr. E. A. Mann, Analyst to the Government of Western Australia. The following table gives the results obtained by Mr. Mann:—

Month.	Weight of sliced core.	Proof gallons spirit per bushel (60lbs.).	Equivalent sugar per 100 core.	Per cent. sugar by analysis.
September	350 grms.	1·24	20·6	26·1
February	6lb.	0·8	13·2	not determined
June	2½cwt.	0·5	10·0	10·5

The Grass Tree (*Xanthorrhoea*) grows freely on Kangaroo Island in South Australia, and from it large quantities of gum were collected prior to the war and exported, principally to Germany, where it was used in the manufacture of varnishes and the like. A considerable quantity also



Blackboy.

reached the United States and found one use, amongst others, as a lacquer for meat tins.

Western Australia is in a position to supply annually thousands of tons of clean blackboy gum at a price which should meet the views of manufacturing chemists whose business includes the many valuable products that can be obtained from the gum. Particularly in the matter of dye stuffs the capabilities of the resin should form the subject of a thorough investigation.

A number of investigators have turned their attention to blackboy, pursuing inquiries into its chemical constituents and their commercial value and utility.

The outside sheathing of blackboy is rich in many directions, yielding amongst other matters drying oils and turpentine substitutes suitable for the manufacture of paints and varnishes, and also for other purposes.

The yields vary according to whether the material is treated dry or not. The following are given by one experimenter as the extreme limits of yield per ton of material used:—

35-45 gallons of water.

25-30 gallons of liquor containing 12-15 per cent. of acetic acid.

4-5 per cent. of methl. alcohol and 2-3 per cent. of light spirit.

25 gallons of crude oil, containing 10 per cent. light oil, 10 per cent. medium oil, 15 per cent. phenols and acids, 60 per cent. pitch, 5 per cent., loss (approx.).

8cwt. of coke residue of high calorific value and gas (5,000 cub. ft.).

A coke residue of very good quality remains. This can be made into briquettes with any suitable matrix. It has been stated that the gross value of the products derivable from the low-temperature retorting of blackboy is greater than that from any other naturally-occurring organic material in Australia.

The Electrification of Railways.

A WESTERN AUSTRALIAN TIMBER'S UNIQUE POSITION.

That Western Australia in due time will follow the lead given by America, Great Britain and certain of the Eastern States in the transformation of the railway motive power from steam to electricity can scarcely be denied. The advantages of the latter form of power are too obvious to call for recapitulation. If British experiences can be taken as a guide this State has in its principal commercial timber a substance of unique value in electrical railway work. Jarrah has been used almost exclusively on English electric railways in connection with trolly-cables, but it has remained for recent experiments to demonstrate the fact that no other material except jarrah seems to be entirely satisfactory. Some time ago it was determined to fit up a section of the Lancashire and Yorkshire Railway with all-metal cars and all-metal appliances of every description. Had the idea been carried to successful accomplishment, jarrah would, of course, have found no place in that all-metal section, but it would seem that the engineer in charge has not been able to carry his all-metal intention out with that completeness which he had hoped for.

Mr. George Hughes, M.Inst., C.E., in a report upon the matter, writes as follows:—

"*Trolly-Cable.*—Naturally the designer was extremely anxious that it should be an 'all-metal' car in every sense of the term, therefore the question of housing the trolly-cable gave rise to considerable investigation, and every endeavour was made to find a substitute for jarrah timber, which had been used for some years quite successfully on the Liverpool-Southport 600-volt section of the Lancashire and Yorkshire Railway. Exhaustive tests had been made in 1909 upon prepared samples of kauri-wood, jarrah, oak (untreated as well as treated with alum and copper sulphate), iron pipes, fireproof cables, concrete, Canadian redwood, uralite-asbestion and wych elm, with a view of approximating to working-conditions and breaking down the material experimented upon with current up to 1,000 ampeers at 600 volts: the object being to ascertain, the arc once started, which design and which material resisted and damped the arc in the most successful way, and with the least damage to the surrounding structure.

"It was found that jarrah fulfilled all the conditions most successfully, nevertheless, when the all-metal car was being designed, further considerable investigations were undertaken to find a substitute for jarrah, but without success; therefore jarrah was used. It is an additional insulation, it will not burn with a flame, and it smothers an arc when formed."

Writing on the same subject, Mr. Francis E. Gobey, O.B.E. Assoc., M.Inst., C.E., adds his testimony to what Mr. Hughes has said. Mr. Gobey reports that—

"Some experiments which had for their object to find the most suitable material for cable-troughing for electric railway cars, with an arc of 1,000 amperes from a 600-volt third rail, resulted in jarrah being proved practically non-inflammable, and it has been very successfully adopted for cable-troughing."

It would seem from the result of these English experiments that the future holds big and unique opportunities for jarrah in electrical railway engineering.

Grass Tree Fibre.

(*Kingia australis.*)

The kingia, which takes its name from one of the State's pioneer explorers, and botanically belongs to the lily family, is peculiar to Western Australia. In appearance it has a close resemblance to blackboy, but the properties of the two trees and their commercial possibilities differ widely. The kingia does not grow in close forests, and it is found scattered over a considerable portion of the South-West, more particularly between the Darling Ranges and the sea and through the karri country to Albany. It is to be met with in abundance on the poorer classes of soil, and it may be said that the leaner the quality of the ground, the better does the grass tree seem to flourish. It attains a height of from six to 25 feet, and the bole has an average diameter of from nine to 10 inches. The outer portion of the trunk is made up of layers or hardened masses of leaf processes. This part of

Kingia Grass Tree.

the trunk is particularly rich in cellulose, and the future commercial usefulness of this portion of the tree will probably depend largely upon the utilisation of this cellulose. The trunk, it may be remarked, is almost always a black colour, like that of the blackboy, caused through the scorching of the outer layer of pressed leaves by bush fires. The core of the tree, which is hard and brittle, is also rich in cellulose, and is surrounded by a hard, matted covering of fibrous material from an inch to three inches in thickness, according to the size of the tree. At the present time the main commercial value of the tree lies almost wholly in this fibrous ring round the core. It is already the basis of a considerable industry in Western Australia in the manufacture of brooms and brushes. Under treatment there can be made from the fibre the coarse and heavy brooms used for street scavenging and similar purposes, as well as the finer material suitable for higher grade brushes. In the matter of street cleaning, brooms of kingia fibre have been used in Perth and Melbourne, and in both cities it has been recognised that the life of such brooms is longer than that of a broom fitted with any other fibre. The strength, toughness, and pliability of kingia fibre, after proper treatment, are remarkable, and its qualities only require to be more widely known to ensure for it a large demand. The process of separating the fibre from the rest of the trunk is a simple one. The heart or core of the kingia has also commercial possibilities. It contains sugar, but not to an extent which would make the extraction a commercial proposition worthy of consideration, and under distillation an alcohol has been obtained. It also presents possibilities in the direction of insulate for freezing works. The outer sheathing of the tree as well as the core being rich in cellulose, are adapted for the making of paper pulp, more particularly for the coarser kinds of paper. In freezing works, cooling chambers and ice safes, the outer sheaf of the kingia acts as an insulator of the first order, and little preparation is necessary to fit it for that purpose. The kingia, unlike the blackboy, is non-resinous. The attention of the manufacturers of brooms and brushes might well be given to the kingia grass tree of Western Australia. It ought to replace much of the imported fibre, and the extent to which it is found in Western Australia is a guarantee that large and regular supplies may be had.

Pine Planting.

The function of forestry in any country is not and ought not to be confined to the care and protection of indigenous forest growths; it interests itself also in the provision, so far as circumstances will permit, of such exotic trees as yields classes of timber that find a market in the community. All the timbers of Western Australia, for example, are hard, but there exists a large demand for woods of a softer nature, and, as these woods do not grow locally, they have to be imported. According to the annual report of the Forests Department for the year ending 30th June, 1919, the value of foreign-grown timbers and articles made of foreign-grown timbers imported during the year 1918 was over £60,000. In normal times, when shipping facilities are plentiful, the annual value of such imported timber before the war was £143,453, and when tonnage in quantity is again to be had, this last amount will certainly be equalled and probably exceeded. A progressive forest policy seeks to prevent the paying away of such large sums for timber from abroad by growing the required timbers at home. This policy is an eminently wise one, for not only is the money kept in the country, but the growing of new kinds of timber provides employment in the planting of the new varieties, in their care during growth, and in reaping and converting them into marketable merchandise when mature.

