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THE INFLUENCE OF THE SIZE AND DESIGN OF NAILS ON THEIR EFFICIENCY WITH RESPECT TO DRIVING AND PULLING FROM VARIOUS SPECIES OF WOOD

BY

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THE INFLUENCE OF THE SIZE AND DESIGN OF NAILS ON THEIR EFFICIENCY WITH RESPECT TO DRIVING AND PULLING FROM VARIOUS SPECIES OF WOOD

Summary

This thesis gives the results of a study of the influence of the size and design of nails on their efficiency with respect to driving and pulling from various species of wood. The study was made at the Forest Products Laboratory of the United States Forest Service in cooperation with the American Steel and Wire Company, primarily to compare two types of nails, a common nail with plain head and regular point, and a special nail with a larger checkered head and a longer "diamond" point.

The results indicate in a general way that the blunter point is the more efficient from the standpoint of ease of driving and low splitting tendency. The influence of the type of point on the wood in driving has a marked effect on their relative holding power. The regular-pointed nail requires slightly greater work to pull immediately after driving. Subsequent soaking of the wood specimens containing the nails, however, results in a slightly greater resistance to withdrawal of the

diamond-pointed nails. The regular-pointed nails require slightly more total work to withdraw while the diamond-pointed nails require a higher maximum load to start withdrawal. In general, the data indicate a slight superiority of the regular-pointed nail, particularly from the standpoint of splitting.

Very little difference was found between the plain and checkered heads in amount of slippage of the hammer in driving, and resultant bending of the nails.

This thesis covers only a small part of the general study of nail design. The whole problem of determining the design of a nail which will do the least damage in splitting, and have the necessary holding power, is one involving a great many factors of extreme importance whose influence is not very well known. A broad study of these factors and their relation to different uses, covering all the important commercial species would undoubtedly lead to greater economy and efficiency in various fields of construction, particularly the wooden container industry.

Purpose

The purpose of this study was primarily to determine the influence of the size and design of

nails on their efficiency with respect to driving, pulling, and freedom from splitting when driven into various species of wood.

Laboratory tests were made under this study in which nails with regular heads and points were compared with nails with a larger checkered head and a longer "diamond" point to determine the relative resistance of the two types to being driven into and pulled from various species. Some tests were made to determine the relative tendency of these two types of nails to split a board when driven into it. Hand-driving tests were also made for the purpose of determining the relative tendency of the plain and checkered nail heads to permit slippage of the hammer and consequent bending of the nails. A comparison was also made of common and barbed nails in one size of nail and one species only.

A few incidental tests were made on boxes to determine the effect of varying the size of nail on the type of failure.

Description of Material

The lumber used for the main series of tests consisted of both green and dry Douglas fir (shipment No. 729), and yellow birch and white pine (shipments Nos. 833 and 845). Sufficient dry mate-

rial was obtained by kiln drying a portion of each species. The material was cut to the desired length and cross section to accommodate the various sizes of nails. Red fir (Abies magnifica), and yellow birch taken from dry stock in the yard were used for the hand-driving tests. The following table shows the approximate dimensions of sticks used in the tests to determine the work absorbed in driving and pulling various sizes of nails:

Nail Size	Cross Section of Stick Inches
4d	2 x 3
6d	2 x 3
8d	3 x 3
10d	3 x 3
20d	3½ x 5
60d	4 x 5

The specimens used to make the nail-splitting tests were sawed from stock on hand at the laboratory.

The nails used in the tests were the common brand with plain or regular head and point, and the common brand with checkered head and long diamond point (see Fig. 17) hereafter referred to as the regular and diamond-pointed nails, respectively. The two types of nails of each gauge were made from the same bundle of wire, thus giving a uniform quality and gauge of wire in the two types of nails. The wire from which the nails were manufactured was all

from the same heat (2962 Car N & SS 768) of selected standard Bessemer steel. Fig. 17 is a photograph of the two principal types of nails in the various gauges tested, and, in addition, an 8d barbed nail.

Marking and Matching

Each stick into which nails were driven was given a series number, lot number, and stick number in the order named. The series number indicates the species and condition (whether green or dry); the lot number refers to the size of nail (4d, 6d, 8d, etc.), and the stick number indicates the treatment to which one-half of the stick was subjected after the nails were driven. Immediately after driving, the nails were pulled from one-half of each stick. The other half of the stick containing the remainder of the nails was then subjected to one of the three conditioning treatments indicated in the last column of the following schedule:

Series No.	Lot No.	Stick No.
1 - (Dry Douglas fir)	1 - (4d)	1 -(soak 1/2 before pulling)
2 - (Green Douglas fir)	2 - (6d)	2 -(dry 1/2 before pulling)
3 - (Dry yellow birch)	3 - (8d)	3 -(soak and dry 1/2 before pulling
4 - (Green yellow birch)	4 - (10d)	
5 - (Dry white pine)	5 - (20d)	
6 - (Green white pine)	6 - (40d)	(not used)
	7 - (60d)	

For example, a stick of green yellow birch (series 4) into which were driven 20d nails (lot 5), and one-half of which was subsequently soaked and then dried before the nails were pulled, would be assigned the stick number 4-5-3.

In order to eliminate as far as possible the influence of variability in material the two types of nails being compared were driven alternately in two rows along the stick as shown in Fig. 18. The nails in the two rows were staggered so as to allow a maximum distance between them.

Description of Pendulum Machine

A machine utilizing the principle of the pendulum and of the type shown in Fig. 18 was used to determine the work in driving and pulling the nails. This machine was previously used for determining the toughness of plywood and was modified to adapt it to this study. The machine as modified consists of a frame built of structural steel channels. From the center of the two horizontal channels (A) is suspended a pendulum whose axis rotates on ball bearings. Concentric with the center of rotation of the pendulum is an 8-inch pulley or drum (B), and to this is attached the pendulum bar which carries the hammer (C) and the weight (D). The position

of the weight on the pendulum bar is adjustable. One edge of the periphery of the drum is graduated into degrees of arc. The angle for any position of the pendulum is read from a vernier attached to the axis by means of a friction spring having the same radius as the graduated circle on the pulley. The indicator on the vernier scale can be adjusted so that it points to zero when the pendulum hangs free in the vertical position. The vernier reads to the nearest 0.1 degree. In both driving and pulling, the pendulum is engaged by a spring release at the angle from which it is desired to drive or pull. When in this position the vernier (O), Fig. 19, is shoved back against the stop (P), Fig. 19, and the angle which the pendulum makes with the original or vertical position may be read.

The driving of the nails is accomplished by means of the hammer head (C) slotted to fit the pendulum bar. The stick into which the nails are to be driven is placed on the carriage (F) which is attached to the heavy cast iron block or anvil (G) which serves to absorb the shock. The stick is held securely in place by means of two eccentric wooden clamps (H) bolted to the carriage. The position of the anvil is adjustable by means of the hand wheel and screw (I).

The machine set up for pulling nails is shown in Fig. 19. The pulling of the nails was effected by means of the wire cable (M), one end of which is attached to the pulley and the other end to a grip which fits over the head of the nail to be pulled. These grips vary in size according to the size of nail and are somewhat similar in shape to a clevice but much smaller. The grip is slotted to slip over the shank of the nail, the end of the slot being countersunk on the inside of the grip to give a seated bearing for the nail head. Two 5/8-inch steel pins (N) threaded at one end, and screwed into the casting (O), which can be moved back and forth similar to the casting (G), Fig. 18, serve as a bearing for the stick while the nails are being pulled. When the pendulum is released in pulling, the vernier remains against the stop at the zero position until the pendulum reaches its maximum swing. When the pendulum reaches the end of its swing after pulling a nail, and starts back,the vernier is carried back with the pulley by means of the friction spring attaching it to the axis. The pendulum is stopped from rotating and the reading of the graduated circle on the pulley opposite the indicator on the vernier is taken. This reading is the maximum angle to which the pendulum rises, and when the pendulum is swinging

free without doing work, would be equal to the angle from which released, providing no friction were present. When a nail is pulled, a certain amount of work is done which is measured by the difference of the versed sines of the two angles after allowing for friction. The initial angle from which the pendulum is dropped can be varied by changing the position of the spring release on the large arc (E), Fig. 18.

Method of Test

Work in Driving Nails

The work or energy absorbed in driving nails was determined by means of the pendulum machine set up as shown in Fig. 18.

In order to get the nails started straight with the first blow, nail holders, varying in length, height, and thickness, according to the size of nail being driven, and of the type shown at (J), Fig. 18, were used. The nails, when placed in the notches of the nail holder and in position for driving, are in a horizontal position with the nail points in contact with the stick into which they are to be driven (see Fig. 18). The nail to be driven is placed in line with the travel of the pendulum hammer, and at such a height that the hammer will strike the nail squarely on the head. The hammer, of course, is also adjust-

able for height so as to hit the nail squarely. The nail holder and the stick into which the nails are being driven were held tightly against the cast iron anvil by the two eccentric wooden clamps (H), Fig. 18. The anvil can be moved forward or backward to any desired position so that for each blow, or in the case of the larger nails, for every two or three blows, the nail can be placed so the hammer hits the head squarely. If the anvil is too far forward, toward the left in Fig. 18, the hammer hits the upper edge of the nail head,and if too far back, or to the right in Fig. 18, it hits the lower edge of the nail head. In either case, the nail is apt to bend before being driven to the required depth. The number of nails which the holder accommodates at one time, and the spacing of nails varied according to the size of nail being driven.

The different types of nails being compared were driven alternately in a straight row along one edge of the stick (see Fig. 18). The stick was then reversed end for end with the same face forward, and a second row of nails driven in the same way. The nails in the two rows were staggered as shown in Fig. 18. Thus far, the nails have received but one blow. At this point, the nail holder was removed, and a short spacer of the same width as the nail holder

placed between each clamp and the stick to hold the stick tightly against the anvil during the remainder of the driving. The number of blows given at one setting of the anvil varied from one to three, or perhaps four, depending upon the penetration at each blow. At any rate, as soon as the nail was driven deep enough so that the hammer no longer struck the nail head squarely, the anvil and carriage were moved forward by means of the hand wheel (I), Fig. 18. The total number of blows given each nail was recorded, together with other pertinent data such as weight of pendulum, and the angle from which pendulum hammer was dropped.

With the exception of a few sticks of series 1 and 2, nails were driven according to two general plans. One of these plans provided that each nail of a lot be given an equal number of normal blows (approximately the number required by a carpenter to drive nails to the same depth) the actual penetration being determined. According to the other plan, all nails of a given lot were driven a definite depth by means of a larger number of light blows, a record of the number of blows required to drive them to this depth being taken. Where the two plans were followed, one-half the number of each type of nail were driven according to each plan. The difference between the number of blows used in the two plans is clearly

indicated in tables 1 to 6, columns 9 and 18.

The penetration of the nails driven according to the first plan was measured by means of a vernier caliper reading to 0.01 inch. This gave the length of nail extending above the stick, which was subtracted from the overall length of nail to give the actual penetration. The nails driven according to the second plan were marked at the depth to which it was desired to have them driven.

All measurements of length of nail or depth of penetration were made to include the full length of the nail point. In order to eliminate the effect of length of nail point in determining unit work values for both the regular and diamond-pointed nails, the depth of penetration for both types was reduced to equivalent volumes by subtracting from the penetration of each, two-thirds the length of the nail point. The average lengths of the nail points for the various sizes of nails of both types are given in column 5 of tables 1 to 8.

Work in Pulling Nails

The pulling of the nails was accomplished by means of the same machine with some slight changes as shown in Fig. 19. The anvil and apparatus for holding the sticks in driving the nails was drawn back so that

it cleared the pendulum during the pulling of the nails. The stick containing the nails to be pulled was then placed on a table against the two steel pins marked (N) in Fig. 19. The position of the casting holding the pins can be changed to suit the length of cable desired. In all pulling tests the casting and pins were so adjusted that the cable became taut when the pendulum was about 15° to the left of the vertical position. The angle of drop of the pendulum was such as to pull the nail with a single swing of the pendulum. The rise of the pendulum after pulling the nail was read by means of the vernier which travels back with the pendulum upon reaching its maximum swing. The position and size of the weight on the pendulum bar is governed by the size of the nail and the species from which the nail is pulled. Different sizes of grips were attached to the end of cable for the different sizes of nails.

Friction

The difference in reading between the initial angle, or angle of drop of the pendulum, and the angle to which the pendulum rises when swinging free, is due to friction in the bearings. This was found to average about 0.5° when the drop was from a 90° angle. This much friction amounts to less than one-half of 1 per cent in most cases. For a given stick,

all nails were pulled from the same angle, the friction factor being constant for both types of nails. For these reasons the friction was neglected in computing the work in driving and pulling.

Static Pulling Tests

The static pulling tests were those made on a 10,000-pound capacity Tinius Olsen universal testing machine to determine the maximum load of withdrawal.

Hand-driving Tests

Hand-driving tests were made in which two carpenters each drove one thousand 10d nails of the regular-head and common-point type, and a similar number of the checkered-head and diamond-point type of the same size. These were driven in groups of 200 and 300, alternating between the regular-head and point, and the checkered-head and diamond-point. Each carpenter started with a different quantity and type of nail so that they could keep no check on each other as to the speed of driving. This was to eliminate any tendency to race. The carpenters stood at an ordinary work bench and drove the nails into 3-inch planks of red fir (Abies magnifica).

Vibration Tests

Vibration tests were made on style 2 boxes built with 2-piece sides, tops, and bottoms of 3/8-inch western yellow pine and 13/16-inch ends and cleats. These boxes were nailed with six nails to a nailing edge, the sizes being 6d, 8d, and 10d nails ground to the same length, and pointed. The boxes were tested on a vibration machine (see Fig. 23) consisting of a platform which was subjected to a horizontal throw of 13/16-inch at the rate of 200 vibrations per minute. During the tests a weight of 650 pounds was placed on top of the box. The boxes were held from sliding endwise on the platform during the test by means of angle irons attached to the table.

Splitting Tests

The relative splitting tendency of the regular and diamond-pointed nails when driven into small blocks 3/4 by 2 inches in cross section, and of varying lengths, was determined as follows: Dry Douglas fir and yellow birch was used, and the nail sizes were 3d, 4d, 6d, 8d, 10d, and 20d for the Douglas fir and 4d, 6d, 8d, and 10d for the birch. The nails were driven through the center of the block and if the block did not split a block 1/4 inch shorter was used. This process was repeated until

a length of block was obtained which was split by the nail. The test for this length of block was then repeated as a check. All blocks for one size nail were taken from the same board.

Computations

The total work in driving the nails was computed by means of the formula $W = wL\theta$ where W is the total work, w the weight of the pendulum, L the distance of center of gravity of pendulum and weight below axis, and θ the versed sine of the angle of drop. $\frac{W}{\text{depth of penetration}}$ is then the work per inch penetration.

The total work in pulling the nails was computed by means of the formula $W = wL(\theta_1 - \theta_2)$ where θ_1 is the versed sine of the angle of drop and θ_2 the versed sine of the angle of rise or final angle. The unit work was obtained by dividing this result by the depth of penetration.

Explanation of Tables, Charts, and Photographs

In tables 1 to 6 are given the results of tests to determine work in driving regular and diamond-pointed nails into green and dry Douglas fir, yellow birch, and white pine. Most of the columns are self explanatory but some will bear a few words

of explanation. The average depth driven as given in columns 14 and 23 as explained in footnote 2, includes only one-third the length of point. These are the values used in determining the unit work values given in columns 15 and 24. The data in columns 16 and 25 are obtained by dividing the unit work value for the diamond-pointed nails by the unit work value for the regular-pointed nails, and expressing them as percentages.

In tables 1a to 6a, are given the results of tests to determine the work in pulling regular and diamond-pointed nails from green and dry Douglas fir, yellow birch, and white pine. Column 9 gives the difference in versed sines of the initial and final angles, which, when multiplied by the distance of center of gravity below axis in column 6, gives the vertical drop in inches of the pendulum if the weight is considered as concentrated at its center of gravity. The length of nail withdrawn, given in column 10, is the depth of penetration including one-third the length of the nail point. The values in column 12 are the ratios of the average work values for the diamond-pointed nails to the average work values for the regular-pointed nails expressed in percentages. The values in column 16 are similar ratios based on the maximum load in static with-

drawal. The values given in column 13 are ratios of the work values after conditioning to the work values before conditioning also expressed in percentages. Column 17 gives similar ratios based on maximum load in static withdrawal.

The first two unit work values given in column 11 of tables 1a to 6a, inclusive, for each stick number are for the pendulum withdrawal of the regular and diamond-pointed nails, respectively, immediately after driving. The ratio of the work in pulling the diamond to the work in pulling the regular-pointed nails, immediately after driving, expressed in percentages, is given as the first value for each stick number in column 12 of these same tables. The last two values in column 11, and the last one in column 12 for each stick of the same tables, apply in a similar way to the nails pulled after being subjected to one of the three conditioning treatments mentioned on page 5.

The data given in columns 14 to 17 under "static withdrawal" refer to the nails pulled on a Tinius Olsen universal testing machine of 10,000 pounds capacity.

The foregoing remarks on tables 1 to 6 and 1a to 6a also apply to tables 7 and 7a, respectively, except that barbed nails instead of the diamond-

pointed nails are compared with the regular-pointed nails. Only 8d nails of these two types were compared. The points and heads were the same, the only difference being the smooth shank in one, and the barbed shank in the other.

Table 8 gives the results of a special series of tests to determine the relative penetrations of the regular and diamond-pointed nails after each of a number of successive blows. The work values given in column 23 are based on the penetration after the last blow of the hammer. The work in pulling these nails from the final depth driven is given in column 35.

Figs. 1 to 13 show graphically the relative work in driving and pulling regular and diamond-pointed nails from both green and dry Douglas fir, yellow birch, and white pine.

Fig. 14 gives graphically the results of a special series of tests on 8d nails driven into green yellow birch. The data represented by this chart are supplementary to data represented in Fig. 8, and are given in tables 4 and 4a.

Fig. 15 shows graphically the relative work in driving and pulling 8d regular and barbed nails. The species into which the nails were driven was dry white pine. This chart is based on data given in

tables 7 and 7a.

Fig. 16 shows graphically the relative penetration for 8d regular and diamond-pointed nails after each successive blow of the pendulum hammer. The left-hand column gives the per cent penetration after each blow for both regular and diamond-pointed nails for three sticks. The right-hand column compares the two types of nails on a percentage basis for each blow. It also compares the two types on a basis of total work in driving and total work in pulling. This chart is based on data given in table 8.

Fig. 17 shows the types and sizes of nails studied.

Fig. 18 is a photograph of the pendulum machine arranged for driving nails.

Fig. 19 is a photograph of the pendulum machine arranged for pulling nails.

Figs. 20 and 21 are top and bottom views of red fir planks driven full of 10d nails by carpenters Nos. 1 and 2, respectively. The groups of nails numbered (1) are those with regular heads and points and those numbered (2) are those with checkered heads and diamond points.

Fig. 22 shows dry yellow birch planks driven full of 8d nails by carpenter No. 2. The groups Nos. 1 and 2 have the same significance as in

Figs. 20 and 21.

Fig. 23 is a photograph of the vibration machine arranged with a box loaded for test. The box as tested is empty.

Analysis of Results

Work in Driving Regular and Diamond-pointed Nails

An examination of tables 1 to 6, 8, and Figs. 1 to 14, shows quite consistently that the nails with the regular points offer slightly less resistance to driving with the pendulum hammer. This is true both when driven with a relatively small number of blows and also when given a relatively large number of lighter blows. At first thought, this would seem contrary to sound reasoning, the natural conclusion being that the diamond-pointed nail with its sharper point would penetrate wood more easily than the regular-pointed nail with its relatively short blunt point.However, experience and a few laboratory tests, have demonstrated that a blunt nail will give less trouble from splitting than a sharp pointed nail, due to the cutting and breaking of the fibers. This accounts, partially at least, for the greater ease of driving the regular-pointed nail. The diamond-pointed nail acts more as

a wedge than the blunter regular-pointed nail, and tends to split the fibers apart, thus rupturing fewer of the fibers.

The form of point which will penetrate with the greatest ease has not been determined. It is probable, however, that this is a variable depending upon the species and condition of timber into which the nail is driven.

Very little difference between the relative ease of driving the regular and diamond-pointed types of nails was found by reason of using a small number of heavy blows, or a relatively large number of light blows. The work per inch of penetration in driving with a large number of light blows is considerably greater than when driving to the same depth with a small number of heavier blows. This is shown by an examination of the values in columns 15 and 24 of tables 1 to 7. This difference, however, is what would naturally be expected when we consider the spring, or giving of the wood and nail which absorbs a certain amount of energy for each blow. The energy absorbed is practically the same for a light and a heavy blow. It is, therefore, evident that the total energy absorbed should be much greater for the light blows. In fact, the blows could easily be so light

as to cause no penetration whatever. This would be especially true of a large nail driven into a dense species. The work values given as a result of the driving tests are not absolute, but relative, and afford a good means of comparison between the types of nails studied.

It is interesting to note that the difference in resistance to driving the regular and diamond-pointed nails is less for birch than for Douglas fir and white pine. This is true of both green and seasoned material and also holds for the two methods of driving.

Work in Pulling Regular and Diamond-pointed Nails

A comparison of the work in pulling the regular and diamond-pointed nails shows that the regular-pointed nails require more work in pulling from green and dry Douglas fir and yellow birch immediately after driving. The difference, however, is quite small, an average of percentages in column 12 for all sizes of nails showing 1.7, 0.7, 1.2, and 8.1 per cent greater work, respectively, for the regular-pointed nails when pulled from dry and green Douglas fir and dry and green yellow birch. On the same basis, the diamond-pointed nails showed 4.9 and 3.2 per cent greater work in pulling, respectively, from dry and green white pine.

The work in pulling after soaking the sticks until of constant weight showed somewhat higher values for the diamond-pointed nails when driven into both green and dry material of all three species. This will be evident from an examination of tables 1a to 6a, and Figs. 1 to 14. If only the sticks which were soaked (stick numbers ending with 1) are considered, an average of all nail sizes shows the diamond points to surpass the regular points by 4.6, 2.9, and 5.4 per cent, respectively, when driven into Douglas fir, yellow birch, and white pine in a dry condition. When driven into green material of the same species, the diamond-pointed nails surpassed the regular-pointed nails by 3.7, 0.7, and 9.7 per cent, respectively, for Douglas fir, yellow birch, and white pine.

The soaking treatment seems to have had the effect of reversing the relative work in pulling the two types of nails from Douglas fir and yellow birch, and to have emphasized the greater work in pulling the diamond-pointed nails from white pine.

All sticks whose numbers end with 2 were allowed to air season before the nails were pulled. These showed the regular-pointed nails to require slightly greater work in pulling when driven into green Douglas fir and both dry and green yellow birch and pulled after air seasoning. The average per-

centages greater than the diamond points, considering all sizes of nails, was 6.2, 6.0, and 10.5 per cent, respectively. The diamond-pointed nails showed 3.7, 0.2, and 4.9 per cent more work in pulling, respectively, from dry Douglas fir, and dry and green white pine subjected to the same treatment.

The sticks whose numbers end with 3 were soaked and then dried subsequent to driving the nails and before pulling them. These showed an average for all sizes of nails of 10.5, 0.6, and 5.7 per cent more work required for the diamond than for the regular-pointed nails, when pulled from Douglas fir and white pine which were dry when nails were driven, and white pine which was green when nails were driven, respectively. The averages for Douglas fir in the green condition, and birch in both the dry and green condition when nails were driven, were 6.8, 1.5, and 7.7 per cent, respectively, in favor of the regular-pointed nails.

In general, the test data show a tendency for the diamond-pointed nails to surpass the regular-pointed nails in work required to withdraw when withdrawal is from a stick which has been soaked subsequent to driving of the nails. A subsequent drying of the wood results in slightly greater work of withdrawal for the regular-pointed nails.

It will be noted from an examination of the percentages in columns 13 of tables 1a to 6a that all three treatments result in a considerable reduction in work of withdrawal. The soaking, and soaking and subsequent drying treatments give the greatest decrease while the air-seasoning treatment gives the least reduction in holding force. This applies to both the regular and diamond-pointed nails.

Static Pulling

The nails pulled on a universal testing machine immediately after driving showed the diamond-pointed nails to require a greater maximum load to start than the regular-pointed nails. This was true for all three species in both the green and dry condition. The difference in holding power between the regular and diamond-pointed nails was least when pulled from green wood, the difference for green birch and white pine being only 1.7 and 6.4 per cent, respectively, in favor of the diamond point. The maximum difference occurred in dry Douglas fir in which case the average maximum load required to pull the diamond-pointed nails exceeded that for pulling the regular-pointed nails by 29.6 per cent.

The values obtained by the static pulling test, of course, are only the maximum loads required to start the nail, whereas the values obtained in the

pendulum pulling test are total work in pulling the nails. A comparison of values obtained by these two methods of pulling indicate that the diamond-pointed nails required the greater load to start them from all three species considered for both green and dry material, while the regular-pointed nails excelled in average force required to pull them from green and dry Douglas fir and yellow birch. The diamond-pointed nails, however, required the greater amount of work to pull from dry and green white pine.

When the sticks were subjected to soaking subsequent to driving, a greater maximum load was required to start the diamond-pointed nails from green and dry material of all three species under consideration, which was also true for pendulum pulling from sticks subjected to the same treatment (see Figs. 1 to 14, and tables 1a to 6a). The air seasoning treatment subsequent to driving the nails, resulted in the diamond-pointed nails exceeding the regular-pointed nails in maximum load of withdrawal for nails driven into dry Douglas fir, and dry and green white pine. The regular-pointed nails, however, exceeded the diamond-pointed nails in maximum load of withdrawal after being driven into green Douglas fir and green and dry yellow birch. It will be noted that similar results were obtained in pendulum pull-

ing for this treatment. The difference between the two types of nails in pulling from yellow birch after air seasoning is so small as to indicate very little difference between the two types of nails for this species. It should also be noted that only one stick is represented in the case of the green and dry Douglas fir.

Soaking and subsequent air seasoning resulted in a somewhat greater maximum load of withdrawal for the diamond-pointed nails when driven into dry and green Douglas fir and white pine, and dry yellow birch. The regular-pointed nails required a slightly higher maximum load to withdraw from the green yellow birch for the same treatment.

The percentages in column 17 of tables 1a to 6a show a decided decrease in maximum load of withdrawal in most cases for all three conditioning treatments. This is true of both types of nails. The decrease, however, is not as great as in the pendulum pulling tests.

Relation Between Force Required to Pull, and Diameter of Nail

The maximum force required to start the withdrawal of a nail (static pulling) seems to vary approximately with the depth of penetration. If we assume this relation to be true then the force re-

quired to withdraw a nail would be represented by the quotient obtained by dividing the total work of withdrawal (W) by the square of the length of penetration (L^2). A plot of these values against diameter of nail for all three species and both conditions at time of driving shows a tendency for the force ($\frac{W}{L^2}$) in pulling on the pendulum machine immediately after driving, to increase approximately in a direct ratio with increase in diameter of nail from 4d to 20d size, for both the regular and diamond-pointed types.

