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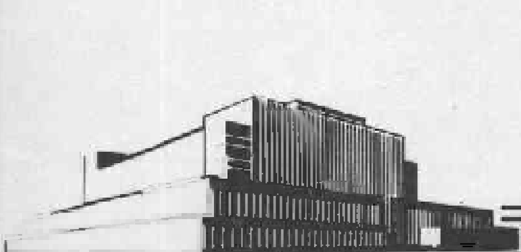

FOREST PRODUCTS LABORATORY
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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

QUALITY AND PERFORMANCE OF SLICED SHOOK FROM SMALL PONDEROSA PINE LOGS

By

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Summary

To determine whether sliced shook from small pine logs is suitable for the manufacture of fruit containers, a quantity of small ponderosa pine logs were heated in water and steam and sliced into side, bottom, and top slats for citrus fruit boxes. The shook were dried in a veneer drier and in a kiln, and the effect of the heating and drying methods on quality was determined.

The sliced shook was made up into citrus boxes that were compared in rough-handling tests with boxes made from sawn slats obtained from the same type of log.

The higher preheating temperature produced better results as far as quality and performance were concerned. The veneer drier produced smoother and straighter shook, but the kiln-dried stock performed better in the tests. The performance of the sliced shook was satisfactory as compared to that of sawn shook.

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[1] Working under the auspices of the South African Council for Scientific and Industrial Research.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Introduction

This report covers research done at the U. S. Forest Products Laboratory to determine whether veneer shook sliced from logs of small diameter is suitable for citrus and other fruit boxes.

The object of the work was to develop means of using small logs economically. The Union of South Africa does not possess natural timber resources suitable for the production of lumber, and it has had to resort to exotic pine and other species to supply its timber requirements. Early thinnings from these pure, even-aged stands yield a large volume of small-sized logs with a top diameter of 5 to 10 inches. Although these logs are of relatively poor quality due to knots and crook, the lack of local timber supplies and the high cost of importation make their economic use desirable if not imperative. Since there are only a few pulp mills in South Africa, a considerable proportion of these logs cannot be absorbed by the pulping plants because of the long and uneconomic hauling distances. Such logs are consequently converted in local mills into box shook, mostly for fruit packaging. The yield, however, is so low that the operation is often unprofitable. It is hoped that the use of slicing machines will assist in solving this problem by giving a better yield in relation to raw material used and in terms of cost of production.

It was not possible to include operating costs and yield determinations as part of the study. Therefore, the work had to be confined to a determination of the quality and performance of sliced shook as compared to that of sawn shook. This was done by inspection of the sliced shook and rough-handling tests of the boxes.

Description of Material

Species and Origin of Logs

Of the species available for this test, ponderosa pine was selected not only because it compares in characteristics with the soft pines grown in South Africa, but also because of the availability of large volumes of small second-growth ponderosa pine logs in the United States. The results of this work may, therefore, have some practical application in the United States.

A number of small 4-foot ponderosa pine logs sent to the Laboratory from Arizona for pulping tests were made available for this work. They were fairly knotty and conformed in quality to the material desired. The only selection done was to extract 56 logs with a top diameter of 6-1/2 to 9-1/2 inches. These logs are shown in figure 1.

Preparation of Material

Sawing. --Twenty-nine logs were selected at random and sawn into boards, and 27 logs into flitches. Sawing was done on a 54-inch diameter, 8-gage, inserted-tooth saw. The boards (fig. 2) were sawn to 1-3/4-inch green thickness for 1-5/8-inch dry stock. After kiln drying, they were dressed and resawn into ends and centers for 50 citrus boxes and into sides, bottoms, tops, and cleats for 10 boxes referred to as group A (table 1).

The logs required for slicing were sawn on three sides. The fourth slab[3] was left on the flitch to act as a shoulder to prevent splintering at the top of the cut (fig. 3).