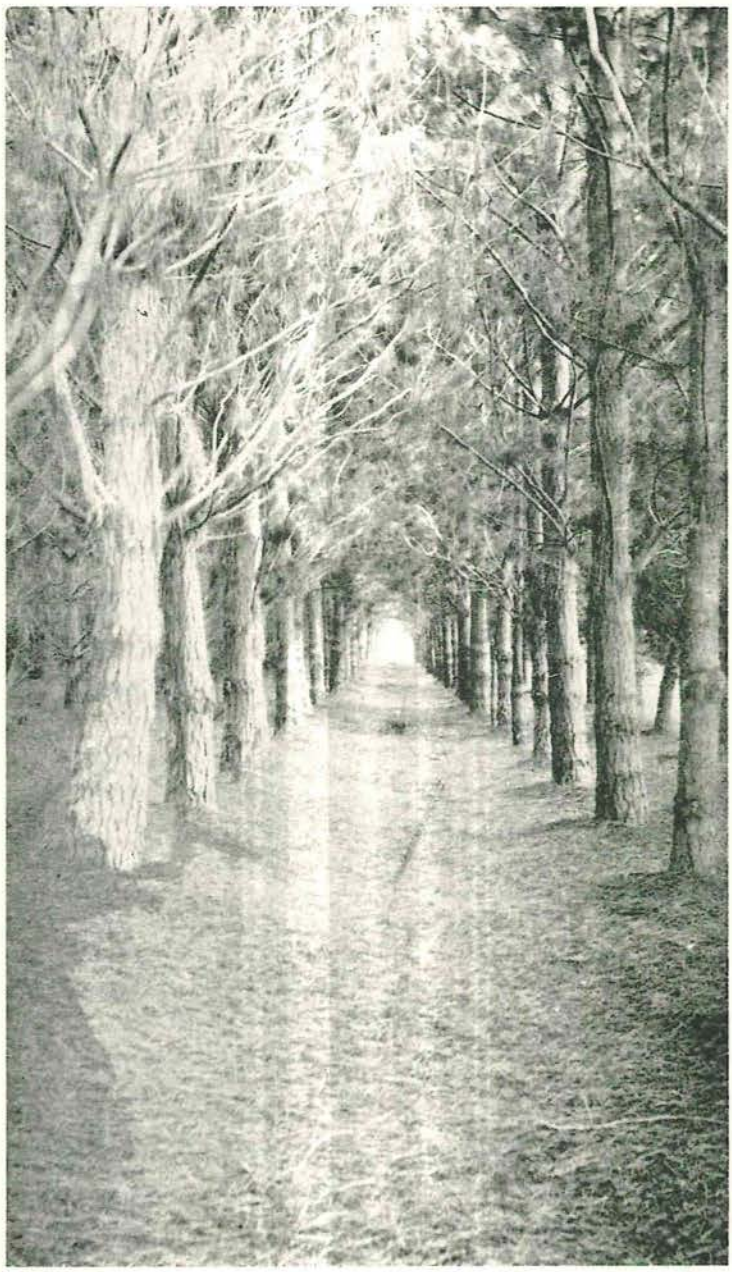
Softwoods—pines—fill many essential purposes in industry. For instance, their comparative lightness as compared with hardwood, recommends them as containers for many kinds of goods. In spite of the fact that native timber can meet every detail in building construction and fulfil most of them better than foreign woods, there continues to exist a large demand for the imported article. This demand, despite the quality of the native wood, is likely to continue, and sound economics indicate that the best way to deal with it is to supply it from local products.

The fruit industry is another instance in point. It is one of Western Australia's growing industries. The lightness of softwoods and their white colour in this case recommends them, and here again is an argument for meeting the local demand by a local supply. There is nothing in local con-

ditions of soil or climate inimical to the planting of pines so long as suitable varieties are selected. There are pines which demand a good soil and a heavy rainfall if the trees are to reach perfection. There are other varieties which thrive in a poorer class of soil and with a lesser rainfall, and there are again still other kinds which do well on what can be called really poor soil, and with a comparatively low annual rainfall. The whole of this soft-wood, whether for structural work or case-making, can be grown locally, and the area required for this purpose will be comparatively small. South Australia furnishes a valuable object lesson in this respect. That State is less bountifully provided with indigenous timber than any other in the Commonwealth, but the local Forestry Department for a generation has been working hard to repair the neglect of nature, and, so far as the softwoods are concerned, has succeeded admirably. Pine plantations of mature timber are now being reaped there. A few months ago timber was being sawn up in South Australia that had been planted by Mr. Ednie-Brown, at one time Conservator of Forests there, and subsequently holding the same office in this State, and the net profit, after deducting all charges including compound interest on the cost of formation, amounted to more than £100 per acre.

The South Australian plantations are very valuable, but they would have been of more value had those at the head of affairs at the time the areas were planted given more attention to the recommendation of the skilled forester in charge. Large areas were required to be planted, but, as the funds made available were quite inadequate for properly planting such big areas, the trees had to be widely spaced, and the effect of this error is being felt now. Pines when widely spaced are apt to grow knotty and a bad shape, and being short and conical, sawing becomes wasteful. Planted closely, as they ought to be, the trees grows taller, have longer barrels, and consequently, fewer knots. From such trees scantling and boards of value for many purposes may be obtained. With close planting at 15 years of age the thinnings would yield valuable case wood, and these thinnings should, under ordinary circumstances, pay the whole cost of formation of the plantation, leaving trees that at maturity would produce first-class timber.

In Western Australia steps are now being taken for the plantation of suitable varieties of pines in various localities. On the Mundaring catchment area it is intended to put in



Pinus insignis at Hamel, 16 years old.

an experimental plantation of 100 acres. A larger work of the kind, and one it is intended shall be one of the State's great permanent pine plantations of the future, will be situated to the northward of Perth on a large area between the Midland line and the coast. This area has already been surveyed. It is proposed to plant something like one square mile per annum. The southern boundary of this plantation will be within 10 miles of Perth. All over Europe it has been found to be of distinct advantage, indeed essential, to have pine plantations in fairly close proximity to cities. The reason for this is firstly economic, and secondly social. When the time comes for the timber to be thinned, the large population close at hand provides at once a ready market for these thinnings, not only for firewood but for numberless purposes and manufactures. If the plantations were far removed from the centres of population, it would not pay to convey such thinnings for long distances to the market.

The social side of the forest has also an importance of its own. These pine forests in due time will become holiday recreation reserves for the people of the city. Examples of forests close to cities and used very largely for recreation purposes are to be found all over Europe, the woods quite close to Paris and to Brussels being very fine illustrations in point.

Of the many varieties of pine the Monterey pine (*Pinus insignus*) is eminently suitable for districts having not less than a 25in. rainfall and soil of good quality. For sandy soil in the same rainfall the *Pinus pinaster,* cluster pine, is indicated. It will do best on poor, silicious sandy soils, and judging by experimental plantings carried out at Hamel and Ludlow, it thrives luxuriantly in the coastal sands. The value of this tree in Europe is well known, for it yields, besides a fair second-class softwood, a large percentage of the turpentine of France. Thinnings of this species already find a good market in Perth for box-making.

The Farmer and Timber.

When a prospective farmer takes up land in any of the agricultural areas of the States, he immediately sets about getting rid of as much of the standing timber as he possibly can. Year after year he increases his acreage under crops until all the land that is suitable for his purpose is occupied. In the earlier days of settlement it never occurred to the pioneer farmers that a time would ever arrive when there would be a shortage of timber in the neighbourhood. In the older settled districts so complete has been the denudation of trees that quite a number of farmers have to buy every stick that they use on the farm, and some are even hard pressed for firewood. What has happened in Western Australia is also taking place in the Eastern States, and already farmers in the latter are seriously contemplating the growing of timber not only for use upon their farms, but as a crop to be turned in due time to hard cash.

In this matter Australia is repeating the experience which has attended settlement by people of British origin in other parts of the world. America may be instanced as a case in point. In the Eastern States of America the destruction of timber has been so complete that sawmills and timber dealers in the district make specialities of what they call "farmers' requirements." The farmer there, having no timber on his land with which to do a bit of fence repairing or well sinking or shed building, has to purchase all that he needs from dealers. The Department of Agriculture in Washington for half a century and more has been giving earnest attention to the matter, with the result that over nearly the whole of the timber States of the Union every farmer has what is known as his "woodlot." This woodlot is either a patch of timber growing on land that cannot profitably be utilised for the usual crops, or it is an area which the farmer has planted with seedling trees with the object of growing them for profit.

The farmer's woodlot in the United States has become an institution among the agricultural community, and the crop of timber it yields is annually reaped as regularly as the other crops. The advice and assistance of the United States

Forest Service is at the disposal of every farmer. If he possesses a strip of old timber country, the Forest Service will teach him how to cultivate it, so that its yield of marketable timber may be increased. He will be told what trees to cut down and what to preserve for the future. In bare patches recommendations will be made as to the kind of tree best suited for the soil and rainfall. In short, the farmer possesses in his woodlot a miniature cultivated forest. If, on the other hand, his woodlot has been planted by himself, it is safe to say that the trees have been selected under the advice of the Forest Service. The "woodlot" system will certainly in due time be adopted in Australia, and farmers within the Commonwealth who are so improvident as not to add to their income by growing timber will be few and far between.

Timber on a farm, however, serves other purposes than adding to the farmer's sources of income. The planting may be so arranged that the trees form wind breaks or act as shade for stock. The kind of tree to be planted in Western Australia depends, of course, upon the soil and rainfall. Pines of many varieties are excellent in the farmer's woodlot. Their "rotation," that is their period of growing to maturity, is very much shorter than that of hardwoods. A young farmer planting eucalypts on his land is extremely unlikely to see them attain such a size as to justify giving them the name of merchantable trees, but when pines are introduced the young farmer may expect to see his crop arrive at maturity, and he may reasonably hope to go on for years reaping the reward of his forethought. Many farms in Western Australia to-day, in the districts more recently settled have considerable wealth of timber on them. The varieties, of course, will depend a good deal on the district, but whatever varieties there may be they are well worth preservation.