However, there is a diameter of nail beyond which no increase in resistance to withdrawal is obtained. In these tests the 60d nails gave but little greater resistance to withdrawal than the 20d nails driven to the same depth. The diameter at which no increase in holding power would be expected is probably very dependent upon the individual species, condition, size of piece, etc., into which nails are driven.

Comparison of Barbed and Common Nails

A comparison of 8d common nails with regular head and point and smooth shanks, and 8d barbed nails with regular head and point driven into dry white pine is given in Fig. 15 and tables 7 and 7a. This comparison indicates that the barbed nails require on the average about 7 per cent less work in driving than the common nails when given four blows. When the nails were driven with a relatively large

number of blows (varying from 11 to 16) to an equal depth, the barbed nails more nearly required the same amount of work to drive as the common nails, being only 2 per cent less.

In pulling on the pendulum machine immediately after driving practically no difference was found between the barbed nails and the regular-pointed nails with smooth shanks. When subjected to the three treatments (see page 5) before pulling, the barbed nails required 39 per cent more work to pull after the stick from which they were to be pulled had soaked 84 days; about 5 per cent less work to pull when the stick was allowed to air season 313 days before pulling, and when the stick was soaked and dried before pulling nails, the barbed nails required 38 per cent more work to pull than the common nail.

The maximum load required to pull on a universal testing machine, immediately after driving was about 6 per cent less for the barbed than for the common nail. The barbed nail required 11 per cent greater load to start after soaking, 14 per cent less load to start after air conditioning, and 90 per cent more load to start after soaking and drying the stick than the common nail. It will be noted that the barbed nails excel in holding power when the stick has been soaked subsequent to driving.

The tests indicate that the barbed nails may be an advantage under some conditions, while under other conditions they may be a disadvantage. The tests, however, were too limited in number to draw any definite conclusions.

Hand Driving Tests

One of the arguments advanced by the manufacturers favoring nails with checkered heads is that there is less tendency for the hammer to slip in driving than in the case of the common head, thus reducing the waste due to bending, as well as being less fatiguing to the carpenter. Another advantage of the checkered head is that it can be centered more easily in manufacture, resulting in a more uniform head.

In order to obtain some data on the relative efficiency of the plain and checkered heads in preventing slippage of the hammer and bending of the nails, as well as information on the relative ease of driving, a series of hand driving tests was made which is described under method of tests.

The tests did not bring out any difference in the number of nails bent due to slipping of the hammer. Carpenter No. 1 bent only two checkered and three plain headed nails, while carpenter No. 2 bent three checkered and one plain headed nail. It was observed in the case of the nails which were bent

that this was due more to the carpenters not gauging their blows properly and hitting the edge of the head, rather than to any difference in tendency of the hammer to slip from either type of nail head. Carpenter No. 1 was of the opinion that his hammer slipped less from the checkered heads and that these nails (diamond points) drove easier. Carpenter No. 2 could notice no difference in either the slippage or relative ease of driving of the two types.

Summing up the time required to drive the two types of nails: Carpenter No. 1 took 93 minutes of total time to drive the regular type and 102 minutes to drive the checkered head and diamond-pointed nails. Carpenter No. 2 took 107 minutes to drive the common brand and 108 minutes to drive the other type. The difference in time required to drive the two kinds of nails is very slight and if any difference can be said to exist in the relative ease of driving or amount of slippage it slightly favors the regular type.

The planks into which these nails were driven were slightly under 3 inches in thickness so that the points of the nails came through on the other side. A rather interesting point brought out by this fact was the greater slivering of the planks on the bottom where the regular points protruded. In

general, the diamond points pierced without tearing off slivers on the bottom as badly as did the regular point. This is shown in Figs. 20 and 21, which are photographs of both sides of the planks into which the nails were driven by carpenters 1 and 2, respectively.

Subsequent to the above tests carpenter No. 2 drove six hundred 8d nails of each of the two types into dry birch in alternating groups of 200 and 300, time being taken as before. In this case, six regular and eight diamond-pointed nails were bent. It took 62 minutes to drive the regular and 70 minutes total time to drive the diamond points (see Fig. 22).

Vibration Tests

The vibration tests were made in an attempt to determine the effect of change of diameter of nails used on the type of failure. It was desired to know if there is a definite diameter of nail at which failure due to vibration changes from a breaking off to a working out of the nails.

In general, it was observed that the larger diameter nails withstood the greatest number of vibrations, and are more apt to work out than break off. The greatest number of failures due to nails breaking off were obtained with the smaller nails.

From the nature of this test the main stress is exerted on the nails in the side pieces when the box is placed with its top up. Each piece was nailed with three nails. It was observed that the center one of these three nails always acted as a pivot, the bending stress being applied to the other two nails. The failure of the nail by breaking off was in all cases observed to take place in nails which were driven into the side grain of the end cleats. The other type of failure was by the nail working out, which was the typical failure of nails which were driven into the end grain of the ends, the lateral resistance being less than when driven into side grain.

Another interesting point was brought out in this connection by varying the number and size of nails in the nailing edge of a box. Approximately the same resistance to vibration and rough handling (indicated by drum test)[1] was shown when either

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[1] The drum test is made in a six-sided drum about 14 feet in diameter which revolves at a very slow rate. Upon these six faces, hazards and guides are arranged in such a manner that, as the drum revolves, the box or crate skids and falls, striking on ends, sides, top, bottom, edges, and corners in such ways that the stresses, shocks, and rough handling of actual transportation conditions are simulated. For this method of testing the box or crate must be loaded with its contents or a substitute which produces the same effect.

eight 6d, or six 8d nails were used.

The tests were few in number, and the results very erratic; consequently, no definite conclusions could be drawn as to the existence of such a relation. There is a considerable field open to investigation of a proper method of testing containers so as to determine the proper relation between length, diameter, type of point, and type of head of nails for box and crate construction.

Splitting Tests

The tests to determine the relative splitting tendency of the two types of points showed very consistently that the diamond-pointed nail splits the longest block, the difference in length split averaging about 15 per cent for the 4d, 6d, 8d, and 10d nails when birch was used, and about 20 per cent for the 3d, 6d, 8d, and 10d nails when Douglas fir was used.

The 20d nails driven into Douglas fir showed that the diamond-pointed nails split a block twice as long as did the regular-pointed nail.

Conclusions

The data indicate a small but consistent difference in ease of driving the regular and diamond-pointed nails which favors the regular or common

point. This difference exists both when the nails are driven with a normal number of relatively heavy blows and also when driven with a large number of light blows to a given depth.

The work in driving with a large number of light blows is considerably greater than driving with a normal number of heavy blows for the same depth of penetration.

The pulling tests by means of the pendulum machine indicate that the regular-pointed nails require more work in pulling, immediately after driving, from the denser species such as Douglas fir and yellow birch, while the diamond pointed nails pull harder from the low density species such as white pine.

The work in pulling from sticks which had been soaked subsequent to driving was found to be greater for the diamond-pointed nails for all three species tested, in both the green and dry condition.

Sticks which were air seasoned, or soaked and air seasoned subsequent to driving the nails, tend to increase the work in pulling the regular-pointed nails over that of the diamond-pointed nails.

In tests to determine the maximum load of withdrawal on a static machine, the diamond-pointed nails surpassed the regular-pointed nails by an

regular and diamond-pointed types. However, there is a diameter of nail beyond which no increase in resistance to withdrawal is obtained. In these tests the 60d nails gave but little greater resistance to withdrawal than the 20d nails driven to the same depth. The diameter at which no increase in holding power would be expected is probably very dependent upon the individual species, condition, size of pieces, etc., into which nails are driven.

The comparison of 8d barbed and 8d common nails with the same type of point driven into dry white pine indicates on the average slightly less work to drive the barbed nails when driven with a normal number of blows and also when driven with a large number of light blows. Practically no difference in work of pulling was found when pulled immediately after driving. The soaking treatment and soaking and subsequent air seasoning treatment indicate considerably more work in pulling the barbed nails, while the air seasoning treatment indicated slightly less work in pulling the barbed nails than the common type. The tests are too limited, however, to draw any definite conclusions.

The hand-driving tests brought out no appreciable difference in the slippage of the hammer from the heads or in tendency to bend of the common type

efficiency in various fields of construction, particularly in the wooden container industry. A study to determine the best design for roofing and shingle nails would be of extreme value at the present time. Studies of nail coatings efficiency of nailed joints, relation of diameter to length of nail, effect of size and thickness of nail head and its relation to diameter and length of shank, and a minute study of the action of the wood fibers of various species on the nail in driving and pulling are only a few of the outstanding problems upon which definite information is lacking at the present time. This type of information is probably most acutely needed by the wooden container industry but would be of value to all users of nails.

Table 1.--Results of tests to determine work in driving regular and diamond-pointed nails into dry Douglas fir

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
							Nails driven small number of blows - pendulum hammer[1]																	
Stick No.[3]	Kind of nail	Size of nail	Average overall length of nails	Average length of nail point	Specific gravity of stick based on oven-dry weight and volume at test	Moisture content of stick when nails were driven	No. of nails driven	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Average: depth driven[2]	Work: Per inch penetration	Work: Ratio D/B	No. of nails	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: Center of gravity below axis	Depth driven[2]	Work: Per inch penetration	Work: Ratio D/B
			Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
1-1-1	Reg.	4d	1.52	.14	.53	14.3	20	3	30	.1340	38.75	8.04	.76	164.8	--	--	--	--	--	--	--	--	--	--
	Dia.		1.54	.22	--	--	20	3	30	.1340	38.75	8.04	.70	179.0	108.8	--	--	--	--	--	--	--	--	--
1-1-2	R	4d	1.53	.14	.53	14.6	20	3	30	.1340	38.75	8.04	.77	162.6	--	--	--	--	--	--	--	--	--	--
	D		1.58	.22	--	--	20	3	30	.1340	38.75	8.04	.69	181.4	111.6	--	--	--	--	--	--	--	--	--
1-1-3	R	4d	1.51	.14	.41	14.9	20	3	30	.1340	38.75	8.04	1.04	120.5	--	--	--	--	--	--	--	--	--	--
	D		1.52	.22	--	--	20	3	30	.1340	38.75	8.04	.98	127.6	106.0	--	--	--	--	--	--	--	--	--
1-2-1	R	6d	2.05	.15	.39	13.8	20	3	40.2	.2362	38.75	8.04	1.34	164.7	--	--	--	--	--	--	--	--	--	--
	D		2.05	.24	--	--	20	3	40.2	.2362	38.75	8.04	1.25	176.8	107.3	--	--	--	--	--	--	--	--	--
1-2-2	R	6d	2.04	.15	.40	13.7	20	3	40.2	.2362	38.75	8.04	1.39	158.6	--	--	--	--	--	--	--	--	--	--
	D		2.04	.24	--	--	20	3	40.2	.2362	38.75	8.04	1.30	169.9	107.1	--	--	--	--	--	--	--	--	--
1-3-1	R	8d	2.54	.17	.50	14.0	20	3	60	.5000	38.75	8.04	1.68	278.0	--	--	--	--	--	--	--	--	--	--
	D		2.53	.27	--	--	20	3	60	.5000	38.75	8.04	1.60	292.1	105.1	--	--	--	--	--	--	--	--	--
1-3-2	R	8d	2.53	.17	.49	14.0	20	3	60	.5000	38.75	8.04	1.68	278.0	--	--	--	--	--	--	--	--	--	--
	D		2.52	.27	--	--	20	3	60	.5000	38.75	8.04	1.57	297.7	107.1	--	--	--	--	--	--	--	--	--
1-3-3	R	8d	2.52	.17	.43	13.2	8	3	40	.2340	38.75	8.04	1.51	144.9	--	13	30	.1340	38.75	8.04	1.39	390.5	--	
	D		2.52	.27	--	--	8	3	40	.2340	38.75	8.04	1.21	180.8	124.7	15	30	.1340	38.75	8.04	1.32	474.5	121.5	
1-4-1	R	10d	3.03	.20	.44	14.3	20	5	60	.5000	38.75	8.04	2.04	382.0	--	--	--	--	--	--	--	--	--	--
	D		3.05	.30	--	--	20	5	60	.5000	38.75	8.04	1.97	395.7	103.5	--	--	--	--	--	--	--	--	--
1-4-2	R	10d	3.02	.20	.49	14.2	20	5	60	.5000	38.75	8.04	2.08	374.1	--	--	--	--	--	--	--	--	--	--
	D		3.05	.30	--	--	20	5	60	.5000	38.75	8.04	2.01	387.0	103.4	--	--	--	--	--	--	--	--	--
1-5-1	R	20d	4.07	.24	.44	14.9	20	6	40.2	.2362	66.10	17.07	2.98	536.6	--	--	--	--	--	--	--	--	--	--
	D		4.06	.37	--	--	20	6	40.2	.2362	66.10	17.07	2.92	548.0	102.1	--	--	--	--	--	--	--	--	--
1-5-2	R	20d	4.05	.24	.43	14.4	20	6	40.2	.2362	66.10	17.07	2.82	567.5	--	--	--	--	--	--	--	--	--	--
	D		4.05	.37	--	--	20	6	40.2	.2362	66.10	17.07	2.69	595.0	104.8	--	--	--	--	--	--	--	--	--
1-5-3	R	20d	4.05	.24	.45	14.5	8	4	40	.2340	66.10	17.07	2.26	467.2	--	27	40	.2340	38.75	8.02	2.84	691.0	--	
	D		4.06	.37	--	--	8	4	40	.2340	66.10	17.07	2.16	488.8	104.5	27	40	.2340	38.75	8.02	2.75	714.0	103.3	
1-7-1	R	60d	6.06	.32	.46	13.4	8	8	40	.2340	66.10	17.07	2.52	838.6	--	55	40	.2340	38.75	8.02	2.79	1434.0	--	
	D		6.07	.52	--	--	8	8	40	.2340	66.10	17.07	2.28	926.0	110.5	63	40	.2340	38.75	8.02	2.65	1728.0	120.4	
1-7-2	R	60d	6.04	.32	.45	14.7	8	8	40	.2340	66.10	17.07	2.43	869.0	--	54	40	.2340	38.75	8.02	2.79	1406.0	--	
	D		6.07	.52	--	--	8	8	40	.2340	66.10	17.07	2.23	949.0	109.5	64	40	.2340	38.75	8.02	2.65	1754.0	124.8	
1-7-3	R	60d	6.06	.32	.38	15.4	8	8	40	.2340	66.10	17.07	2.73	774.2	--	42	40	.2340	38.75	8.02	2.79	1094.0	--	
	D		6.07	.52	--	--	8	8	40	.2340	66.10	17.07	2.58	820.0	106.0	46	40	.2340	38.75	8.02	2.65	1261.0	115.3	

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of nail minus two-thirds the length of the nail point.

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

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Table 2.--Results of tests to determine work in driving regular and diamond-pointed nails into green Douglas fir

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
									Nails driven small number of blows - pendulum hammer[1]											Nails driven large number of light blows - pendulum hammer					
									Drop angle			Distance: center of gravity below axis		Work				Drop angle			Distance: center of gravity below axis		Work	
Stick No.[3]	Kind of nail	Size of nails	Average overall length of nails	Average length of nail point	Specific gravity of stick based on oven-dry weight and volume at test	Moisture content of stick when nails were driven	No. of nails driven	No. of blows	Degree	Versed sine	Weight of pendulum		Average depth driven[2]	Per inch penetration	Ratio D/R	No. of nails	No. of blows	Degree	Versed sine	Weight of pendulum		Depth driven[2]	Per inch penetration	Ratio D/R
			Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
2-1-1	Reg.	4d	1.50	.14	.44	27.1	20	½	30	.1340	38.75	8.04	1.07	117.2	--	--	--	--	--	--	--	--	--	--
	Dia.		1.51	.22	--	--	20	½	30	.1340	38.75	8.04	1.01	124.2	106.0	--	--	--	--	--	--	--	--	--
2-1-2	R	4d	1.50	.14	.42	66.6	20	½	30	.1340	38.75	8.04	1.11	112.9	--	--	--	--	--	--	--	--	--	--
	D		1.51	.22	--	--	20	½	30	.1340	38.75	8.04	1.02	123.0	109.0	--	--	--	--	--	--	--	--	--
2-1-3	R	4d	1.50	.14	.36	29.3	20	½	30	.1340	38.75	8.04	1.01	124.2	--	--	--	--	--	--	--	--	--	--
	D		1.50	.22	--	--	20	½	30	.1340	38.75	8.04	.95	132.1	106.3	--	--	--	--	--	--	--	--	--
2-2-1	R	6d	2.03	.15	.32	93.6	20	½	40.2	.2362	38.75	8.04	1.60	138.2	--	--	--	--	--	--	--	--	--	--
	D		2.02	.24	--	--	20	½	40.2	.2362	38.75	8.04	1.48	149.4	108.1	--	--	--	--	--	--	--	--	--
2-2-2	R	6d	2.03	.15	.41	30.2	20	½	40.2	.2362	38.75	8.04	1.59	138.2	--	--	--	--	--	--	--	--	--	--
	D		2.02	.24	--	--	20	½	40.2	.2362	38.75	8.04	1.47	150.4	108.8	--	--	--	--	--	--	--	--	--
2-2-3	R	6d	2.04	.15	.42	30.2	20	½	40.2	.2362	38.75	8.04	1.58	139.8	--	--	--	--	--	--	--	--	--	--
	D		2.04	.24	--	--	20	½	40.2	.2362	38.75	8.04	1.45	152.3	109.0	--	--	--	--	--	--	--	--	--
2-3-1	R	8d	2.53	.17	.48	28.2	20	½	60.0	.5000	38.75	8.04	1.79	261.1	--	--	--	--	--	--	--	--	--	--
	D		2.52	.27	--	--	20	½	60.0	.5000	38.75	8.04	1.75	267.1	102.4	--	--	--	--	--	--	--	--	--
2-3-2	R	8d	2.52	.17	.51	30.2	20	½	60.0	.5000	38.75	8.04	1.80	259.8	--	--	--	--	--	--	--	--	--	--
	D		2.53	.27	--	--	20	½	60.0	.5000	38.75	8.04	1.79	261.0	100.5	--	--	--	--	--	--	--	--	--
2-3-3	R	8d	2.53	.17	.47	29.2	19	½	60.0	.5000	38.75	8.04	1.84	254.0	--	--	--	--	--	--	--	--	--	--
	D		2.54	.27	--	--	20	½	60.0	.5000	38.75	8.04	1.78	262.7	103.5	--	--	--	--	--	--	--	--	--
2-4-1	R	10d	3.03	.20	.53	29.4	20	½	60.0	.5000	38.75	8.04	2.22	351.1	--	--	--	--	--	--	--	--	--	--
	D		3.06	.30	--	--	20	½	60.0	.5000	38.75	8.04	2.25	346.1	98.6	--	--	--	--	--	--	--	--	--
2-4-2	R	10d	3.03	.20	.54	28.6	20	½	60.0	.5000	38.75	8.04	2.18	357.5	--	--	--	--	--	--	--	--	--	--
	D		3.05	.30	--	--	20	½	60.0	.5000	38.75	8.04	2.18	357.4	100.0	--	--	--	--	--	--	--	--	--
2-4-3	R	10d	3.02	.20	.55	30.0	19	½	60.0	.5000	38.75	8.04	2.17	359.2	--	--	--	--	--	--	--	--	--	--
	D		3.05	.30	--	--	20	½	60.0	.5000	38.75	8.04	2.11	369.5	102.8	--	--	--	--	--	--	--	--	--
2-5-1	R	20d	4.06	.24	.45	29.9	8	½	40.0	.2340	66.10	17.07	2.22	356.6	--	8	20	40.0	.2340	38.75	8.02	2.84	511.8	--
	D		4.04	.37	--	--	8	½	40.0	.2340	66.10	17.07	2.17	365.0	102.4	8	20	40.0	.2340	38.75	8.02	2.75	528.4	103.1
2-5-2	R	20d	4.06	.24	.46	30.2	18	½	40.0	.2340	66.10	17.07	2.72	582.0	--	--	--	--	--	--	--	--	--	--
	D		4.06	.37	--	--	18	½	40.0	.2340	66.10	17.07	2.70	587.0	100.9	--	--	--	--	--	--	--	--	--
2-5-3	R	20d	4.06	.24	.51	31.3	17	½	40.0	.2340	66.10	17.07	3.04	521.0	--	--	--	--	--	--	--	--	--	--
	D		4.07	.37	--	--	16	½	40.0	.2340	66.10	17.07	3.08	514.6	98.7	--	--	--	--	--	--	--	--	--
2-7-1	R	60d	6.05	.32	.46	26.0	8	½	40.0	.2340	66.10	17.07	2.99	706.4	--	8	40	40.0	.2340	38.75	8.02	2.79	1041.0	--
	D		6.06	.52	--	--	8	½	40.0	.2340	66.10	17.07	2.80	755.0	106.8	8	42	40.0	.2340	38.75	8.02	2.65	1151.0	110.6
2-7-2	R	60d	6.07	.32	.43	30.0	8	½	40.0	.2340	66.10	17.07	2.57	514.0	--	8	32	40.0	.2340	38.75	8.02	2.79	833.0	--
	D		6.08	.52	--	--	8	½	40.0	.2340	66.10	17.07	2.43	544.0	105.8	8	34	40.0	.2340	38.75	8.02	2.65	933.0	112.0
2-7-3	R	60d	6.05	.32	.46	28.7	8	½	40.0	.2340	66.10	17.07	2.55	518.0	--	8	33	40.0	.2340	38.75	8.02	2.79	860.0	--
	D		6.08	.52	--	--	8	½	40.0	.2340	66.10	17.07	2.52	569.0	109.8	8	34	40.0	.2340	38.75	8.02	2.65	933.0	108.4

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of nail minus two-thirds the length of the nail point.

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.
One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

17840M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

G.E.H.
12/1/22

Table 3.--Results of tests to determine work in driving regular and diamond-pointed nails into dry birch

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
							Nails driven small number of blows - pendulum hammer[1]										Nails driven large number of light blows - pendulum hammer							
					Specific gravity	Moisture content			Drop angle			Distance:		Work				Drop angle			Distance:		Work	
Stick No.[3]	Kind of nail	Size of nails	Average overall length of nails	Average length of nail point	of stick based on oven-dry weight and volume at test	of stick when nails were driven	No. of nails driven	No. of blows	Degrees	Versed sine	Weight of pendulum	center of gravity below axis	Average depth driven[2]	Per inch pene-tration	Ratio D/R	No. of nails	No. of blows	Degrees	Versed sine	Weight of pendulum	center of gravity below axis	Depth driven[2]	Per inch pene-tration	Ratio D/R
			Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
3-1-1	Reg.	4d	1.52	.14	.54	12.6	8	1	30.0	.1340	38.75	8.04	.57	146.5	--	8	10	20.0	.0603	38.75	8.04	.91	206.5	--
	Dia.		1.53	.22	--	--	8	1	30.0	.1340	38.75	8.04	.53	157.5	107.5	8	10	20.0	.0603	38.75	8.04	.85	221.0	107.0
3-1-2	R	4d	1.51	.14	.55	11.2	8	2	30.0	.1340	38.75	8.04	.53	157.4	--	8	12	20.0	.0603	38.75	8.04	.91	247.6	--
	D		1.53	.22	--	--	8	2	30.0	.1340	38.75	8.04	.48	174.0	110.4	8	12	20.0	.0603	38.75	8.04	.85	265.0	107.1
3-1-3	R	4d	1.52	.14	.54	12.7	8	3	30.0	.1340	38.75	8.04	.54	154.5	--	8	11	20.0	.0603	38.75	8.04	.91	227.0	--
	D		1.52	.22	--	--	8	3	30.0	.1340	38.75	8.04	.51	163.7	106.0	8	10	20.0	.0603	38.75	8.04	.85	221.0	97.4
3-3-1	R	8d	2.54	.17	.58	12.4	8	4	40.0	.2340	38.75	8.04	1.05	416.4	--	8	46	20.0	.0603	38.75	8.04	1.39	621.2	--
	D		2.53	.27	--	--	8	4	40.0	.2340	38.75	8.04	1.02	428.6	102.7	8	46	20.0	.0603	38.75	8.04	1.32	654.2	105.2
3-3-2	R	8d	2.53	.17	.58	11.8	8	4	40.0	.2340	38.75	8.04	1.05	416.5	--	8	50	20.0	.0603	38.75	8.04	1.39	675.5	--
	D		2.52	.27	--	--	8	4	40.0	.2340	38.75	8.04	1.02	428.6	102.7	8	48	20.0	.0603	38.75	8.04	1.32	683.1	101.0
3-3-3	R	8d	2.52	.17	.60	12.1	8	4	40.0	.2340	38.75	8.04	1.12	390.4	--	8	54	20.0	.0603	38.75	8.04	1.39	729.2	--
	D		2.52	.27	--	--	8	4	40.0	.2340	38.75	8.04	1.07	408.7	104.6	8	54	20.0	.0603	38.75	8.04	1.32	768.0	105.2
3-5-1	R	20d	4.04	.24	.62	13.7	8	7	40.0	.2340	66.10	17.07	1.95	948.0	--	8	63	40.0	.2340	38.75	8.02	2.34	1956.0	--
	D		4.04	.37	--	--	8	7	40.0	.2340	66.10	17.07	2.05	901.1	95.1	8	54	40.0	.2340	38.75	8.02	2.25	1745.0	89.3
3-5-2	R	20d	4.04	.24	.63	13.5	8	7	40.0	.2340	66.10	17.07	2.05	901.0	--	8	54	40.0	.2340	38.75	8.02	2.34	1678.0	--
	D		4.04	.37	--	--	8	7	40.0	.2340	66.10	17.07	2.03	910.0	101.0	8	54	40.0	.2340	38.75	8.02	2.25	1745.0	104.0
3-5-3	R	20d	4.07	.24	.61	12.7	8	7	40.0	.2340	66.10	17.07	1.92	963.3	--	8	76	40.0	.2340	38.75	8.02	2.34	2359.0	--
	D		4.05	.37	--	--	8	7	40.0	.2340	66.10	17.07	1.88	984.0	102.1	8	72	40.0	.2340	38.75	8.02	2.25	2324.0	98.8
3-7-1	R	60d	6.06	.32	.55	13.1	8	4	50.0	.3572	66.10	17.07	2.14	1131.0	--	8	39	40.0	.2340	38.75	8.02	2.29	1237.0	--
	D		6.08	.52	--	--	8	4	50.0	.3572	66.10	17.07	2.05	1101.0	104.1	8	52	40.0	.2340	38.75	8.02	2.15	1758.0	142.0
3-7-2	R	60d	6.07	.32	.65	13.0	8	7	50.0	.3572	66.10	17.07	1.73	1632.0	--	8	79	50.0	.3572	38.75	8.02	2.29	3831.0	--
	D		6.08	.52	--	--	8	7	50.0	.3572	66.10	17.07	1.60	1661.0	101.8	8	82	50.0	.3572	38.75	8.02	2.15	4204.0	110.5
3-7-3	R	60d	6.05	.32	.57	13.5	8	7	50.0	.3572	66.10	17.07	2.21	1279.0	--	8	44	50.0	.3572	38.75	8.02	2.29	2335.0	--
	D		6.06	.52	--	--	8	7	50.0	.3572	66.10	17.07	2.04	1305.0	108.4	8	52	50.0	.3572	38.75	8.02	2.15	2885.0	125.8