Slicing. --Before slicing, 12 flitches were preheated in water at 140° F., and 12 were preheated in steam at 180° F. (table 1). Three flitches were sliced into shook at room temperature to compare their appearance and quality with the preheated stock, but this unheated material was not used in rough-handling tests. Slicing was done on an 8-foot veneer slicer with a hydraulic dogging device that holds the flitch at an incline and moves it in a vertical plane against a horizontal stationary knife (fig. 4). Side and bottom slats were sliced to 0.210-inch thickness to dry to 0.200 inch, and shook for tops was sliced 0.197 inch thick to dry to 0.187 inch (3/16 inch) final thickness. Slicer settings are given in table 2.

Drying. --The sawn boards intended for ends and centers and for slats for group A boxes were seasoned in a compartment kiln to a final moisture content of approximately 12 percent. The maximum dry-bulb and wet-bulb temperatures used in the drying schedules were 160° and 149° F., respectively.

The sliced shook was divided into two groups for drying purposes. All the pieces cut from a flitch were numbered consecutively. The odd-numbered pieces were dried in a veneer drier, and the even-numbered ones in a compartment kiln. In this manner, the effect of the drying medium upon shook of similar origin and character could be assessed.

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[3] Using different means of mounting the flitches, bolts to be cut on a box-shook slicer could be slabbed on four sides without danger of splitting during cutting.

The 30-foot, roller-conveyor drier operated at a temperature of 310° to 315° F., and the 1/5-inch-thick slats for sides and bottoms passed through in 22 minutes. The 3/16-inch shook for tops was run through in 20 minutes. The average moisture content of the dried shook varied from approximately 4 percent in heartwood to approximately 25 percent in sapwood. Such variation is not unusual in veneer.

The even-numbered pieces were stacked in single layers between stickers and dried to approximately 12 percent in a compartment kiln at a maximum dry-bulb temperature of 170° F. and a maximum wet-bulb temperature of 150° F.

Experimental Procedure

General

After drying, the sliced shook was examined to determine the effect on quality of preheating and drying method. The shook was then sawn to length and width for sides, bottoms, tops, and cleats for citrus boxes.

Ten boxes were made up from the shook of each group as shown in table 1. Five from each group were loaded and subjected to drop-corner tests, while five were tested by the incline-impact method.

Marking and Matching

All shook was marked with the log and/or slice number, so that the origin could be traced. To balance variables due to log characteristics, a system of randomization was used in the allocation of the various components for each box and in the allocation of boxes for the two tests. Of course, the slats were retained within their groups.

To facilitate recording the damage to the containers, the box components were marked as follows: Top - 1, right side - 2, bottom - 3, left side - 4, end toward observer - 5, opposite end - 6, and center - 7. The edges and corners are designated by combinations of these numbers. This marking is in accordance with Designation D 775-47 as described in part 7 of the American Society for Testing Materials (ASTM) Standards and is shown in figure 5.

Specification and Assembly of Boxes

California-type citrus boxes were used in the test program, because they constitute a substantial proportion of the fruit boxes used in South Africa and also because the United States and South African specifications for this box are similar.

With certain minor modifications, the dimensions were based on the specification for container No. 635 as prescribed in Freight Container Tariff 1-E issued May 23, 1956, and South African Bureau of Standards Specification No. 60 of 1949. The specification is shown in table 3.

The ends and centers consisted of either two 3-inch pieces and one 5-1/2-inch piece or three equal pieces. These pieces were butt-jointed together with three 1- by 1/2-inch corrugated fasteners per joint.

In the unitized tops, the slats were secured to the cleats by 2 staggered 20-gage, machine-driven staples per shook end.

The boxes were hand nailed according to a preset nailing pattern. Fourpenny, orange-box nails (1-1/4 inches by 15 gage by 7/32-inch head) were used throughout. Each bottom or side slat was attached to each end or center with three nails. The cleated top was nailed to each end with 4 nails and was strapped down in the middle by nailing each end of a flat metal strap (3/8 x 0.020 inch) with 1 nail passing through the strap and side slat and into the center.

Rough-Handling Tests

Moisture conditions.--To eliminate a variable in box performance caused by differences in moisture content, all shook was kept in the humidity room until an equilibrium moisture content had been reached. The room was maintained at a constant temperature of 73° F. with a relative humidity of 50 percent. All boxes were assembled in this room and tested immediately, after the moisture content of the different components had been determined by means of a moisture meter. The average moisture content corrected for species was 8.2 percent. Immediately after testing, samples were cut from the boxes, and the moisture content was determined by the ovendry method. The average for this was 9.4 percent.