Our principal commercial timbers, karri and jarrah, are being cut down at such a rate that the present volume of home and export trade cannot for long be continued. There will assuredly arrive a period when jarrah and karri will be comparatively scarce woods until the new crop has grown. During that period less used timbers will acquire a new value and a new significance. Among these timbers are yate, blackbutt, morrell, York gum, salmon gum, raspberry jam, banksia, sheaoak, and others. When jarrah and karri become scarce, these just named will certainly acquire an enhanced value. The farmer will be wise, therefore, to treat the timber on his

land with great circumspection, and on no account to waste it recklessly. It is not, however, intended that farmers should grow timber on land suitable for the use of agricultural crops, but only on such portions of their holdings as are not adapted for these crops, and upon which timber is the most profitable crop which can possibly be grown. These are the areas which the farmer should cultivate, and conserve against the time when timber will be scarce and dear.

Wattle Growing.

The wattle is Australia's national floral emblem. Its rich golden flower has inspired poets, and it is always referred to with admiring pride. The other side of the shield exhibits no idealism whatever, and presents only a scene of systematic destruction. The bark of the wattle contains a powerful tanning agent, and has therefore a commercial value. The consequence has been that everywhere in Australia the wattle has been ruthlessly sacrificed for the sake of its bark. At one time the export trade in wattle bark was very large. To-day the quantity sent abroad is negligible. Australia, indeed, is now unable to supply her own wants for tanning materials, and imports largely, principally from South Africa. The irony concealed in the last-mentioned fact is that South Africa imported the seed from Australia, started growing, and kept on growing wattle while Australia was destroying it, and now Australia has practically no wattle, while South Africa's export of wattle bark and wattle bark extract runs into hundred of thousands per annum, and is yearly increasing.

The tan-bark position in Australia became so serious that the Interstate Commission of Trade, after examining all the evidence, recommended that a bounty of £1 per ton should be paid on all wattle bark grown and used in Australia. In the Eastern States the cultivation of wattle is now being

seriously taken up, but so far the subject has received no attention in Western Australia. There are few landholders in the parts of the State where soil and climatic conditions are favourable, who have not some land that might well be spared for wattle culture. The following hints on the cultivation of the varieties of wattle whose barks hold the largest percentage of tannin may be of use. The golden wattle (*Acacia pycnantha*) is the best for all but the wettest parts of the South-West, in these the black wattle (*Acacia decurrens* variety *molissima*) will be most suitable. The ground should be prepared by ploughing and harrowing well. In heavy ground it will be necessary to cross-plough and re-harrow. Acacia seed takes a considerable time to germinate. It can, however, be made to germinate very rapidly by soaking. Place the seed in a bucket and pour scalding water on it, and leave it for 24 hours. It will then have swollen and become soft. Spread it out on a large tarpaulin for a few hours to dry off, and it is then ready to sow. The season for sowing depends largely on the rainfall. From one to three lbs. to the acre, according as the seed is drilled in or sown broadcast, is sufficient. In the heavy rainfall districts September is the best month, while in the 18 to 25 inches districts June to July will probably answer best. The most convenient method of sowing seed is by drilling in. The drills should be six feet apart, and the seeds dropped about four feet apart in the drill. Broadcast sowing is frequently resorted to, and while using up more seed and making thinning operations more difficult, is a good alternative method. A high stemmed tree, free of branches for the first half of its length, is what should be aimed at. Hence the comparatively close sowing—four feet apart in the rows. At three to four years every alternate tree should be removed. In South Africa the bark of the young trees that have been removed is sold. In seven years the crop should be good enough to strip. In wattle growing it is most essential to lay out a working plan, and all operations should be conducted in accordance with that plan. Select an area of ground, divide it off into seven equal parts, and prepare and sow one part only each year. At the eighth year the area first sown should be stripped, and the regular rotation of sowing an area and reaping an area begun. Cultivators of wattle must take measures to protect their plantations from fire. A wide fire-break round the plantation is effectual, if kept quite clean. In between the seven-yearly blocks a half-chain break will give an extra insurance, and enable the easy carting of the crop and working of the blocks. The cost of

putting in a crop of wattle must, of course, depend on the circumstances. In Victoria and South Australia the cost of stripping ranges from £2 to £2 15s. a ton, figures which leave handsome margins of profit, when you consider that Natal wattle is landed at over £10 per ton.

There is a world shortage of tanning agents, and of these wattle is among the best. It would seem, therefore, that those engaging in its cultivation are entering into a business which offers substantial inducements in the way of returns. Further than that, those growing wattle are helping to keep in the country money now sent abroad, and, at the same time, providing a fresh avenue of employment for Australian citizens. A supply of golden wattle seed is available at the State nursery for free distribution to *bona fide* growers.

Forest Fires.

Of the many problems which have to be dealt with by the forester, there is none which is so constantly with him as that of fire. Its shadow is always over him: its dread possibilities are ever present in his mind. Even when he has at his disposal, or has pressed into his service, every device, every scheme, and every precaution which experience has proved to be more or less effective, he is still at ease. When, from one cause or another, he is without fire-fighting machinery of any kind, or possesses it only to a totally inadequate extent, his cares become proportionately increased. It may with perfect frankness be admitted that there is no such thing as absolute prevention in the matter of forest fires. But it is possible to prevent the vast majority of them—preventible and unavoidable alike—to minimise the damage caused by them, and by so doing preserve a nation's timber wealth for the use of posterity. The experience of every country whose forests are of sufficient extent and value to entitle them to be regarded as national assets stands out as proof that cannot be shaken. In America reckless exploitation and forest fires reduced the available area of saleable timber to such an extent that popular alarm was created. Nearly every State

Karri logs on trucks.

in the Union has now its legalised code of fire protection regulations, and over all there is the Federal Act (the Weekes Act) dealing with the subject. The result has been that the future of America's great timber industry has been furnished with the main element which goes to ensure permanency. Canada was even in a worse condition than America before she awoke to a realisation of the position. It is estimated by competent authorities that two-thirds of Canada's forest resources have been destroyed by fires—most of them preventible. But conservation and prevention are now in operation in all the provinces, British Columbia leading the way. In Canada, however, the whole burden is not on the shoulders of the Government. The lumbermen, the men who are earning their living in the forests, are alive to the fact that their own future existence is at stake, and they energetically co-operate with the State officials in the great work of fire prevention and control. In the "Canadian Lumberman" of 1st February of this year the following paragraph appears:—

"In view of the success of co-operative fire protection in the province of Quebec between the Government, the limit holders, and the private owners, the Commission offers the suggestion that the formation of a similar association be considered by the limit holders and by the Government of Ontario."

A similar scheme of co-operation for mutual relief from a common enemy has been agreed to by the lumbermen on the Pacific coast and the Government of British Columbia. The general question of fire protection came up for discussion at the Canadian Lumberman's annual meeting in February last, and the Hon. C. Howard Ferguson, Minister of Lands, Forests, and Mines, speaking about fire protection, said:—

"In order to work out the financial aspect of the question satisfactorily they had devised a plan under which the lumbermen would pay little, if anything, more than they were paying to-day. He thought that the lumbermen should be prepared to pay from one-quarter to one-third of the cost of fire protection in Ontario, but he desired to take on himself and the department entire responsibility for the administration of the service. Taking the figures in the records of the department, he thought that about 1 per cent. per acre would produce just about the amount the lumbermen were spending to-day on fire protection."

Here, too, is the testimony of a British Columbia authority:—

"Experience had proved conclusively that the co-operative system of fire fighting was the strongest and most efficient when the drought period came and men had to be gathered and hurried to fires. During the season, 457 fires had been extinguished. A number of the companies were doing a great deal to prevent fire."

In South Africa fire prevention has followed as the natural result of putting the forests under scientific management. Many outbreaks of fire occur, but they rarely do much damage. In Australia, the case is quite different. Mr. D. E. Hutchins, who made an official inspection of Australia's timber resources, some two years ago, crystallises the Australian position thus:—"If there were no forestry in Australia, beyond mere fire prevention, the benefit to the country would be incalculable. This is almost a truism to anyone who has travelled far through the forests of Australia; but, on the other hand, few Australians will admit that the fire protection of the forest is practicable. They have not travelled through the forests of countries with climates like Australia, and gone round with the forest officers of those countries to see how their fire protection is managed .... I am in a position to assert positively that the control of fire in Australian forests is solely a matter of organisation; and I have spent a lifetime doing fire work in India, in South Africa, and in British East Africa; while my visits to Southern Europe have shown me how fire is successfully controlled in forests there."

Possible cause of apathy.—It may be that some of Australia's apathy in the past is due to the prevalence in some quarters of a belief that a fire through the bush is a good thing. The contention has no solid basis in fact. It arose probably from observing that fire is in due time followed by an ample growth of succulent feed for stock. That is not denied, but the forester affirms, and there is no gainsaying the weight of his statement that the new feed is purchased at too great a price, at a price, in fact, which eventually means timber bankruptcy. The evils to a forest resulting from fire are many. It will be sufficient here to summarise only a few of them. Let it be understood, in the first place, that the "clean-up" of undergrowth (which a fire effects) is not a good thing. A beautiful park-like expanse with trees symetrically arranged is not a natural forest. A soil "choked with undergrowth" is the proper condition of a forest until the undergrowth is killed down by the close growth of timber, which it is the forester's craft to produce. The decaying ground herbage, undergrowth, and fallen leaves form the open rich vegetable compost—the humus—which is essential to a healthy forest. Fire destroys this. In the wake of fire come crooked young trees with short boles and double crowns producing at maturity relatively little good timber. Large

trees are defoliated, "greedy growth" occurs, gum pockets are formed, and the timber value is depreciated. All who have travelled through the jarrah forest will have noticed areas burnt the year before, when the crowns of the trees are leafless, and the stems covered with a growth of little green shoots. These are the greedy branches. Each one of these falls off in a year or two, and leaves a gum pocket. More serious still is the destruction of seedlings and saplings. If a timber industry is to prosper, there must be a steady rotation of mature timber. Fires render this impossible. There are other evils, but enough have been named to demonstrate that the fresh feed following a fire is purchased at an enormous price, a price indeed which no country, whatever the area of its forest, can afford to pay indefinitely. The circumstances under which a first fire may perhaps do little harm or indeed be of advantage are few, and appear to be limited to country that has been cut out. A first fire in such country may assist the germination of dormant seeds, but subsequent visitations by destroying seedlings and humus can have only an ill-effect.

