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FORESTS DEPARTMENT.

Western Australia.

AIR SEASONING STUDY.

FIRST REPORT ON THE AIR SEASONING OF ONE-INCH JARRAH FLOORING.

WITH NOTES ON EXISTING PRACTICE IN THE MAIN STACKING YARDS IN THE JARRAH FORESTS OF THE SOUTH-WEST OF WESTERN AUSTRALIA,

AND

RECOMMENDATIONS FOR MORE EFFICIENT AND ECONOMICAL PROCEDURE.

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FIRST REPORT.

AIR SEASONING INVESTIGATION.

1. *Purpose of Investigation.*

Towards the end of the year 1924 it was decided to undertake a comprehensive investigation into the air seasoning of Jarrah flooring stock in this State. Although Jarrah is in every respect an ideal timber for flooring and furniture, its popularity has suffered considerably owing to inefficient and careless methods of air seasoning. Previous work has shown that it is possible to season Jarrah in a kiln so that the movement due to changes in atmospheric conditions is not greater than with other recognised cabinet woods, and the present investigations have shown that much can be accomplished by improved methods of air seasoning. Prior to the undertaking of this investigation, it was considered that certain classes of Jarrah timber, such as flooring, could best be seasoned by combined air seasoning and kiln drying, and it is hoped that among the results of this investigation will be the securing of data required in this connection concerning necessary period and conditions for preliminary air seasoning. In this report the progress of the investigations up to date, and the results indicated at the present stage, are set out.

2. *Extent and Period.*

Two modes of procedure presented themselves. The first method to be considered was the erection of trial stacks in different positions in stacking yards, certain variable conditions being dealt with in each stack, which would be left in position until no more moisture could be evaporated from the boards. But, except for the erection at the State Saw Mills' yard at Carlisle of four test stacks, which were demolished long before the full value of the experiments could be obtained, this method was not undertaken on account of the expense involved, the disorganisation of the yards, and the fact that the desired result could be obtained by a more economical procedure. The second method to be considered was the investigation of stacks actually in existence or being erected, and the examination and comparison of the conditions extant and the methods actually being adopted. It was decided to adopt this latter mode of procedure as the more economical, expeditious, and effective. Preliminary investigations on these lines were commenced at the State Saw Mills' yard at Carlisle in August, 1924. During December, 1924, a field party was formed to undertake a circuit of the chief stacking yards between Perth and Nannup, covering a distance of about 180 miles; and the initial circuit was completed in May, 1925. Thereafter a continual circuit was maintained, sample boards were re-weighed, replacements were effected where sample boards had disappeared owing to the demolition of stacks, and data was collected from stacks being demolished. These circuits will continue until April, 1927. The following factors have received attention during the course of the investigations: the position, condition and layout of the yard, the height, width, spacing, covering and direction of stacks, types and slope of foundations, spacing of boards, width, thickness and spacing of strips.

On making a first visit to a stacking yard, a rough sketch was prepared showing the orientation of the stacks; topographical features of interest

and any information bearing on the factors above-mentioned were noted. Wherever stacks were in course of erection, sample boards were prepared and placed in representative positions throughout the stack. Sample boards were cut also from existing stacks throughout the yard by means of a keyhole saw. Sections for determining the moisture content of the sample boards were in every case cut and weighed, and then forwarded to Perth. When a stack was being demolished, boards were chosen in representative positions throughout the stack, and sections were cut from each to determine by direct test its moisture content.

At subsequent visits to the yards, sample boards are being re-weighed and, by means of the variations of the weights, the rate of drying is calculated. Where short lengths of timber are used as sample boards, the ends are sealed, to prevent excessive end drying.

3. *Seasonal Influence on the Rate of Drying.*

Two outstanding features which have manifested themselves in the course of these investigations are the rapidity with which green boards dry in hot summer weather, and the very quick rate of re-absorption in wet weather. Under normal summer conditions, boards will drop from 70 per cent. of moisture to 15 per cent. to 20 per cent. in from one to two months, whereas boards at 15 per cent. at the end of summer will absorb moisture up to about 25 per cent. in the first few weeks of winter. A graph is submitted showing typical drying during hot weather, and the quick rate of re-absorption in wet weather. The object is to give an indication of general behaviour under average conditions; it will, however, be recognised that the mutation is frequently more marked. Figure 1 shows typical rise and fall in moisture content.

The phenomenon of rapid initial drying in summer must not be misconstrued into indicating that, in a matter of weeks, boards may be considered to be seasoned; the facts are entirely the reverse, and timber which has been stacked for twelve months is certainly not in a seasoned condition, even in those yards where drying conditions are the most satisfactory. There is not, however, sufficient data available as yet regarding two years' old stacks for it to be stated what effect two summers will have upon the condition of the boards. The greater proportion of moisture will evaporate very quickly from Jarrah boards, but it is in the removal of that small amount of moisture essential if the timber is to be brought to a thoroughly seasoned condition that the difficulty lies, and, in order to approach as nearly as is possible under air seasoning conditions to this state, it is essential to pay the greatest attention to the matter of yard layout and stacking methods referred to in this report. It is impossible to estimate the loss due to careless and unscientific methods adopted in many yards, but the harmful effect it has had on the name of Jarrah is unfortunately only too well known.