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of nail minus two-thirds the length of the nail point. penetration

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

17841 M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 25, 1922.

12/14/22

Table 4.--Results of tests to determine work in driving regular and diamond-pointed nails into green birch

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
								Nails driven small number of blows - pendulum hammer[1]										Nails driven large number of light blows - pendulum hammer							
Stick No.[3]	Kind of nail	Size of nails	Average overall length of nails	Average length of nail point	Specific gravity of stick based on oven-dry weight and volume at test	Moisture content of stick when nails were driven	No. of nails driven	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance center of gravity below axis	Average depth driven[2]	Work: Per inch penetration	Work: Ratio D/R	No. of nails	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance center of gravity below axis	Depth driven[2]	Work: Per inch penetration	Work: Ratio D/R
			Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
4-1-1	Reg.	4d	1.52	.14	.57	55.2	8	2	30.0	.1340	38.75	8.04	.70	119.4	--	8	9	20.0	.0603	38.75	8.04	.91	186.0	--
	Dia.		1.53	.22	--	--	8	2	30.0	.1340	38.75	8.04	.66	126.6	106.0	8	8	20.0	.0603	38.75	8.04	.85	176.9	95.2
4-1-2	R	4d	1.51	.14	.60	65.0	8	2	30.0	.1340	38.75	8.04	.63	132.2	--	8	9	20.0	.0603	38.75	8.04	.91	186.0	--
	D		1.53	.22	--	--	8	2	30.0	.1340	38.75	8.04	.61	137.0	103.4	8	9	20.0	.0603	38.75	8.04	.85	199.1	107.2
4-1-3	R	4d	1.51	.14	.56	66.3	8	2	30.0	.1340	38.75	8.04	.75	111.4	--	8	7	20.0	.0603	38.75	8.04	.91	144.6	--
	D		1.52	.22	--	--	8	2	30.0	.1340	38.75	8.04	.74	112.9	101.3	8	7	20.0	.0603	38.75	8.04	.85	154.8	107.0
4-3-1	R	8d	2.53	.17	.61	53.2	8	3	40.0	.2340	38.75	8.04	.96	227.6	--	8	40	20.0	.0603	38.75	8.04	1.39	540.5	--
	D		2.53	.27	--	--	8	3	40.0	.2340	38.75	8.04	.96	228.0	100.2	8	39	20.0	.0603	38.75	8.04	1.32	554.8	102.5
4-3-2	R	8d	2.53	.17	.61	62.8	8	3	40.0	.2340	38.75	8.04	.91	240.5	--	8	46	20.0	.0603	38.75	8.04	1.39	622.0	--
	D		2.52	.27	--	--	8	3	40.0	.2340	38.75	8.04	.90	243.4	101.1	8	43	20.0	.0603	38.75	8.04	1.32	612.0	98.3
4-3-3	R	8d	2.53	.17	.55	60.6	8	3	40.0	.2340	38.75	8.04	.97	225.8	--	8	38	20.0	.0603	38.75	8.04	1.39	514.0	--
	D		2.53	.27	--	--	8	3	40.0	.2340	38.75	8.04	.96	228.2	101.2	8	37	20.0	.0603	38.75	8.04	1.32	526.5	102.5
4-3-1-8	R	8d	2.52	.17	.57	61.9	8	4	40.0	.2340	38.75	8.04	1.19	245.3	--	8	46	20.0	.0603	38.75	8.04	1.56	554.0	--
	D		2.52	.27	--	--	8	4	40.0	.2340	38.75	8.04	1.21	241.2	98.3	8	41	20.0	.0603	38.75	8.04	1.59	484.3	87.5
4-3-2-8	R	8d	2.54	.17	.57	62.8	8	4	40.0	.2340	38.75	8.04	1.07	272.6	--	8	54	20.0	.0603	38.75	8.04	1.56	650.0	--
	D		2.53	.27	--	--	8	4	40.0	.2340	38.75	8.04	1.08	270.2	99.3	8	52	20.0	.0603	38.75	8.04	1.59	614.0	94.5
4-3-3-8	R	8d	2.54	.17	.57	56.5	8	4	40.0	.2340	38.75	8.04	1.15	253.7	--	8	46	20.0	.0603	38.75	8.04	1.56	554.0	--
	D		2.52	.27	--	--	8	4	40.0	.2340	38.75	8.04	1.11	262.8	103.6	8	47	20.0	.0603	38.75	8.04	1.59	555.0	102.8
4-5-1	R	20d	4.06	.24	.62	60.9	8	5	40.0	.2340	66.10	17.07	2.09	632.0	--	8	58	40.0	.2340	38.75	8.02	2.34	1180.0	--
	D		4.07	.37	--	--	8	5	40.0	.2340	66.10	17.07	2.12	622.7	98.5	8	32	40.0	.2340	38.75	8.02	2.25	1033.0	87.7
4-5-2	R	20d	4.08	.24	.62	56.8	8	5	40.0	.2340	66.10	17.07	2.12	622.6	--	8	34	40.0	.2340	38.75	8.02	2.34	1056.0	--
	D		4.06	.37	--	--	8	5	40.0	.2340	66.10	17.07	2.13	620.0	99.6	8	28	40.0	.2340	38.75	8.02	2.25	904.5	85.6
4-5-3	R	20d	4.06	.24	.61	71.6	8	5	40.0	.2340	66.10	17.07	1.89	698.5	--	8	41	40.0	.2340	38.75	8.02	2.34	1274.0	--
	D		4.03	.37	--	--	8	5	40.0	.2340	66.10	17.07	1.95	677.0	97.0	8	38	40.0	.2340	38.75	8.02	2.25	1228.0	96.3
4-7-1	R	60d	6.06	.32	.56	45.6	8	5	50.0	.3572	66.10	17.07	2.41	837.0	--	8	37	50.0	.3572	38.75	8.02	2.79	1474.0	--
	D		6.08	.52	--	--	8	5	50.0	.3572	66.10	17.07	2.39	844.0	100.8	8	32	50.0	.3572	38.75	8.02	2.65	1341.0	91.0
4-7-2	R	60d	6.06	.32	.63	38.5	8	5	50.0	.3572	66.10	17.07	2.40	840.0	--	8	40	50.0	.3572	38.75	8.02	2.79	1592.0	--
	D		6.07	.52	--	--	8	5	50.0	.3572	66.10	17.07	2.38	847.5	100.8	8	35	50.0	.3572	38.75	8.02	2.65	1467.0	92.1
4-7-3	R	60d	6.05	.32	.57	45.1	8	5	50.0	.3572	66.10	17.07	2.50	807.0	--	8	38	50.0	.3572	38.75	8.02	2.79	1515.0	--
	D		6.07	.52	--	--	8	5	50.0	.3572	66.10	17.07	2.47	816.1	101.2	8	36	50.0	.3572	38.75	8.02	2.65	1509.0	99.7

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of ~~nail~~ minus two-thirds the length of the nail point. penetration

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

17842 M

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

Table 5.--Results of tests to determine work in driving regular and diamond-pointed nails into dry white pine

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
					Specific gravity	Moisture content	Nails driven small number of blows - pendulum hammer[1]									Nails driven large number of light blows - pendulum hammer								
			Average overall length	Average length of nail point	of stick based on oven-dry weight and volume at test	of stick when nails were driven	No. of nails driven	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Average depth driven[2]	Work: Per inch penetration	Work: Ratio D/R	No. of nails	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Depth driven[2]	Work: Per inch penetration	Work: Ratio D/R
Stick No.[3]	Kind of nail	Size of nails	Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
5-1-1	Reg.	4d	1.51	.14	.39	11.3	8	4	20.0	.0603	38.75	8.04	.78	96.4	--	8	33	10.0	.0152	38.75	8.04	.91	171.8	--
	Dia.		1.52	.22	--	--	8	4	20.0	.0603	38.75	8.04	.68	110.6	114.6	8	38	10.0	.0152	38.75	8.04	.85	211.8	123.3
5-1-2	R	4d	1.52	.14	.39	12.2	8	4	20.0	.0603	38.75	8.04	.76	98.9	--	8	30	10.0	.0152	38.75	8.04	.91	156.2	--
	D		1.53	.22	--	--	8	4	20.0	.0603	38.75	8.04	.68	110.6	111.8	8	34	10.0	.0152	38.75	8.04	.85	189.5	121.2
5-1-3	R	4d	1.52	.14	.39	10.5	8	4	20.0	.0603	38.75	8.04	.76	98.9	--	8	34	10.0	.0152	38.75	8.04	.91	176.8	--
	D		1.53	.22	--	--	8	4	20.0	.0603	38.75	8.04	.67	112.2	113.6	8	37	10.0	.0152	38.75	8.04	.85	206.3	116.9
5-3-1	R	8d	2.52	.17	.34	11.8	8	4	30.0	.1340	38.75	8.04	1.15	145.3	--	8	16	20.0	.0603	38.75	8.04	1.39	216.2	--
	D		2.53	.27	--	--	8	4	30.0	.1340	38.75	8.04	1.00	167.0	114.8	8	17	20.0	.0603	38.75	8.04	1.32	242.0	111.9
5-3-2	R	8d	2.54	.17	.34	10.1	8	4	30.0	.1340	38.75	8.04	1.24	134.8	--	8	12	20.0	.0603	38.75	8.04	1.39	162.3	--
	D		2.52	.27	--	--	8	4	30.0	.1340	38.75	8.04	1.11	150.5	111.8	8	14	20.0	.0603	38.75	8.04	1.32	199.3	122.8
5-3-3	R	8d	2.53	.17	.35	10.9	8	4	30.0	.1340	38.75	8.04	1.17	142.6	--	8	13	20.0	.0603	38.75	8.04	1.39	175.6	--
	D		2.52	.27	--	--	8	4	30.0	.1340	38.75	8.04	1.04	160.5	112.5	8	16	20.0	.0603	38.75	8.04	1.32	227.5	129.5
5-5-1	R	20d	4.06	.24	.38	13.0	8	5	30.0	.1340	66.10	17.07	2.07	365.2	--	8	28	30.0	.1340	38.75	8.02	2.34	498.5	--
	D		4.04	.37	--	--	8	5	30.0	.1340	66.10	17.07	1.86	406.2	111.4	8	33	30.0	.1340	38.75	8.02	2.25	611.0	122.6
5-5-2	R	20d	4.07	.24	.40	11.3	8	5	30.0	.1340	66.10	17.07	2.08	363.5	--	8	27	30.0	.1340	38.75	8.02	2.34	481.0	--
	D		4.07	.37	--	--	8	5	30.0	.1340	66.10	17.07	1.92	393.7	108.3	8	28	30.0	.1340	38.75	8.02	2.25	518.2	107.7
5-5-3	R	20d	4.05	.24	.39	12.7	8	5	30.0	.1340	66.10	17.07	2.11	358.3	--	8	25	30.0	.1340	38.75	8.02	2.34	446.0	--
	D		4.05	.37	--	--	8	5	30.0	.1340	66.10	17.07	1.97	383.8	107.0	8	28	30.0	.1340	38.75	8.02	2.25	518.2	116.5
5-7-1	R	60d	6.06	.32	.33	15.8	8	4	40.0	.2340	66.10	17.07	2.73	387.0	--	8	17	40.0	.2340	38.75	8.02	2.79	445.0	--
	D		6.07	.52	--	--	8	4	40.0	.2340	66.10	17.07	2.40	440.6	114.0	8	20	40.0	.2340	38.75	8.02	2.65	548.1	123.7
5-7-2	R	60d	6.05	.32	.35	14.4	8	4	40.0	.2340	66.10	17.07	2.61	404.5	--	8	19	40.0	.2340	38.75	8.02	2.79	495.0	--
	D		6.06	.52	--	--	8	4	40.0	.2340	66.10	17.07	2.37	445.8	110.2	8	22	40.0	.2340	38.75	8.02	2.65	603.2	121.7
5-7-3	R	60d	6.06	.32	.37	13.4	8	4	40.0	.2340	66.10	17.07	2.40	440.0	--	8	22	40.0	.2340	38.75	8.02	2.79	573.1	--
	D		6.06	.52	--	--	8	4	40.0	.2340	66.10	17.07	2.11	500.5	113.7	8	26	40.0	.2340	38.75	8.02	2.65	713.0	124.4

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of nail minus two-thirds the length of the nail point. ← penetration

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

17843M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

B.E.N. 12/19/22

Table 6.--Results of tests to determine work in driving regular and diamond-pointed nails into green white pine.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
							Nails driven small number of blows - pendulum hammer[1]										Nails driven large number of light blows - pendulum hammer							
Stick No.[3]	Kind of nail	Size of nails	Average overall length of nails	Average length of nail point	Specific gravity based on oven-dry weight and volume at test	Moisture content of stick when nails were driven	No. of nails driven	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Average depth driven[2]	Work: Per inch penetration	Work: Ratio D/R	No. of nails	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Depth driven[2]	Work: Per inch penetration	Work: Ratio D/R
			Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
6-1-1	Reg.	4d	1.51	.14	.32	76.1	8	2	20.0	.0603	38.75	8.04	.75	50.1	--	8	12	10.0	.0152	38.75	8.04	.91	62.4	--
	Dia.		1.52	.22	--	--	8	2	20.0	.0603	38.75	8.04	.69	54.4	108.6	8	11	10.0	.0152	38.75	8.04	.85	61.3	98.3
6-1-2	R	4d	1.51	.14	.32	62.4	8	2	20.0	.0603	38.75	8.04	.80	46.9	--	8	12	10.0	.0152	38.75	8.04	.91	62.4	--
	D		1.52	.22	--	--	8	2	20.0	.0603	38.75	8.04	.73	51.5	109.5	8	11	10.0	.0152	38.75	8.04	.85	61.3	98.3
6-1-3	R	4d	1.51	.14	.35	34.2	8	2	20.0	.0603	38.75	8.04	.73	51.4	--	8	13	10.0	.0152	38.75	8.04	.91	67.7	--
	D		1.52	.22	--	--	8	2	20.0	.0603	38.75	8.04	.67	56.1	109.0	8	12	10.0	.0152	38.75	8.04	.85	66.9	98.8
6-3-1	R	8d	2.52	.17	.32	88.6	8	2	30.0	.1340	38.75	8.04	1.09	76.6	--	8	16	15.0	.0341	38.75	8.04	1.39	122.4	--
	D		2.52	.27	--	--	8	2	30.0	.1340	38.75	8.04	.98	85.2	111.2	8	16	15.0	.0341	38.75	8.04	1.32	128.8	105.0
6-3-2	R	8d	2.53	.17	.33	80.7	8	2	30.0	.1340	38.75	8.04	1.08	77.4	--	8	13	15.0	.0341	38.75	8.04	1.39	99.2	--
	D		2.50	.27	--	--	8	2	30.0	.1340	38.75	8.04	1.00	83.6	108.0	8	14	15.0	.0341	38.75	8.04	1.32	112.7	113.5
6-3-3	R	8d	2.53	.17	.31	70.4	8	2	30.0	.1340	38.75	8.04	1.07	78.1	--	8	14	15.0	.0341	38.75	8.04	1.39	107.0	--
	D		2.52	.27	--	--	8	2	30.0	.1340	38.75	8.04	.98	85.3	109.1	8	15	15.0	.0341	38.75	8.04	1.32	120.8	112.9
6-5-1	R	20d	4.04	.24	.35	73.0	8	1	30.0	.1340	66.10	17.07	2.21	205.3	--	8	14	30.0	.1340	38.75	8.02	2.34	249.3	--
	D		4.05	.37	--	--	8	1	30.0	.1340	66.10	17.07	2.13	213.0	103.7	8	14	30.0	.1340	38.75	8.02	2.25	259.2	103.9
6-5-2	R	20d	4.05	.24	.36	37.2	8	1	30.0	.1340	66.10	17.07	2.25	201.8	--	8	12	30.0	.1340	38.75	8.02	2.34	213.6	--
	D		4.06	.37	--	--	8	1	30.0	.1340	66.10	17.07	2.13	213.0	105.6	8	13	30.0	.1340	38.75	8.02	2.25	240.8	112.8
6-5-3	R	20d	4.06	.24	.28	73.9	8	1	30.0	.1340	66.10	17.07	2.22	204.5	--	8	15	30.0	.1340	38.75	8.02	2.34	267.2	--
	D		4.05	.37	--	--	8	1	30.0	.1340	66.10	17.07	2.07	219.0	107.1	8	15	30.0	.1340	38.75	8.02	2.25	278.0	104.0
6-7-1	R	60d	6.06	.32	.34	46.2	8	1	40.0	.2340	66.10	17.07	2.64	300.0	--	8	13	40.0	.2340	38.75	8.02	2.79	338.8	--
	D		6.08	.52	--	--	8	1	40.0	.2340	66.10	17.07	2.47	321.0	107.1	8	14	40.0	.2340	38.75	8.02	2.65	383.8	113.2
6-7-2	R	60d	6.07	.32	.36	44.6	8	1	40.0	.2340	66.10	17.07	2.36	336.0	--	8	16	40.0	.2340	38.75	8.02	2.79	417.0	--
	D		6.08	.52	--	--	8	1	40.0	.2340	66.10	17.07	2.21	358.8	106.9	8	18	40.0	.2340	38.75	8.02	2.65	493.6	118.4
6-7-3	R	60d	6.06	.32	.34	61.8	8	1	40.0	.2340	66.10	17.07	2.40	330.1	--	7	17	40.0	.2340	38.75	8.02	2.79	442.9	--
	D		6.08	.52	--	--	8	1	40.0	.2340	66.10	17.07	2.25	352.5	106.7	9	13	40.0	.2340	38.75	8.02	2.65	493.6	111.5

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of nails minus two-thirds the length of the nail point. penetration

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(5) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

17844 M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

Table 7.--Results of tests to determine work in driving plain and barbed nails with regular heads and points

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
					Specific gravity	Moisture content	Nails driven small number of blows - pendulum hammer[1]										Nails driven large number of light blows - pendulum hammer							
Stick No.[3]	Kind of nail	Size of nails	Average overall length of nail	Average length of nail point	of stick based on oven-dry volume at test	of stick when nails were driven	No. of nails driven	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Work: Average depth driven[2]	Work: Per inch penetration	Work: Ratio B/R	No. of nails	No. of blows	Drop angle: Degrees	Drop angle: Versed sine	Weight of pendulum	Distance: center of gravity below axis	Depth driven[2]	Work: Per inch penetration	Work: Ratio B/R
			Inches	Inches		Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent					Lbs.	Inches	Inches	In.-lbs.	Per cent
5-3-1-S	Reg.	8d	2.52	.17	.35	10.3	8	4	30.0	.1340	38.75	8.04	1.22	137.0	--	8	12	20.0	.0603	38.75	8.04	1.39	162.3	--
	Barb.		2.52	.17	--	--	8	4	30.0	.1340	38.75	8.04	1.29	129.5	94.6	8	12	20.0	.0603	38.75	8.04	1.32	170.7	105.1
5-3-2-S	R	8d	2.53	.17	.33	10.3	8	4	30.0	.1340	38.75	8.04	1.21	138.0	--	8	12	20.0	.0603	38.75	8.04	1.39	162.3	--
	B		2.52	.17	--	--	8	4	30.0	.1340	38.75	8.04	1.31	127.5	92.4	8	11	20.0	.0603	38.75	8.04	1.32	156.5	96.4
5-3-3-S	R	8d	2.52	.17	.33	10.0	8	4	30.0	.1340	38.75	8.04	1.08	154.7	--	8	16	20.0	.0603	38.75	8.04	1.39	216.3	--
	B		2.52	.17	--	--	8	4	30.0	.1340	38.75	8.04	1.18	141.5	91.5	8	14	20.0	.0603	38.75	8.04	1.32	199.1	92.1

[1]The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2]The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall penetration minus two-thirds the length of the nail point.

[3]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of the stick was subjected before nails were pulled.
One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

Table 7a.--Results of tests to determine work in pulling plain and barbed nails with regular heads and points

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
					Pendulum withdrawal								Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance: center of gravity below axis	Initial angle: Degrees	Initial angle: Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work: Per inch withdrawn	Work: Ratio B/R	Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio B/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent	Per cent		Lbs.	Per cent	Per cent	
5-3-1-S	Reg.	10.3	4	64.29	17.45	59.8	.4970	.6016	1.39	485.5	--	--	4	66	--	--	
	Barb.	--	4	64.29	17.45	59.8	.4970	.5683	1.32	533.6	99.6	--	4	80	115.3	--	
	B	58.6	4	64.29	17.45	59.8	.4970	.0376	1.39	30.4	--	62.5	4	81	--	122.7	Half of stick was soaked 84 days before pulling nails.
	B	--	4	64.29	17.45	59.8	.4970	.0496	1.32	42.2	138.8	87.2	4	94	110.7	117.5	
5-3-2-S	R	10.3	4	64.29	17.45	59.8	.4970	.5971	1.39	482.6	--	--	4	69	--	--	
	B	--	4	64.29	17.45	59.8	.4970	.5673	1.32	482.5	100.1	--	4	99	94.8	--	
	R	8.0	4	64.29	17.45	59.8	.4970	.0854	1.39	68.9	--	14.3	4	174	--	252.2	Half of stick was dried 313 days before pulling nails.
	B	--	4	64.29	17.45	59.8	.4970	.0770	1.32	65.5	95.1	13.6	4	158	86.4	229.0	
5-3-3-S	R	10.0	4	64.29	17.45	59.7	.4955	.5998	1.39	484.0	--	--	4	106	--	--	
	B	--	4	64.29	17.45	59.7	.4955	.5892	1.32	484.0	130.0	--	4	82	73.0	--	
	R	9.0	4	64.29	17.45	59.7	.4955	.0790	1.39	64.5	--	15.3	4	143	--	134.9	Half of stick was soaked 82 days then dried 332 days before pulling nails.
	B	--	4	64.29	17.45	59.7	.4955	.1045	1.32	38.9	138.3	13.4	4	287	190.5	350.0	

[1]The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axie equals the vertical drop of the center of gravity of pendulum.

[2]The length withdrawn is taken as the penetration of the nail including point, minus two-thirds the length of the nail point.

[3]Length withdrawn same as Column 10.

[4]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.
One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

18078 M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
MARCH 21, 1923.

G.E.H.
1-13-23

Table 8.--Work in driving regular and diamond-pointed nails into, and pulling them from, dry Douglas fir - Relative penetration after each successive blow

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
														Penetration After Driving[2]										
								Drop angle				First blow[1]		Second blow		Third blow		Fourth blow		Total depth driven		Work		
Stick No.[3]	Kind of nail	Size of nail	Average overall length of nail	Average length of nail point	Specific gravity of stick based on oven-dry weight - Vol. at test	Moisture content of stick	No. of nails driven	Degrees	Versed sine	Weight of pendulum	Distance center of gravity below axis	Actual	Ratio D/R	Actual	Ratio D/R	Actual	Ratio D/R	Actual	Ratio D/R	Actual	Ratio D/R	Per inch penetration	Ratio D/R	Remarks
			Inches	Inches		Per cent				Lbs.	Inches	Inches	Per cent	Inches	Per cent	Inches	Per cent	Inches	Per cent	Inches	Per cent	In.-lbs.	Per cent	
1-3a-1	Reg.	8d	2.54	.17	.45	14.5	16	60.0	.5000	38.75	8.04	.80	--	1.37	--	1.82	--	--	--	1.82	--	256.8	--	Driven into radial face
	Dia.	8d	2.55	.27	--	--	16	60.0	.5000	38.75	8.04	.76	95.0	1.30	94.9	1.73	95.1	--	--	1.73	95.1	270.9	105.5	" " " "
1-3a-2	R	8d	2.54	.17	.51	11.2	18	60.0	.5000	38.75	8.04	.67	--	1.18	--	1.60	--	1.96	--	1.96	--	318.0	--	" " tangential "
	D	8d	2.53	.27	--	--	18	60.0	.5000	38.75	8.04	.60	89.6	1.08	91.5	1.49	93.1	1.82	92.9	1.82	92.9	342.4	107.6	" " " "
1-3a-3	R	8d	2.53	.17	.40	12.2	22	50.0	.3572	38.75	8.04	.58	--	1.00	--	1.34	--	1.63	--	1.63	--	273.2	--	" " " "
	D	8d	2.54	.27	--	--	22	50.0	.3572	38.75	8.04	.53	91.4	.92	92.0	1.24	92.5	1.52	93.3	1.52	93.3	292.8	107.1	" " " "

26	27	28	29	30	31	32	33	34	35	36
						PULLING				
					Drop angle		Difference in versed sines of initial and final angles[5]	Length withdrawn[4]	Work	
Stick No.[3]	Kind of nail	Size of nail	Weight of pendulum	Distance center of gravity below axis	Degrees	Versed sine			Per inch withdrawn	Ratio D/R
			Lbs.	Inches				Inches	In.-lbs.	Per cent
1-3a-1	R	8d	64.29	17.45	75.2	.7446	.2325	1.82	143.4	--
	D	8d	64.29	17.45	75.2	.7446	.2119	1.73	137.4	95.8
1-3a-2	R	8d	64.29	17.45	75.2	.7446	.2885	1.96	165.1	--
	D	8d	64.29	17.45	75.2	.7446	.2507	1.82	154.5	93.6
1-3a-3	R	8d	64.29	17.45	75.2	.7446	.2240	1.63	154.3	--
	D	8d	64.29	17.45	75.2	.7446	.1973	1.52	145.7	94.5

[1] The number of blows was approximately the number required by a carpenter to drive nails to the same depth.

[2] The penetration of the nail point is based on the penetration of an equivalent volume the diameter of the shank, taken as one-third the length of point. The penetration is then the overall length of nail minus two-thirds the length of the nail point.

[3] These sticks were not subjected to conditioning treatments subsequent to driving nails, but were pulled the same day as driven.

[4] The length withdrawn is the same as the total depth driven, column 21.