PROTECTIVE LEGISLATION AGAINST FOREST FIRES.

In every country where the national forest property is administered under legislative enactment, provision is made for the punishment of persons illegally setting fire to forests or using fire in such a way that damage to the forests results. The fire evil in the United States and Canada has affected the national forest property so disastrously that the penalties for wilfully or carelessly causing fires are severe. So gravely is the danger from fire regarded in the countries named that complete and elaborate measures for the prevention of fire are in existence, including patrols by aeroplanes.

The Forests Act of Western Australia contains the following provisions dealing with the subject:—

If any person—

(a) lights, kindles, or assists to light or kindle, or aids or abets another person in lighting or kindling any fire within the boundaries or within twenty yards of any boundary of a State forest or timber reserve; or

(b) leaves, without taking due precaution against its spreading or causing injury, a fire lighted or kindled by him as aforesaid, or in the lighting or kindling of which he has aided or abetted;

and in either case any forest produce is burnt or injured, or is in danger of being burnt or injured, such person shall be guilty of a forest offence, and liable, on conviction, to imprisonment for not exceeding one year, or to a penalty not exceeding one hundred pounds.

A reward of not exceeding fifty pounds may be paid by the department to any person, not being a forest officer, who shall give such information as may lead to a conviction under this section.

In the event of a fire occurring in or adjacent to any State forest or timber reserve, a forest officer may call upon any person residing or working within a radius of five miles of the outbreak to assist in extinguishing the fire.

All persons who in response to such call shall render the assistance required shall be remunerated at the prescribed rate.

Any person who sets fire in the open air to any tree, wood, bush, or grass on any land contiguous to a State forest, or timber reserve, without giving notice of his intention to a forest officer so as to allow such officer to be present at the firing, commits a forest offence.

The officers of the Forests Department are, however, fully aware that summonses and fines, while most necessary to enable them to make examples of those who infringe the law, are only used as a last resource. They recognise that the people themselves must learn that the forests of Western Australia are their own heritage, and that to burn them is to destroy their own and their children's wealth.

Forests and Sand Drifts.

The reclamation of sand wastes by tree planting is by no means a present day invention. In ancient times the value of trees, shrubs, and grasses in arresting the progress of drifting sands and transforming valueless country into arable land was known and practised. In more modern times many notable instances of what can be done by well conceived effort in this direction may be named. In Russia, for example, the loss of valuable land through sand drift encroachment had attracted so much attention, and the lesson it taught was so clearly understood, that in 1888 a law dealing with the subject was brought into operation. Under this law forests were declared to be "preserved forests" when they served as preventives against the formation of barrens and shifting sands, and the encroachment of dunes along sea-shores, or the banks of navigable rivers, canals, and artificial reservoirs, or when they protected from sand drifts, towns, villages, and agricultural areas. In the matter of what can be done in the way of reclaiming land that has become useless and valueless through being covered by shifting sands, France affords the classic example. How 2,500,000 acres of barren land, of practically no value, was changed in the space of 70 years into a huge forest, having a value ranging from £2 an acre for recently cut-over land to £100 an acre for land timbered with trees of 50 years' growth, and how, during the process, drifting sands which engulfed villages and destroyed large areas of cultivable land were stayed, the population increased from 70,000 to 300,000, and the department converted from being one of the poorest in all France to one of the richest and most prosperous, is the story told in a report, "The Maritime Pine in the Landes of Gascony," by Capt. L. C. Tilt, of the Canadian Forestry Corps, commanded by Brig. Gen. J. B. White, who served many months in France.

The report provides a striking object lesson for Australia and Australians. In this country, where so much of our natural wealth originates in the forests, considerable tracts of land around our coasts which are either already covered by drift sands or are in danger of encroachment, ought, in the public interest, to be reclaimed or made safe by planting with suitable trees, shrubs, and grasses.

The following extract from Captain Tilt's report is printed in the belief that it will prove of interest as well as of practical value to those concerned with the conservation and development of Australia's forest heritage:—

"The home of the Maritime Pine, sometimes called the Bordeaux Pine, is on the sand plains or lands of Gascony, on the Atlantic coast, in the S.W. part of France. The Maritime Pine is also found in small quantities along the coast from Bordeaux to Boulogne and in the Central part of France and along the coast of the Mediterranean.

"The area covered by this great forest in Gascony is as follows for each of the three departments:—

Landes	516,608	hectares
Gironde	461,915	„
Lot-et-Garrone	100,000	„
Total	1,078,523	„

(1 hectare equals 2.47 acres.)

"In the department of Landes 55 per cent. of the total area is timbered, the highest for any department in France, while in the Gironde 46 per cent. is in forest.

"This area forms a triangle with apex to the north, bordered on the east by the Gironde and Garonne Rivers, on the west by the Atlantic Coast, and on the south by the Adour River from Dak to Bayonne."

It may be said with perfect justification that there is no State in the Commonwealth which has not, on its coast, or in some inland district or districts, areas of land where the sand is slowly but surely eating its way into and threatening ruin to country capable of being made use of by man. Western Australia has its shifting sands, but the danger has been recognised and remedies are being applied.

Near Karridale is to be found the famous Barranup Sand Patch, where during the short time that the M. C. Davies mills were running, the sand moved eastward so rapidly as to make it necessary to build three roads one after the other. It was finally stopped through the energetic steps taken by the milling company planting marram grass. To-day there is an expanse of about two miles deep along the coast of sand dunes. Here and there are to be seen the tops of karri trees protruding from sand hills 150 to 200 feet high. There are many other localities round the coast where drift sands prevail, and almost everywhere drift sand conditions are possible if the vegetation now holding the dunes is destroyed.

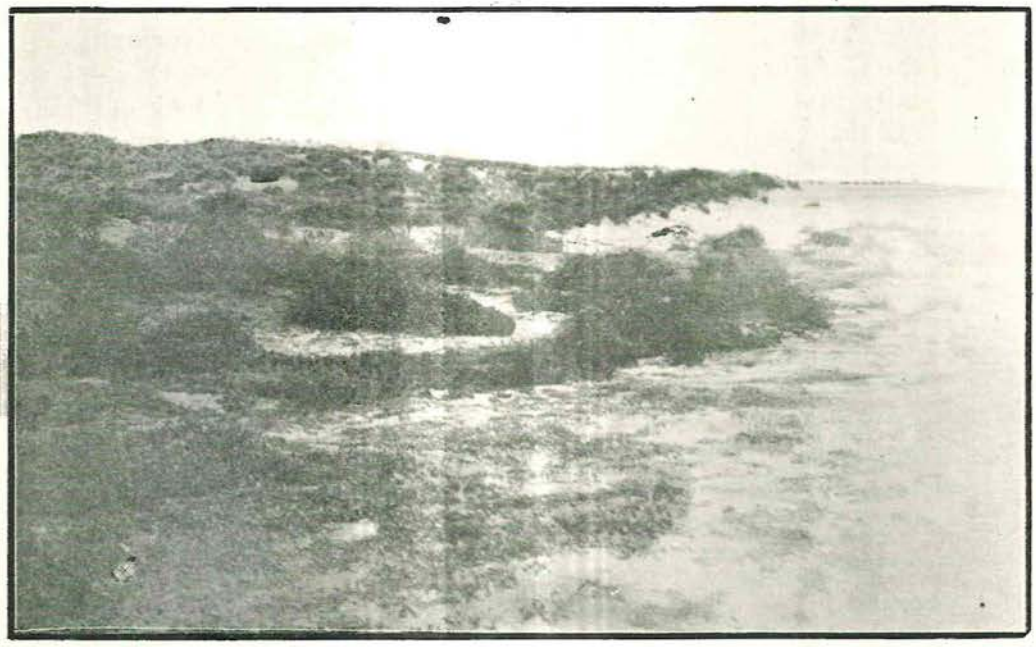
Jarrah Regrowth on a cut-out concession.

At the mouth of the Warren, and between that river and the Gardiner River is a large sand patch. Here, history relates that a farmer got stuck with his wagon. He took out his team and drove them home, intending to return later to get his wagon out. He put it off till too late, for when he got back his wagon was no longer to be found. It had been covered by a hill of sand.