4. *Position of Yard.*

The yards included in the air seasoning circuit are scattered throughout nearly the whole of the Jarrah milling area, and show a fair range of weather conditions. It has been demonstrated that the rate of drying is slower in the wetter localities than where the yard is situated in a dry, open and sandy position. However, so long as the stack is left to season for a sufficient length of time, the slower drying yards can dry their boards to as low a

moisture percentage as is obtained in the yards where conditions are more conducive to rapid drying. But, as the time of drying is always an important consideration, the choice of a suitable site is an important matter. An open, sandy position is preferable, but the main considerations are good drainage and a free circulation of air.

5. *Foundations of Stacks.*

Before the foundations are placed in position, the site for the yard should be cleared not only of trees, but also of all scrub and vegetation of any kind. Undulations should be removed, but a gentle even slope is advantageous. Finally, the yard should be thoroughly drained. Foundations should be carefully laid, preferably composed of double sleepers, and strips should be placed on top of the sleepers before the stack is commenced. In order to help in the draining of rainwater from stacks, and thus reduce re-absorption, a side slope of ½in. per foot of width is recommended; where possible, the cant should be towards the weather side. The spacing of sleepers at 2ft. 6in. centres, with a maximum of 3ft., is recommended.

6. *Spacing of Stacks.*

It has been found that close spacing of stacks hinders rapid seasoning considerably. This is most marked in the lower portion of the stack, and in boards other than those on the outside. The bad practice of piling timber in between stacks and at their ends, unfortunately very prevalent, greatly accentuates this undesirable effect, or entirely removes the advantage, which would otherwise be gained, where stacks are sufficiently spaced. It is difficult to see what advantage may be expected from spacing stacks at all, if the intervals are to be filled with green timber, piles of strips or rubbish generally, all of which tend to create moist stagnant air, instead of allowing free circulation. It is suggested that, at the very least, 3 feet should be left between stacks, and preferably 4 feet, and that, under no circumstances, should anything be piled or thrown in the intervening spaces.

7. *Unstacking.*

The question of unstacking is intimately connected with the above remarks on the seasonal influence on the rate of drying (Section 3), and the advantage to be gained by demolishing stacks at the end of summer is apparent. From what has been written regarding winter re-absorption, it can readily be seen that, under present conditions, boards sold in winter do not even remotely approach a seasoned condition. No one would think of using timber stacked for only one month in summer, although this would be as dry as, if not dryer than, two years' old material unstacked during the winter from uncovered stacks. Unstacking should be carried out as much as possible during the summer.

8. *Covering of Stacks.*

The unsatisfactory state of affairs due to winter re-absorption can be materially improved by means of efficient covering of stacks. By inspection of graph No. 4, it will be noticed that the top portion of the stack, although having dried in summer down to a lower moisture percentage than the bottom, has nevertheless increased during winter to a higher moisture content than

the latter. This is obviously due to the direct effect of rain, which does not affect the lower as much as the higher parts of the stack; the advantageous consequences of covering which would eventuate in this case can readily be appreciated. The reduction in re-absorption varies with the improvement in the covering, and it may be mentioned that timber completely seasoned (12 per cent.) will, under ideal covering conditions, re-absorb at the most only up to the summer moisture percentage of boards air seasoned under present conditions (14 per cent. to 16 per cent.). Furthermore, covering would be of great advantage in preventing undue degrade in the top layers of the stack, owing to severe summer conditions.

Covering should not be an expensive item, as low-grade timber could be used for this purpose, although it is suggested that it would be worth the expense even if it were necessary to use first class material. There should be a considerable overhang at sides and ends, both to prevent rain dripping on to the stack, and as a protection against the direct rays of the sun; and the roof should be sloped to enable the water to run off instead of dripping through into the stack. Experiments have been carried out in order to find out whether rain falling on boards in transit in open trucks would counteract the beneficial effect of the covering. It has been found that even heavy incessant rain during transit would not seriously detract from the advantageous effect of covering stacks, as such boards are usually placed under cover on arrival, and then put through a planer, which would largely remove the layer which had been wetted by exposure during transit. Nevertheless, timber merchants, contractors and builders might do much to reduce ill effects due to seasoned timber used in construction, particularly flooring, being exposed to wet weather conditions.

The adoption of a covering for stacks is recommended, with an overhang at sides and ends.