[5] The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

18126M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922. H.E.N. 1-24-23

Table 1a.--Results of tests to determine work in pulling regular and diamond-pointed nails from dr/ Douglas fir before and after conditioning

Sheet 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
					Pendulum withdrawal								Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance: center of gravity: below axis	Initial angle: Degrees	Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work: Per inch withdrawn	Work: Ratio D/R	Work: Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
1-1-1	Reg.	14.3	10	64.29	17.45	40.2	.2362	.0515	.76	76.0	--	--	--	--	--	--	
	Dia.	--	10	64.29	17.45	40.2	.2362	.0464	.72	72.2	95.0	--	--	--	--	--	
	R	38.1	10	64.29	17.45	40.2	.2362	.0216	.76	31.9	--	41.9	--	--	--	--	Half of stick was soaked 63 days
	D	--	10	64.29	17.45	40.2	.2362	.0197	.68	32.5	101.8	45.0	--	--	--	--	before pulling nails.
1-1-2	R	14.6	10	64.29	17.45	40.2	.2362	.0472	.78	67.9	--	--	--	--	--	--	
	D	--	10	64.29	17.45	40.2	.2362	.0428	.70	68.6	101.0	--	--	--	--	--	
	R	12.7	10	64.29	17.45	40.0	.2340	.0425	.75	63.6	--	93.8	--	--	--	--	Half of stick was dried 91 days
	D	--	10	64.29	17.45	40.0	.2340	.0373	.67	62.4	98.1	91.0	--	--	--	--	before pulling nails.
1-1-3	R	14.9	10	64.29	17.45	40.0	.2340	.0486	1.04	52.5	--	--	--	--	--	--	
	D	--	10	64.29	17.45	40.0	.2340	.0456	.98	52.3	99.7	--	--	--	--	--	
	R	9.0	9	64.29	17.45	40.0	.2340	.0212	1.04	22.8	--	43.4	--	--	--	--	Half of stick was soaked 44 days then dried
	D	--	9	64.29	17.45	40.0	.2340	.0195	.97	22.5	98.8	43.0	--	--	--	--	324 days before pulling nails.
1-2-1	R	13.8	10	64.29	17.45	60.0	.5000	.0776	1.34	65.0	--	--	--	--	--	--	
	D	--	10	64.29	17.45	60.0	.5000	.0747	1.22	68.5	105.4	--	--	--	--	--	
	R	36.6	10	64.29	17.45	60.0	.5000	.0374	1.35	31.1	--	47.8	--	--	--	--	Half of stick was soaked 17 days
	D	--	10	64.29	17.45	60.0	.5000	.0345	1.27	30.5	98.1	44.5	--	--	--	--	before pulling nails.
1-2-2	R	13.7	10	64.29	17.45	60.0	.5000	.0800	1.39	64.5	--	--	--	--	--	--	
	D	--	10	64.29	17.45	60.0	.5000	.0811	1.30	70.1	108.7	--	--	--	--	--	
	R	12.7	10	64.29	17.45	60.0	.5000	.0776	1.39	62.6	--	97.1	--	--	--	--	Half of stick was dried 17 days
	D	--	10	64.29	17.45	60.0	.5000	.0821	1.29	71.4	114.0	101.7	--	--	--	--	before pulling nails.
1-3-1	R	14.0	9	64.29	17.45	75.2	.7445	.2174	1.70	143.5	--	--	--	--	--	--	
	D	--	11	64.29	17.45	75.2	.7445	.1935	1.62	135.9	95.3	--	--	--	--	--	
	R	44.3	11	64.29	17.45	75.2	.7445	.0695	1.66	48.3	--	32.3	--	--	--	--	Half of stick was soaked 61 days
	D	--	9	64.29	17.45	75.2	.7445	.0659	1.59	45.1	97.5	33.7	--	--	--	--	before pulling nails.
1-3-2	R	14.0	10	64.29	17.45	75.2	.7445	.1708	1.58	115.2	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.1569	1.54	109.6	96.3	--	--	--	--	--	
	R	12.8	10	64.29	17.45	75.2	.7445	.1721	1.69	114.2	--	100.5	--	--	--	--	Half of stick was dried 89 days
	D	--	10	64.29	17.45	75.2	.7445	.1659	1.59	117.1	102.6	107.0	--	--	--	--	before pulling nails.
1-3-3	R	13.2	4	64.29	17.45	75.1	.7429	.2571	1.45	199.0	--	--	4	214	--	--	
	D	--	4	64.29	17.45	75.1	.7429	.2308	1.31	225.0	112.0	--	4	266	124.3	--	
	R	11.2	4	64.29	17.45	75.1	.7429	.1062	1.45	93.7	--	42.1	4	177	--	82.7	Half of stick was soaked 39 days then dried
	D	--	4	64.29	17.45	75.1	.7429	.1444	1.32	122.6	146.4	55.0	4	266	150.2	100.0	219 days before pulling nails.
1-4-1	R	14.3	10	64.29	17.45	75.2	.7445	.4120	2.06	226.6	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.3379	1.97	192.4	84.9	--	--	--	--	--	
	R	47.8	10	64.29	17.45	75.2	.7445	.0864	2.05	47.4	--	21.1	--	--	--	--	Half of stick was soaked 62 days
	D	--	10	64.29	17.45	75.2	.7445	.0858	1.97	48.8	102.4	25.4	--	--	--	--	before pulling nails.
1-4-2	R	14.2	10	64.29	17.45	75.2	.7445	.2593	2.08	142.0	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.2494	2.00	140.0	100.0	--	--	--	--	--	
	R	12.7	10	64.29	17.45	75.2	.7445	.2360	2.08	127.3	--	91.1	--	--	--	--	Half of stick was dried 87 days
	D	--	10	64.29	17.45	75.2	.7445	.2280	2.02	126.7	99.5	90.6	--	--	--	--	before pulling nails.
1-5-1	R	14.9	10	98.77	22.28	75.2	.7445	.4415	2.77	325.0	--	--	--	--	--	--	
	D	--	10	98.77	22.28	75.2	.7445	.3718	2.88	283.7	87.1	--	--	--	--	--	
	R	50.0	10	98.77	22.28	75.2	.7445	.1010	2.96	75.1	--	23.1	--	--	--	--	Half of stick was soaked 147 days
	D	--	10	98.77	22.28	75.2	.7445	.1208	2.96	89.4	119.0	31.5	--	--	--	--	before pulling nails.
1-5-2	R	14.4	10	98.77	22.28	75.2	.7445	.4002	2.82	312.4	--	--	--	--	--	--	
	D	--	10	98.77	22.28	75.2	.7445	.3535	2.69	269.0	92.5	--	--	--	--	--	
	R	14.9	10	98.77	22.28	75.2	.7445	.2477	2.81	178.2	--	55.9	--	--	--	--	Half of stick was dried 277 days
	D	--	10	98.77	22.28	75.2	.7445	.2339	2.68	192.0	107.7	66.4	--	--	--	--	before pulling nails.
1-5-3	R	14.5	4	98.77	22.28	75.0	.7412	.3194	2.84	247.4	--	--	4	183	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.2657	2.75	212.7	86.0	--	4	208	113.6	--	
	R	14.2	4	98.77	22.28	75.0	.7412	.2021	2.84	156.6	--	63.3	4	207	--	113.1	Half of stick was soaked 127 days then dried
	D	--	4	98.77	22.28	75.0	.7412	.1882	2.75	150.5	96.1	70.7	4	194	93.8	93.3	132 days before pulling nails.

Note: See sheet 2 for footnotes.

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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

Table 1a(continued)

Sheet 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Pendulum withdrawal										Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance center of gravity below axis	Initial angle Degrees	Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work[3] Per inch withdrawn	Ratio D/R	Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
1-7-1	R	13.4	4	98.77	22.28	75.0	.7412	.5083	2.79	401.0	--	--	4	260	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.4930	2.65	409.0	102.0	--	4	360	138.5	--	
	R	48.0	4	98.77	22.28	75.0	.7412	.1086	2.79	81.8	--	20.4	4	210	--	80.8	Half of stick was soaked 128 days
	D	--	4	98.77	22.28	75.0	.7412	.1073	2.65	89.0	108.7	21.8	4	233	110.9	64.7	before pulling nails.
1-7-2	R	14.7	4	98.77	22.28	75.0	.7412	.4664	2.79	368.0	--	--	4	290	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.4596	2.65	374.0	101.5	--	4	371	127.9	--	
	R	13.2	4	98.77	22.28	75.0	.7412	.2354	2.79	185.5	--	50.4	4	169	--	58.3	Half of stick was dried 253 days
	D	--	4	98.77	22.28	75.0	.7412	.2241	2.65	186.1	100.4	49.8	4	208	123.1	56.1	before pulling nails.
1-7-3	R	15.4	4	98.77	22.28	75.1	.7429	.3415	2.79	269.0	--	--	4	146	--	--	
	D	--	4	98.77	22.28	75.1	.7429	.3487	2.65	289.5	107.6	--	4	210	143.8	--	
	R	11.0	4	98.77	22.28	75.1	.7429	.1812	2.79	142.8	--	53.0	4	162	--	111.0	Half of stick was soaked 120 days then dried
	D	--	4	98.77	22.28	75.1	.7429	.1729	2.65	143.5	100.5	49.6	4	154	95.1	73.3	235 days before pulling nails.

[1]The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

[2]The length withdrawn is taken as the full length [illegible] including point, minus two-thirds the length of the nail point.

[3]Length withdrawn same as Column 10.

[4]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.
One-half of sticks whose numbers end with
(1) soaked before pulling,
(2) air seasoned before pulling,
(3) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

17846M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

H.E.H.
1-15-23

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Pendulum withdrawal										Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance center of gravity below axis	Initial angle: Degrees	Initial angle: Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work: Per inch withdrawn	Work: Ratio D/R	Work: Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
2-1-1	Reg.	27.1	10	64.29	17.45	40.2	.2362	.0647	1.10	66.0	--	--	--	--	--	--	
	Dia.	--	10	64.29	17.45	40.2	.2362	.0595	1.04	64.0	97.0	--	--	--	--	--	
	R	52.9	10	64.29	17.45	40.2	.2362	.0331	1.04	35.7	--	54.1	--	--	--	--	Half of stick was soaked 54 days before pulling nails.
	D	--	10	64.29	17.45	40.2	.2362	.0326	.96	37.4	104.7	58.4	--	--	--	--	
2-1-2	R	66.6	10	64.29	17.45	40.2	.2362	.0682	1.06	72.2	--	--	--	--	--	--	
	D	--	10	64.29	17.45	40.2	.2362	.0620	.98	70.9	98.2	--	--	--	--	--	
	R	13.0	10	64.29	17.45	40.2	.2362	.0607	1.15	59.2	--	82.0	--	--	--	--	Half of stick was dried 272 days before pulling nails.
	D	--	10	64.29	17.45	40.2	.2362	.0569	1.07	59.8	101.0	84.0	--	--	--	--	
2-1-3	R	29.3	10	64.29	17.45	40.2	.2362	.0681	1.05	72.8	--	--	--	--	--	--	
	D	--	10	64.29	17.45	40.2	.2362	.0628	.98	71.9	98.8	--	--	--	--	--	
	R	8.0	10	64.29	17.45	40.2	.2362	.0338	.97	39.1	--	53.7	--	--	--	--	Half of stick was soaked 53 days then dried 323 days before pulling nails.
	D	--	10	64.29	17.45	40.2	.2362	.0305	.92	37.0	94.6	51.5	--	--	--	--	
2-2-1	R	93.6	10	64.29	17.45	60.0	.5000	.1302	1.54	94.8	--	--	--	--	--	--	
	D	--	10	64.29	17.45	60.0	.5000	.1285	1.42	101.2	106.8	--	--	--	--	--	
	R	102.9	10	64.29	17.45	60.0	.5000	.0822	1.65	55.9	--	58.9	--	--	--	--	Half of stick was soaked 52 days before pulling nails
	D	--	10	64.29	17.45	60.0	.5000	.0863	1.54	63.0	112.8	62.2	--	--	--	--	
2-2-2	R	30.2	10	64.29	17.45	60.0	.5000	.1417	1.59	100.5	--	--	--	--	--	--	
	D	--	10	64.29	17.45	60.0	.5000	.1317	1.46	101.2	100.8	--	--	--	--	--	
	R	12.2	10	64.29	17.45	60.0	.5000	.0828	1.59	58.3	--	57.9	--	--	--	--	Half of stick was dried 271 days before pulling nails.
	D	--	10	64.29	17.45	60.0	.5000	.0730	1.46	55.4	95.1	54.7	--	--	--	--	
2-2-3	R	30.2	10	64.29	17.45	60.0	.5000	.1364	1.60	95.6	--	--	--	--	--	--	
	D	--	10	64.29	17.45	60.0	.5000	.1324	1.47	100.9	105.5	--	--	--	--	--	
	R	12.9	10	64.29	17.45	60.0	.5000	.0886	1.54	63.1	--	66.0	--	--	--	--	Half of stick was soaked 52 days then dried 219 days before pulling nails.
	D	--	10	64.29	17.45	60.0	.5000	.0720	1.44	56.0	88.8	55.5	--	--	--	--	
2-3-1	R	28.2	10	64.29	17.45	75.2	.7445	.2801	1.77	177.6	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.2622	1.75	168.1	94.8	--	--	--	--	--	
	R	41.1	10	64.29	17.45	75.2	.7445	.1655	1.62	101.9	--	57.4	--	--	--	--	Half of stick was soaked 52 days before pulling nails.
	D	--	10	64.29	17.45	75.2	.7445	.1599	1.75	102.6	100.7	61.0	--	--	--	--	
2-3-2	R	30.2	10	64.29	17.45	75.2	.7445	.2693	1.79	181.2	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.2758	1.79	173.0	95.6	--	--	--	--	--	
	R	12.4	10	64.29	17.45	75.2	.7445	.1330	1.80	82.8	--	45.7	--	--	--	--	Half of stick was dried 270 days before pulling nails.
	D	--	10	64.29	17.45	75.2	.7445	.1175	1.80	73.5	88.5	42.4	--	--	--	--	
2-3-3	R	29.2	9	64.29	17.45	75.2	.7445	.2975	1.87	178.4	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.2894	1.80	180.5	101.2	--	--	--	--	--	
	R	12.8	10	64.29	17.45	75.2	.7445	.1269	1.82	78.2	--	43.8	--	--	--	--	Half of stick was soaked 52 days then dried 270 days before pulling nails.
	D	--	10	64.29	17.45	75.2	.7445	.1102	1.75	70.6	90.3	39.1	--	--	--	--	
2-4-1	R	29.4	10	64.29	17.45	75.2	.7445	.4249	2.18	232.5	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.4542	2.24	227.4	97.7	--	--	--	--	--	
	R	45.3	10	64.29	17.45	75.2	.7445	.2166	2.26	108.4	--	46.7	--	--	--	--	Half of stick was soaked 50 days before pulling nails.
	D	--	10	64.29	17.45	75.2	.7445	.2214	2.26	110.0	101.4	48.4	--	--	--	--	
2-4-2	R	28.6	10	64.29	17.45	75.2	.7445	.4230	2.18	217.6	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.4174	2.18	215.0	98.9	--	--	--	--	--	
	R	12.7	10	64.29	17.45	75.2	.7445	.1832	2.17	94.3	--	43.3	--	--	--	--	Half of stick was dried 268 days before pulling nails.
	D	--	10	64.29	17.45	75.2	.7445	.1757	2.18	90.5	95.9	42.1	--	--	--	--	
2-4-3	R	30.0	9	64.29	17.45	75.2	.7445	.4369	2.12	231.0	--	--	--	--	--	--	
	D	--	10	64.29	17.45	75.2	.7445	.4206	2.11	223.6	96.7	--	--	--	--	--	
	R	10.0	10	64.29	17.45	75.2	.7445	.1730	2.21	87.9	--	38.1	--	--	--	--	Half of stick was soaked 58 days then dried 312 days before pulling nails.
	D	--	10	64.29	17.45	75.2	.7445	.1483	2.11	78.8	89.6	35.2	--	--	--	--	
2-5-1	R	29.9	4	98.77	22.28	75.1	.7429	.5850	2.84	453.2	--	--	4	280	--	--	
	D	--	4	98.77	22.28	75.1	.7429	.5451	2.75	452.1	99.7	--	4	275	98.5	--	
	R	52.7	4	98.77	22.28	75.1	.7429	.1444	2.84	111.8	--	24.7	4	244	--	87.2	Half of stick was soaked 128 days before pulling nails.
	D	--	4	98.77	22.28	75.1	.7429	.1435	2.75	114.8	102.7	25.4	4	240	98.4	87.2	
2-5-2	R	30.2	8	98.77	22.28	75.3	.7462	.3884	2.79	308.9	--	--	--	--	--	--	
	D	--	8	98.77	22.28	75.3	.7462	.3584	2.65	276.8	90.2	--	--	--	--	--	
	R	10.0	10	98.77	22.28	75.3	.7462	.1803	2.64	150.3	--	49.0	--	--	--	--	Half of stick was dried 370 days before pulling nails.
	D	--	9	98.77	22.28	75.3	.7462	.1707	2.61	144.0	95.8	52.0	--	--	--	--	
2-5-3	R	31.3	10	98.77	22.28	75.2	.7445	.4397	3.09	312.8	--	--	--	--	--	--	
	D	--	9	98.77	22.28	75.2	.7445	.4191	3.12	300.6	96.4	--	--	--	--	--	
	R	11.0	7	98.77	22.28	75.2	.7445	.1376	2.96	102.3	--	32.7	--	--	--	--	Half of stick was soaked 134 days then dried 235 days before pulling nails.
	D	--	7	98.77	22.28	75.2	.7445	.1397	3.10	99.2	97.0	33.0	--	--	--	--	

Note: See sheet 2 for footnotes.

17647M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

Table 2a (continued)

Sheet 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
					Pendulum withdrawal					Work			Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance center of gravity below axis	Initial angle Degrees	Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Per inch withdrawn	Ratio D/R	Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
2-7-1	R	26.0	4	98.77	22.28	75.0	.7412	.3706	2.89	282.1	--	--	4	349	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.3349	2.76	307.8	109.0	--	4	392	112.3	--	
	R	53.5	4	98.77	22.28	75.0	.7412	.2141	2.89	163.0	--	57.8	4	322	--	92.4	Half of stick was soaked 130 days before pulling nails.
	D	--	4	98.77	22.28	75.0	.7412	.1990	2.66	163.0	100.0	53.0	4	372	115.5	94.9	
2-7-2	R	30.0	4	98.77	22.28	75.0	.7412	.3150	2.79	248.5	--	--	4	227	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.3098	2.65	257.0	103.4	--	4	291	128.2	--	
	R	11.0	4	98.77	22.28	75.0	.7412	.1772	2.79	139.6	--	56.2	4	127	--	56.0	Half of stick was dried 364 days before pulling nails.
	D	--	4	98.77	22.28	75.0	.7412	.1455	2.65	121.0	86.8	47.1	4	98	77.2	53.7	
2-7-3	R	28.7	4	98.77	22.28	75.0	.7412	.3395	2.79	267.9	--	--	4	263	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.3108	2.65	258.0	96.5	--	4	366	129.3	--	
	R	10.0	4	98.77	22.28	75.0	.7412	.1795	2.79	141.6	--	52.9	4	175	--	61.9	Half of stick was soaked 129 days then dried 235 days before pulling nails.
	D	--	4	98.77	22.28	75.0	.7412	.1685	2.65	139.9	98.8	54.2	4	208	118.9	56.8	

[1]The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

[2]The length withdrawn is taken as the full length of the nail including point, minus two-thirds the length of the nail point.

[3]Length withdrawn same as Column 10.

[4]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling,
(2) air seasoned before pulling,
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

17848M

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

G.E.H.
1-15-23

Table 3.--Results of tests to determine work in pulling regular and diamond-pointed nails from dry birch before and after conditioning

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
					Pendulum withdrawal									Static withdrawal			
		Moisture content of stick when nails were pulled			Distance center of gravity below axis	Initial angle		Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work			No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after conditioning to load before conditioning	Remarks
Stick No.[4]	Kind of nail		No. of nails	Weight of pendulum		Degrees	Versed sine			Per inch withdrawn	Ratio D/R	Ratio of work after conditioning to work before conditioning					
		Per cent		Lbs.	Inches				Inches	Inch-lbs.	Per cent			Lbs.	Per cent		
3-1-1	Reg.	12.6	4	64.29	17.45	40.0	.2340	.0544	.91	67.1	--	--	4	154	--	--	
	Dia.	--	4	64.29	17.45	40.0	.2340	.0501	.85	66.1	98.5	--	4	197	127.9	--	
	R	77.0	4	64.29	17.45	40.0	.2340	.0258	.91	31.8	--	47.5	4	99	--	64.3	Half of stick was soaked 129 days
	D	--	4	64.29	17.45	40.0	.2340	.0254	.85	30.9	97.3	46.7	4	103	104.1	52.3	before pulling nails.
3-1-2	R	11.2	4	64.29	17.45	40.0	.2340	.0548	.91	67.6	--	--	4	168	--	--	
	D	--	4	64.29	17.45	40.0	.2340	.0513	.85	67.8	100.2	--	4	200	119.0	--	
	R	10.9	4	64.29	17.45	40.0	.2340	.0630	.91	77.6	--	114.8	4	208	--	123.8	Half of stick was dried 254 days
	D	--	4	64.29	17.45	40.0	.2340	.0515	.85	67.8	87.3	100.0	4	217	104.3	108.5	before pulling nails.
3-1-3	R	12.7	4	64.29	17.45	40.0	.2340	.0655	.91	80.8	--	--	4	240	--	--	
	D	--	4	64.29	17.45	40.0	.2340	.0578	.85	76.3	94.4	--	4	241	100.4	--	
	R	12.3	4	64.29	17.45	40.0	.2340	.0359	.91	43.8	--	53.5	4	101	--	42.1	Half of stick was soaked 127 days then dried
	D	--	4	64.29	17.45	40.0	.2340	.0334	.85	44.1	102.0	57.9	4	99	98.1	41.0	126 days before pulling nails.
3-3-1	R	12.4	4	64.29	17.45	75.1	.7429	.1826	1.99	147.4	--	--	4	298	--	--	
	D	--	4	64.29	17.45	75.1	.7429	.1548	1.32	131.6	89.3	--	4	284	95.3	--	
	R	64.3	4	64.29	17.45	75.1	.7429	.0660	1.39	53.2	--	36.1	4	135	--	45.3	Half of stick was soaked 125 days
	D	--	4	64.29	17.45	75.1	.7429	.0664	1.32	56.4	106.0	42.8	4	151	116.3	53.2	before pulling nails.
3-3-2	R	11.8	4	64.29	17.45	75.1	.7429	.1962	1.39	158.4	--	--	4	348	--	--	
	D	--	4	64.29	17.45	75.1	.7429	.1621	1.32	154.9	92.8	--	4	323	92.9	--	
	R	12.0	4	64.29	17.45	75.1	.7429	.1274	1.39	102.8	--	64.8	4	231	--	66.4	Half of stick was dried 247 days
	D	--	4	64.29	17.45	75.1	.7429	.1066	1.32	90.7	88.4	58.6	4	241	104.3	74.6	before pulling nails.
3-3-3	R	12.1	4	64.29	17.45	75.1	.7429	.1532	1.39	123.7	--	--	4	274	--	--	
	D	--	4	64.29	17.45	75.1	.7429	.1455	1.32	123.8	100.1	--	4	329	120.1	--	
	R	10.0	4	64.29	17.45	75.1	.7429	.0590	1.39	47.6	--	38.5	4	98	--	35.7	Half of stick was soaked 120 days then dried
	D	--	4	64.29	17.45	75.1	.7429	.0482	1.32	41.2	86.6	33.3	4	102	104.2	31.0	230 days before pulling nails.
3-5-1	R	13.7	4	98.77	22.28	75.0	.7412	.4551	2.34	428.0	--	--	4	510	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.3572	2.25	349.1	81.6	--	4	537	105.3	--	
	R	59.3	4	98.77	22.28	75.0	.7412	.1072	2.34	100.9	--	23.6	4	205	--	40.2	Half of stick was soaked 113 days
	D	--	4	98.77	22.28	75.0	.7412	.1093	2.25	106.8	105.8	30.6	4	200	97.6	37.3	before pulling nails.
3-5-2	R	13.5	4	98.77	22.28	75.1	.7429	.4450	2.34	418.5	--	--	4	547	--	--	
	D	--	4	98.77	22.28	75.1	.7429	.3487	2.25	340.9	81.4	--	4	597	109.2	--	
	R	12.2	4	98.77	22.28	75.1	.7429	.3038	2.34	285.5	--	68.2	4	330	--	60.3	Half of stick was dried 247 days
	D	--	4	98.77	22.28	75.1	.7429	.2727	2.25	266.7	93.4	78.5	4	303	91.8	50.7	before pulling nails.
3-5-3	R	12.7	4	98.77	22.28	75.0	.7412	.4638	2.34	436.0	--	--	4	558	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.3627	2.25	354.4	81.2	--	4	553	99.1	--	
	R	14.0	4	98.77	22.28	75.0	.7412	.1146	2.34	107.8	--	24.7	4	102	--	18.2	Half of stick was soaked 113 days then dried
	D	--	4	98.77	22.28	75.0	.7412	.1174	2.25	114.8	106.5	32.3	4	127	124.5	22.9	234 days before pulling nails.
3-7-1	R	13.1	4	98.77	22.28	75.1	.7429	.3157	2.29	303.1	--	--	4	392	--	--	
	D	--	4	98.77	22.28	75.1	.7429	.4039	2.15	413.0	136.2	--	5	526	134.2	--	
	R	62.0	4	98.77	22.28	75.1	.7429	.0935	2.29	89.8	--	29.6	4	231	--	58.8	Half of stick was soaked 111 days
	D	--	4	98.77	22.28	75.1	.7429	.0907	2.15	92.9	103.4	22.5	4	223	96.6	42.4	before pulling nails.
3-7-2	R	13.0	4	98.77	22.28	75.2	.7445	.5121	2.29	492.5	--	--	4	681	--	--	
	D	--	4	98.77	22.28	75.2	.7445	.4729	2.15	483.8	98.2	--	4	828	121.5	--	
	R	12.6	4	98.77	22.28	75.2	.7445	.3033	2.29	291.3	--	59.2	4	394	--	57.8	Half of stick was dried 237 days
	D	--	4	98.77	22.28	75.2	.7445	.3048	2.15	311.8	106.9	64.4	3	387	98.3	46.8	before pulling nails.
3-7-3	R	13.5	4	98.77	22.28	75.1	.7429	.3874	2.29	372.2	--	--	4	412	--	--	
	D	--	4	98.77	22.28	75.1	.7429	.4563	2.15	466.9	125.4	--	4	613	148.8	--	
	R	11.3	4	98.77	22.28	75.1	.7429	.1352	2.29	129.4	--	34.8	4	139	--	33.8	Half of stick was soaked 109 days then dried
	D	--	4	98.77	22.28	75.1	.7429	.1246	2.15	128.0	99.0	27.4	4	145	104.3	23.7	234 days before pulling nails.

[1] The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

[2] The length withdrawn is taken as the full length [illegible] including point, minus two-thirds the length of the nail point.

[3] Length withdrawn same as Column 10.