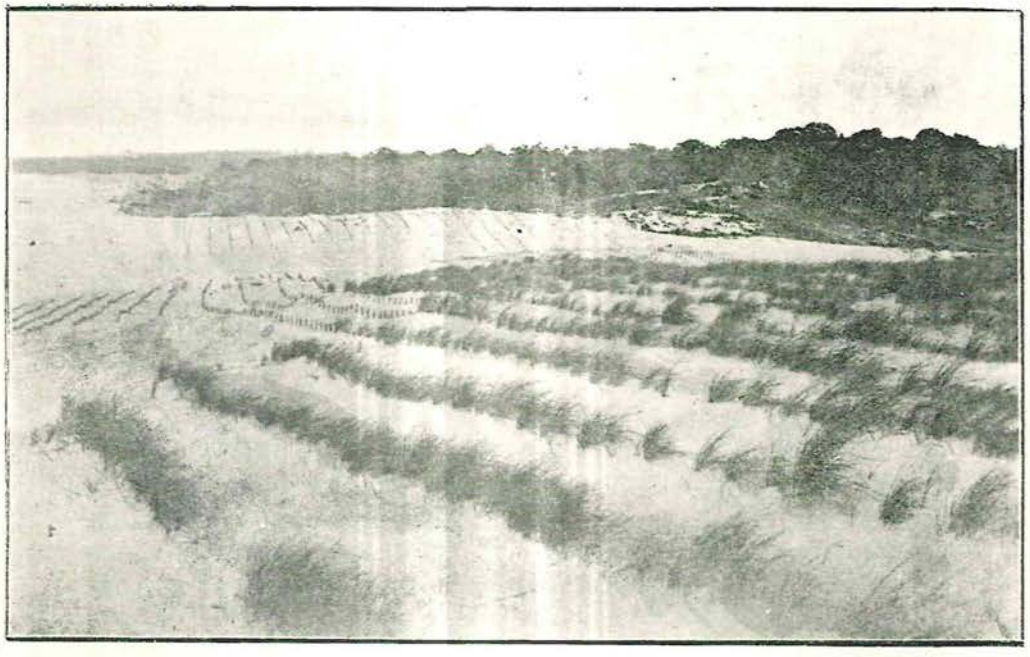
Near Denmark, along the Kent road, is a sand drift which has entirely covered a patch of immense karri trees. Around Albany the same conditions occur, and so on round the coast instances of drift sands can be multiplied. With the growth of the population of the State and the pushing forward of agriculture round the coastal belt, it will be necessary to take these sand drifts in hand, fix them and reforest them with pines.

Inland sand drift conditions also occur throughout Australia. The best known examples are probably those to be found in the interior of South Australia. There the natural vegetation was destroyed by man and his flocks and by the rabbit, with the result that what was once fair grazing country is now shifting sand. Inland in Western Australia we find sand plains intersected with agricultural land, and these conditions offer dangerous possibilities wherever the climate is such that farming may be done. The farmer, too, often clears all the timber in sight, irrespective of whether the land is suitable for wheat-growing and other agricultural development or not, with the result that not only does he expose his farm lands to the desiccating winds which now blow unchecked by tree growth, but also he exposes these lands to the invasion of the sand from neighbouring sand plains. A journey through the Eastern Wheat Belt will convince any impartial observer of the danger that is threatening the country through the thoughtless clearing of the land of all timber. The lesson which Algeria and Mesopotamia teach has not been learnt in Western Australia. Those two countries once contained large areas of very fertile agricultural land, but, owing to the over-destruction of the natural covering to-day, the area of agricultural land has been reduced to an almost negligible quantity, and the once fertile lands are covered with sand. In Algeria resort is being had to the eucalyptus trees of Australia to stem the invasion of the sand.

At Cottesloe, a residential suburb of Perth, on the coast, the sand-drift question for long has given much anxiety to



Marram Grass at Cottesloe.



Marram Grass at Cottesloe.

the local authorities. With praiseworthy energy the Town Council set to work to plant marram grass extensively. The grass has taken root very satisfactorily, and it would seem to be a question of a short while when the sand-drift menace shall have become a thing of the past. The next step will be to establish pines or other trees on the fixed sands, for marram grass only thrives while the sand is blowing, and permanent vegetation must be substituted. The illustrations on another page vividly demonstrate what has been done at Cottesloe to overcome the drift sand menace by the planting of marram grass.

Advantages of Timber over Metal.

It is not here suggested that timber ought, for every purpose, take the place of metal. There are numerous conditions and positions which metal alone can satisfactorily fill; equally there are many situations now occupied by metal to which wood might well be applied.

In constructional work timber has many advantages over metal. Among these are:—

1. Wood being an organic structure can be reproduced. Forests have been cut down at a greater rate than they have been regenerated, yet, under a well-conceived forest management, forests can be made to yield indefinitely. With metal and stone the more extensively they are used the quicker the supply will become exhausted, and it is impossible to replace them.

2. Timber is stronger than is generally supposed. In tensile strength (resistance to a pull lengthwise of the grain) a bar of certain woods exceeds a similar bar of iron or steel of the same weight and height. A selected piece of yate timber resisted a stress of 19½ tons to the square inch.

3. Timber can stand a far greater distortion than metal without losing its power to regain its original position. In this way timber gives a warning before reaching breaking point.

4. Hardwood beams require prolonged intense heat to destroy their usefulness. The surface becomes charred and protects the inner portion. Timber beams will also remain in position after a fire and carry a load, while iron and steel beams will under the same heat bend, twist out of shape, and fall.

5. Timber does not corrode like metal. It lasts longer, even without paint, in exposed situations. With metal access to moist air must be prevented. Impurities in iron cause brittleness and weakness. Timber continuously under water lasts longer than iron or steel.

6. Timber is a poor conductor of heat and electricity. it is pleasant to touch, it is more artistic, and has a beauty absent from metal, and has none of the injurious effects of iron and steel.

7. Pieces of wood may be strongly glued together; metals, on the other hand, would require welding or soldering. By too frequent re-heating and forging wrought iron is weakened.

8. Certain timbers may be used for cask-making, and such casks are in every way preferable to metal. The elasticity of certain woods renders them superior to any metal for the resonant parts of musical instruments.

Sir T. G. Jackson, R.C., in his book "Reason in Architecture," 1906, page 171, says:—

"Iron construction is really still in an experimental stage; we do not yet know how it will stand the test of time. Meanwhile, all experience hitherto tends to show that an architect who wishes his building to go down to posterity will do wisely to let iron play as small a part as possible in its construction. It has been prophesied that 30 years hence no one will employ iron in his buildings, at all events as the main element in their fabric. The failure of a single tie-rod seems to have been the cause of the collapse of the roof at Charing Cross Station, and it is certain that no monster roof of that kind will ever be put up again. To say nothing of great railways and other engineering works, it is disquieting to think of the miles and miles of streets in London and other towns where the whole of the upper storeys rest on girders accessible to atmospheric changes, liable to rust and fatigue and possible injury by vibration, which no one can examine and which cannot be repainted."

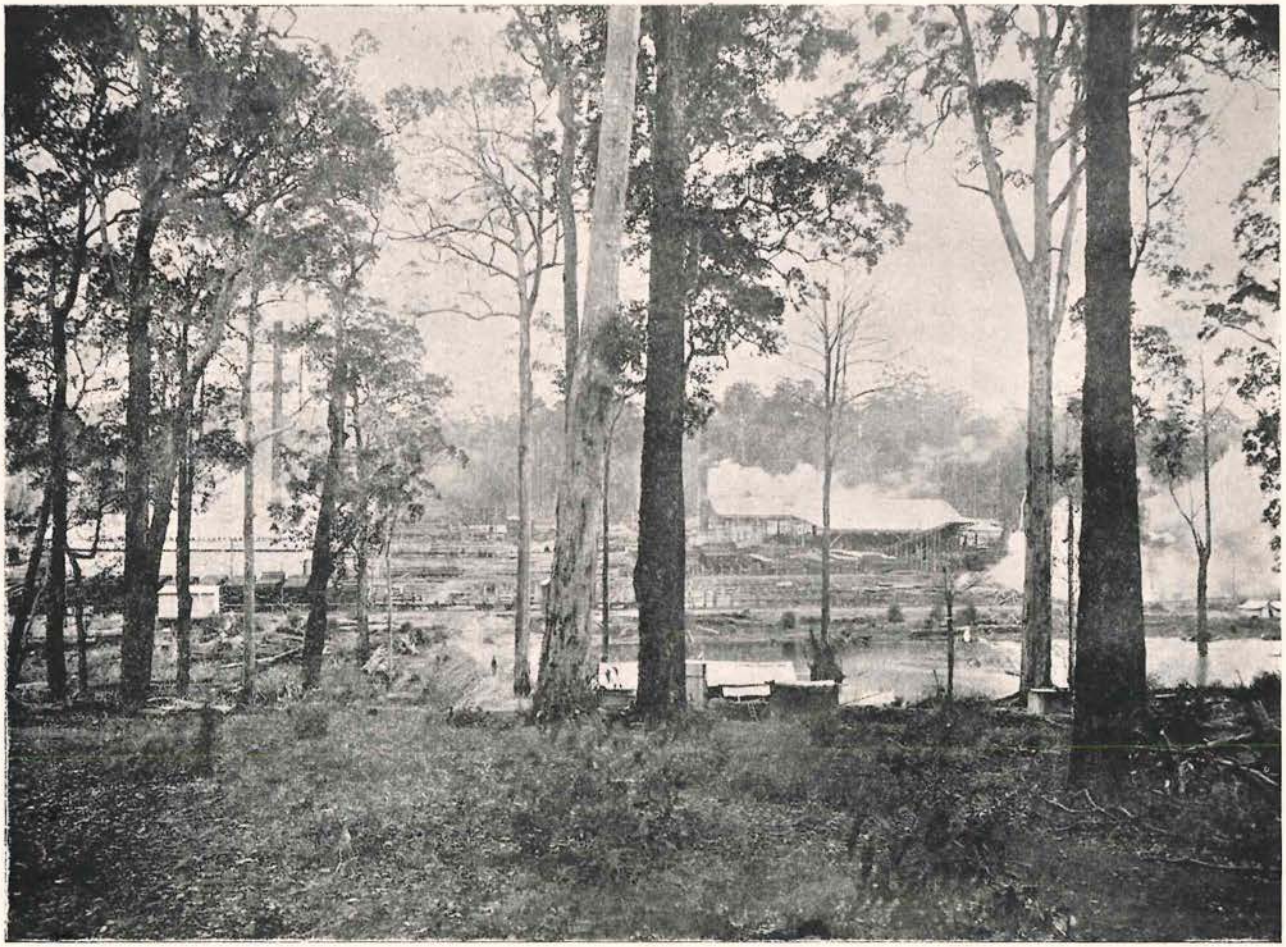
Measuring the Height of a Tree.