9. *Position of the Board in the Stack.*

Considerable attention has been given to the procuring of data relative to the effect on the rate of drying of the position of the board in the stack. In the first place, taking the stack as a whole, the lower the board is in the stack, the more slowly will it dry, apart from the abnormal results due to rain (Figs. 3 and 4). Then, taking the position of the board in the tier, corner boards dry the quickest of all, followed by the boards on the side, whilst the slowest drying is found in the middle (Fig. 2). The effect of position may be such that, while boards on the outside of the higher portion of the stack may be as dry as possible under ordinary air seasoning conditions, those in the bottom part of the stack and in the middle may not even approach a seasoned condition, and be absolutely unfit for sale (Fig. 5). This variation, however, becomes almost negligible in yards adopting the best stacking methods. Attention to the important matters of procuring optimum stacking conditions is unfortunately conspicuous by its absence in most of the stacking yards in the State, with the result that so-called air seasoned Jarrah flooring is seldom at that moisture percentage which would be expected under satisfactory conditions.

Attention to the improvement of stacking conditions is essential in order to increase the drying rate of boards in the lower and middle portions of the stack.

10. *Spacing of Boards.*

Boards are sometimes stacked edge to edge and sometimes a small space is left between each board. The latter practice would appear to be the most advantageous, particularly in helping to reduce the discrepancy between the drying rates of inside and outside boards. Care should be taken that each space is immediately above the one below, thus making a straight vertical chimney for the unrestricted passage of air. The staggering of boards is not recommended, as it prevents this desirable effect.

Boards should be piled open-spaced, creating straight, vertical chimneys throughout the stack.

11. *Thickness of Strips.*

The important subject of stripping has received considerable attention, and observations have been carried out on stacks with strips varying in thickness from 1in. down to ⅜in. The advantage of thick strips appears to be very doubtful, and they would probably be inclined to cause case-hardening, although some benefit may be obtained by using them when stacking in winter. Strips ½in. thick appear to give better results than ⅜in. at any time. By employing this thickness, free circulation throughout the stack seems to be obtained, and undue severity of conditions in hot weather is avoided.

Strips ½in. thick are recommended for general practice.

12. *Width of Strips.*

Strips 1½in. wide are recommended.

13. *Spacing of Strips.*

The wide spacing of strips should be avoided, as it causes undue degrade due to warping. It might pay to space at 2ft. centres, but this could be determined only by grading through the planer.

It is recommended that strips be spaced at 2ft. 6in. centres, with a maximum of 3ft.

14. *General Stacking Conditions.*

From what has been written above, the importance of paying the greatest attention to general stacking conditions will be evident. The worst and least excusable condition is that of untidiness and uncleanliness; some of the stacking yards would appear to be regarded as storage places rather than machines for the production of seasoned timber. The yard should be well-drained and no stagnant or running water allowed beneath the stacks. Foundations should be carefully laid, preferably composed of double sleepers, and strips should be placed on top of the sleepers before stacking is commenced. The benefit in reducing degrade of timber by maintaining a straight vertical line of strips will amply repay the small amount of extra labour entailed in obtaining this result.

It is strongly recommended that each end of the stack should present a straight and even face, boards being laid from each end. An inspection of a stack where boards are allowed to project beyond the last strip will show how much loss is entailed by this practice. Moreover, it will be found just as quick to stack the one way as the other. The practice of docking

from boards before stacking, ends suffering from such defects as warping, gum, bad splitting, etc., is commended, and should prove to be a profitable procedure.

15. *Testing of Stacks.*

To those who have studied this report, it will be evident that, if sawmillers are to improve their methods of seasoning, it is essential that they should be in a position to know the condition of their timber. It would seem almost unnecessary to point out the absurdity of attempting to decide whether a board is seasoned or not by weighing it in the hand; but the fact that the opinion that this is possible is held shows the need for the following information.

Whereas the average oven dry weight of Jarrah is 48 lbs. per cubic foot, specimens have been recorded with an oven dry weight as low as 38 lbs. and as high as 57 lbs. per cubic foot. In other words, two boards of exactly the same size may be taken, both at exactly the same moisture content, and one may weigh as much as 50 per cent. more than the other; or two pieces of timber of precisely the same dimensions may weigh exactly the same amount and yet one piece may be green and the other seasoned. Consequently, the mere weighing of timber, whether in the balance or by hand, cannot possibly give any indication as to its state of dryness.

Furthermore, the opinion is held that it is possible to tell the condition of timber as it goes through the planing machine, but, since the hardness of wood alters with its density, the figures given above will serve to show how misleading any indications of this nature are bound to be. Moreover, the planer only touches the extreme outer layers of the wood, which are always fairly dry, and it is not affected in the slightest by the greater portion of the board, wherein lies nearly all the difference between one that is seasoned and one that is totally unfit for higher grade use. But, as explained above, it is impossible to determine if the outer layer even is seasoned, by judging its comparative density. It is, therefore, of the utmost importance that at every stacking yard there should be some method of determining the moisture content of timber.

