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FORESTS DEPARTMENT

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THE AIR SEASONING OF JARRAH FLOORING.

RECOMMENDATIONS FOR MORE EFFICIENT AND ECONOMICAL PRACTICE.

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THE AIR SEASONING OF JARRAH FLOORING.

FOREWORD.

During the past few years a comprehensive investigation into the air seasoning of Jarrah flooring stock in this State has been carried out. Although Jarrah is a high-grade timber suitable for flooring and furniture, its popularity, both in this State and overseas, has suffered considerably owing to inefficient and careless methods of air seasoning. Previous work carried out by the Department has shown that it is possible to season Jarrah in a modern kiln, so that the movement due to changes in atmospheric conditions is no greater than with other recognised cabinet woods, and the investigation of which this bulletin constitutes the final report, has shown that much can be accomplished by improved methods of air seasoning. The first report was published in 1926, but it was recognised that the period of the investigations was too short to lay down any definite rules in connection with a problem which offers such a diversity of qualifying factors. The continuation of the investigations has confirmed the earlier recommendations set out in the first report.

The data collected since the inception of this test has reached fairly extensive proportions, and care has been taken to eliminate, as far as possible, the personal equation. Sawmillers, therefore, may with confidence adopt the suggestions for improvement contained herein, in the knowledge that they represent facts which have emerged from a mass of corroborative evidence. In cases where recommendations involve some cost beyond that of present practice, it will be found that the reduction in the wastage of material and the improvement of the final product will more than counterbalance the expenditure entailed.

The original circuit included fifteen yards throughout the Jarrah Sawmilling area, but conditions in many of the yards were so similar that the latter half of the study was confined to those yards situated at Mundijong, Yarloop, Holyoake and Jarrahwood, which include a fairly representative variety of conditions prevailing in the seasoning yards of this State.

S. L. KESSELL,
Conservator of Forests.

SUMMARY.

This report covers the results of continued Air Seasoning Investigation on 1in. flooring stock during 1926 and 1927, and follows the first report issued in 1926.

After brief notes on seasoning of timber and moisture content, the effect of the following is discussed in detail:—

Position of Yard.

A stacking yard should be regarded as a seasoning machine, and not as a storage area, and the same care should be taken in the selection of a seasoning yard as is done in the choosing of a mill site.

Foundations.

Insufficient height of foundations retards drying in lower layers of stack. Foundations at least 2 sleepers high (9in.) recommended, and at no place should the ground be nearer than 9in. to the bottom tier of boards.

Period of Stacking.

Under present practice the period of stacking may be longer than necessary due to the following causes:—

(a) Measurement of seasoned state by period since stacking. The practice of allowing a definite period before unstacking is not necessarily sound, as it may mean demolition in winter, when, due to reabsorption of moisture, the timber is far less seasoned than several months earlier. Where timber is urgently required loss may be caused by leaving stacks in a depreciating condition waiting for a definite period to elapse. This could be avoided by the use of sample boards and direct tests for moisture content. The old fallacy that there is some essential difference between the original "sap" and moisture taken up by timber exposed to rain still persists. Timber which may have been thoroughly seasoned but by exposure is allowed to reabsorb rainwater swells and behaves for all practical purposes as "green timber." It is equally fraudulent to sell flooring which has been stacked for three years, but is unstacked and left exposed to the weather in winter as "seasoned" as to sell timber two months off the saw as seasoned.

(b) Bad stacking conditions cause a lag in the drying in various parts of the stack so that perhaps 90 per cent. of the boards in a stack may be waiting for the remaining 10 per cent. to dry. Good drying conditions will give fairly even drying throughout the stack.

Spacing of Stacks.

Insufficient space between stacks retards drying, particularly of lower tiers. Spacing of 4ft. with a minimum of 3ft. is recommended for stacks up to 6ft. wide and 12ft. high. If height or width of stacks is increased, spacing between stacks should be increased.

Exclusion of Rain.

This represents the greatest single improvement possible in present seasoning practice. Rain penetrating stacks in winter rapidly increases the moisture content of the boards. In uncovered stacks once winter rains have

set in, boards are absolutely unfit for use until at least the following January. Sloping the stack slightly in its width and the provision of a sloping rain-proof cover is recommended.

Position of Board in Stack.

Generally the lower a board is in the stack the slower is the drying rate. Some boards behave erratically and the only sound method of determining the condition of a stack is the placement of sample boards in representative positions in the stack.

Width of Stack.

Up to 6ft. there appears to be no reduction in the drying rate in the middle of the stack.

Spacing of Boards.

An edge to edge space between boards is an advantage. These spaces should be vertically above one another to form flues to facilitate circulation in lower portion of stack.

Height of Stack.

If practicable, high stacks are not deleterious from a seasoning standpoint, provided the spacing between stacks is increased.

Strips.

Strips of even thickness properly spaced mean less degrade from distortion in drying.

Strips ½in. thick give best results generally, but 1in. strips may be used if desired; for winter stacking a width of 1½in. and spacing of 2ft. 6in. with a maximum of 3ft. is recommended. Increasing the spacing greatly increases degrade.

SHORT NOTES ARE GIVEN ON:

Moisture Distribution Tests.

The method of testing is described and the effect of the season on moisture distribution discussed. These tests show that the moisture distribution is most even during the first three months of the year.

Capacity of Stacking Yards.

Under recommended conditions, the capacity would be about 2,500 loads per acre. Attempts to increase this would probably result in reduction of quality of dried timber, or in reduction of the annual output per acre.

Ringbarking before Felling.

An experiment carried out on a tree suggests that there is nothing to gain by ringbarking trees for a period of 12 months before felling.

Conclusion.

The problems chiefly requiring consideration are the elimination of excessive re-absorption in winter months and the reduction of the present standard of final moisture content (about 15 per cent.). A standard 2 or 3 per cent. lower would greatly improve the service of the manufactured material and is quite feasible if strict attention to all possible improvements is given.

Seasoned Timber—A Definition.

Seasoning consists essentially of the removal of a quantity of water from the timber. The moisture content of green Jarrah is about 80 per cent. The figure 12 per cent. may be taken as an indication of the moisture content of satisfactorily seasoned timber, but, under present air seasoning conditions, 15 per cent. is about the average for timber unstacked during the summer months Shrinkage takes place fairly uniformly as the moisture dries out, but the rate of shrinkage relative to the rate of drying increases as the lower moisture content is reached. About 1/10th or even more of the total shrinkage of a board in drying to 12 per cent. moisture content takes place between 15 per cent. and 12 per cent. moisture content, so that the importance of the last few per cent. is readily appreciated. It is a comparatively easy matter to reduce the moisture content to 15 per cent., but the removal of the extra 2 or 3 per cent. needs particular care in stacking practice. Observance of conditions as set out in this report should put the figure of 12 per cent. within practical limits of air seasoning. While further shrinkage would take place if the timber were dried below this figure, at 12 per cent. the moisture in the timber and the moisture in the atmosphere is more or less in a state of equilibrium under average conditions where the timber is used in the coastal area, so that 12 per cent. represents a desirable figure to aim at. In the drier goldfields areas, for satisfactory results it would be necessary to go below this, say to 8 per cent. but this could only be obtained by restacking in the drier area or by kiln drying. On the other hand, in wetter districts in the extreme South-West, an extra 1 per cent. or 2 per cent. would not be deleterious.