A number of instruments or mechanical devices for ascertaining the height of objects are in use. Some of these are simple in construction and not difficult to use, while others require more or less technical skill for their adjustment.

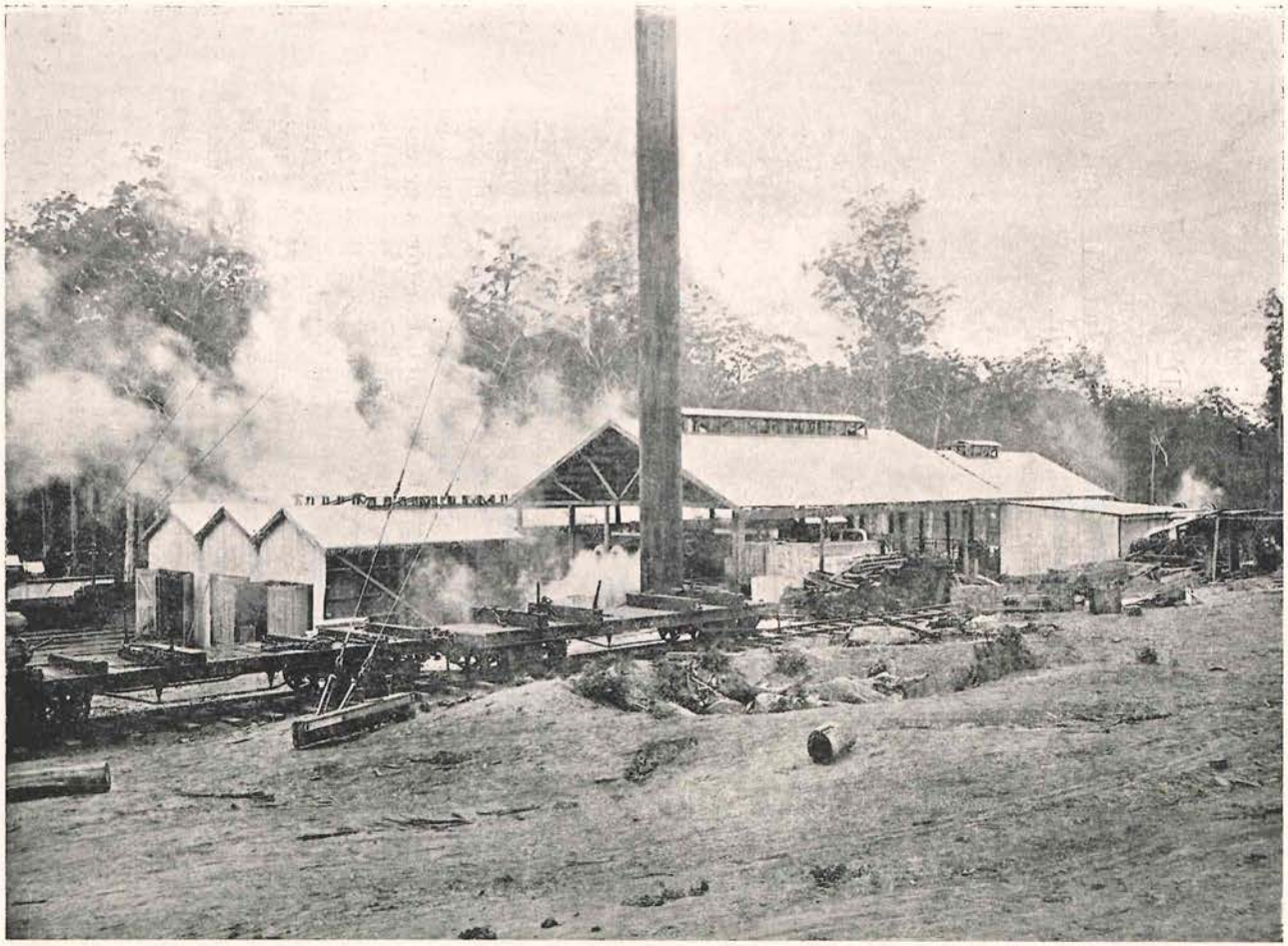
The work may be done, however, without special appliances, and the following methods may be recommended:—Measure the length of the shadow of the tree, and also the shadow of a straight stick of known length, set perpendicularly in the earth; multiply the length of the shadow of the tree by the length of the stick, and divide the product by the length of the shadow of the pole; the result will be the height of the tree.

A method used when the sun is not shining is to set two sticks or poles in a line with the tree. From a point on one pole sight across the second pole to the base and to the top of the tree. Let some one note the points at which the lines of vision cross the second pole, and then measure the distance between these points. Also measure the distance between the sighting point on the first pole to the base of the tree and to the lowest vision point on the second pole. Multiply the distance between the upper and lower vision points on the second pole by the longer of the other two measurements, and divide by the shorter; the result will be the height of the tree.

Another method sometimes used is as follows:—The observer walks a distance from the tree about equal to its estimated height; he then lies on his back stretched out at full length, and an assistant notes on a vertical staff erected at his feet the exact point where his line of vision to the top of the tree crosses the staff. The height of this point from the ground is measured, and his own height from his feet to his eyes. Let AB be distance from observer's feet to his



No. 1 State Mill, Manjimup. Note big Marri (redgum) trees in foreground.



Powellising Plant, Nos. 2 and 3 State Mills, Pemberton.

eyes, C the point on staff where his vision crosses, D the base, and E the top of the tree. Then—

$$AB : BC = AD : DE$$

or

$$DE = \frac{BC \times AD}{AB}$$

Example.—Let AB equal 6, BC equal 5, and AD equal 60, then $\frac{5 \times 60}{6} = 50$, the height.

Measuring the Volume of Trees or Logs.

Mensuration plays a very important part in scientific forestry and is the basis of all forest management. Organised forestry is essentially a business proposition and, consequently, if it is to be run on sound lines, there must be regular periodic stock takings. To do this, the forester cannot handle his stock, but must measure an enormous number of trees standing. To facilitate such operations the trained forester calls higher mathematics to his aid and evolves yield tables, which show him the volume to be expected from a unit area of a certain class of country carrying a given species of tree; form factor and volume tables assist him to calculate the volume of single trees. It is on such foundations as these that the whole science of forest valuation is built up.

No timber operations, however far removed they may be from forestry, are so haphazard that they do not require methods of arriving at the cubic contents of round mill logs. Unfortunately, rule of thumb methods have largely prevailed in the past. An Englishman called Hoppus published very many years ago an unsatisfactory system, which, unfortunately, was universally adopted in England and from there spread to Australia. To find the volume of a log, Mr. Hoppus

suggested measuring the girth in the centre of the log and dividing by four, this he very logically called the quarter girth, but to arrive at the volume he squared his quarter girth and multiplied by the length of the log.

$$\text{i.e., volume} = \left\{\frac{\text{girth}}{4}\right\}^2 \times \text{length.}$$

Realising that this was only a crude approximation of the true volume, it was claimed that it represented the actual timber obtained from the log when squared. As a matter of fact, the result obtained is 78½ per cent. of the true volume, while in Western Australia the recovery is less than 50 per cent.

A log, as everyone knows, is rarely a true cylinder. It tapers so that the butt end is larger than the top end. Consequently, it depends largely on the degree of accuracy required as to what method shall be employed in measuring. For ordinary work it usually suffices to measure the log in the centre, and calculate the area of the section at that point and multiply it by the length.

$$\text{i.e., volume} = \left\{\frac{\text{diameter}}{2}\right\}^2 \times 3{\cdot}14 \times \text{length}$$

$$\text{or} = \frac{(\text{girth})^2}{4 \times 3{\cdot}14} \times \text{length.}$$

It is often more convenient to take the dimensions of the two ends instead of the centre; in which case the volume is obtained by averaging the area of the two ends and multiplying by the length,

$$\text{i.e., volume} = \frac{\text{area of one end} + \text{area of the other}}{2} \times \text{length}$$

It should be carefully noted that it does not suffice to average the two diameters or the two girths first, as the case may be, for a considerable error is thereby introduced. For those who prefer some simple method of arriving at the approximate contents of a log, the following rule may be recommended:— Measure the girth in the centre, divide it by five, square the result and multiply by the length. This gives one-half the true volume. Thus, in order to arrive at the actual volume, the result must be doubled—

$$\text{i.e.,} = \left\{\frac{\text{girth}}{5}\right\}^2 \times \text{length} \times 2$$

Arbor Day.