For the purpose of seasoning, wood can be considered to be composed of two materials, wood fibre and water; seasoning consists of the removal of a certain quantity of the latter. For any given piece of timber, the dry wood fibre is a constant quantity, and is, therefore, taken as a basis for calculation, and the moisture present is stated as a percentage of this constant:—

e.g., Weight of a piece of timber, green .. .. 180 ozs.
Weight of piece of timber, oven dry .. .. .. 120 ozs.
Quantity of moisture present in green state .. .. 60 ozs.
Moisture content stated as a percentage of oven dry weight $\frac{60}{120} \times 100 = 50$ per cent.

In order to obtain the moisture content of a board, a section about ½in. thick is cut at least 18in. from each end, weighed, and then oven dried at a temperature of 212deg.-240deg. F. (higher temperatures would produce charring) for about forty-eight hours, or until it no longer continues to

lose weight, and is consequently completely dry. It is then re-weighed and the difference between the two weights of the section expressed as a percentage of its dry weight will give its moisture percentage. The average of the two sections is considered to be the moisture percentage of the board itself.

The method which should be adopted is to place sample boards, the moisture content of which has been determined, in representative positions in a stack as it is being erected, remembering that, as the middle of the stack dries the slowest, sample boards should not be confined to the outside of the stack. The ends of these sample boards should be painted with, or dipped in, a material such as molten paraffin wax, to prevent end drying and consequent inaccurate results. These sample boards should be weighed immediately after dipping, and the theoretical dry weight calculated:—

e.g., Weight of sample board .. .. 17 lbs.
Moisture percentage (from sections) .. .. .. 70 per cent.
Wood fibre + Water .. .. 170 per cent.

170 per cent. = 17 lbs.

$$100 \text{ per cent.} = \frac{17}{170} \times 100 = 10 \text{ lbs.}$$

Weight of wood fibre, or theoretical dry weight of board .. .. 10 lbs.

Subsequent re-weighings of the sample boards will give, by a simple calculation, their moisture percentages at any given time. Taking the example given above, if the sample board weighed at a future date 14.7 lbs., its moisture content would be found as follows:—

Weight of board at date .. .. 14.7 lbs.
Theoretical dry weight .. .. 10.0 lbs.
Weight of moisture .. .. 4.7 lbs.

$$\text{Moisture percentage } \frac{4.7}{10} \times 100 = 47 \text{ per cent.}$$

Valuable information can be obtained during the demolition of stacks. Boards should be selected from representative positions throughout the stack, and their moisture content determined by means of sections cut as explained above. This information would be of particular value where sample boards had not been placed in the stack. The variation in dryness throughout the stack can be discovered, and methods adopted to reduce this in the future, if excessive; and, if the boards are found to be insufficiently seasoned, they may be stacked for a period after planing, and the otherwise unsatisfactory behaviour of the timber considerably ameliorated.

The following apparatus would be required: a balance weighing from 0.1 up to 100 grammes, one weighing from ½ oz. up to 15 lbs., a small oven for drying sections, a saw, and a supply of paraffin wax or other material for painting the ends of sample boards.

Detailed information regarding this equipment will be supplied by this Department, and any information relative to the carrying out of these tests will be provided and explained.

SUMMARY OF RECOMMENDATIONS.

Spacing of stacks—4ft. edge to edge. Minimum 3ft.

Spacing of strips—2ft. 6in. centres. Maximum 3ft.

Thickness of strips—½in.

Width of strips—1½in.

Boards open spaced, with openings vertically above one another.

Foundations: Double sleepers, with cant towards weather side of ½in. per foot.

Efficient covering of stacks.

Vertical line of strips, directly over foundations.

Efficient yard drainage.

Absolute cleanliness of yard.

Spaces between stacks unobstructed.