Although a moisture content of 9 percent may appear somewhat low for best box performance, previous work done at the Laboratory showed that there was little difference in the performance of orange boxes made from white fir with a moisture content just below 18 percent or just above 9 percent and tested at these same moisture contents. Table 4 reflects the range and average moisture content values for the different components.

Loads and weights.--The dummy loads consisted of simulated oranges made at the Laboratory. The loading material was made of spheres covered with a soft plastic. They were approximately equal to the 126 or 150 size orange in both size and weight. In this test, all the boxes contained 138 simulated oranges. A loaded box is shown in figure 6.

The assembled boxes had an average weight of 7.1 pounds, with an average gross weight of 85.7 pounds. The average weight for each group is shown in table 5.

Drop-cornerwise test.--In this test, the loaded box was suspended so that a pair of diagonally opposite corners were in a vertical line. It was then dropped upon each corner from a height of 6 inches onto a cast iron plate (fig. 7). The drops were made in numerical rotation in accordance with Designation D 775-47, Procedure B of the American Society for Testing Materials. After 8 falls from 6 inches, the cycle was repeated at the same height. The test was continued until one or more of the oranges spilled from the box or could be easily removed without further damaging the box. This is a severe test of the container's ability to absorb shock and resist distortion.

Incline-impact or conbur test.--The incline-impact testing device consists of a track inclined at an angle of 10 degrees to the horizontal and ending in a sturdy wood bumper placed at right angles to the track. A dolly mounted on roller-bearing casters travels on the track. Each container is so placed on the dolly that the edge of the box to receive the impact projects beyond the lower end of the dolly. The loaded dolly is released at a predetermined distance from the bumper, rolls down the track, and the overhanging edge of the box strikes the bumper and receives the impact. The device is shown in figure 8.

In this test, the dolly was released at a point 3 feet 4 inches from the bumper, with the box projecting 4 inches, so that the edge of the box to receive the impact was 3 feet from the bumper. After all four side edges had received an impact, the cycle was repeated from the same distance until failure of the box occurred; that is, until one or more of the oranges spilled from the box or could be easily removed. This test was carried out in accordance with Designation D 880-50, Procedure A of the American Society for Testing Materials.

Results and Discussions

General

Due to limitations in material and time, only 5 boxes could be tested in each of the 10 test groups. A statistical analysis of the results, however, show them to be sufficiently significant at a 5 percent level to allow conclusions to be drawn from them.

Slicing and Drying

To compare the effect of preheating of logs and method of drying on shook quality, all shook was graded after drying. To avoid the removal of defects before grading, the pieces were graded in the full 4-foot lengths before they were crosscut and edged to final dimensions. The pieces were graded for warping, smoothness, splitting, slicing breakaway, and knots. Although knots are inherent characteristics and their incidence is not affected by treating methods, they were included in the grading process because their presence affected the other qualities.

The grades were based on the following standards:

Grade 1. Conforms to the requirements for citrus boxes.

Grade 2. Suitable for use in citrus boxes but with the following limitations:

Warping: Warped to an extent that it would be difficult to use them in an automatically fed nailing machine, but quite suitable for hand nailing (fig. 9).

Smoothness: Contains roughness that will detract somewhat from the appearance of the box.

Splitting, Slicing breakaway, and Knots: Presence of these defects will affect the yield when recovering to final dimensions.

Grade 3. Not suitable for use in citrus boxes.

The results of the grading are shown in table 6 and figure 10.

In general, the knots sliced well in both water- and steam-heated stock (fig. 11), but in some instances, the large knots and distorted grain surrounding them caused warping, splitting, and some roughness (fig. 12). The shook sliced from the outside of the log dried straighter than the shook near the pith (fig. 13).

Effect of preheating on slicing and shook quality. --The flitches preheated in steam at approximately 180° F. sliced easier, smoother, and produced a tighter veneer than the ones preheated in water at 140° F. This was probably due to the higher temperature rather than the heating medium.

There was little difference in warping between the steam- and water-heated units, but the shook cut at room temperature showed a greater tendency to warp.