Position of Yard

In the selection of a mill site, the question of seasoning stacks is admittedly of secondary importance, but, in the past, it has been one which has undoubtedly been ignored; the result has been that a yard giving conditions suitable for seasoning is the exception, and, in some cases, it would be better if no attempt were made to retain timber at the mill site for seasoning purposes.

It may be stated generally that board seasoning yards in the extreme South-West should be avoided as much as possible, but where they are inevitable, greater care is essential for satisfactory results. Valleys where there is a heavy rainfall, a closed in position, and perhaps running water, are totally unsuitable for air-seasoning, and should be avoided. A clean, open, well-drained position is to be desired, and the best results will be obtained in dry localities, but in wetter districts, by unstacking at the correct time, employing thicker strips, and paying strict attention to other essentials, satisfactorily seasoned timber can be obtained.

It may be intimated however, that the best drying conditions for flooring may be too severe for wide boards or thicker stock and yards unsuitable for board seasoning may possibly prove advantageous for the drying of these other materials, at least as a preliminary to final drying in sheds and kilns.

Orientation of Stacks.

The direction of the length of a stack with reference to the points of the compass does not appear to have an appreciable effect upon the drying of the boards in a stack. Where it is proposed to slope the stacks in the width, it is desirable to arrange the yard layout, so that this slope will be towards the prevailing weather.

Period of Stacking.

Special stacks were retained in order to discover whether boards would reach, after a second summer, a moisture content lower than that attained at the end of the first summer. As it happened, the summer of 1926-27 was decidedly wetter than that of 1925-26, with the result that boards tended to maintain a higher average during the latter period than during the former.

It is evident therefore, that with the existing unsatisfactory stacking conditions, particularly the absence of any attempt to exclude rain from stacks, much time is now wasted and is in some cases worse than wasted.

Under present conditions timber can be seasoned up to a certain stage, but it is scientifically and economically unsound for sawmillers to involve themselves in the expense of an extended period of seasoning before they have so revised and reorganised their methods in general that their timber may derive further benefit if stacked beyond a certain period.

Sawmillers are urged to be satisfied with none but the very best methods for air-seasoning their timber; and their attention is drawn to the fact that a large amount of money is being positively wasted, as represented by the interest charges upon the outlay of capital involved in their stacked timber. Under conditions as they exist at present, timber will cease drying considerably earlier than would be the case under improved practices; and if the cost of storing for a longer period is not to be completely thrown away, it is essential that the timber should be enabled to benefit by the full period of stacking.

Foundations.

There is a tendency for the moisture content in the bottom tiers of a stack to remain higher than that prevailing in the rest of the stack. Special care with the layort of foundations will go a long way towards obviating this undesirable state of affairs. There should be, between the bottom tier of boards and the ground, space sufficient to ensure against air stagnancy; to this end double sleepers are recommended, but even greater space would be beneficial.

Even where a suitable locality has been chosen, in accordance with the recommendations delineated above, it is essential to pay particular attention to the positions on which foundations are laid, and low-lying parts, presenting difficulty in drainage, should be left alone. Moreover, particular attention should always be paid to the provision of effective drainage, and to the keeping of the precincts of the stack free from vegetation and rubbish. A drain the full length of the yard, with channels leading from the spaces between the stacks, should in most cases prove to be ample prevention against stagnant water, while cleanliness around the foundations could be maintained by sending a labourer around periodically.

The spacing of sleepers should be 2ft. 6in. centres, with a maximum of 3ft. and a side slope of ½in. per foot width, would prove of advantage in stimulating the drainage of rainwater from the stacks.

Spacing of Stacks.

A casual inspection of the stacking yards of this State would show a remarkable lack of uniformity and methodical layout. Even were no good purpose to be served, strictly from the point of view of seasoning, the efficiency and economy resultant from systematic procedure should of themselves prove to be sufficient. But, without maintaining a sufficient spacing

between stacks, it is impossible to reap the full benefit from the very considerable expenditure involved in air-seasoning. It is realised that, at some mill sites, space is limited, and that sawmillers are constrained either to congest their stacks or to stack elsewhere. In these cases, the latter alternative is strongly recommended.

Spaces between stacks are not always regarded in their true light, as integral parts of a contrivance for seasoning timber; if such were the case, the necessity for standard dimensions and the complete cleaning up of all weed growth and rubbish would be patent. But it has been noted, with regret, that the tendency still prevails to use the spaces by piling them with rubbish generally and strips in particular, to the detriment of their true function, namely that of ensuring free circulation of air.

Keeping clear the spaces between stacks is the more important in that the obstructions affect chiefly the lower portions; and it is there that, even under the best conditions, the drying lags. The anomaly, therefore, occurs of the aggravation of an influence causing retardation in a portion of the stack, instead of that stimulation which is necessary to accelerate the drying rate where it is sluggish.

Edge to edge spacing of at least 3ft. is strongly recommended, and, where possible, a 4ft. space should be provided, and a rigid rule should be enforced against piling anything in the spaces.

Exclusion of Rain from Stacks.

The provision of adequate covering for stacks is a factor to which absolutely no attention has been given in any stacking yard in this State, and, as a result, the product of even the most efficient yards falls far short of attaining that standard of quality which may reasonably be expected of air-seasoned Jarrah boards. The extent to which uncovered timber re-absorbs moisture can be but faintly realised, or some attempt would have been made to cope with this important problem. The necessity for covering may be appreciated when it is realised that the winter moisture content of seasoned timber, under efficient covering, would be about 16 per cent., or even less, while that of uncovered boards is 25 per cent. or 30 per cent.

Demolition of uncovered stacks should not take place from May to December inclusive. A study of the graphs (see Figs. 1, 2, and 3) submitted with this report should dispel any doubt which might exist on this question; it will be observed that the winter moisture content of seasoned boards is higher than that reached by green timber after a few weeks of summer weather.

Any sawmiller would be shocked at the suggestion that he should sell, as seasoned, timber which had been stacked for only one month in summer; and yet the anomaly of placing on the market in winter timber of a moisture content of 25 per cent. is not appreciated, although the latter would be less fit for commercial purposes than the former. When it is realised that timber under cover maintains a winter moisture content of only about 16 per cent. and even lower than that, it will be appreciated that, if boards are to be unstacked in winter, covering is essential.

The study of moisture distribution, to which reference will be made later, has further demonstrated the desirability of covering. In spring, with the first spell of warm, dry weather, moisture is drawn off the outer layers of the board, but as soon as showery conditions return, this incipient drying ceases, and re-absorption commences. Thus, drying from the centre has not even begun when conditions are reversed; so that, with the recurrence of dry weather, drying from the outside has to start again.