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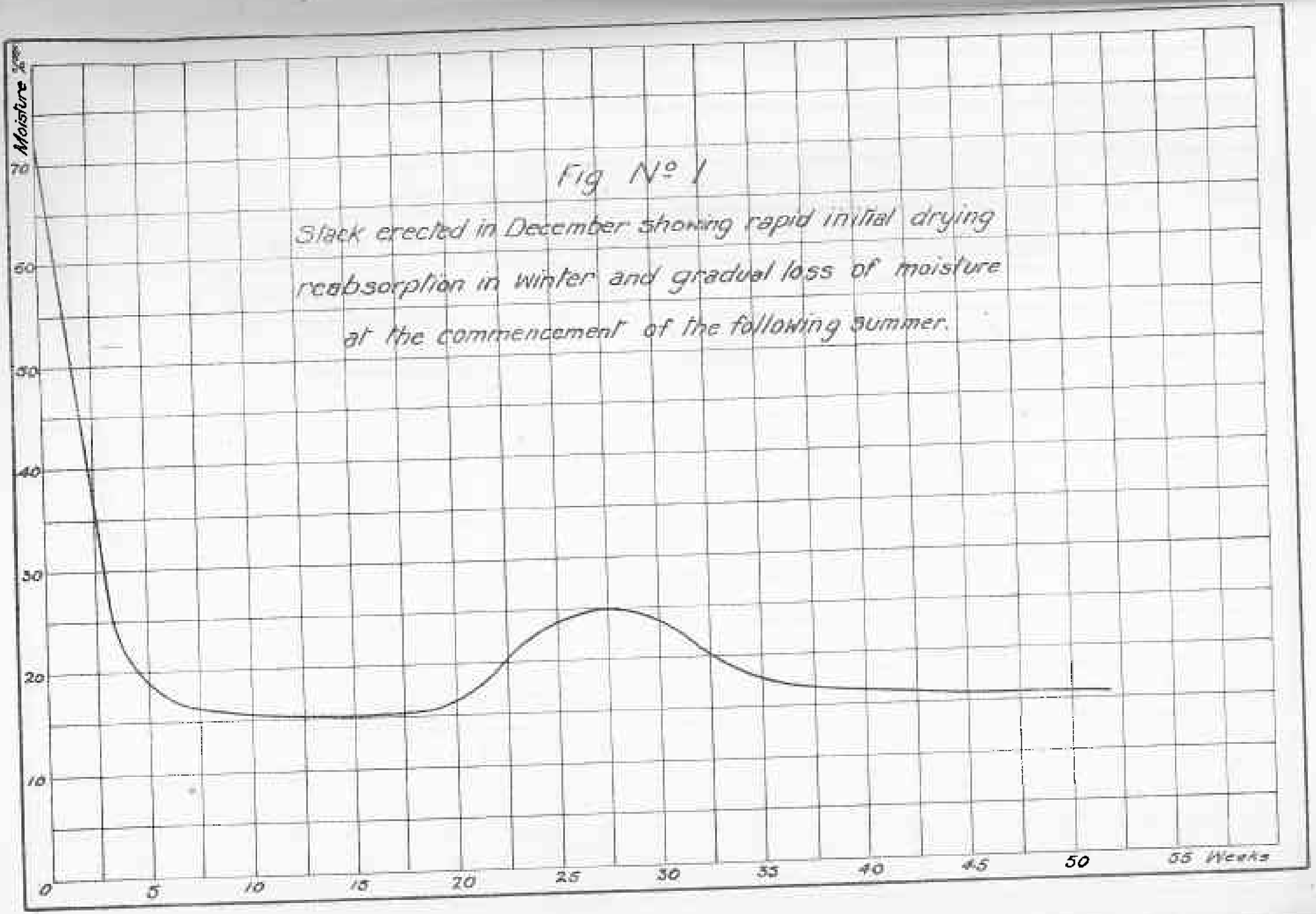
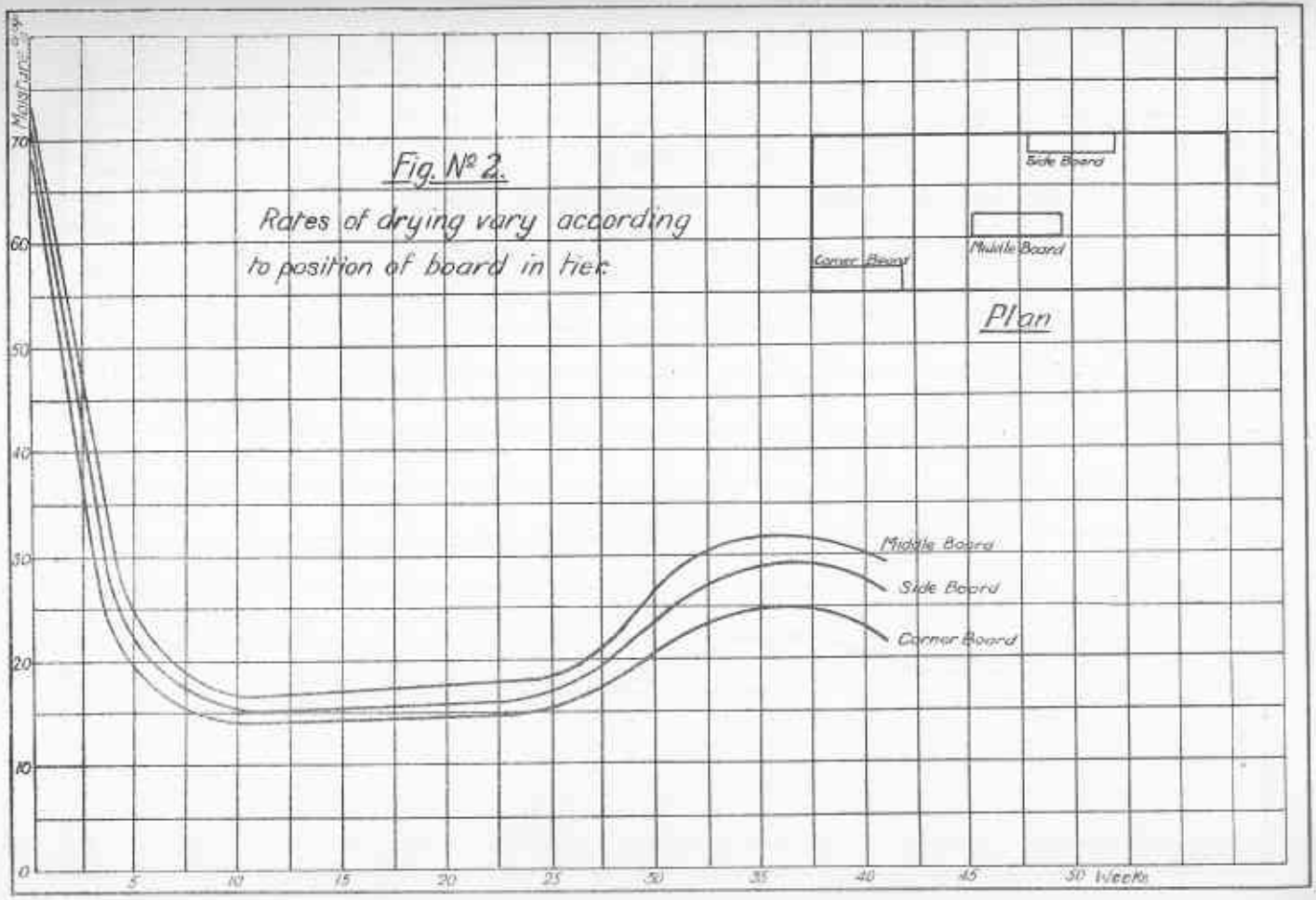