The happy idea of setting aside a day for the planting of trees is American in origin. The day was first celebrated on 7th April, 1872, in Nebraska, U.S.A. Something over 30 years passed before the day was recognised in Australia. Victoria in 1909, it would seem, being the first to publicly proclaim a day to be known for all time as Arbor Day. Since then every State in the Commonwealth has given recognition to the day, more particularly as regards the schools. Arbor Day furnishes gratifying evidence that a forest-conscience is being aroused and stimulated in Australia. The day testifies to a new found belief that forest conservation is a national duty. In Western Australia Arbor Day has received legal recognition and constitution. Clause 72 of the Forests Act reads, as follows:—

> "One day shall be set apart in every year for the planting of trees in the several land divisions of the State, and such day shall be called 'Arbor Day.'"

The Education Department, with a fitting sense of the importance of trees to the community, encourages the planting of trees in school grounds. By so doing the children acquire some knowledge of tree-growth, while the part that trees play in the life of a people is impressed upon them by their teachers. There is a wide field in Western Australia for worthy endeavour in this direction. In many parts of the State the hand of the vandal has destroyed every tree, and the roads are, in consequence, bare, shelterless, and uninviting. Such roads should certainly be planted with suitable trees. By way of assisting in the good work, the Forest Department is prepared to supply, at cost price, young trees for planting in any suitable places throughout the State. But there are other cogent reasons besides beautifying landscapes and road vistas why the planting of trees should be seriously and systematically attended to. It is open to doubt whether there is any other matter which can approach in importance in Western Australia that of tree planting and forest preservation. If our forests disappear, or the full volume of tree life is not kept up by steady planting, the water supply will be gravely affected, our hillsides will become bare rocks, our alluvial lands will lack moisture and cease to produce as they

ought, rains will produce floods, springs will dry up or yield but slightly. It was upon recognition of these baneful results following denudation of trees, without planting, that led in Nebraska to the inauguration of Arbor Day.

So far as tree planting by public bodies and landowners is concerned, there are numerous advantages attending the system of using healthy seedlings instead of raising them from seeds. But with schools the case is entirely different, for valuable cultural lessons are to be learned from watching the process of preparing the ground to the nurture of the infant seedling. Summarised these advantages may be put thus:—

(a) The cost is less;

(b) Varieties especially suited to the district may be obtained;

(c) The trees when ready for planting out are acclimatised;

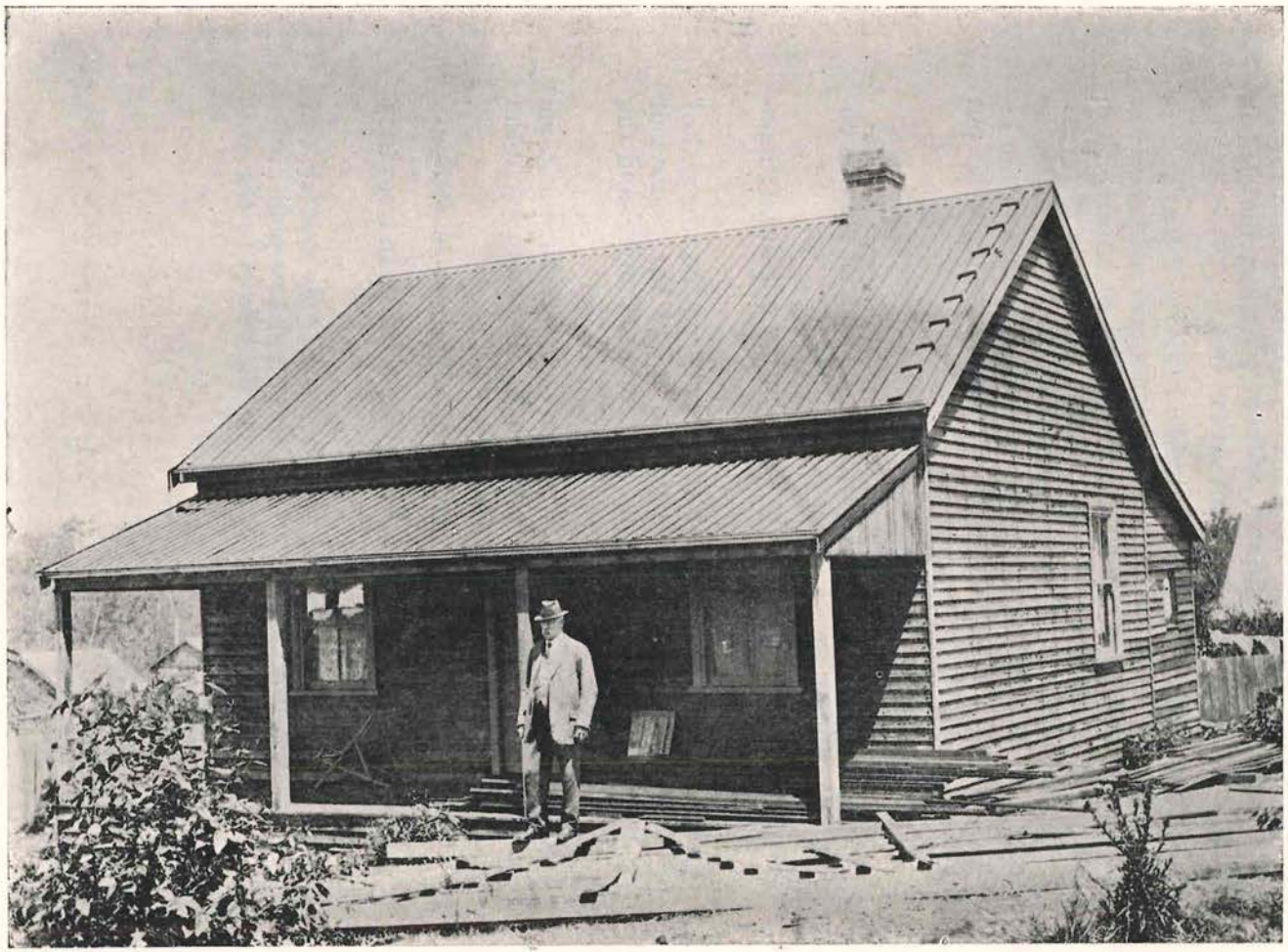
(d) The time which must elapse between the removal of the plant from its pot or bed to the permanent place of planting is very much shorter, and the tree consequently suffers less check;

(e) It is possible to sow some seeds in the positions where the trees are to remain, and so to avoid the necessity for transplanting;

(f) The most suitable time for planting may be chosen;

(g) Greater interest is taken by the children in trees they have raised from seed;

(h) The educational value of the work is far greater, and the practice of tree-raising and tree-planting is more likely to spread from the school to the children's homes.



Worker's Cottage, State Saw Mills.

Nor'-West Timber Resources.

The vast area north of the Tropic has been traversed by exploring parties on many occasions. Some of these parties have been in search of minerals and others were looking for pastoral country, and on nearly every occasion their reports contained reference to timber. But, up to date, no party having as its sole object the discovery of merchantable timber has explored the country. The Forests Department has numerous records referring to many various species of trees there to be found, but does not yet possess exact information as to quantities and localities. A systematic survey of the Nor'-West for forestry purposes has yet to be made. It seems certain, however, that nowhere in the Nor'-West are there to be found such huge aggregations of trees entitling them to the name of "forests." The timber growth in the northern regions seems mostly to be of the savannah kind, that is, growing in clumps of limited size or as individual trees separated from each other by considerable spaces.

Coolabah is a small eucalypt reported as fairly plentiful near Wyndham. The wood is harder than lignum-vitæ, for which it is an excellent substitute.

In the north and north-east the pines form larger forests of closer individual growth. Of the pines the principal member of the family found in the Nor'-West is the Cypress pine, which is scattered over a wide area along the northern coast. It yields a timber of high value in building construction, and it is said to be almost immune to the attacks of white ants. From the Cambridge Gulf to the Northern Territory border this tree is found in patches of more or less area, but the precise extent of its habitat and the density of its growth have yet to be determined.

The Nor'-West is also endowed with a number of trees whose bark is rich in tannin, the active agent in tanning operations. All the mangrove barks hold tannin, some of them to an extent which places them in the front rank. Ridge gum bark is also heavily charged with tannin, as are the barks of other trees found in the Nor'-West. The possibility of turning these to commercial account depends on the cost of collection, handling, and freight.

A West Australian ebony occurs between Broome and Wyndham, and is similar in every respect to the much valued African ebony. Along the coast this tree only attains the size of a small tree eight or nine inches in diameter, but it is possible that further inland it may grow to a larger size. Like its African sister only the heart wood is black, and so it is necessary to have a tree of fair dimensions to yield ebony of commercial size.

Big Trees in Western Australia.

All of the native trees of the State furnishing merchantable timber are large in size, compared, say, with the native trees of Europe. The average karri tree in height and yield of timber is equal to any found in the Commonwealth. When what remains of the present over-mature crop of jarrah and karri has been cut down, it is unlikely that specimens equal in bulk to what the forests have already yielded or still possess will be seen by future generations. When the State's forests have become "cultivated," trees will be cut when they reach maturity. Sentiment may dictate the preservation of a few for a period far beyond that of maturity, as reminders of the giants of former days, but whole forests of giant trees will no longer be seen. An official travelling overland in 1840 from Perth to King George's Sound describes the karri he saw as "monsters whose size is almost incredible," and he mentions one which had fallen as being "over 400 feet in length and over 300 feet to the first branch." These figures are the traveller's estimates, and it is possible that exact measurement might have reduced them somewhat. Many accurately measured instances testify to the huge proportions to which karri may attain. The height of karri taken on an average may be put down as slightly over 200 feet, with a barrel from 120 to 150 feet to the first limb, and a diameter three feet from the ground of from four to five feet. But very many specimens exceed these averages. Mr. J. Ednie Brown,

at one time Conservator of Forests of Western Australia, measured one at Karridale, and gives the following figures as its dimensions:—

34 feet in circumference at three feet from the ground;
160 feet to the first limb;
14 feet in circumference at the first limb;
Over 200 feet in extreme height.