As this state of affairs continues until the rain ceases, some weeks of hot summer weather must elapse before moisture can be drawn from the centre and the timber can reach a seasoned condition. Nevertheless, if the stacks were protected from rain, the effect of spring showers would be negligible, and the drying effect of fine spring weather would be retained instead of being dissipated by the first shower, with the result that the timber would be fit for use considerably earlier than otherwise.

Unless stacks are to be completely covered by a shed roof, two variations of present practice are necessary. Firstly the provision of a sloping rain-proof cover on each stack overhanging the sides and ends of the stacks, to protect in addition these portions as much as possible, and, secondly, each stack to be built sloping slightly in the width (½in per foot), so that any rain which beats into the stack will not have the opportunity to lie in pools on the surfaces of boards. Sloping of a stack in the length is sometimes adopted, but this is far less advantageous than sloping in the width, since, with the former method, pools tend to form at the strips which are at right angles to the direction of water flow.

The opinion is held by some that rain serves a good purpose by washing the sap out of the timber. Without entering into a discussion upon this matter, there may be mentioned two points, which will demonstrate that, even if anything might be said in its favour, yet it has absolutely no bearing upon the question of covering stacks. Firstly, the washing effect must be absolutely nil on a large quantity of the boards of a stack (this will be perfectly clear to anyone who has observed stacks in winter time), and, secondly, the time required for a leaching process would be altogether prohibitive.

Position of the Board in the Stack.

The vital importance of moisture content in different parts of the stack is seen when it is realised that the decision as to whether a stack of timber is seasoned must depend upon the condition of those boards of which the rate of drying is the slowest; for, even though only a small percentage of the boards were to shrink, the good effect of the thoroughly seasoned condition of the remainder of a floor would be discounted. A close study of the behaviour of many hundreds of sample boards and the graphing of their moisture contents, in some cases for a period of over two years, have provided some enlightenment on this subject. It was mentioned in the First Report that the lower the board is in a stack, the slower will be its drying rate, also that those in the middle will take longer to dry than those on the outside (this will be subject to a certain qualification explained under the heading of Moisture Distribution), while those at the corners dry quickest of all. It will be clear, therefore, that the moisture content of a board on the outside of the stack cannot be taken as an indication of the condition of the stack as a whole; but there are further complications, which render more involved the moisture determination of a stack of timber.

On the inspection of the graphs of sample boards, certain tendencies stand out persistently; firstly, that the graphs of certain boards describe an erratic course throughout the whole period, secondly, that those of others are inclined to maintain a high level throughout, and, thirdly, that the moisture contents of some boards are disposed to preserve a low level throughout the period of stacking (see Figs. 4 and 5). While it is outside the scope of this test thoroughly to investigate the causes of these phenomena—the erection of special stacks would be necessary—certain aspects of the problem may be given consideration at this juncture. These tendencies

are entirely independent of the influences of position mentioned above, as there are cases of every position in the stack providing graphs of each of the three types.

Briefly, there would appear to be three main reasons for these tendencies. Firstly, timber varies considerably in density and maturity from board to board, secondly, while the majority of the boards are cut on the back, a quantity of the slower drying quarter-cut boards are usually to be found, while, thirdly, some boards receive severe case-hardening influences in the early stages, and this retards their later drying.

Although individual boards may maintain a low level, or a high level, or describe an erratic course throughout the stacking period, it is impossible to say in which category a particular board may come. As it is essential to determine the moisture content of those boards which are the least dry, before a decision may be reached as to whether the stack is seasoned or not, a certain number of samples must of necessity be taken from such positions in the stack as will ensure representative results. The only way to obtain dependable data will be by the placement of sample boards in certain positions during the erection of the stack, and these positions must be so chosen that the moisture content of those boards which are the least dry will be known. A method of placing sample boards to obtain this result is suggested in an appendix.

A feature which is most noticeable on inspecting the graphs of sample boards is the fact that, where the stacking conditions are the best, the difference between the moisture contents of different boards will be the least. In fact, one who had never even seen the yards would pick out at once, from the graphs, the yard in which the most efficient methods were in practice.

Moisture Distribution.

In order to obtain some idea of the distribution of moisture throughout the thickness of the board, at each visit to a seasoning yard, tests have been carried out in the following manner. A section is cut from the middle of a board, and this section is cut again, at right angles to the original cut, into three pieces, one representing the top side, one the middle, and one the bottom side of the board: the moisture content of each piece is then determined in the usual way.

The tests have been confined to timber below fibre saturation point and deal mainly with the rise and fall of moisture content during the latter stages of drying.

During the original drying period, that is, before winter rain has caused any re-absorption of moisture, the outside sections are usually of a lower moisture percentage than the middle, but this difference decreases as the board reaches a low moisture content, until, finally it may disappear altogether.

As soon as winter rains commence, the position is reversed, and it is generally found that the outside of the board is 1 or 2 per cent. higher than the middle. The difference is higher immediately after rain, and, sometimes, probably due to a pool of water on the board, outside sections have been found to be as much as 7 per cent. higher than the middle; while, if there has been a spell of fine weather during the winter, and the outsides of the boards have started to dry, there may be little or no difference in moisture content. But, in spite of these temporary fluctuations, the general tendency is for the outside to have a higher moisture content during the winter, and

at the end thereof there is shown to have been a general rise, varying according to locality, yard layout and other factors, with the middle portion of the board lower than the rest. During spring, drying recommences, but does not proceed to any appreciable extent, and, until the summer starts, there is not much change in the centre of the board. The fact that the drying of the board as a whole does not progress to any great extent before the advent of summer is due pre-eminently to the lack of covering of stacks, for, although the outside may have dried sufficiently to produce a moisture gradient, which will induce drying from the centre, so soon as showery conditions set in, the boards in the unprotected stacks commence to re-absorb moisture, and the moisture gradient is neutralised or even reversed. It can be seen, therefore, that, where stacks are not covered, there is little opportunity, until a fairly extensive dry spell sets in, for discharging any of the moisture from the centre of the board. In fact, it may be said that, except under ideal weather conditions, and the very best stacking practice, the centre of the board cannot, before the end of the year, be expected to have dried sufficiently to fit the timber for unstacking and commercial use.

During the first three months of the year, the distribution of moisture throughout the board is at its evenest—except when summer rain causes an increase, of a temporary nature, in the moisture content of the outside of the board—and the condition of the timber is the best that can be obtained under present conditions.