Fig Nº 1

Stack erected in December showing rapid initial drying reabsorption in winter and gradual loss of moisture at the commencement of the following summer.


Moisture %
70
60
50
40
30
20
10
0
5
10
15
20
25
30
35
40
45
50 Weeks
Fig. Nº 2.
Rates of drying vary according to position of board in tier.
Side Board
Middle Board
Corner Board
Plan
Middle Board
Side Board
Corner Board

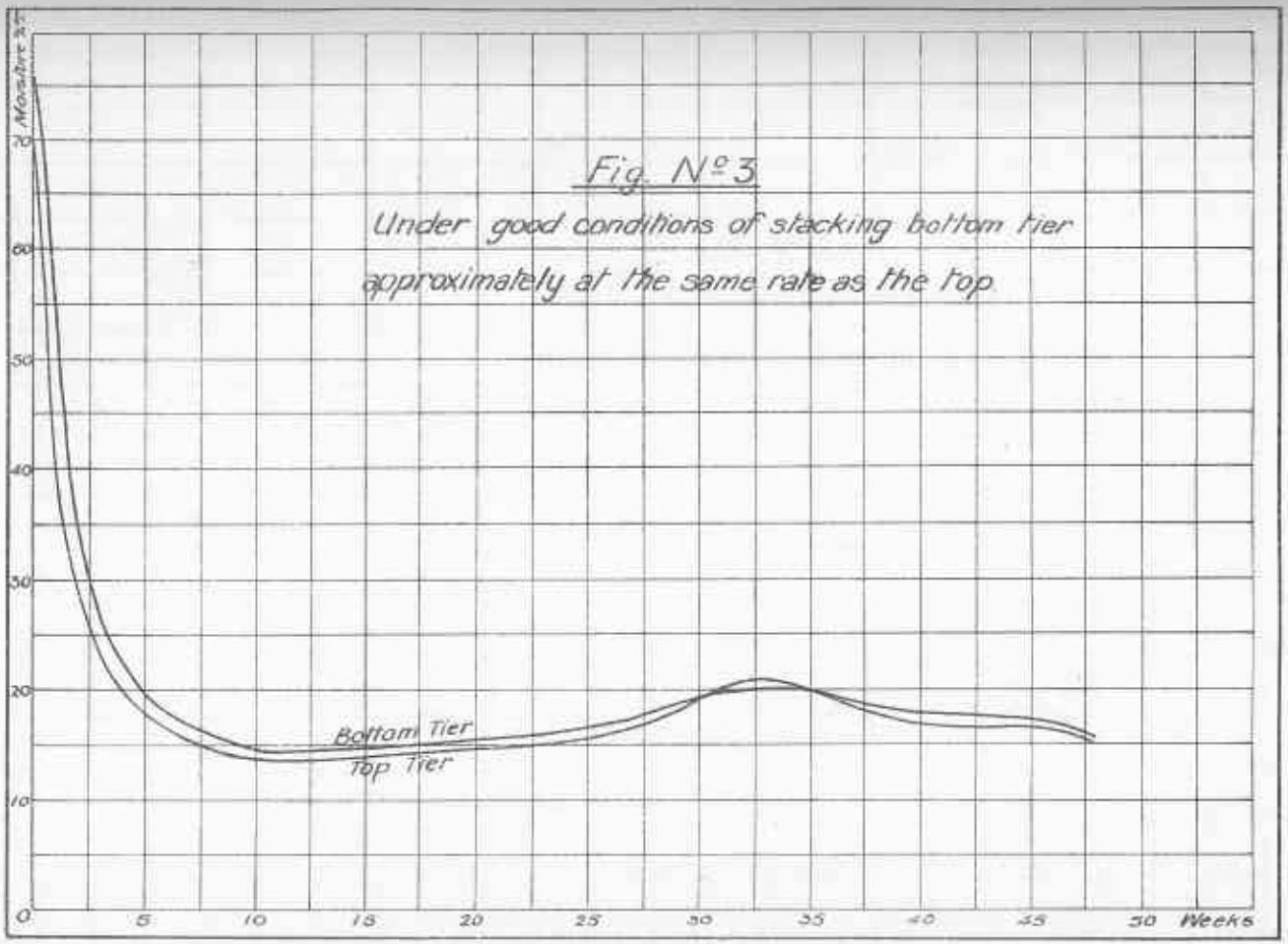


Fig. Nº 3

Under good conditions of stacking bottom tier approximately at the same rate as the top