[4] The first digit of the stick number is the series number and refers to the species; the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.
One-half of sticks whose numbers end with
(1) soaked before pulling,
(2) air seasoned before pulling,
(3) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

H.E.N. 1-15-'23

Table 4a.--Results of tests to determine work in pulling regular and diamond-pointed nails from green birch before and after conditioning

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Pendulum withdrawal										Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance of center of gravity below axis	Initial angle: Degrees	Initial angle: Versed sine	Difference in versed sines of initial and final angles[1]	Length with-drawn[2]	Work: Per inch with-drawn	Work: Ratio D/R	Work: Ratio of work after to work before conditioning	No. of nails	Maximum load per inch with-drawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
4-1-1	Reg.	55.2	4	64.29	17.45	40.0	.2340	.0681	.91	84.0	--	--	4	[illegible]	--	--	
	Dia.	--	4	64.29	17.45	40.0	.2340	.0586	.85	77.3	92.0	--	4	[illegible]	98.6	--	
	R	76.0	4	64.29	17.45	40.0	.2340	.0415	.91	51.2	--	61.0	4	190	--	68.1	Half of stick was soaked 108 days before pulling nails.
	D	--	4	64.29	17.45	40.0	.2340	.0382	.85	50.3	98.2	65.1	4	217	114.2	78.6	
4-1-2	R	65.0	4	64.29	17.45	40.0	.2340	.0662	.91	81.5	--	--	4	269	--	--	
	D	--	4	64.29	17.45	40.0	.2340	.0603	.85	79.5	97.6	--	4	[illegible]	102.3	--	
	R	12.1	4	64.29	17.45	40.0	.2340	.0455	.91	56.0	--	68.8	4	[illegible]	--	58.8	Half of stick was dried 233 days before pulling nails.
	D	--	4	64.29	17.45	40.0	.2340	.0417	.85	55.0	98.2	69.2	4	190	120.3	69.1	
4-1-3	R	66.3	4	64.29	17.45	40.0	.2340	.0679	.91	83.8	--	--	4	246	--	--	
	D	--	4	64.29	17.45	40.0	.2340	.0608	.85	80.2	95.7	--	4	233	94.8	--	
	R	9.0	4	64.29	17.45	40.0	.2340	.0239	.91	29.4	--	35.1	4	70	--	28.5	Half of stick was soaked 107 days then dried 230 days before pulling nails.
	D	--	4	64.29	17.45	40.0	.2340	.0230	.85	30.4	103.4	37.9	4	71	101.4	30.4	
4-3-1	R	53.2	4	64.29	17.45	75.2	.7445	.1734	1.39	139.9	--	--	4	392	--	--	
	D	--	4	64.29	17.45	75.2	.7445	.1464	1.32	124.4	88.9	--	4	383	97.8	--	
	R	75.0	4	64.29	17.45	75.2	.7445	.1240	1.39	100.3	--	71.7	4	344	--	87.8	Half of stick was soaked 107 days before pulling nails.
	D	--	4	64.29	17.45	75.2	.7445	.1384	1.32	117.6	111.2	94.5	4	348	101.2	90.9	
4-3-2	R	62.8	4	64.29	17.45	75.2	.7445	.1687	1.39	136.2	--	--	4	350	--	--	
	D	--	4	64.29	17.45	75.2	.7445	.1493	1.32	126.9	93.2	--	4	378	108.0	--	
	R	10.0	4	64.29	17.45	75.2	.7445	.0659	1.39	53.2	--	39.0	4	61	--	17.5	Half of stick was dried 336 days before pulling nails.
	D	--	4	64.29	17.45	75.2	.7445	.0443	1.32	37.6	70.7	29.7	4	59	96.7	15.6	
4-3-3	R	60.6	4	64.29	17.45	75.2	.7445	.1667	1.39	131.3	--	--	4	395	--	--	
	D	--	4	64.29	17.45	75.2	.7445	.1583	1.32	134.6	102.5	--	4	432	109.3	--	
	R	10.0	4	64.29	17.45	75.2	.7445	.0939	1.39	75.7	--	57.6	4	158	--	40.0	Half of stick was soaked 106 days then dried 232 days before pulling nails.
	D	--	4	64.29	17.45	75.2	.7445	.0746	1.32	63.4	83.8	47.1	4	138	87.4	31.9	
4-3-1-S	R	61.9	4	64.29	17.45	75.0	.7412	.1889	1.56	135.8	--	--	4	285	--	--	
	D	--	4	64.29	17.45	75.0	.7412	.1795	1.59	126.6	93.3	--	4	273	97.8	--	
	R	88.2	4	64.29	17.45	75.0	.7412	.1117	1.56	80.3	--	59.2	4	268	--	94.1	Half of stick was soaked 85 days before pulling nails.
	D	--	4	64.29	17.45	75.0	.7412	.1101	1.59	77.7	96.8	61.3	4	261	99.3	95.6	
4-3-2-S	R	62.8	4	64.29	17.45	75.0	.7412	.2080	1.56	149.5	--	--	4	321	--	--	
	D	--	4	64.29	17.45	75.0	.7412	.1901	1.59	134.1	89.8	--	4	296	94.0	--	
	R	10.0	4	64.29	17.45	75.0	.7412	.1234	1.56	88.8	--	59.4	4	185	--	57.6	Half of stick was dried 314 days before pulling nails.
	D	--	3	64.29	17.45	75.0	.7412	.1099	1.59	77.5	87.3	57.8	4	152	84.0	51.3	
4-3-3-S	R	56.5	4	64.29	17.45	75.0	.7412	.2022	1.56	145.3	--	--	4	306	--	--	
	D	--	4	64.29	17.45	75.0	.7412	.1952	1.59	137.8	94.8	--	4	313	104.2	--	
	R	11.0	4	64.29	17.45	75.0	.7412	.1008	1.56	72.5	--	49.9	4	123	--	40.2	Half of stick was soaked 83 days then dried 230 days before pulling nails.
	D	--	4	64.29	17.45	75.0	.7412	.0918	1.59	64.7	89.3	47.0	4	126	104.6	40.3	
4-5-1	R	60.9	4	98.77	22.28	60.0	.5000	.3227	2.34	303.7	--	--	4	518	--	--	
	D	--	4	98.77	22.28	60.0	.5000	.2702	2.25	264.1	87.0	--	4	501	96.7	--	
	R	73.6	4	98.77	22.28	60.0	.5000	.1978	2.34	186.0	--	61.3	4	485	--	93.6	Half of stick was soaked 105 days before pulling nails.
	D	--	4	98.77	22.28	60.0	.5000	.1934	2.25	189.0	101.6	71.5	4	440	90.8	87.9	
4-5-2	R	56.8	4	98.77	22.28	60.0	.5000	.3604	2.34	338.5	--	--	4	519	--	--	
	D	--	3	98.77	22.28	60.0	.5000	.2989	2.25	292.0	86.2	--	4	503	97.0	--	
	R	13.0	4	98.77	22.28	60.0	.5000	.1569	2.34	147.3	--	43.5	4	96	--	18.5	Half of stick was dried 234 days before pulling nails.
	D	--	4	98.77	22.28	60.0	.5000	.1300	2.25	127.1	86.4	43.6	4	100	104.1	19.9	
4-5-3	R	71.6	4	98.77	22.28	60.0	.5000	.3211	2.34	302.0	--	--	4	503	--	--	
	D	--	4	98.77	22.28	60.0	.5000	.2655	2.25	259.5	86.0	--	4	523	100.0	--	
	R	11.0	4	98.77	22.28	60.0	.5000	.1091	2.34	102.5	--	33.9	4	81	--	16.1	Half of stick was soaked 104 days then dried 231 days before pulling nails.
	D	--	4	98.77	22.28	60.0	.5000	.1101	2.25	107.6	105.0	41.4	4	89	105.8	17.1	

Note: See sheet 2 for footnotes.

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MADISON, WISCONSIN
November 23, 1922.

A.E.H. 12/8/22

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
								Pendulum withdrawal						Static withdrawal			
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance: center of gravity below axis	Initial angle: Degrees	Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work: Per inch withdrawn	Work: Ratio D/R	Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	Inch-lbs.	Per cent			Lbs.	Per cent		
4-7-1	R	45.6	4	98.77	22.28	75.2	.7445	.5040	2.79	398.1	--	--	4	465	--	--	
	D	--	4	98.77	22.28	75.2	.7445	.3961	2.65	329.0	82.6	--	4	495	101.1	--	
	R	42.8	4	98.77	22.28	75.2	.7445	.2858	2.79	229.0	--	56.5	4	477	--	102.6	Half of stick was soaked 102 days before pulling nails.
	D	--	4	98.77	22.28	75.2	.7445	.2597	2.65	215.4	95.8	65.5	4	487	97.0	98.4	
4-7-2	R	38.5	4	98.77	22.28	75.1	.7429	.4909	2.79	355.5	--	--	4	386	--	--	
	D	--	4	98.77	22.28	75.1	.7429	.4170	2.65	348.0	97.4	--	4	500	123.1	--	
	R	10.5	4	98.77	22.28	75.1	.7429	.1805	2.79	142.3	--	40.1	4	108	--	27.9	Half of stick was dried 337 days before pulling nails.
	D	--	4	98.77	22.28	75.1	.7429	.1777	2.65	147.6	103.7	42.7	4	105	93.0	21.0	
4-7-3	R	45.1	4	98.77	22.28	75.2	.7445	.4747	2.79	374.1	--	--	4	540	--	--	
	D	--	4	98.77	22.28	75.2	.7445	.4135	2.65	343.4	91.8	--	4	572	106.7	--	
	R	11.5	4	98.77	22.28	75.2	.7445	.1825	2.79	143.7	--	38.4	4	131	--	24.2	Half of stick was soaked 102 days then dried 230 days before pulling nails.
	D	--	4	98.77	22.28	75.2	.7445	.1380	2.65	114.6	79.6	33.4	4	118	85.5	20.6	

[1] The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

[2] The length withdrawn is taken as the full length ~~of shank~~ including point, minus two-thirds the length of the nail point.

[3] Length withdrawn same as Column 10.

[4] The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

G.E.H. 1-15-23

Table 5a.--Results of tests to determine work in pulling regular and diamond-pointed nails from dry white pine before and after conditioning

Sheet 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Pendulum withdrawal						Static withdrawal								
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance center of gravity below axis	Initial angle: Degrees	Initial angle: Versed sine	Difference in versed sines of initial and final angles[1]	Length with- drawn[2]	Work: Per inch with- drawn	Work: Ratio D/R	Work: Ratio of work after to work before conditioning	No. of nails	Maximum load per inch with- drawn[3]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
5-1-1	Reg.	11.3	4	64.29	17.45	40.1	.2351	.0477	.91	58.8	--	--	4	64	--	--	
	Dia.	--	4	64.29	17.45	40.1	.2351	.0469	.85	61.9	105.3	--	4	67	98.3	--	
	R	62.5	4	64.29	17.45	40.1	.2351	.0165	.91	20.1	--	34.2	4	43	--	67.2	Half of stick was soaked 101 days before pulling nails.
	D	--	4	64.29	17.45	40.1	.2351	.0183	.85	22.8	113.4	36.9	4	49	107.7	73.1	
5-1-2	R	12.2	4	64.29	17.45	40.1	.2351	.0449	.91	55.4	--	--	4	52	--	--	
	D	--	4	64.29	17.45	40.1	.2351	.0433	.85	57.2	103.3	--	4	69	125.5	--	
	R	10.5	4	64.29	17.45	40.1	.2351	.0449	.91	55.4	--	100.0	4	117	--	225.5	Half of stick was dried 226 days before pulling nails.
	D	--	4	64.29	17.45	40.1	.2351	.0436	.85	57.5	103.8	100.5	4	146	117.0	211.6	
5-1-3	R	10.5	4	64.29	17.45	40.3	.2373	.0511	.91	63.0	--	--	4	73	--	--	
	D	--	4	64.29	17.45	40.3	.2373	.0353	.85	46.6	74.0	--	4	84	107.7	--	
	R	11.0	4	64.29	17.45	40.3	.2373	.0406	.91	50.0	--	79.4	4	92	--	126.0	Half of stick was soaked 98 days then dried 127 days before pulling nails.
	D	--	4	64.29	17.45	40.3	.2373	.0391	.85	51.4	102.7	110.3	4	99	100.0	117.8	
5-3-1	R	11.8	4	64.29	17.45	60.2	.5030	.1055	1.39	85.3	--	--	4	82	--	--	
	D	--	4	64.29	17.45	60.2	.5030	.1152	1.32	98.4	115.2	--	4	88	101.7	--	
	R	61.6	4	64.29	17.45	60.2	.5030	.0429	1.39	34.6	--	40.6	4	78	--	92.7	Half of stick was soaked 99 days before pulling nails.
	D	--	4	64.29	17.45	60.2	.5030	.0440	1.32	37.4	108.1	38.0	4	86	108.6	97.8	
5-3-2	R	10.1	4	64.29	17.45	60.2	.5030	.1052	1.39	84.9	--	--	4	94	--	--	
	D	--	4	64.29	17.45	60.2	.5030	.1062	1.32	90.2	106.2	--	4	110	110.7	--	
	R	10.0	4	64.29	17.45	60.2	.5030	.0974	1.39	78.6	--	92.6	4	202	--	214.5	Half of stick was dried 254 days before pulling nails.
	D	--	4	64.29	17.45	60.2	.5030	.0936	1.32	79.6	101.2	88.3	4	216	101.4	196.5	
5-3-3	R	10.9	4	64.29	17.45	60.2	.5030	.1048	1.39	84.6	--	--	4	108	--	--	
	D	--	4	64.29	17.45	60.2	.5030	.1038	1.32	88.4	104.5	--	4	111	97.4	--	
	R	12.5	4	64.29	17.45	60.2	.5030	.0760	1.39	61.3	--	72.4	4	126	--	116.7	Half of stick was soaked 98 days then dried 126 days before pulling nails.
	D	--	4	64.29	17.45	60.2	.5030	.0698	1.32	59.3	96.7	87.1	4	118	89.1	106.8	
5-5-1	R	13.0	4	64.29	17.45	75.5	.7496	.3335	2.34	160.0	--	--	4	136	--	--	
	D	--	4	64.29	17.45	75.5	.7496	.3446	2.25	171.8	107.3	--	4	142	100.6	--	
	R	--	4	64.29	17.45	75.5	.7496	.1714	2.34	82.1	--	51.3	4	150	--	110.3	Half of stick was soaked 97 days before pulling nails.
	D	--	4	64.29	17.45	75.5	.7496	.1546	2.25	77.1	93.9	44.8	4	196	125.7	137.5	
5-5-2	R	11.3	4	64.29	17.45	75.1	.7429	.4058	2.34	194.5	--	--	4	163	--	--	
	D	--	4	64.29	17.45	75.1	.7429	.3701	2.25	184.5	91.3	--	4	195	114.9	--	
	R	12.1	4	64.29	17.45	75.1	.7429	.2889	2.34	138.5	--	71.2	4	242	--	148.6	Half of stick was dried 223 days before pulling nails.
	D	--	4	64.29	17.45	75.1	.7429	.3148	2.25	157.0	109.0	85.0	4	275	109.2	141.1	
5-5-3	R	12.7	4	64.29	17.45	75.1	.7429	.3262	2.34	156.4	--	--	4	133	--	--	
	D	--	4	64.29	17.45	75.1	.7429	.3560	2.25	177.5	113.5	--	4	140	101.3	--	
	R	14.2	4	64.29	17.45	75.1	.7429	.2532	2.34	110.8	--	70.8	4	167	--	125.7	Half of stick was soaked 97 days then dried 126 days before pulling nails.
	D	--	4	64.29	17.45	75.1	.7429	.2356	2.25	117.5	106.1	66.2	4	177	101.8	126.4	

Note: See sheet 2 for footnotes.

17852 M

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FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922. 11/10/22

Table 5a (continued)

Sheet 2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
						Pendulum withdrawal							Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance center of gravity below axis	Initial angle Degrees	Initial angle Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn	Work Per inch withdrawn	Work Ratio D/R	Work Ratio of work after to work before conditioning	No. of nails	Maximum load per inch withdrawn[2]	Ratio D/R	Ratio of load after to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	In.-lbs.	Per cent			Lbs.	Per cent		
5-7-1	R	15.8	4	98.77	22.28	75.0	.7412	.1973	2.79	155.6	--	--	4	150	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.2270	2.65	188.5	121.1	--	4	180	131.3	--	
	R	9.5	4	98.77	22.28	75.0	.7412	.1569	2.79	123.6	--	79.4	4	99	--	76.1	Half of stick was dried 326 days
	D	--	4	98.77	22.28	75.0	.7412	.1578	2.65	122.9	106.0	69.5	4	130	125.0	72.2	before pulling nails.
5-7-2	R	14.4	4	98.77	22.28	75.0	.7412	.2564	2.79	207.3	--	--	4	111	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.2755	2.65	226.7	110.2	--	4	170	146.0	--	
	R	9.5	4	98.77	22.28	75.0	.7412	.1575	2.79	124.4	--	60.0	4	89	--	80.6	Half of stick was dried 329 days
	D	--	4	98.77	22.28	75.0	.7412	.1299	2.65	107.9	86.8	47.2	4	115	122.9	67.8	before pulling nails.
5-7-3	R	13.4	4	98.77	22.28	75.0	.7412	.2706	2.79	213.4	--	--	4	145	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.2746	2.65	228.0	106.8	--	4	191	125.2	--	
	R	14.9	4	98.77	22.28	75.0	.7412	.1834	2.79	144.6	--	67.8	4	129	--	89.1	Half of stick was soaked 95 days then dried
	D	--	4	98.77	22.28	75.0	.7412	.1687	2.65	140.0	96.7	61.4	4	158	136.4	82.9	128 days before pulling nails.

[1]The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

[2]The length withdrawn is taken as the full length [redacted] including point, minus two-thirds the length of the nail point.

[3]Length withdrawn same as Column 10.

[4]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.

One-half of sticks whose numbers end with
(1) soaked before pulling.
(2) air seasoned before pulling.
(3) soaked, then air seasoned before pulling.

The treatments were similar for both green and air-dry material.

17853M

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FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
November 23, 1922.

G.E.H. 1-15-23

Table ca--Results of tests to determine work in pulling regular and diamond-pointed nails from green white pine before and after conditioning

Sheet 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
						Pendulum withdrawal							Static withdrawal				
Stick No.[4]	Kind of nail	Moisture content of stick when nails were pulled	No. of nails	Weight of pendulum	Distance center of gravity below axis	Initial angle: Degrees	Initial angle: Versed sine	Difference in versed sines of initial and final angles[1]	Length withdrawn[2]	Work: Per inch withdrawn	Work: Ratio D/R	Ratio of work after conditioning to work before conditioning	No. of nails	Maximum load per inch withdrawn[3]	Ratio D/R	Ratio of load after conditioning to load before conditioning	Remarks
		Per cent		Lbs.	Inches				Inches	Ins.-lbs.	Per cent			Lbs.	Per cent		
6-1-1	Reg.	76.1	4	64.29	17.45	39.9	.2328	.0288	.91	55.5	--	--	4	75	--	--	
	Dia.	--	4	64.29	17.45	39.9	.2328	.0285	.85	57.6	105.8	--	4	71	88.3	--	
	R	123.0	4	64.29	17.45	39.9	.2328	.0187	.91	25.1	--	65.0	4	76	--	101.5	
	D	--	4	64.29	17.45	39.9	.2328	.0203	.85	26.8	116.0	71.4	4	82	101.4	115.5	
6-1-2	R	62.4	4	64.29	17.45	39.9	.2328	.0270	.91	53.3	--	--	4	57	--	--	
	D	--	4	64.29	17.45	39.9	.2328	.0267	.85	55.5	106.0	--	4	72	117.5	--	
	R	10.0	4	64.29	17.45	39.9	.2328	.0161	.91	44.5	--	135.6	4	71	--	125.0	
	D	--	4	64.29	17.45	39.9	.2328	.0294	.85	38.8	87.2	110.0	4	82	107.7	115.8	
6-1-3	R	34.2	4	64.29	17.45	39.9	.2328	.0320	.91	39.4	--	--	4	56	--	--	
	D	--	4	64.29	17.45	39.9	.2328	.0309	.85	40.8	96.7	--	4	73	121.6	--	
	R	12.3	5	64.29	17.45	39.9	.2328	.0290	.91	35.7	--	90.8	4	70	--	125.6	
	D	--	4	64.29	17.45	39.9	.2328	.0303	.85	40.8	106.8	100.0	4	75	100.0	102.7	
6-3-1	R	88.6	4	64.29	17.45	59.8	.4970	.0670	1.39	54.1	--	--	4	107	--	--	
	D	--	4	64.29	17.45	59.8	.4970	.0656	1.32	55.8	103.2	--	4	118	103.4	--	
	R	120.0	4	64.29	17.45	59.8	.4970	.0460	1.39	37.1	--	68.6	4	99	--	92.6	
	D	--	4	64.29	17.45	59.8	.4970	.0438	1.32	37.1	100.0	66.6	4	117	112.3	99.2	
6-3-2	R	80.7	4	64.29	17.45	59.8	.4970	.0575	1.39	46.4	--	--	4	113	--	--	
	D	--	4	64.29	17.45	59.8	.4970	.0691	1.32	58.7	126.5	--	4	106	89.2	--	
	R	11.2	4	64.29	17.45	59.8	.4970	.0812	1.39	65.6	--	141.4	4	138	--	122.3	
	D	--	4	64.29	17.45	59.8	.4970	.0730	1.32	62.0	94.5	105.6	4	160	109.8	150.6	
6-3-3	R	70.4	4	64.29	17.45	59.8	.4970	.0745	1.39	60.1	--	--	4	109	--	--	
	D	--	4	64.29	17.45	59.8	.4970	.0674	1.32	57.2	95.3	--	4	108	93.5	--	
	R	14.3	4	64.29	17.45	59.8	.4970	.0798	1.39	64.6	--	107.4	4	147	--	134.8	
	D	--	4	64.29	17.45	59.8	.4970	.0763	1.32	64.8	100.3	113.3	4	177	114.7	164.0	
6-5-1	R	73.0	4	64.29	16.58	75.0	.7412	.2685	2.34	122.3	--	--	4	128	--	--	
	D	--	4	64.29	16.58	75.0	.7412	.2377	2.25	112.6	92.1	--	4	164	108.8	--	
	R	80.5	4	64.29	16.58	75.0	.7412	.1483	2.34	67.4	--	55.0	4	150	--	117.1	
	D	--	4	64.29	16.58	75.0	.7412	.1622	2.25	76.8	114.0	68.2	3	170	109.4	103.6	
6-5-2	F	37.2	4	64.29	17.45	75.0	.7412	.2167	2.34	103.8	--	--	4	134	--	--	
	D	--	4	64.29	17.45	75.0	.7412	.2290	2.25	114.2	110.0	--	4	135	96.5	--	
	R	13.1	4	64.29	17.45	75.0	.7412	.2233	2.34	107.1	--	103.5	4	150	--	111.9	
	D	--	4	64.29	17.45	75.0	.7412	.2533	2.25	126.4	117.9	110.6	4	202	129.3	149.5	
6-5-3	R	73.9	4	64.29	16.58	75.0	.7412	.2552	2.34	115.5	--	--	4	141	--	--	
	D	--	4	64.29	16.58	75.0	.7412	.2526	2.25	119.6	103.5	--	4	166	113.3	--	
	R	10.0	4	64.29	16.58	75.0	.7412	.1048	2.34	79.5	--	68.9	4	106	--	75.1	
	D	--	4	64.29	16.58	75.0	.7412	.1077	2.25	85.0	106.9	71.1	4	104	94.8	62.8	
6-7-1	R	46.2	4	98.77	22.28	75.0	.7412	.1921	2.79	149.8	--	--	4	163	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.2010	2.65	166.8	111.3	--	4	187	109.0	--	
	R	68.6	4	98.77	22.28	75.0	.7412	.1077	2.79	84.8	--	56.6	4	165	--	101.3	
	D	--	4	98.77	22.28	75.0	.7412	.1110	2.65	92.2	108.7	55.3	4	212	122.0	115.4	
6-7-2	R	44.6	4	98.77	22.28	75.0	.7412	.2461	2.79	194.0	--	--	4	160	--	--	
	D	--	4	98.77	22.28	75.0	.7412	.2554	2.65	212.0	93.7	--	4	211	125.8	--	
	R	12.0	4	98.77	22.28	75.0	.7412	.1909	2.79	150.5	--	77.6	4	163	--	101.8	
	D	--	4	98.77	22.28	75.0	.7412	.1847	2.65	153.5	108.9	72.4	4	147	85.3	69.6	
6-7-3	R	61.8	5	98.77	22.28	75.0	.7412	.2662	2.79	209.8	--	--	4	191	--	--	
	D	--	5	98.77	22.28	75.0	.7412	.2366	2.65	198.5	93.7	--	4	223	110.6	--	
	R	9.5	4	98.77	22.28	75.0	.7412	.1487	2.79	117.1	--	55.9	4	117	--	61.3	
	D	--	4	98.77	22.28	75.0	.7412	.1536	2.65	127.6	108.9	64.8	4	127	103.1	56.9	

[1]The difference in versed sines of initial and final angles multiplied by the distance of center of gravity below axis equals the vertical drop of the center of gravity of pendulum.

[2]The length withdrawn is taken as the full length of the nail including point, minus two-thirds the length of the nail point.

[3]Length withdrawn same as Column 10.

[4]The first digit of the stick number is the series number and refers to the species, the second digit is the lot number and refers to the nail-size, and the third digit is the stick number and refers to the treatment to which one-half of stick was subjected before nails were pulled.
One-half of sticks whose numbers end with
(1) soaked before pulling,
(2) air seasoned before pulling,
(3) soaked, then air seasoned before pulling.
The treatments were similar for both green and air-dry material.

17854 M

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MADISON, WISCONSIN
November 23, 1922.