Moisture distribution tests taken at the beginning of winter give evidence of a rate of re-absorption varying usually in an inverse ratio to the distance of the board from the outside of the stack. Of six or seven sample boards in the same tier, one behind the other, the moisture percentage of the centre prong of a board has been found generally to be lower than that of the next board nearer to the outside of the stack. Increased protection from wetting, and milder conditions in the initial stages of drying as the middle of the stack is approached are, without doubt, mainly responsible for this state of affairs. The moisture contents of the outside sections of the board do not show the same reduction as the centre of the stack is approached, and, from a study of the moisture contents of the whole sections, little evidence of this tendency would be observable. The more delicate methods of moisture distribution tests have exhibited a qualification to the statement contained in the First Report relative to the position of the board in the stack, in that, although in certain cases outside boards may show a slightly lower moisture content than boards in the middle of the stack, no general rule can be stated to that effect. Furthermore, it may be stated that, during winter, as the distance from the outside of the stack increases, so may a slight decrease in moisture content become apparent. This has a bearing upon the subject of the width of the stacks, which will be discussed in the following section.

Width of Stacks.

The opinion appears to be held by some that narrow stacks are to be desired, nevertheless it is very questionable as to whether any good purpose may be served by this practice. In the preceding section, notice was drawn to the fact that, during winter, the moisture content of the centre of a board is inclined to be lower at the middle of the stack than in the case of boards on the outside. At no period of the year may it be said that a higher moisture content will be found in the centre of stacks of a width of 4ft. 6in. (a dimension which is in fairly common use) than the average elsewhere at the same level. It will be seen, therefore, that stacks may, with advan-

tage, be increased in width, and it may be mentioned in this connection that the erection and demolition of stacks are simplified and accelerated, when plenty of room is available for those who are working on top of the stack to pass to and fro. From the point of view of the sawmiller, who has limited space at his disposal, this question of the width of stacks has an important, though indirect, bearing upon the spaces between stacks; for, by increasing the width, he may either increase the size of the spaces or the amount of timber stacked in a certain area, or both. Narrow stacks and narrow spaces should be avoided, as providing no economy of space, being of a distinct disadvantage from the point of view of labour, and being unsound so far as seasoning of the timber is concerned.

The question arises as to the width to which stacks may be built, and, while no definite statement can be vouched at this stage, yet the data available all indicates that, up to a width of 6ft. 0in. at any rate, there is no reduction in the drying rate in the middle of the stack. To obtain the information that is desirable upon the subject, and to find the ultimate width to which stacks may with safetly be built, would necessitate the erection of special sacks under such conditions as would ensure the furnishing of conclusive evidence of the behaviour of the boards throughout stacks of varying widths. From the point of view of the reduction of stacking space alone, without regard to other considerations, it should prove to be of considerable value to sawmillers to know how wide their stacks may be built, and it is very probable that considerable advantage, strictly from the point of view of seasoning, would be derived from a thorough investigation of this factor.

Pending further tests, there is no evidence sufficiently definite to recommend any divergence from existing practice of a width from 4ft. 6in. to 6ft.

Spacing of Boards.

The most usual practice in this State is to leave a small space between the edges of the boards, and this practice was recommended in the First Report. Moreover, staggering of boards was deprecated, on the score that it inhibits the free vertical passage of air through the stack. It has, therefore, been assumed, in making the recommendation for wider stacks in the preceding section, that boards would not be stacked edge to edge nor staggered; for either of these practices tends to retard drying in the centre of the stack. In laying the boards, care should be taken that they are placed directly one above the other, so that the spaces form a straight vertical chimney; a little care in this direction would be amply justified by results. A space of 1½in. between boards in the same tier is recommended, except with 4in. boards, where 1in. should be sufficient.

Height of Stacks.

The limit to the height of stacks is probably fixed more by handling costs than by seasoning considerations. The average height of stacks in this State is between 11 and 12 feet, but, in some yards, stacks are as low as 9 feet. On the other hand, isolated yards stack as high as 18 feet to 20 feet. The seasoning of the lower layers must be retarded in stacks this high, but it is considered that, up to twelve feet, the height of stacks has little effect as far as seasoning is concerned. The main objection which is preferred against high stacks is that above a certain height handling costs increase to an inordinate extent. It is suggested that sawmillers would find it to their advantage to check this assertion, and find out by actual test that height beyond which further stacking would be uneconomical. It has been noticed

that, in certain yards, where there is lack of space, stacks are not built to a height which elsewhere has not appeared to constitute an expensive procedure. Sawmillers would find the collection of data relative to this matter comparatively simple, and they would gain valuable information based on facts, instead of prejudice. Pending further investigation, a height of twelve feet is tentatively recommended.

It must be remembered, however, that, if the height of stacks is unduly increased, the spacing between stacks must also be increased. For example, for a 15ft. stack, a spacing of 4ft. 6in. would be desirable, while for a 20ft. stack, the spacing should be 5 feet.

Thickness, Width and Spacing of Strips.

The recommendations concerning strips, expressed in the First Report, have been confirmed. The most satisfactory thickness of strip for general use under the conditions extant in the Jarrah belt is ½ inch. Where the very best results are desired, and there is no objection to a little extra trouble, an improvement in the lower layers of the stack may be obtained by the use of strips of 1 inch in thickness. In the case of stacks erected during winter, and where the timber is required to be seasoned as early as possible in the following summer, 1-inch thick strips may be used to advantage. Under these conditions, the boards will dry at a slow rate in the early stages during winter and spring—and with the advent of summer, their moisture content will be sufficiently low to allow of an increased severity of conditions due to the employment of 1-inch strips, without the deleterious effects of rapid drying from the green state. A width of 1½ inches, and a spacing of 2 feet 6 inches with a maximum of 3 feet, should give the most satisfactory results.

Ring Barking Before Felling.

The suggestion has been put forward that advantageous results, from the point of view of seasoning, might ensue from the ringbarking of trees some time—say, 12 months—before felling, and, as a result, it was decided to conduct an experiment of a preliminary nature, in order to obtain some indication as to whether any good purpose might be served by further pursuing this subject. To this end, a tree was selected in January, 1926, in the Jarrahwood district, in a position which would be reached by the fallers in approximately 12 months' time, and it was ringed, the sapwood being completely severed. In February, 1927, the tree was felled, lopped and barked without any difficulty, and sawn into a log 40 feet long, with a mid-girth of slightly over 10 feet, and containing rather more than 6 loads of timber. It was reported that the operations in the mill appeared to be easier than with the average log. 1,260 super feet of 1-inch boards were cut from the log, and on this certain experiments were conducted. The moisture content of the boards varied between 80 per cent. and 85 per cent., and, consequently the idea that drying to any appreciable extent may result within a reasonable period from the ringbarking of a tree must be discounted.

The boards from this tree were placed upon a partially erected stack; amongst them were included some sample boards, which were re-weighed at intervals during a period of about nine months. The process of drying presented no features of an unusual nature, which might be allocated to any peculiarities of the timber itself. Hence the complete absence of any indications of abnormality precludes the advisability of proceeding further with an investigation, which shows no promise of being of service to the sawmilling industry. But this experiment may be of interest to those who have considered the advisability of this practice.

Conclusion.