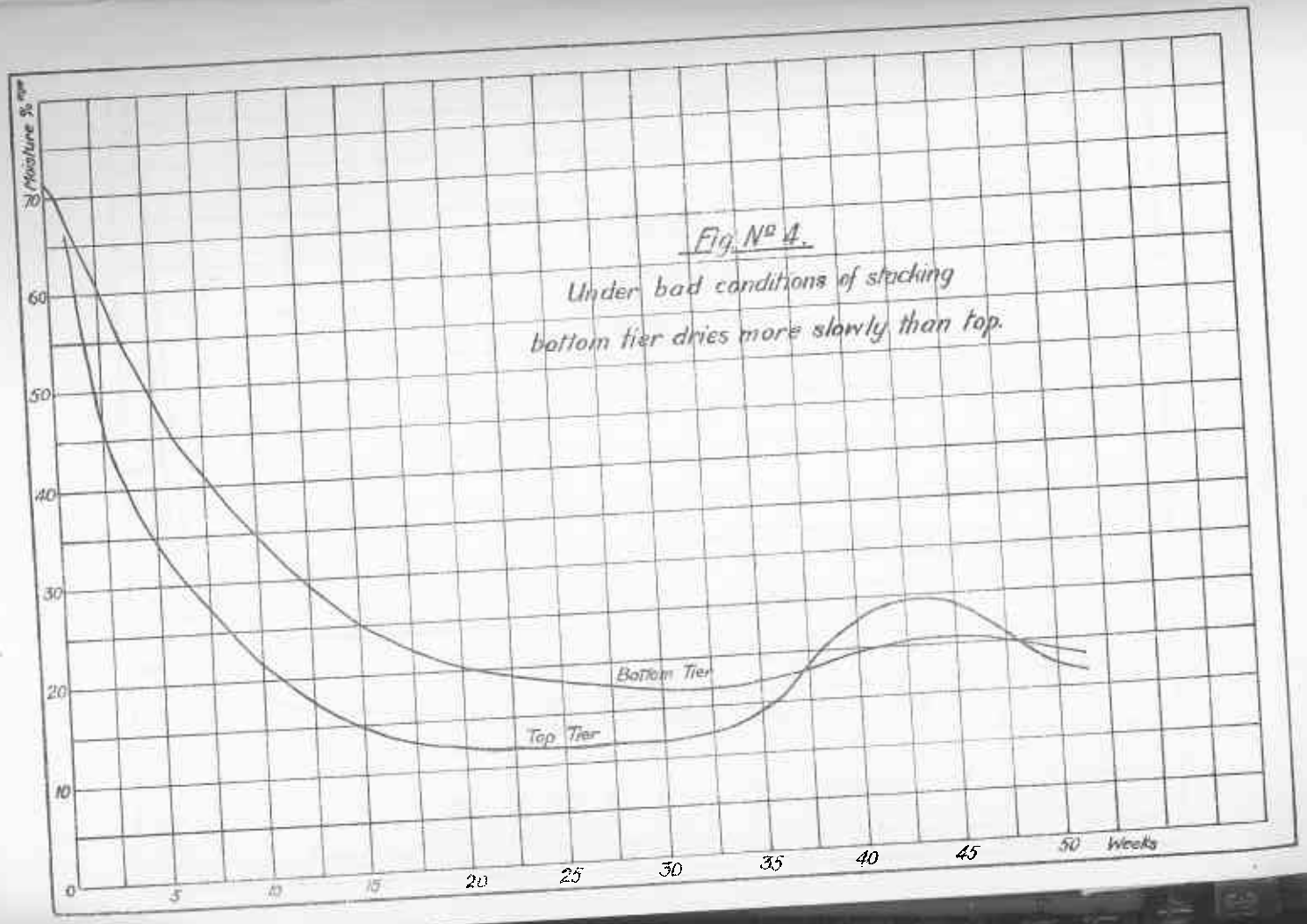
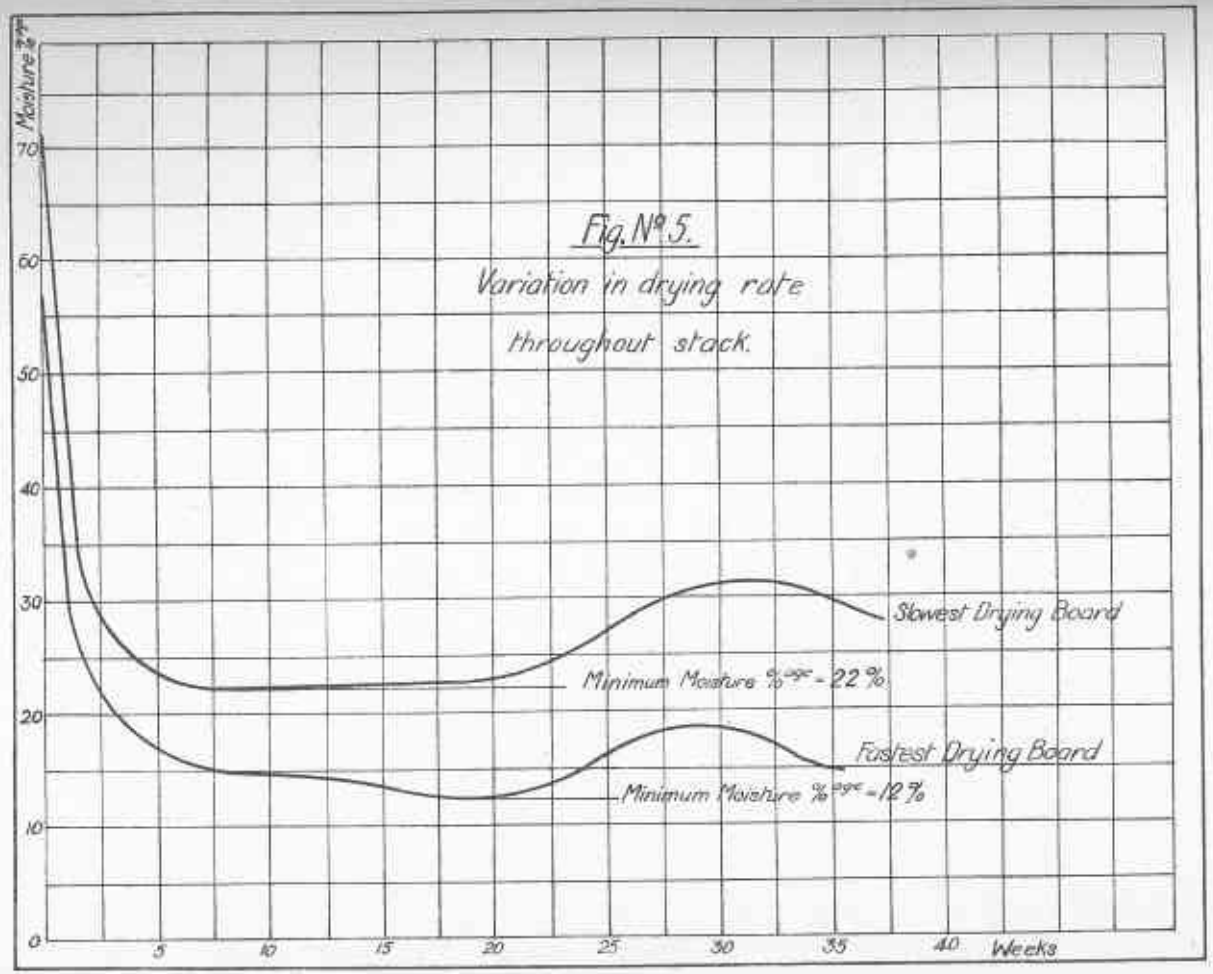


Fig. No 4.

Under bad conditions of stacking bottom tier dries more slowly than top.


Moisture %
70
60
50
40
30
20
10
0
5
10
15
20
25
30
35
40
Weeks
Fig. Nº 5.
Variation in drying rate
throughout stack.
Slowest Drying Board
Minimum Moisture % dsc - 22 %
Fastest Drying Board
Minimum Moisture % dsc - 12 %