H.E.H. 1-15-23

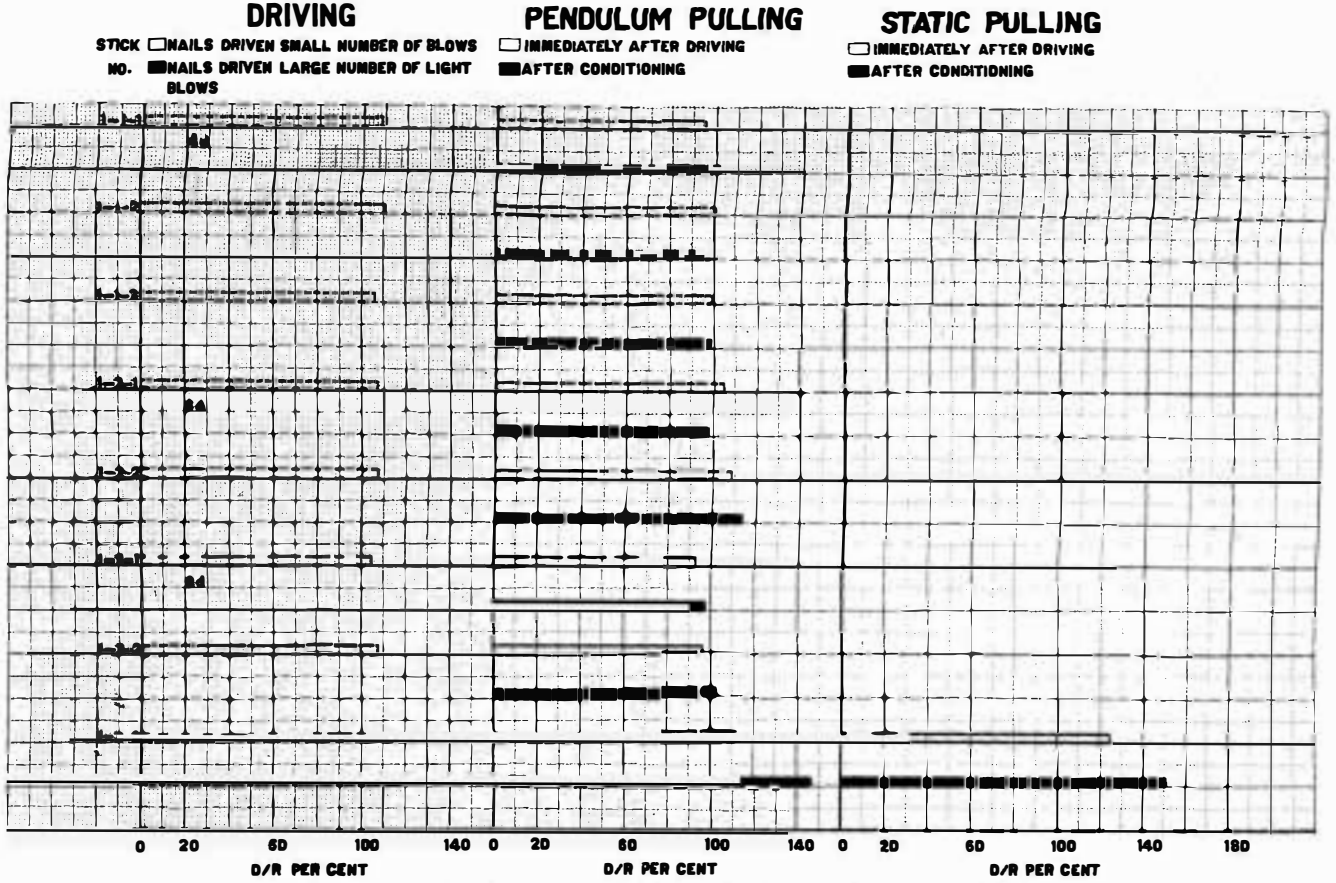

FIG. 1 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—DRY DOUGLAS FIR

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

18124 M 3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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MADISON, WISCONSIN
November 25, 1922.

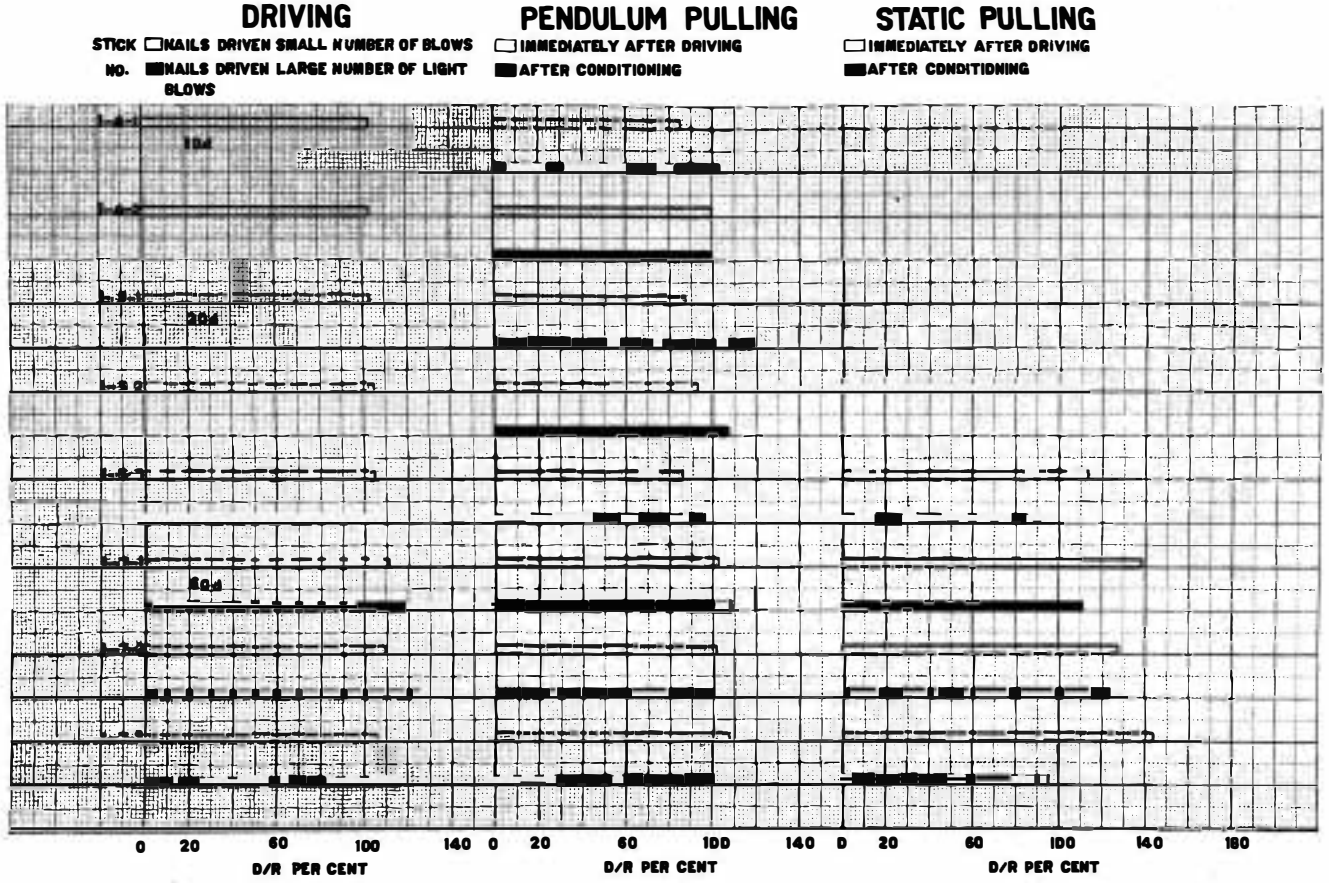

FIG. 2 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—DRY DOUGLAS FIR

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING
2—AIR SEASONED BEFORE PULLING
3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

18114 M

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MADISON, WISCONSIN
November 23, 1922.

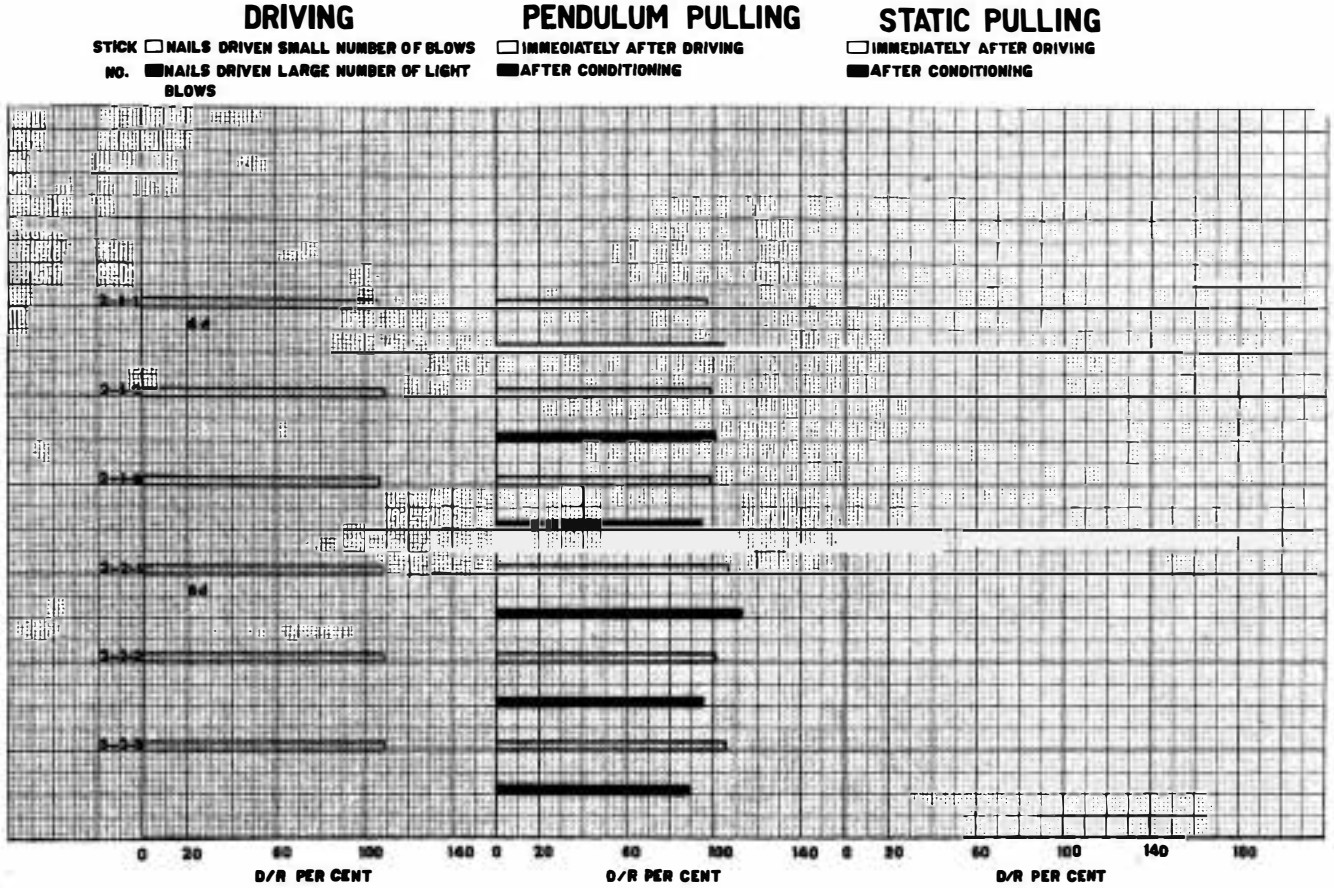

FIG. 3 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—GREEN DOUGLAS FIR

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

18121M 1— SOAKED BEFORE PULLING
2—AIR SEASONED BEFORE PULLING
3—SOAKED, THEN AIR SEASONED BEFORE PULLING
THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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MADISON, WISCONSIN
November 23, 1922.

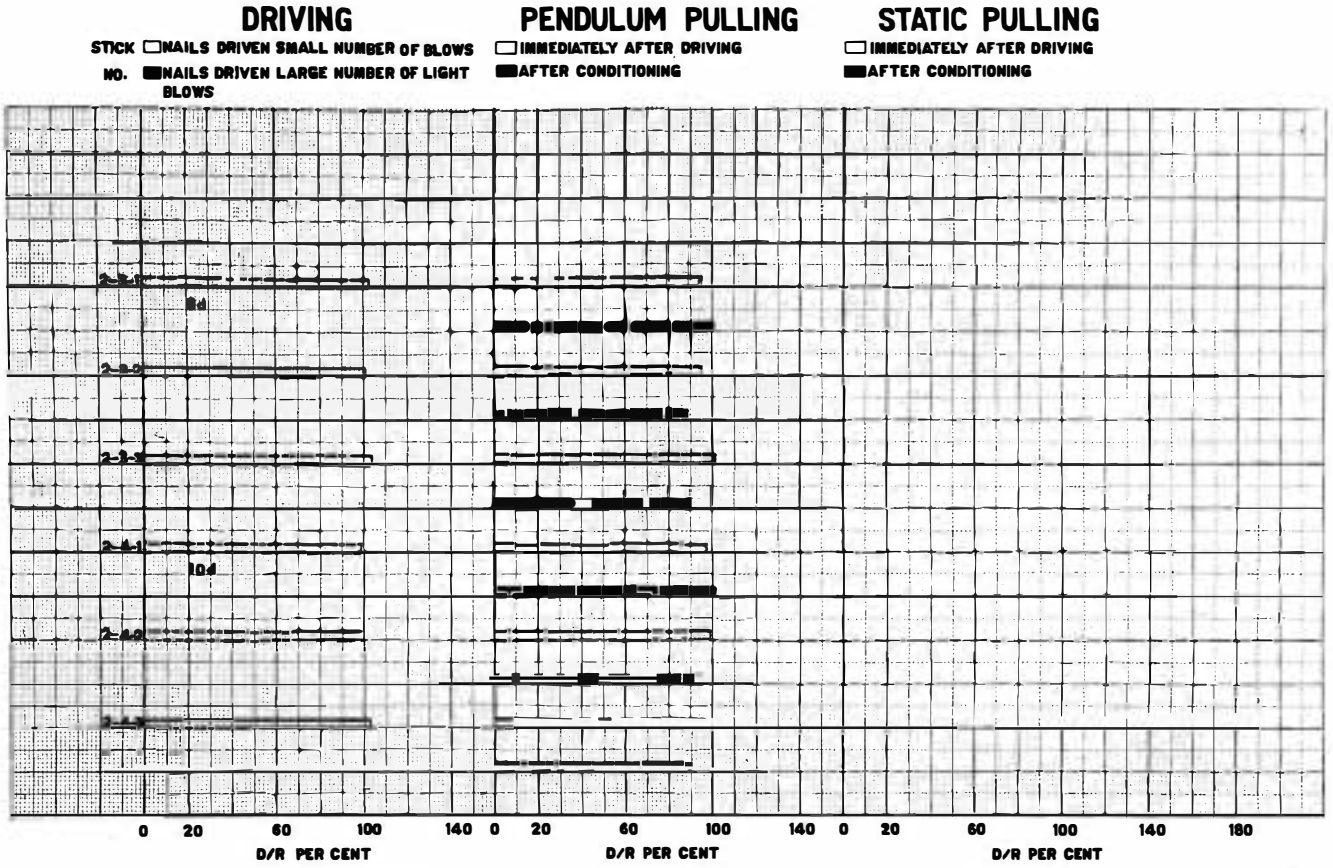

FIG.4 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—GREEN DOUGLAS FIR

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF ST CKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

1812.2M 3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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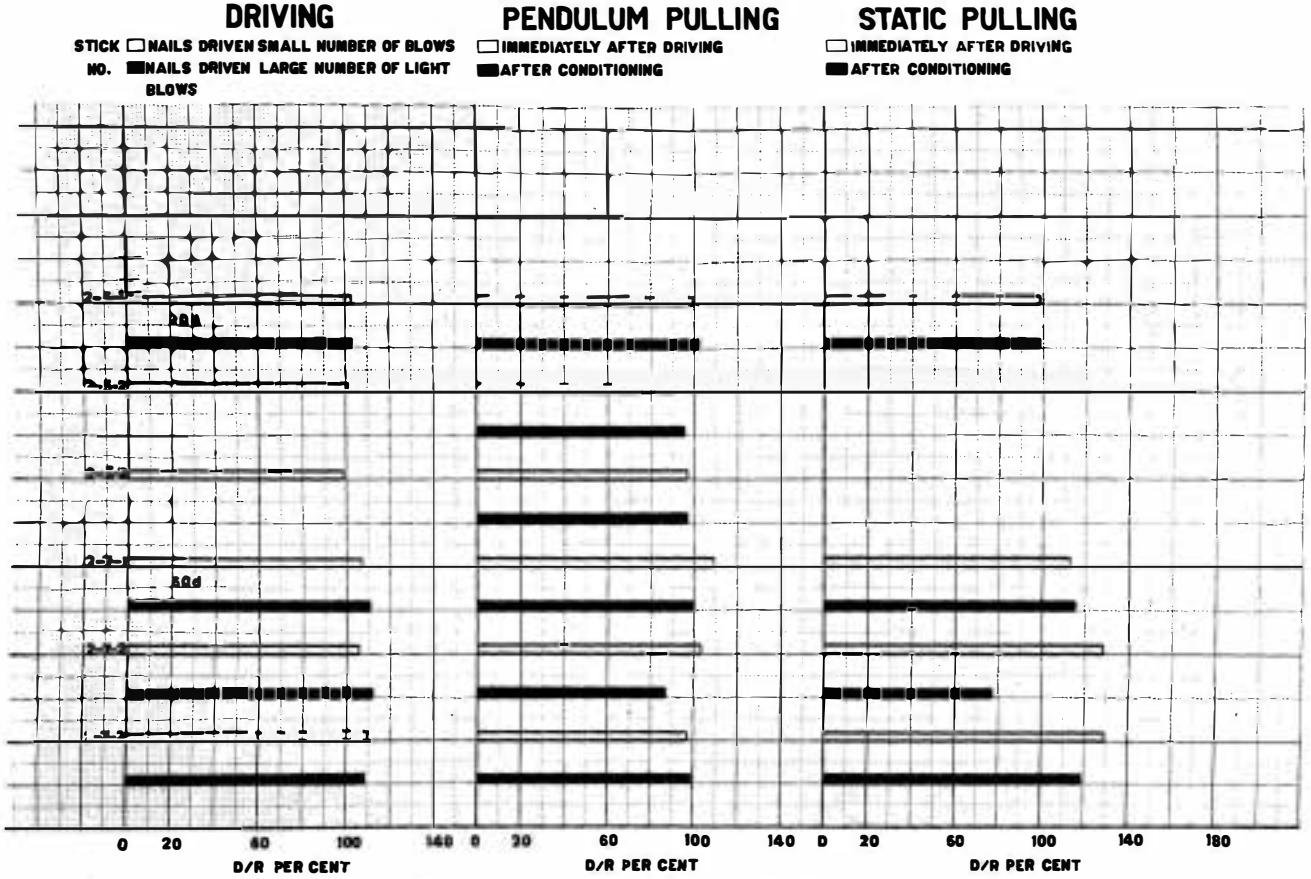

FIG.5 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—GREEN DOUGLAS FIR

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

18123M 3—SOAKED, THEN AIR SEASONED BEFORE PULLING

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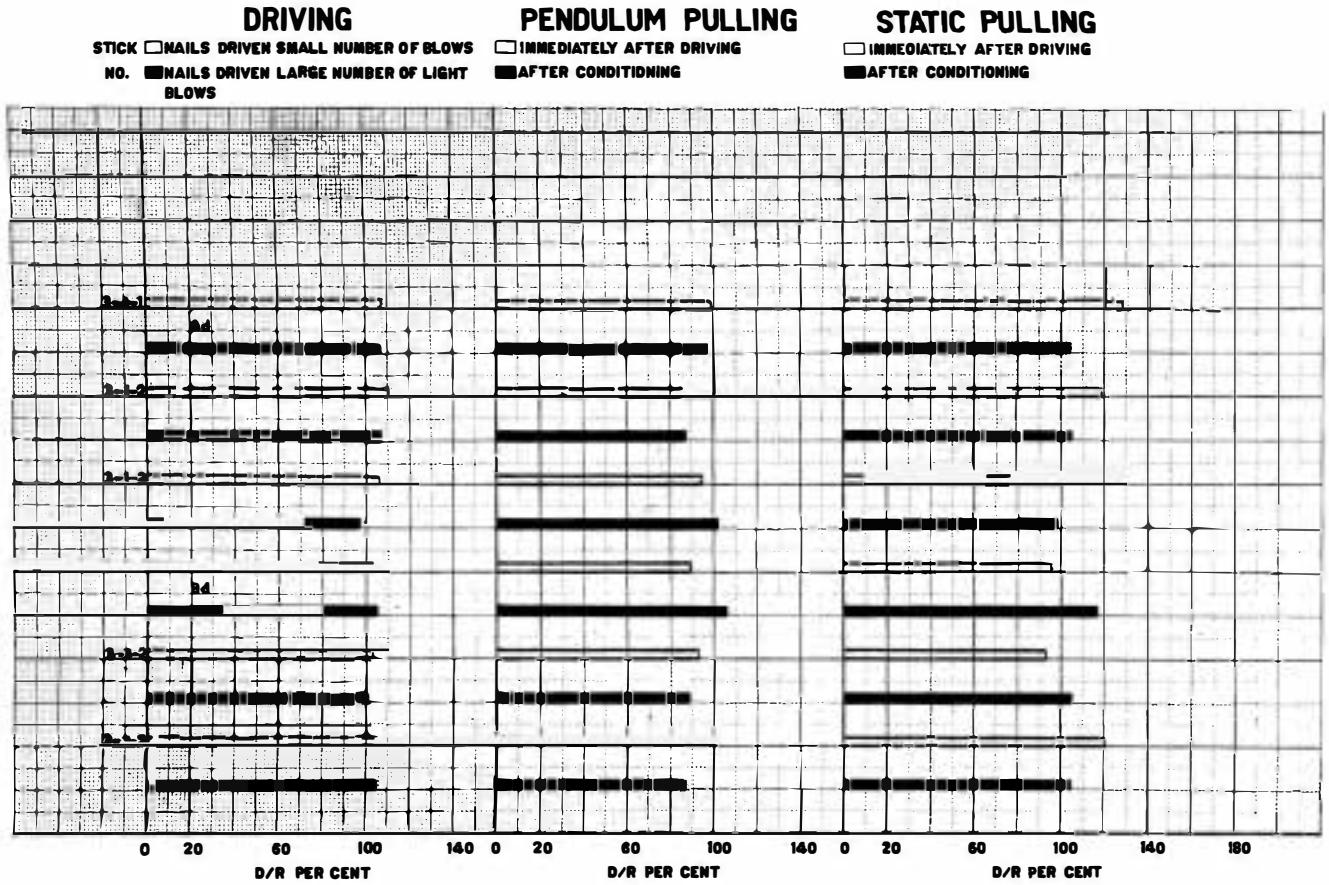

FIG.6 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—DRY YELLOW BIRCH

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF ST CKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING
2—AIR SEASONED BEFORE PULLING
3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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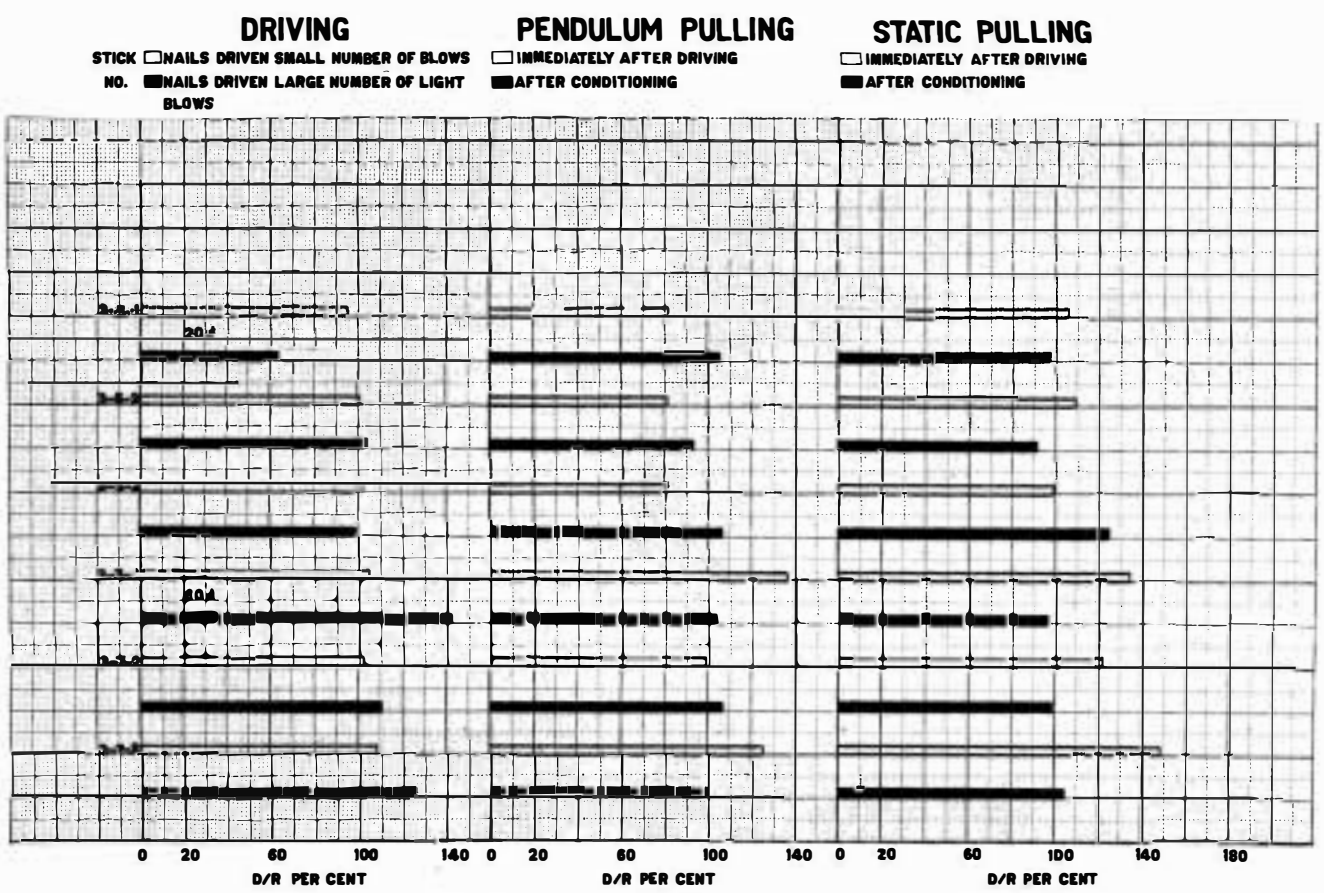