An attempt has been made to demonstrate in this report directions in which improvement may be made in air-seasoning practice in this State. The standard of seasoned timber has been so persistently below that quality which is to be desired that an opinion has become prevalent that in jarrah some inherent characteristic is the cause of inevitable shrinkage, however carefully it has been seasoned. That this opinion is totally inaccurate will be apparent to all who have made any study of the problem; and it is hoped that a concerted effort will be made on behalf of the sawmillers to prove to the public the fallacy of this conception. It must be recognised that the problems to be tackled are the elimination of excessive re-absorption in winter months and the driving off of 2 or 3 per cent. of moisture more than that which is reached at present. As the moisture content of the timber is reduced, so does driving off of further moisture present increasing difficulties. To reduce 1 in. jarrah boards to a moisture content of about 15 per cent. is a comparatively simple matter, and the majority of stacking yards are able to approximate this figure, but to reduce the moisture content in a further 2 or 3 per cent. demands particular care towards the improvement of stacking practice. There have been suggested in the body of this report a number of methods whereby stacking practice may be improved; from a single improvement marked effect cannot be expected, and it is only by means of a general improvement in every possible manner that the best result will be attained. It will be appreciated that, although one improvement may be more efficacious than the others, yet its effect alone would be inadequate to provide the amelioration desired; and that nothing must be overlooked which will tend to increase the drying rate. A general reorganisation of stacking practice is required, each little improvement that is effected doing its part towards the goal aimed at. The necessity for reorganisation is clear, when it is observed that throughout the sawmilling area there is a general lack of uniformity, even amongst yards under the same general management. An inspection of the following summary of recommendations will show that, in the majority of cases, no increase in expenditure would be entailed, and, in cases where some cost in excess of present requirements may be expected, the recommendation is made with the conviction that it will be amply repaid, and that sawmillers who are actuated by a desire to see the best results from jarrah, will not be deterred by a proposition which should prove to be a sound investment. The proposed measures, by which present practices may be improved, are summarised hereunder:—

Reduction or cessation of stacking in unsatisfactory yards.

Unstacking and storage at end of summer; or covering of stacks.

High foundations.

Efficient yard drainage.

4ft. 0in. spacing between stacks; minimum 3ft. 0in.

Spaces between stacks clear of strips, timber, and rubbish.

Edge-to-edge spacing between boards: spaces vertically above one another.

Strips ½in. thick, 1½in. wide.

Spacing of strips 2ft. 6in.; maximum 3ft. 0in.

APPENDIX.

Use of Sample Boards in Air Seasoning.

From consideration of the report and attached graphs the approximate time of unstacking for best results can be obtained. It has been stressed, however, that the maxima and minima of moisture content as shown on characteristic graphs are dependent on the season. Further, moisture content is not the sole criterion of seasoned timber, and the most satisfactory method of judging the seasoned state of a stack is the use of sample boards placed in position when the stack is erected and tested when the stack is about to be demolished.

A suitable procedure for control of seasoning by the use of sample boards is detailed below.

Selection and Preparation of Samples.—Select three 12 feet boards as representative samples. These must be straight-grained pieces free from any knots or gum veins and cut on the back. Cut as illustrated in diagram (Fig. 6), discarding 1 foot at each end and leaving five samples each two feet long from each board. Paint all samples on the end and back half an inch from each end.

Placement of Samples.

(a) In stacking place 5 samples from the first board behind each other in the third tier from the bottom, in the centre of the stack and on the side to which the stack is sloped (see diagram, Fig. 6).

(b) Place 5 samples from the second board similarly in the middle tier.

(c) Place the remaining 5 samples similarly in the third tier from the top.

Testing of Sample Boards.

No testing for moisture content is necessary at the time of erection.

When the stack approaches dryness as gauged by graphs, take the second and fourth sample board counting from the outside of the stack in each tier and test as below. The other boards must be kept in position for further tests if necessary.

For Moisture Content.—Moisture content is defined as the ratio of water to drywood substance expressed as a percentage. As it is not convenient to dry out the whole board, representative sections are tested for moisture content.

From each sample board two sections ⅜in. long are cut about seven inches from each end. Each piece is weighed immediately after cutting on a chemical balance weighing to .01 gram. The sections are then dried in an oven maintained at a temperature between 215° F. and 225° F. until no further loss of weight take place. Drying out overnight will be found sufficient if the oven temperature is correct. Moisture content is then expressed as $\frac{\text{loss of weight}}{\text{dry weight}} \times 100$. With care in weighing the moisture content of the two sections from the same sample should not vary by more

than 1½ per cent., so that the average moisture content should be correct to 1 per cent. As indicated in the report. 12 per cent. is a desirable figure to aim at.

Case-hardening and Moisture Distribution.

A case-hardened piece of timber is popularly known as a piece in which the outside is harder than the centre as a result of excessive drying of its surface at some stage of the seasoning process. Case-hardening results in the centre portion of the wood being in a state of tension and the outside layers in compression.

To test for case-hardening a half-inch section is cut from the middle of the sample board, and this section is then pronged as illustrated by two sawcuts running parallel to the original board face. The centre prong is broken out and the behaviour of the two outside prongs noted immediately after cutting. If the prongs remain straight or incline towards or away from one another to a slight extent, the timber is not case-hardened and stresses present are not sufficient to be deleterious. If, however, the prongs nip and bend on one another, the timber is case-hardened. A further period of stacking is necessary till the stresses are alleviated, as machining would upset the state of equilibrium of the stresses in the board and lead to warping and twisting of the timber.

The prong test gives a useful indication of moisture distribution. If after the test for case-hardening the prong is left in a warm, dry place, further drying and shrinkage will take place. If the moisture distribution has been uneven the prongs will curve on drying towards each other, if the moisture content is higher on the inside, and away from each other if higher on the outside. If the movement is very marked a further drying period is indicated.

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FIG. 1

CHARACTERISTIC GRAPH SHOWING AVERAGE M.C. OF STACK LAID DOWN IN EARLY WINTER

N.B. 1. This graph represents average M.C. in a stack erected under good conditions in the open without covering.