From these figures it may be ascertained that the bole of the tree from the bottom to the first limb contained nearly 6,000 cubic feet of timber, weighing over 40 tons. The karri is a tree of comparatively rapid growth. In illustration of this Mr. Ednie Brown gives the following particulars of a specimen grown on the road from Giblett's to the Vasse:—

Height of whole tree—153 feet;
Height to top of available timber—100 feet;
Thickness of bark—half-inch;
Diameter at two feet seven inches from ground—one foot eleven and a-half inches;
Age of tree by concentric rings—Thirty-five years.

"It is a matter of local record," continues Mr. Ednie Brown, "that a resident on the Warren lived and raised a family in the hollow of one of these fallen monsters. This specimen was said to be over 300 feet in height and some 12 feet in diameter at the base."

Jarrah also exhibits some specimens of unusual size. Cases are on record of individual trees of which the measurements run into figures far in excess of the average. One tree of abnormal size was found about three miles west of the old Wellington Mill on the Ferguson River, measuring 22 feet in circumference at five feet up from the ground, and 80 feet to the first branch. Another large specimen on the Ferguson area went 21 feet in circumference at four feet from the ground, and 75 feet to the first branch.

Tuart sometimes attains a height of 150 feet and a diameter of 22 feet at the base. In some cases the trees run up 70 or 80 feet to the first branch. It is on record that a huge specimen was felled in order to provide a board to send to the Great Exhibition in London in 1852. It was expected that a board 12 feet wide would have been got out of this tree, but no saw was to be found capable of dealing with the log, so the project fell through.

NOTES OF INTEREST.

Blackboy gum, in the days when ship and boat building was an industry of the first importance in Western Australia, was much employed by ship and boat builders. By mixing it with Stockholm or coal tar a very satisfactory "pitch" was obtained.

The first steam sawmill in Western Australia was erected in Guildford, and the first regular yard for the sale of sawn and other timber was kept by Mr. Monger, and situated under Mount Eliza.

For the first 30 years of the Colony of Western Australia jarrah was colloquially termed "mahogany," and was exported under that name.

The sandalwood industry of Western Australia has had many vicissitudes. Sometimes the price has been high, and exporters and cutters have done remarkably well, at other times the market rate in the East has been so low that it did not pay to export the wood. It is on record that one shipment to Singapore brought only 2s. 1d. per picul (133⅓lbs.)

Some of the early colonists, with memories of the beauty and usefulness of the English oak, and apparently with but limited faith in the capabilities of the land of their adoption, determined to cultivate in Western Australia the oak of their homeland. So, within five years of the foundation of the Colony, Mr. J. Drummond, the Government Botanist, was notifying the public that seedlings of English oak were for sale at a low rate at the Botanic Gardens, Perth, and the cultivation of these trees was strongly recommended to settlers. The absence of groves of English oak to-day is probably due to the fact that Mr. Drummond's invitation was not widely responded to, probably because the great majority of the people had discovered that the local timbers were equally as serviceable.

Writing in 1884 of the Hamelin Timber Station, Mr. J. Harris, Inspector of Forests, says, "The mill-beach railway remains in excellent repair, and the karri-wood rails show but very little signs of wear and tear. The steep gradients are now protected with steel plates, which have greatly contributed to make the line safe and useful.

The Quindalup Station, writes Mr. Harris, was the first established in the Colony, Mr. Yelverton, senior, having commenced cutting at Quindalup about 30 years since, and during the period several hundreds of cargoes have been shipped. Mr. Yelverton has made many substantial improvements in the machinery. The vertical saw is much improved, and is worked by two men, as at Karridale. In 1884 at Quindalup, the cost of production of sawn timber, f.o.b., was about 20s. per load, hewn square from 40s. to 50s. per load, and round piles about 9d. per foot.

At Karridale in 1884 the men in the mill, on the tramways, and at the Hamelin worked not less than 10 hours per day. Wages of the men varied from 6s. to 12s. a day, boys as high as 4s. a day.

In his report for 1886, Mr. Harris wrote, "The men are ready for their work at the mills before the dawn of day, and with the exception of an hour for dinner, are employed till sundown. Extra wages are given to men willing to work after hours.

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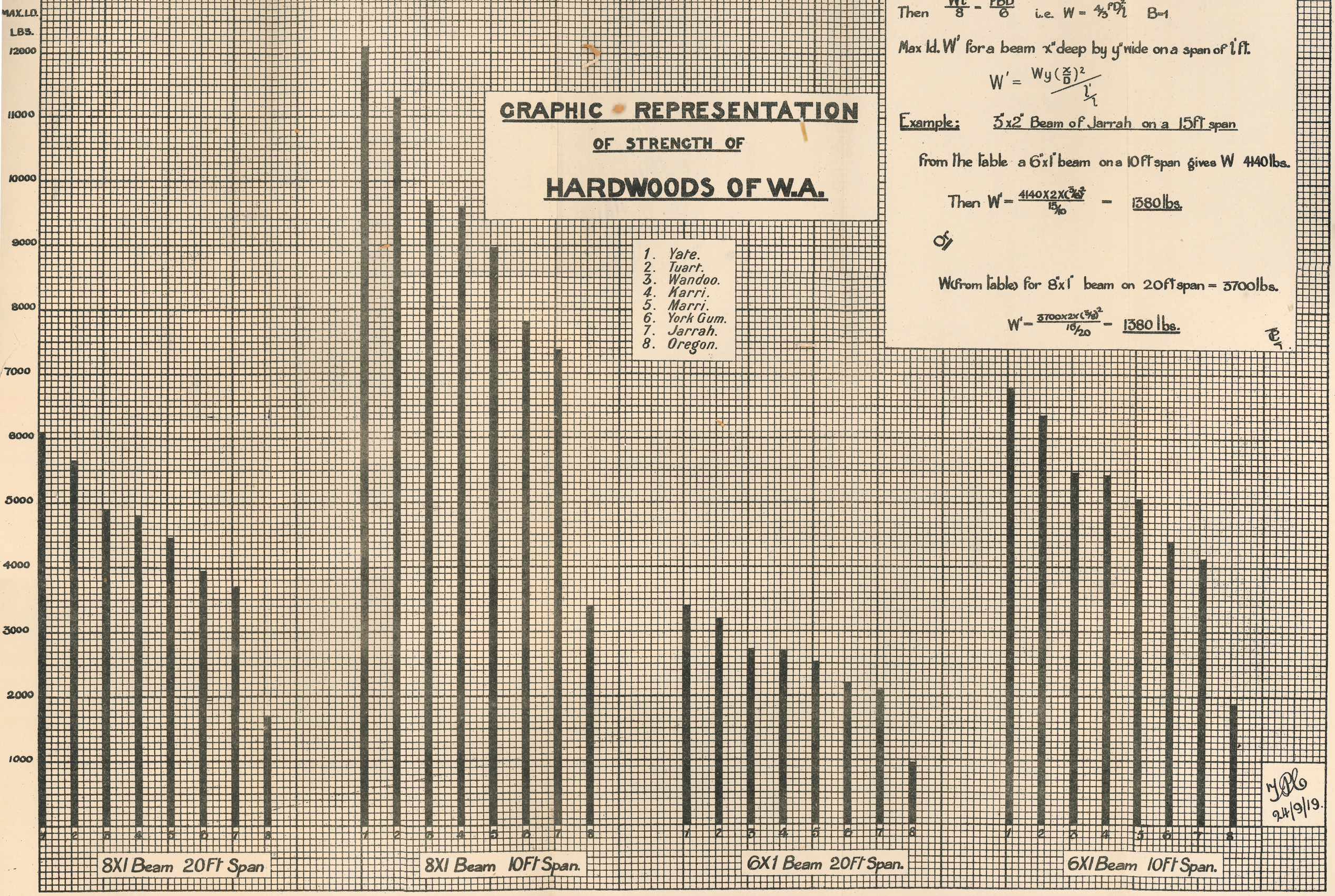
FORESTS DEPARTMENT PERTH, WESTERN AUSTRALIA.

GRAPHIC REPRESENTATION

OF STRENGTH OF

HARDWOODS OF W.A.

1. Yate.
2. Tuart.
3. Wandoo.
4. Karri.
5. Marri.
6. York Gum.
7. Jarrah.
8. Oregon.



W - Max ld at elastic limit f - Fibre stress at elastic limit

l - Span B - Breadth D - Depth

Then $\frac{Wl}{8} = \frac{fBD^2}{6}$ i.e. $W = \frac{4}{3}\frac{fD^2}{l}$ B=1

Max ld. W' for a beam x" deep by y" wide on a span of l' ft.

$$W' = \frac{Wy\left(\frac{x}{D}\right)^2}{\frac{l'}{l}}$$

Example: 3"x2" Beam of Jarrah on a 15ft span

from the table a 6"x1" beam on a 10ft span gives W 4140lbs.

Then $W' = \frac{4140 \times 2 \times (3/6)^2}{15/10}$ = 1380lbs.

Or

W(from table) for 8"x1" beam on 20ft span = 3700lbs.

$W' = \frac{3700 \times 2 \times (3/8)^2}{15/20}$ = 1380lbs.

WL 24/9/19.

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