FIG. 7 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—DRY YELLOW BIRCH

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

3—SOAKED. THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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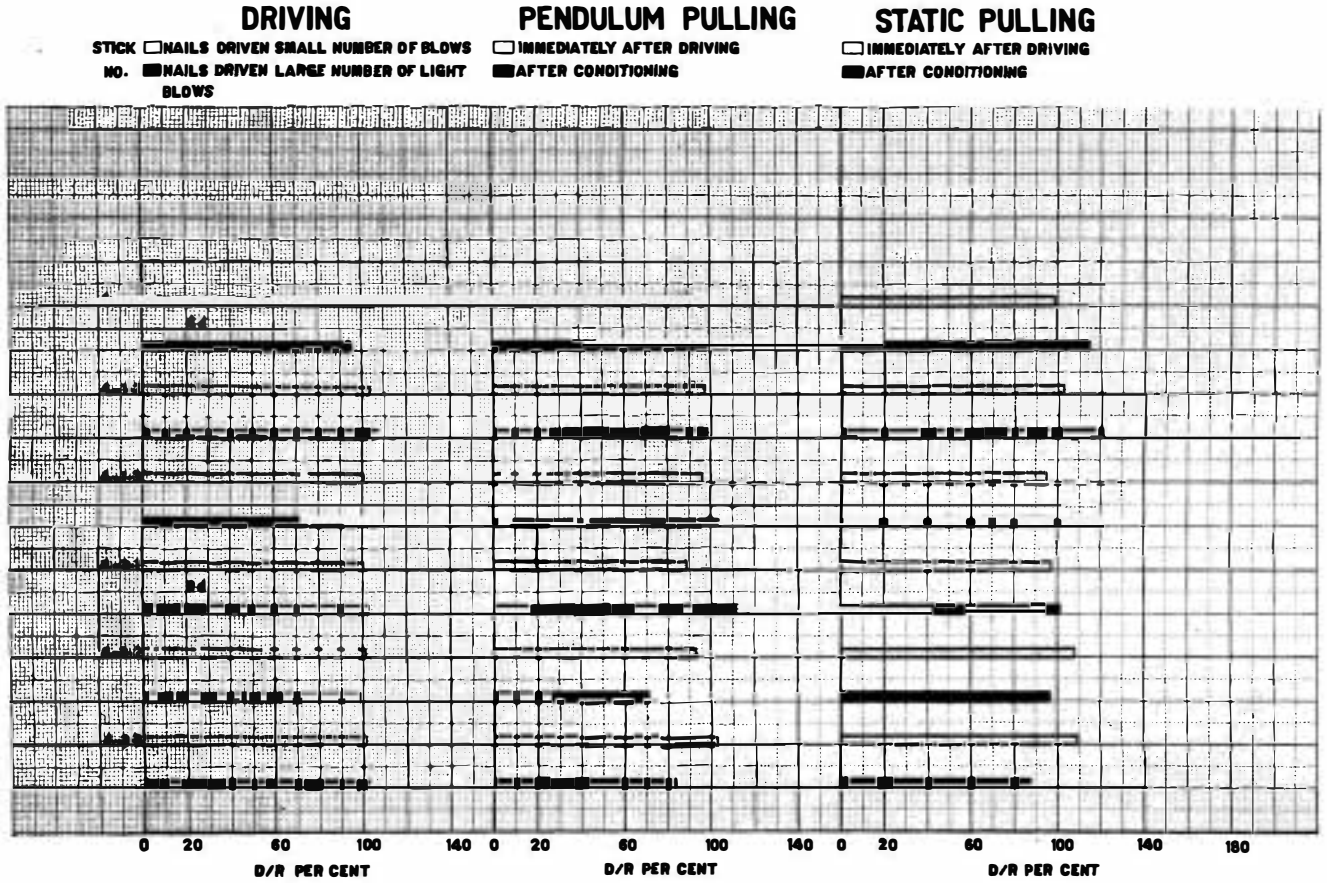

FIG.8 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—GREEN YELLOW BIRCH

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

1—SOAKED BEFORE PULLING
2—AIR SEASONED BEFORE PULLING
3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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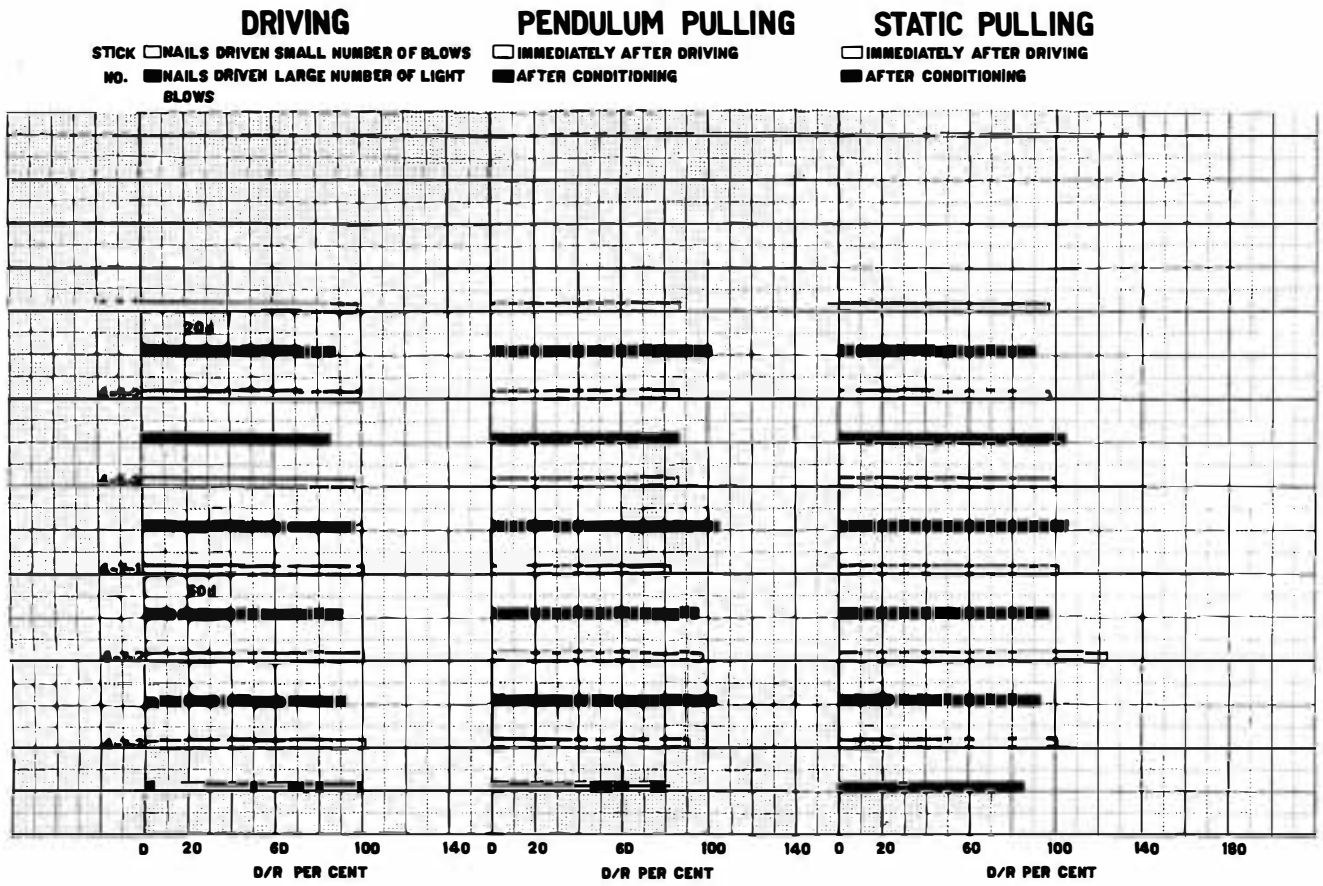

FIG.9 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—GREEN YELLOW BIRCH

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

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2—AIR SEASONED BEFORE PULLING
3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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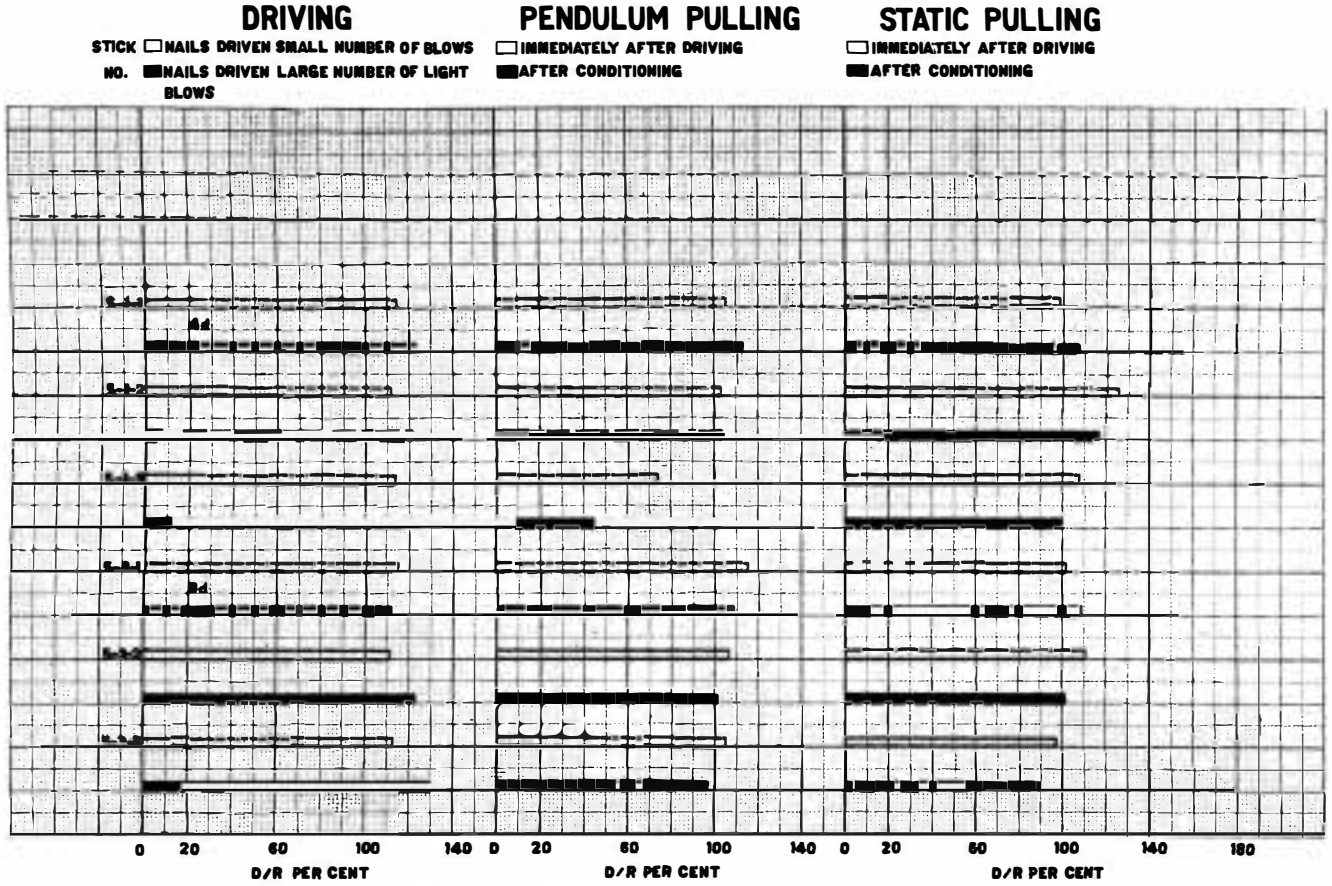

FIG.10—RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS—DRY WHITE PINE

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF ST CKS WHOSE NUMBERS END WITH

1—SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

3—SOAKED, THEN AIR SEASONED BEFORE PULLING

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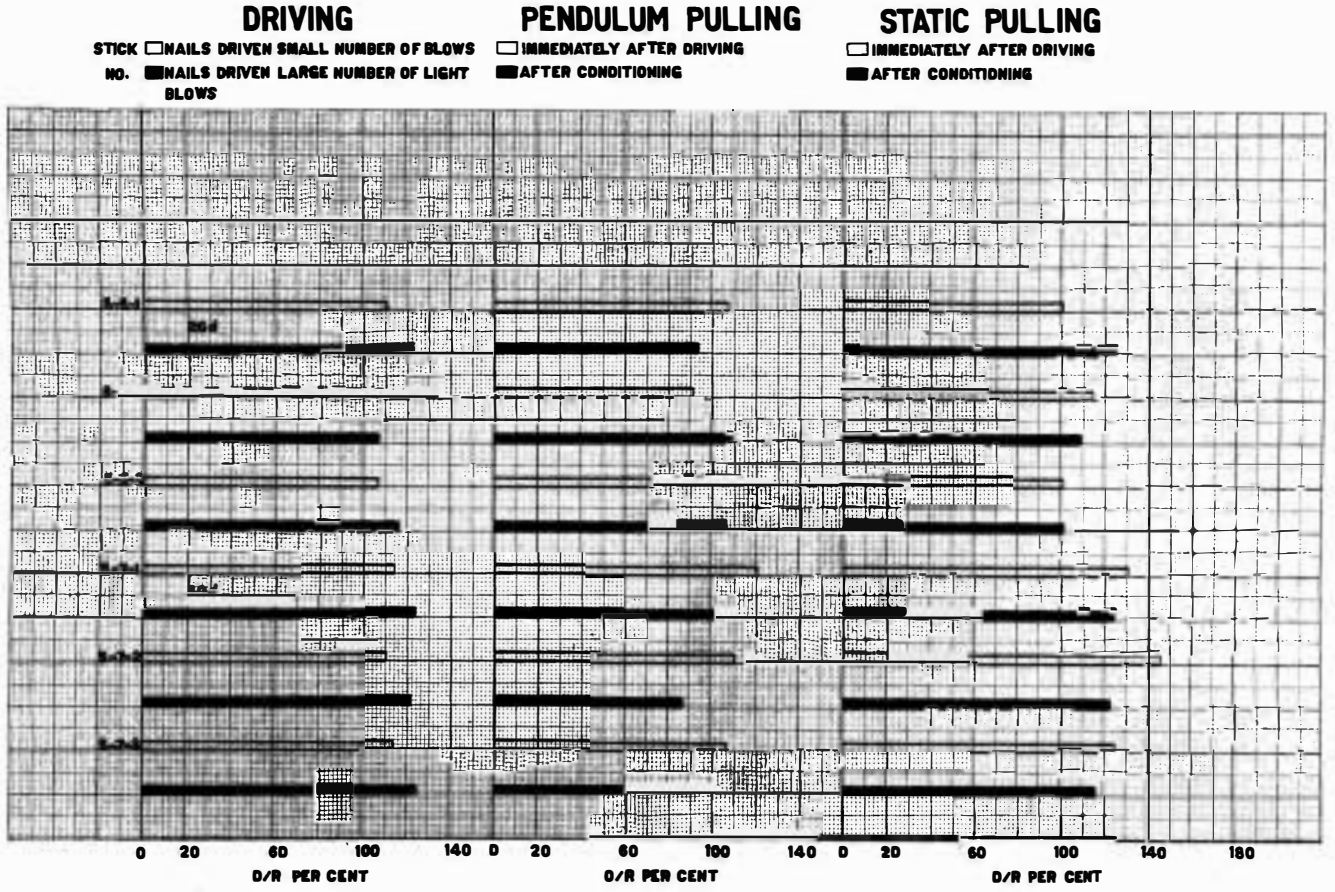

FIG. 11 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS— DRY WHITE PINE

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE—HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE—HALF OF ST CKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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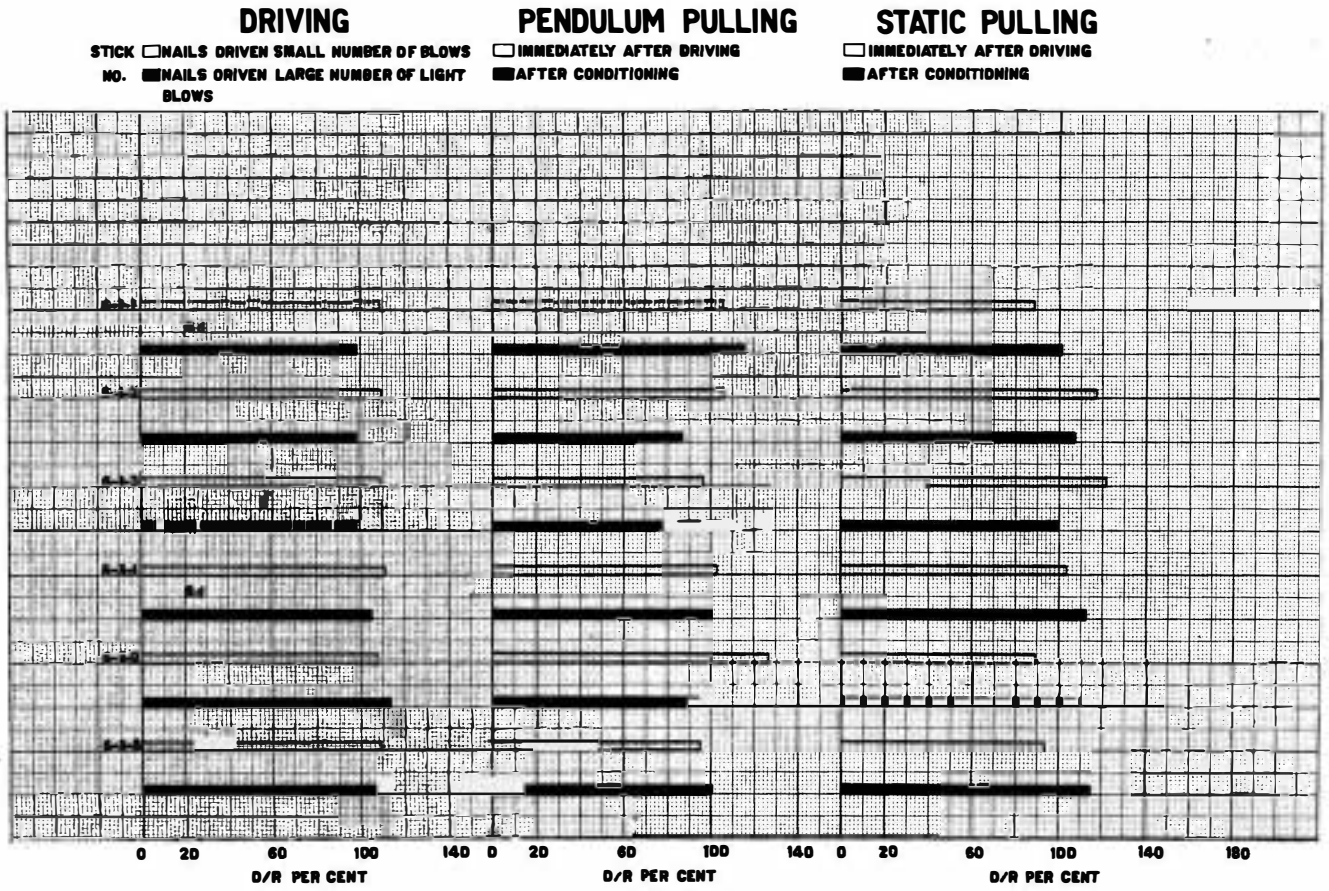

FIG. 12 —RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS— GREEN WHITE PINE

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE—HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE—HALF OF STICKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING
2—AIR SEASONED BEFORE PULLING
3—SOAKED. THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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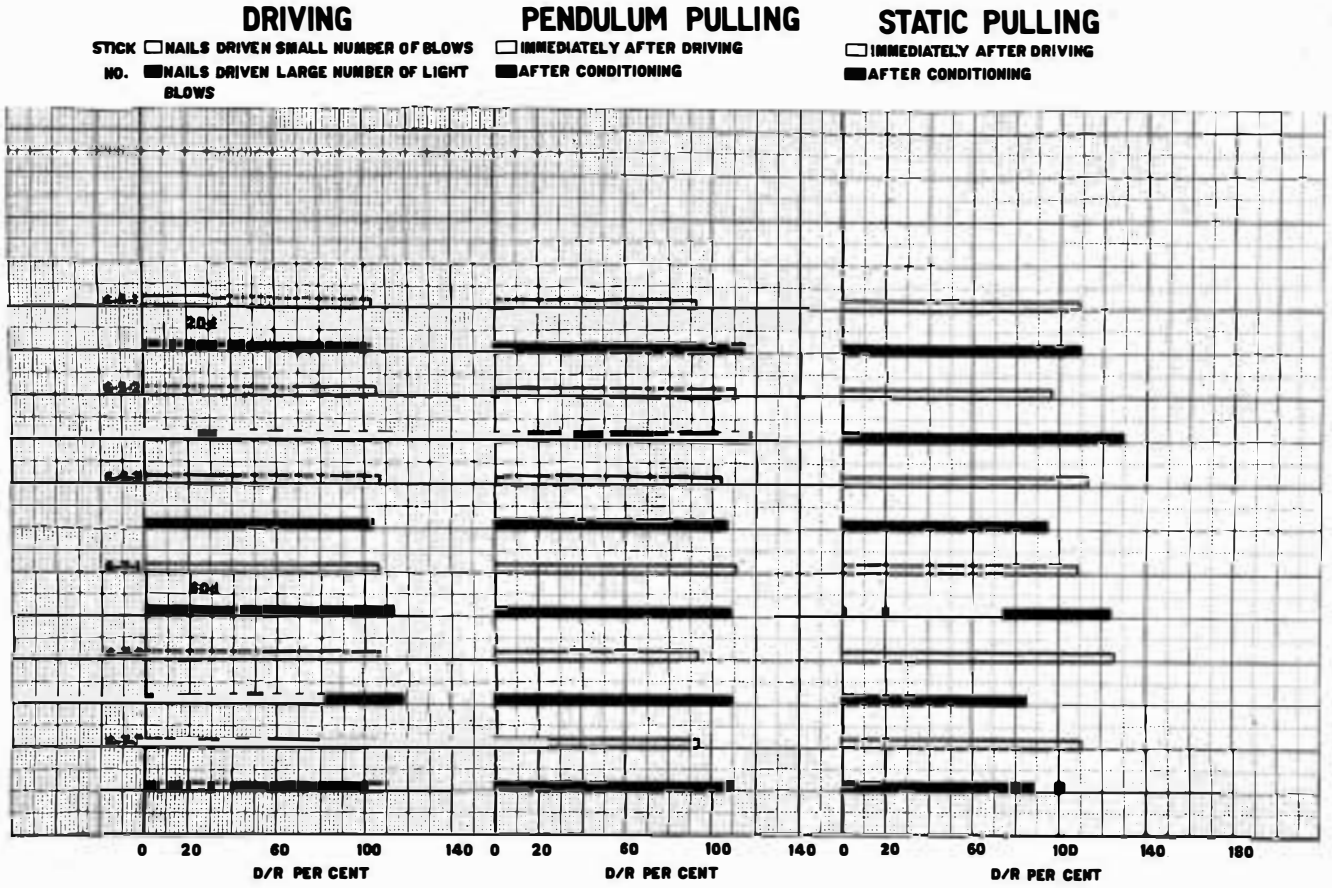

FIG. 13 — RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS— GREEN WHITE PINE

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE—HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE—HALF OF ST CKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING
2—AIR SEASONED BEFORE PULLING
3—SOAKED, THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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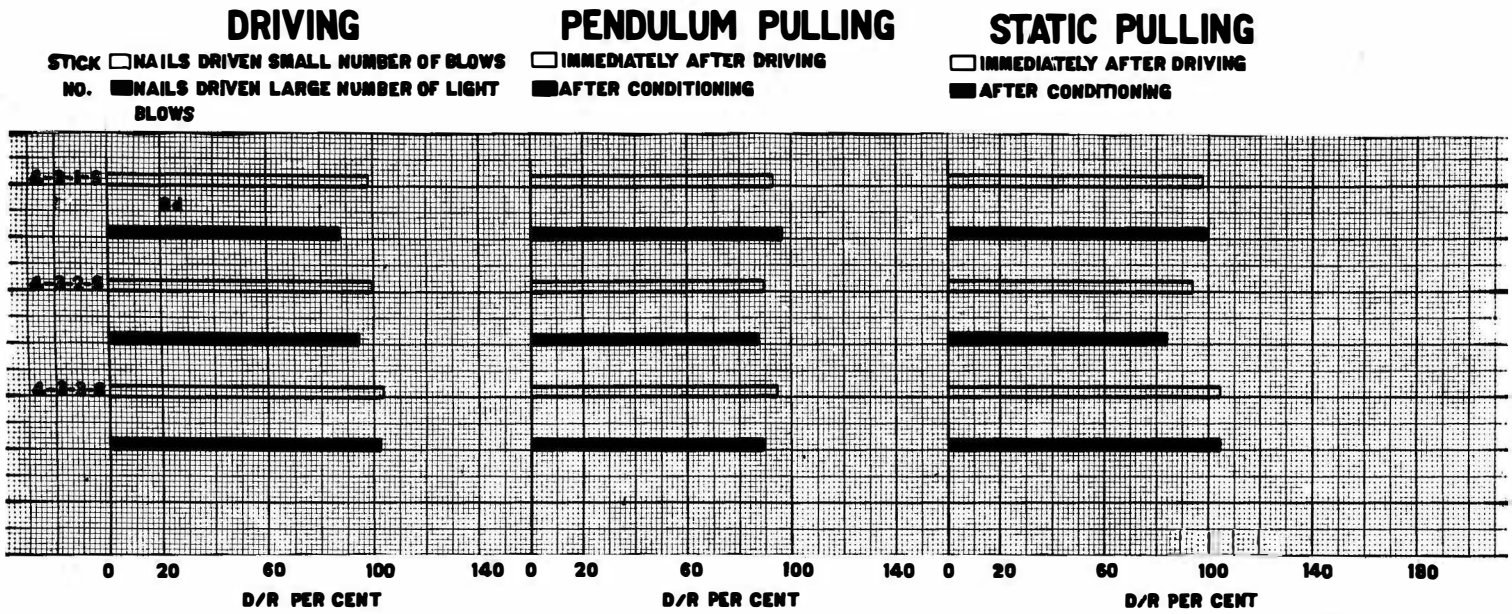

FIG. 14—RELATIVE WORK IN DRIVING AND PULLING REGULAR AND DIAMOND POINTED NAILS— GREEN YELLOW BIRCH

NOTE D=DIAMOND POINT. R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF ST CKS WHOSE NUMBERS END WITH

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2—AIR SEASONED BEFORE PULLING
3—SOAKED. THEN AIR SEASONED BEFORE PULLING

THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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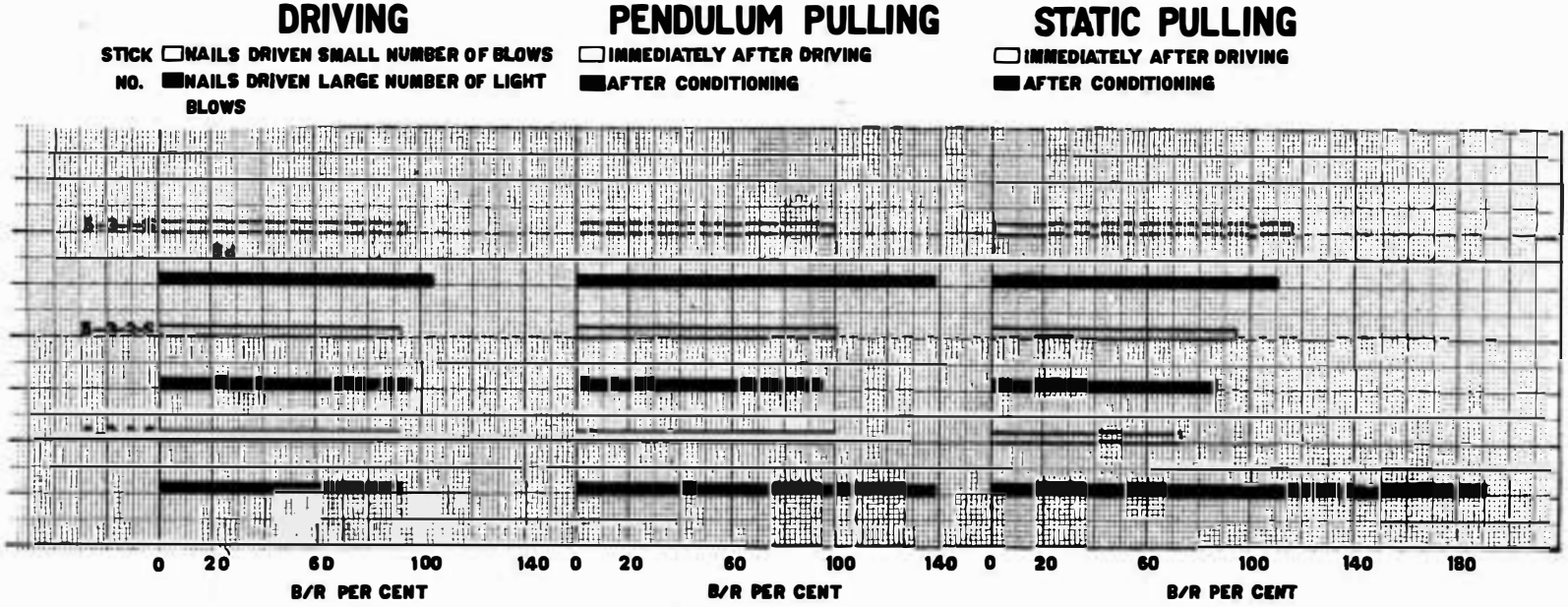