2. Demolition is practicable for a short period in less than twelve months.

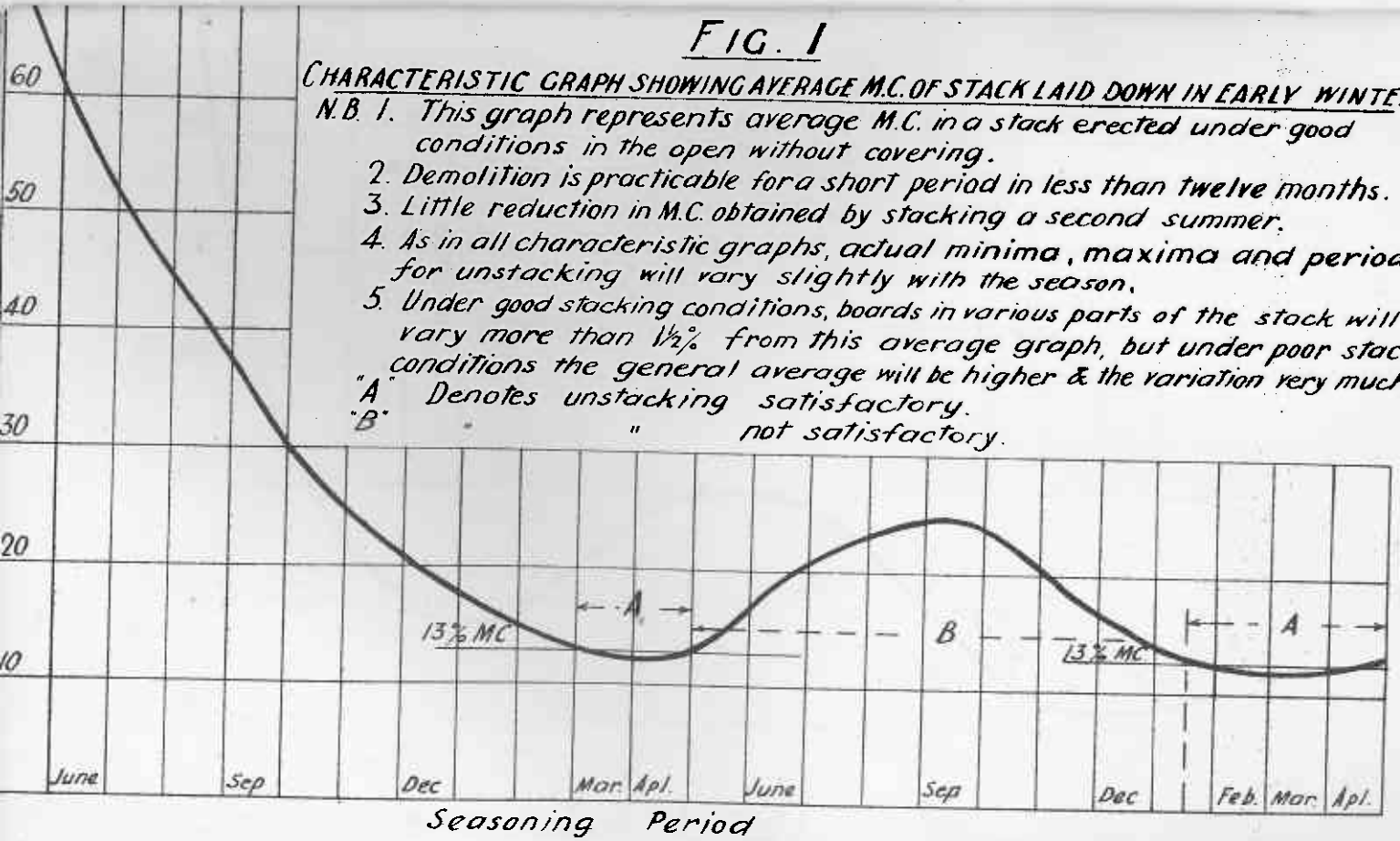
3. Little reduction in M.C. obtained by stacking a second summer.

4. As in all characteristic graphs, actual minima, maxima and period for unstacking will vary slightly with the season.

5. Under good stacking conditions, boards in various parts of the stack will not vary more than 1½% from this average graph, but under poor stacking conditions the general average will be higher & the variation very much greater

"A" Denotes unstacking satisfactory.

"B" " not satisfactory.



Seasoning Period

FIG. 2

CHARACTERISTIC GRAPH SHOWING AVERAGE M.C. OF STACK LAID DOWN LATE IN YEAR.

N.B. 1. This graph represents average M.C. in stack erected under good conditions in the open without covering.

2. Demolition is not practicable till the second summer.

3. See notes 4 and 5, Fig 1.

"A" Denotes unstacking satisfactory.

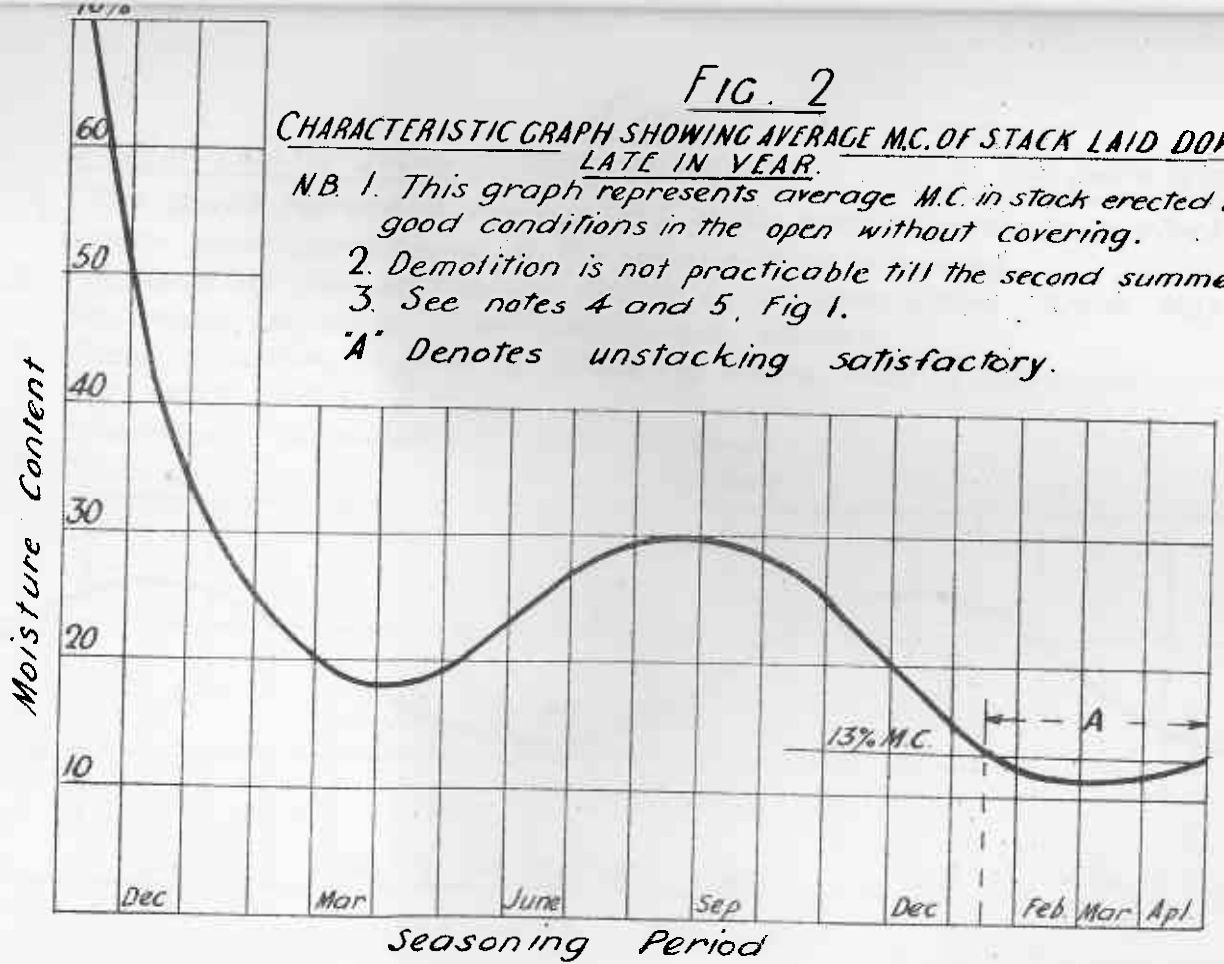


FIG 3.

CHARACTERISTIC GRAPH SHOWING AVERAGE M.C. OF STACK LAID DOWN SEVERAL YEARS

N.B. 1. This graph represents average M.C. after several years in a stack erected under good conditions in the open without covering.

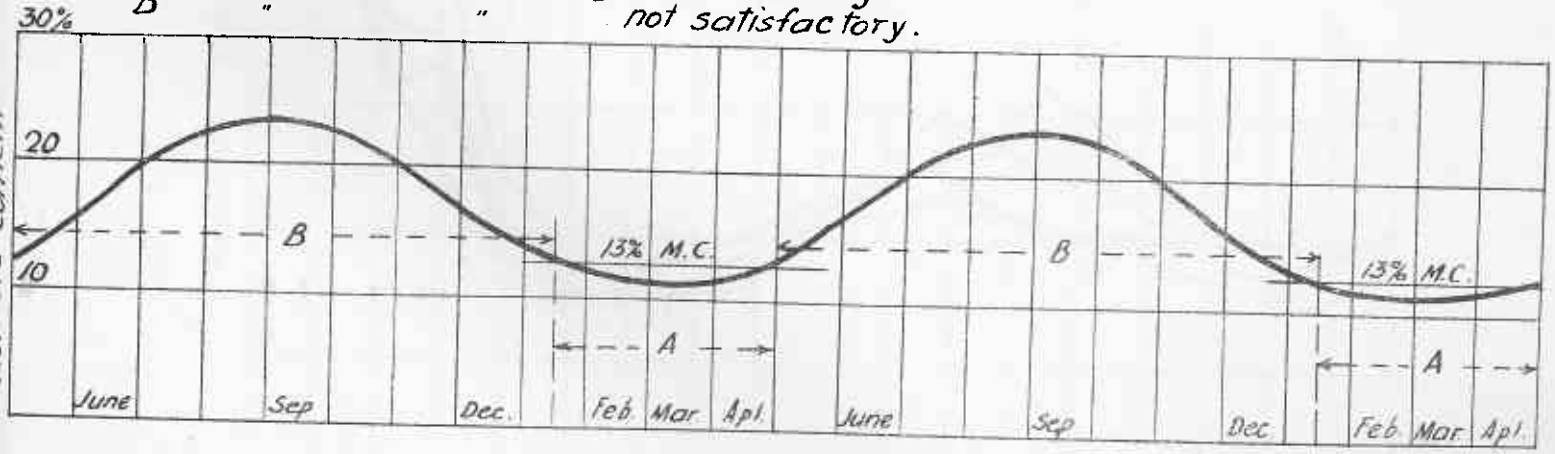
2. Unstacking for seasoned timber is not practicable from May to December inclusive from uncovered stacks.

3. There is nothing to gain by stacking more than 2 summers without covering the stacks.

4. See notes 4 & 5 Fig 1.

"A" Denotes Unstacking satisfactory.

"B" " " not satisfactory.



Seasoning Period

FIG 4.

Poor stacking conditions showing divergency between graphs of individual boards & generally high level.

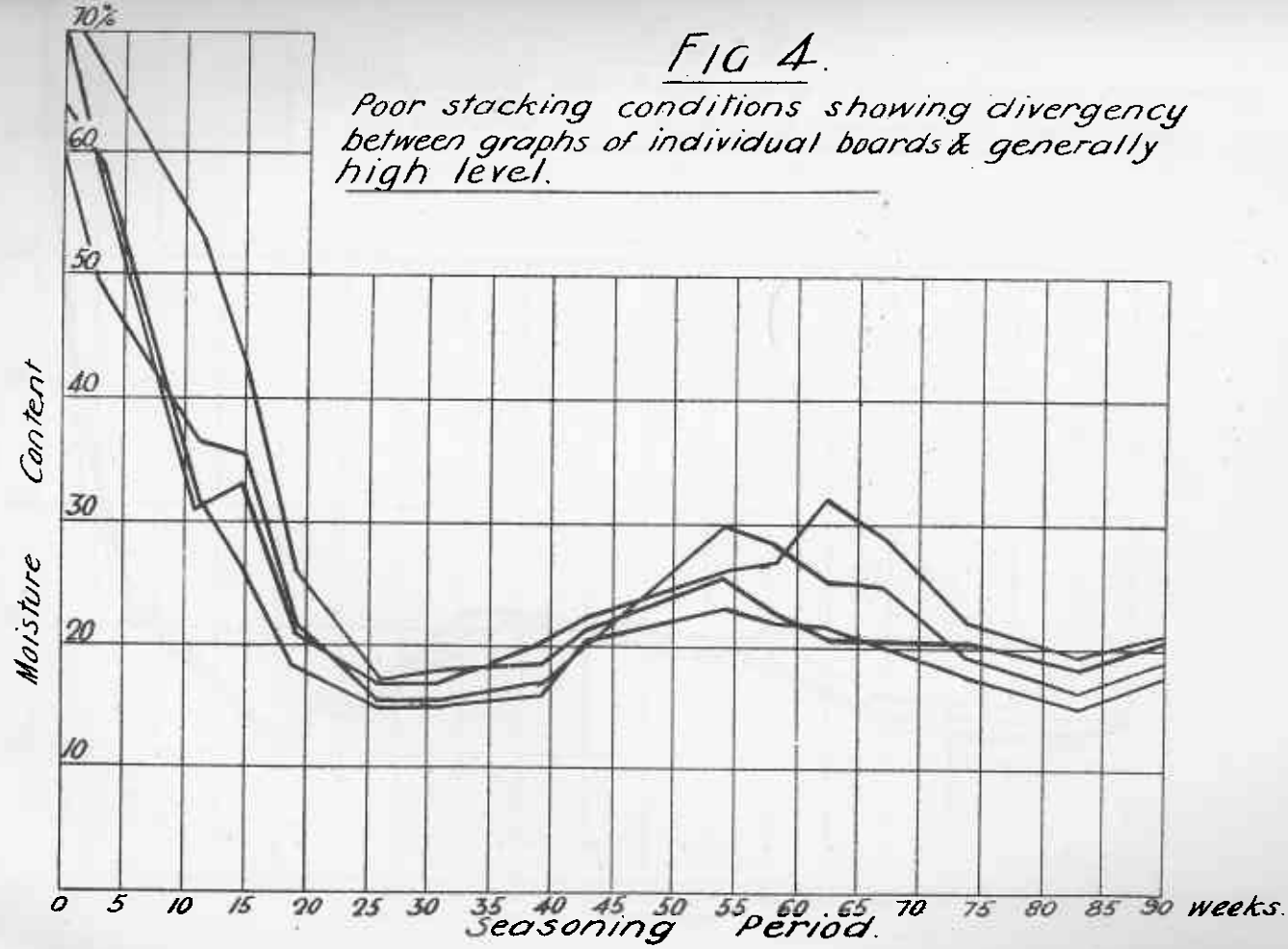


FIG. 5

Improved stacking conditions showing conformity of individual graphs & generally lower level.