FIG.15—RELATIVE WORK IN DRIVING AND PULLING REGULAR AND BARBED NAILS — DRY WHITE PINE

NOTE B=BARBED R=REGULAR POINT. THE FIRST DIGIT OF THE STICK NUMBER IS THE SERIES NUMBER AND REFERS TO THE SPECIES. THE SECOND DIGIT IS THE LOT NUMBER AND REFERS TO THE NAIL SIZE. THE THIRD DIGIT IS THE STICK NUMBER AND REFERS TO THE TREATMENT TO WHICH ONE-HALF OF THE STICK WAS SUBJECTED BEFORE NAILS WERE PULLED. ONE-HALF OF STICKS WHOSE NUMBERS END WITH

1— SOAKED BEFORE PULLING

2—AIR SEASONED BEFORE PULLING

3—SOAKED. THEN AIR SEASONED BEFORE PULLING

18116M THE TREATMENTS WERE SIMILAR FOR BOTH GREEN AND DRY MATERIAL

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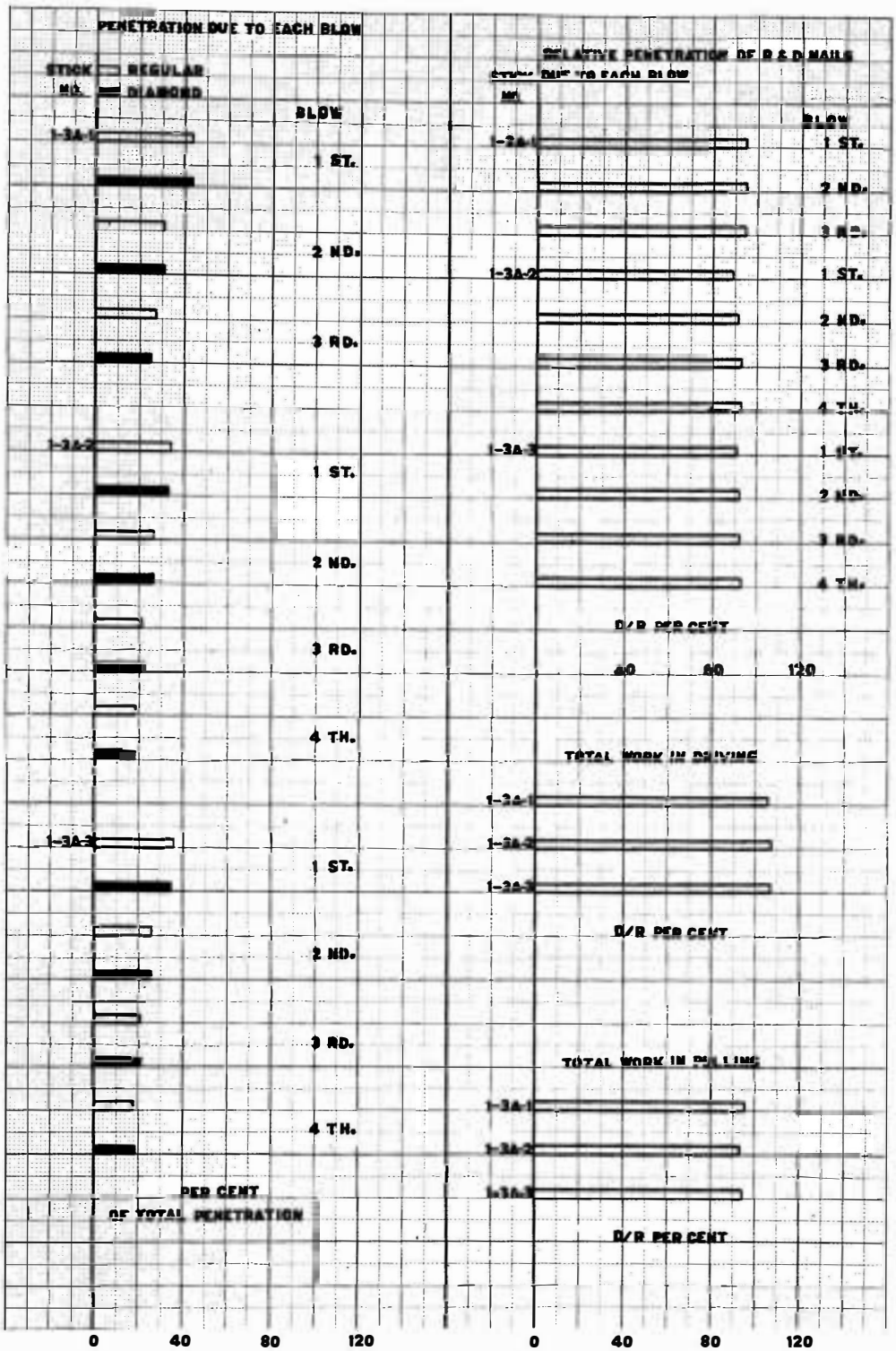

FIG.—16—RELATIVE PENETRATION FOR REGULAR AND DIAMOND POINTED NAILS AFTER EACH SUCCESSIVE BLOW.—DRY DOUGLAS FIR

NOTE
D=DIAMOND POINT
R=REGULAR POINT
NAILS ALL 8d

18125 M

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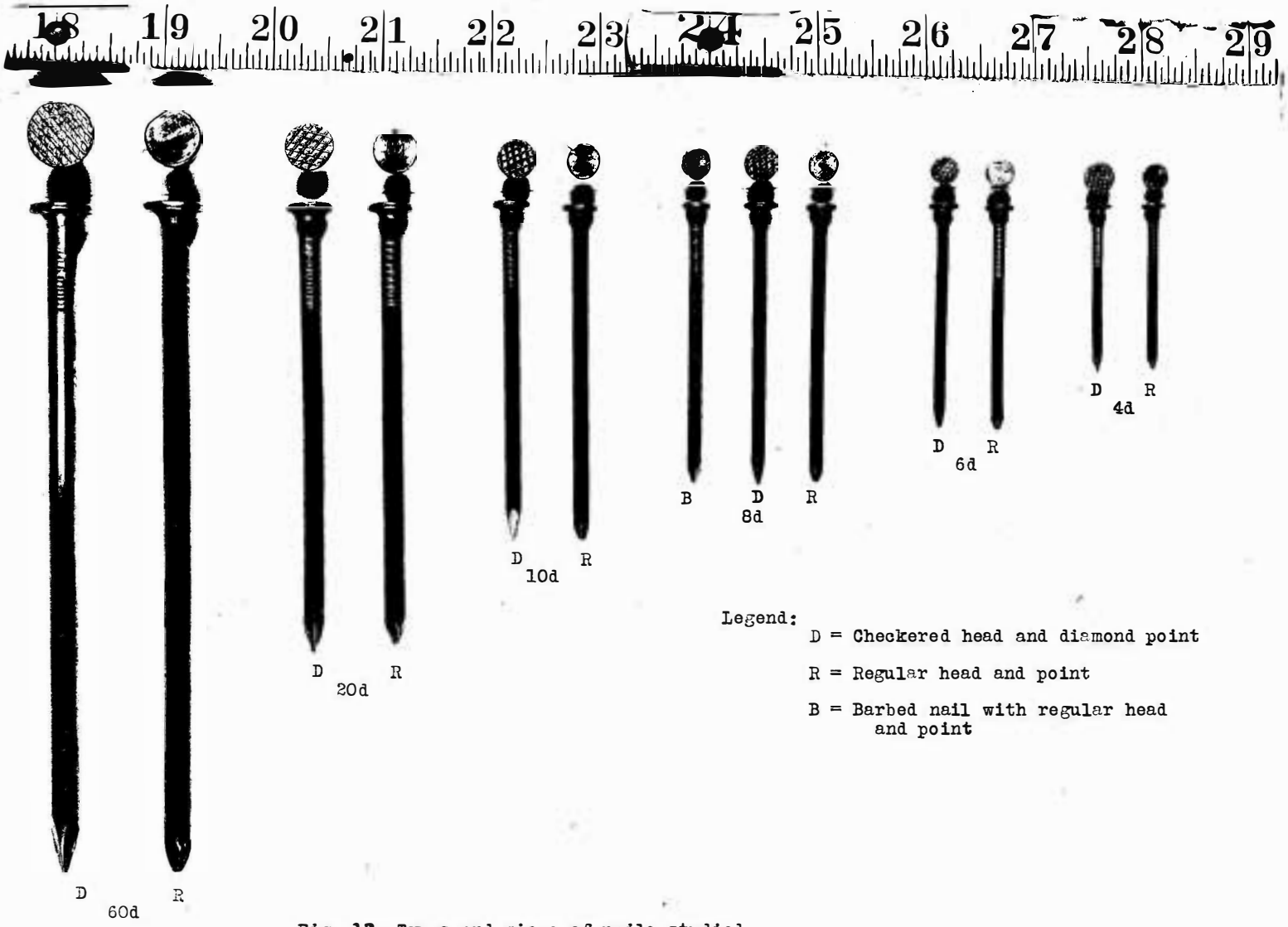

Fig. 17- Types and sizes of nails studied

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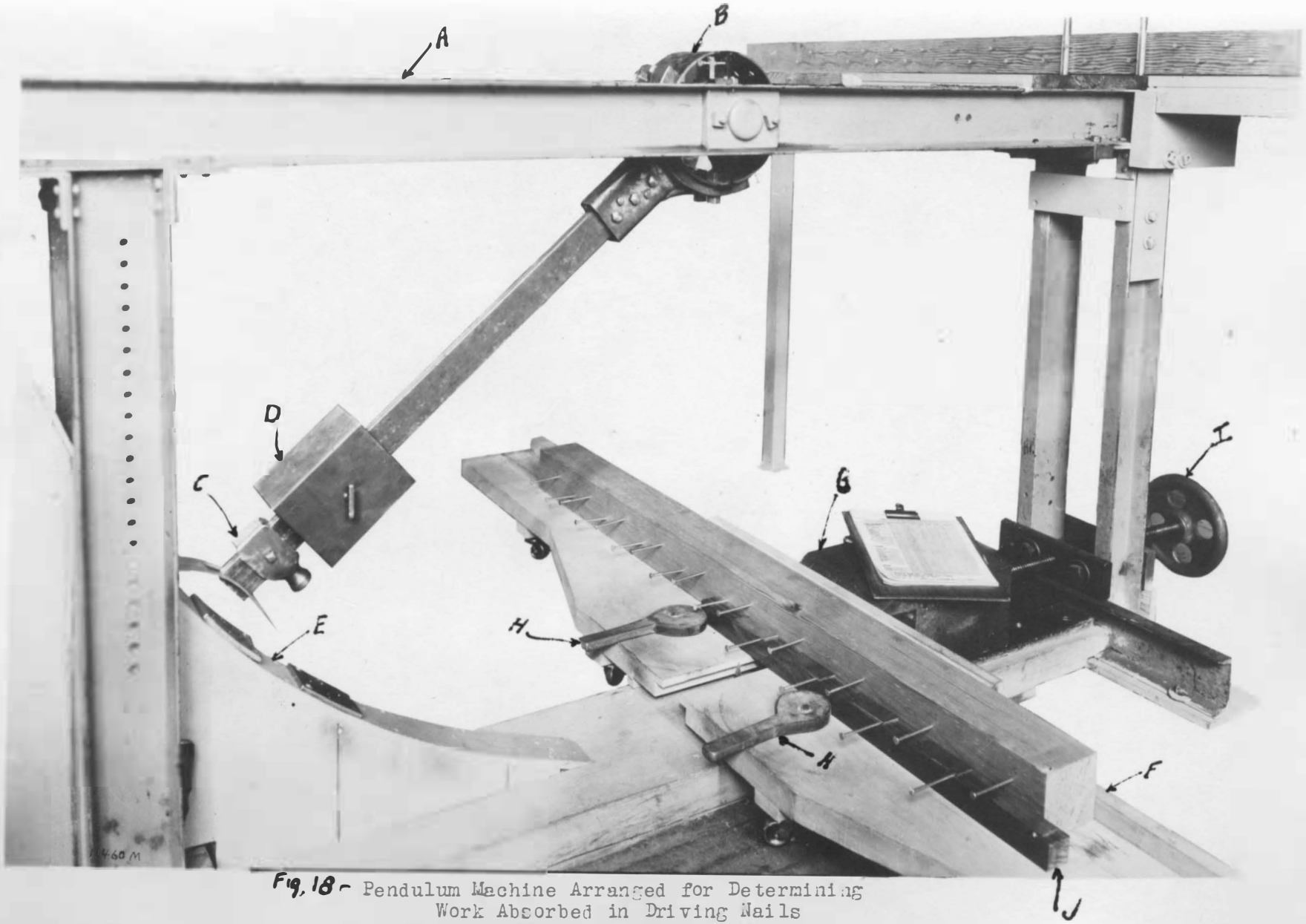

Fig. 18 - Pendulum Machine Arranged for Determining Work Absorbed in Driving Nails

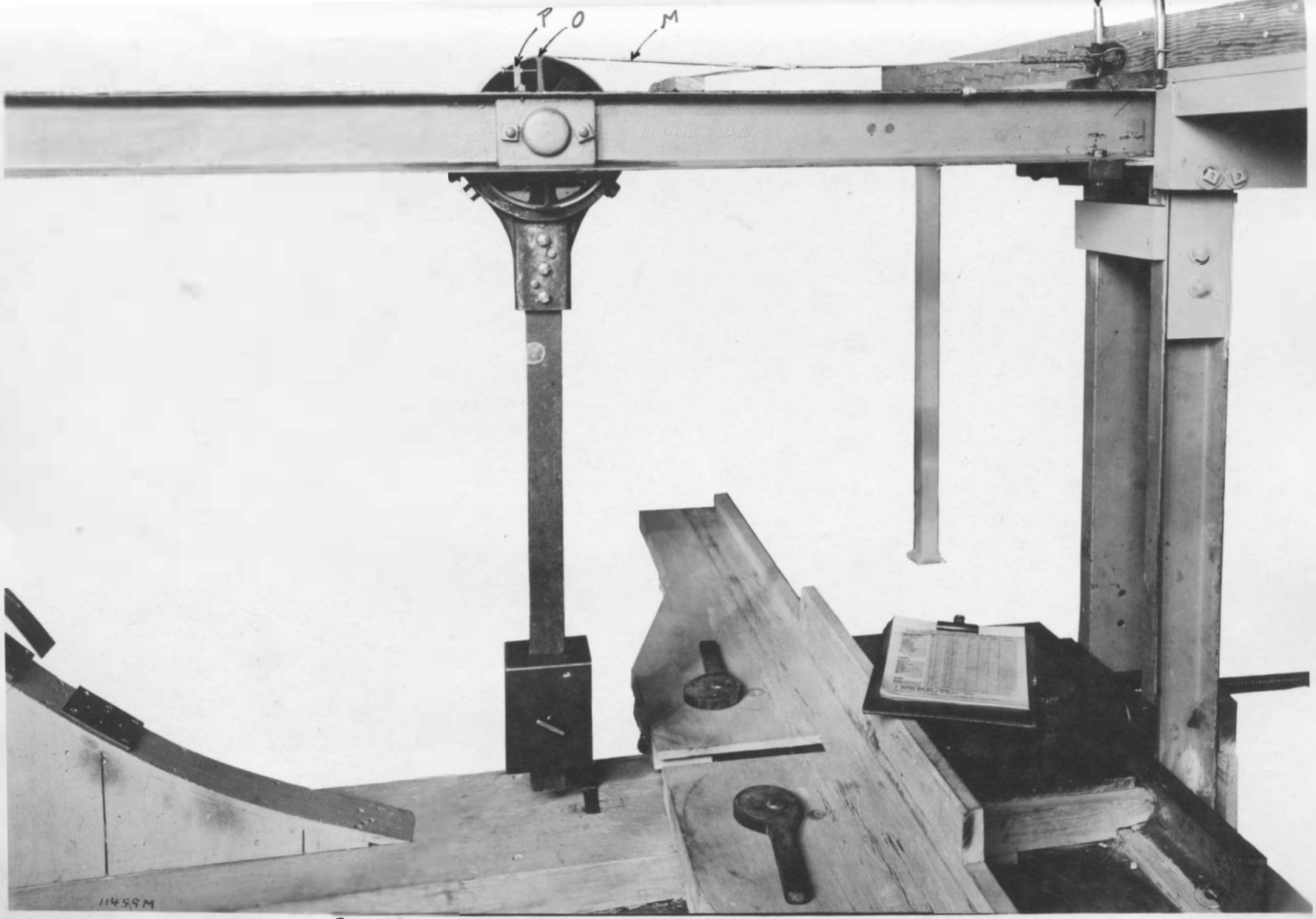

Fig. 19 - Pendulum Machine Arranged for Determining Work Absorbed in Pulling Nails

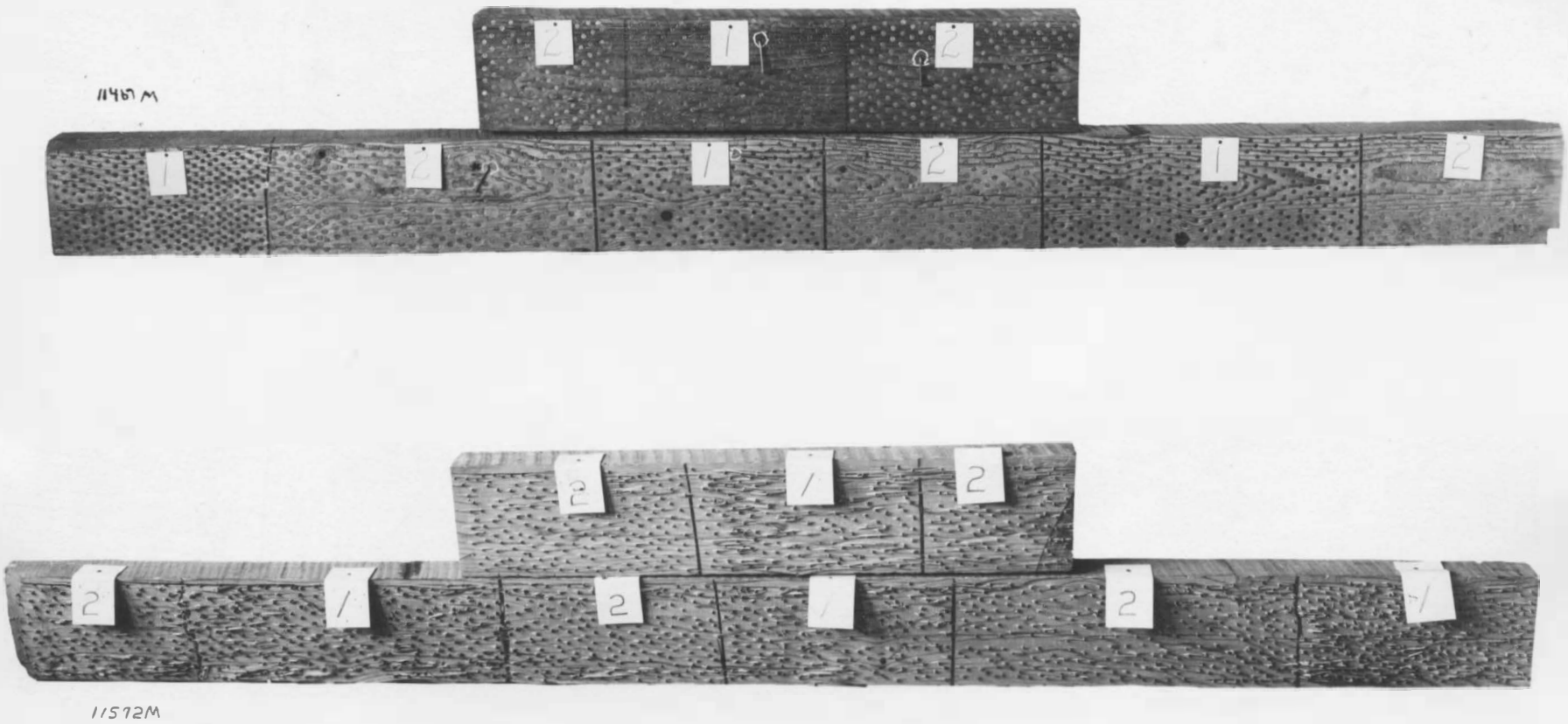

Fig. 20.--View of both sides of red fir planks driven full of 10d nails by carpenter No. 1.

1 = regular head and point. 2 = checkered head and diamond point.

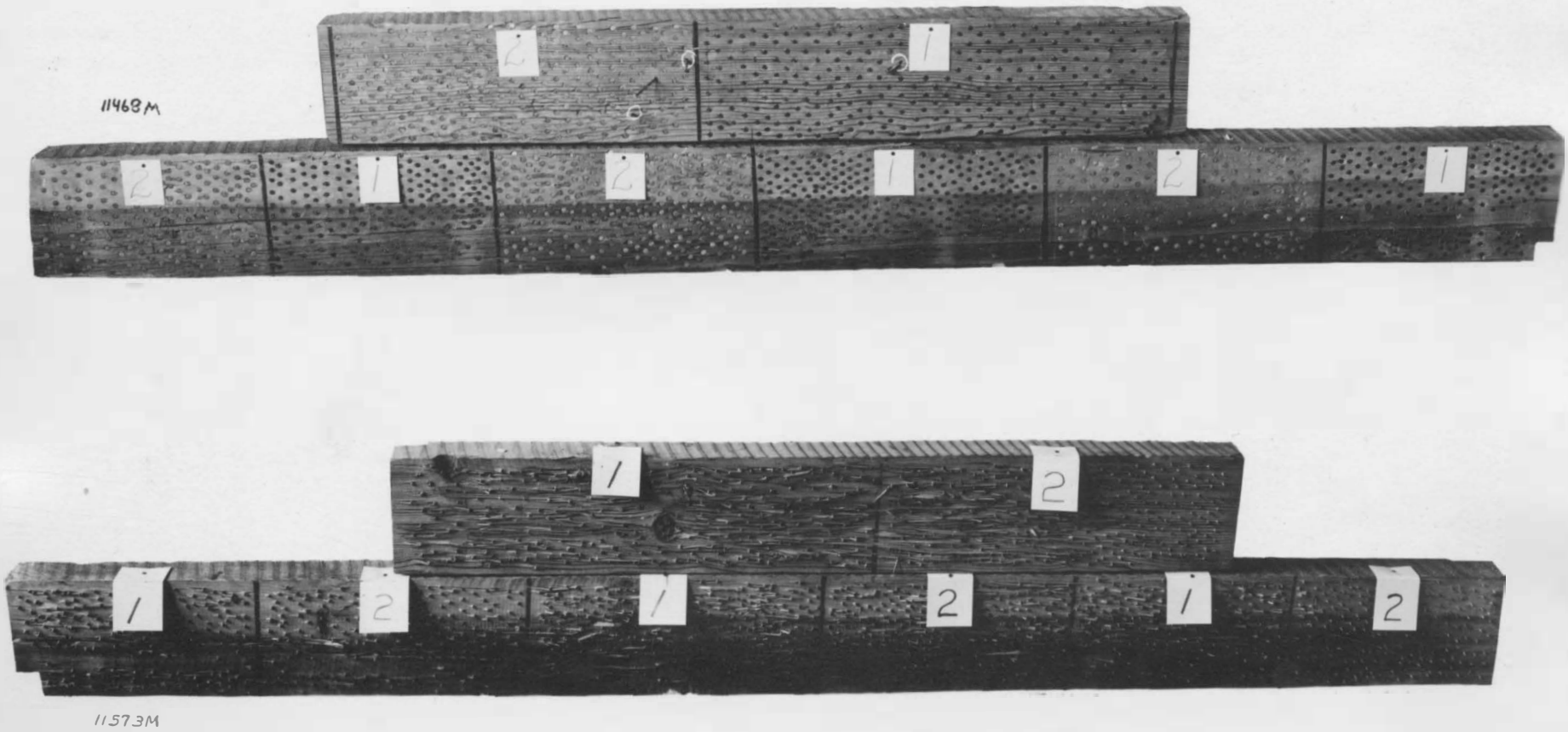

Fig. 21.--View of both sides of red fir planks driven full of 10d nails by carpenter No. 2.

1 = regular head and point. 2 = checkered head and diamond point.

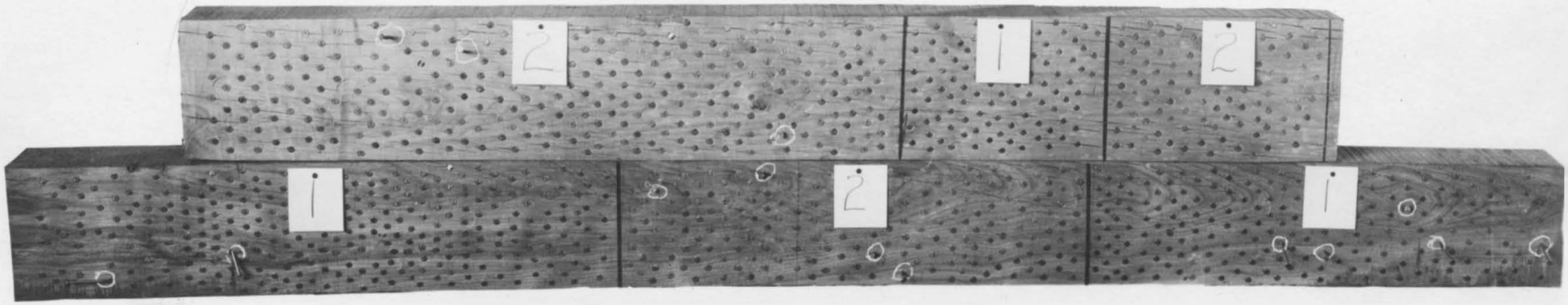

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Fig. 22.--Dry yellow birch planks driven full of 8d nails by carpenter No. 2.

1 = regular head and point. 2 = checkered head and diamond point.

Fig. 23.--Vibration machine.