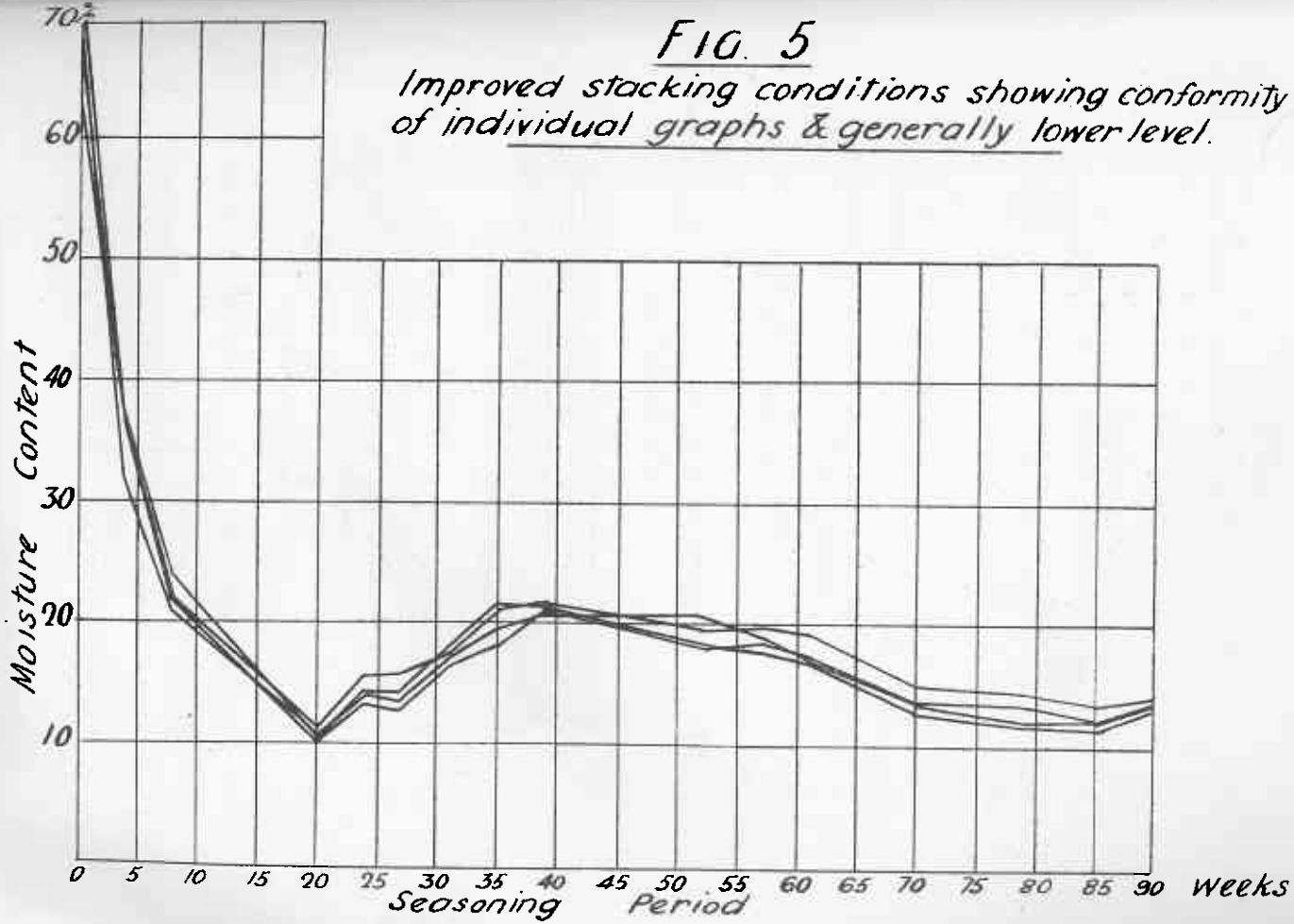
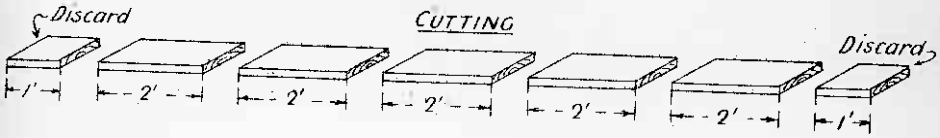
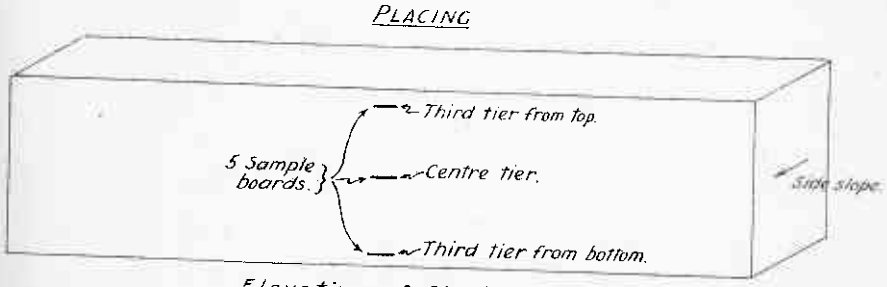


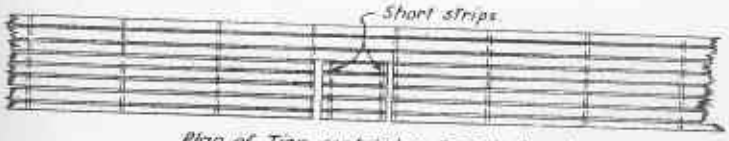
FIG 6.

— SAMPLE BOARDS —





Elevation of Stack



Plan of Tier containing Sample Boards

1. Cut Sections (one at a time)

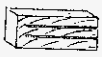
For Moisture Content

2. Weigh green.
3. Dry out.
4. Weigh dry.

Moisture Content = $\frac{\text{Green weight} - \text{Dry weight}}{\text{Dry weight}} \times 100$

For Case hardening

2. Prong.



3. Note behavior directly after

For Moisture Distribution

4. Note behavior 24 hrs. later.