As far as smoothness was concerned, the steam treatment gave considerably better results than the water treatment. Again the water-heated material was considerably better than the shook sliced at room temperature, which was rather rough. The results are shown in figures 14, 15, and 16.

With regard to splitting, there was no visible difference in the steam- and water-heated stock, but the shook sliced at room temperature developed considerably more splitting.

Although there was no pronounced difference, the flitches sliced at room temperature showed the greatest tendency to break away during slicing, followed by the water-heated and then the steam-heated flitches.

Effect of method of drying on shook quality. --It will be noted in table 6 and figure 10 that the shook dried in the veneer drier was much straighter than the kiln-dried stock. This is also illustrated in figure 13. In smoothness, there was also a noticeable difference in favor of the shook dried in the veneer drier. Both methods of drying produced the same amount of splitting, but it was not pronounced.

Performance of Boxes in Rough-Handling Tests

No significant failures, such as splitting, developed during the assembly of the ends, centers, and cleated tops or the nailing of the boxes. Also, there were no visible differences in quality between the five groups prior to testing.

Drop-cornerwise test. --Most of the boxes failed as a result of a combination of failures. The important ones were as follows, given in order of predominance:

1. Sides and bottoms: (a) Shearing from nails (figs. 17 and 18)
(b) Breaking across grain (figs. 17, 19, and 20)
(c) Splitting (fig. 21)
(d) Pulling from nails (fig. 17)

2. Centers: Splitting along grain between fastenings (figs. 18 and 20)

3. Top slats: Breaking across grain (figs. 17 and 19).

Since breaking across grain was in most instances accompanied by the presence of knots or cross grain, its incidence must be attributed more to the inherent characteristics and quality of the log than to the treatment applied.

The ends did not disclose any weaknesses. In some ends, small pieces splitting away at nails facilitated the pull of these nails from the ends (fig. 21, end 5). Another feature was the twisting of the end components at the fasteners, but this did not affect the performance of the boxes.

The centers failed in 7 out of the 25 boxes due to splitting along the grain between the corrugated fasteners (figs. 18 and 21). Because of its location in the box, it was not always possible to determine at which stage failure of the center commenced. From a study of the sequence of failures, it appeared that most of these centers failed only after the box had been distorted and weakened by pulling and shearing from nails and splitting. It is also significant that the boxes in which the centers failed performed as well or better than the average for the group.

The cleated tops failed in 7 out of the 25 boxes, but in only 2 of these was top failure the major cause of failure of the box. In the other instances, a combination of failures of the sides and tops caused final failure (fig. 19). Most of the failures occurred in the sides and bottoms, but there was no significant difference in the types of failure occurring in the veneer and sawn boxes.

The numerical results of the tests are shown in table 8.

<u>Incline-impact test.</u>--The force of impact in this test is in the same plane as the faces of the ends and centers, and no failures occurred in these components. Considerable splitting of top slats took place, but this was not a limiting factor in the performance of the box. Only one box failed because of breakage across the grain of a top slat (fig. 22).

Failing of the sides and bottoms was responsible for 95 percent of the box failures. Some breaking across grain occurred, but splitting, pulling, and shearing from nails were the main weaknesses (fig. 22). As in the drop-cornerwise test, the types of failure in the sawn and veneer boxes were similar.

The numerical results of the tests appear in table 7.

Effect of preheating of logs on box performance.--Boxes made of shook cut from steam-heated logs gave a better overall performance than those made of water-heated material. The boxes made of water-heated material gave slightly better results in the incline-impact test, but in the drop test, those of steam-heated material performed considerably better. Taking the performance of the sawn boxes as the standard at 100 percent, the performance ratings of boxes made of steam-heated and water-heated material in the drop test were respectively 113 and 73 percent. This can probably be attributed to the fact that the steam-heated logs gave tighter veneer because of the higher temperature applied. The results are given in tables 7 and 8.

The types of failure for the two methods of heating were identical. Since most of the failures were due to splitting and to pulling and shearing from nails, however, it appeared that the tighter veneer produced at the higher temperature was better able to withstand these tendencies.

Effect of method of drying on box performance.--In the incline-impact test, the kiln-dried shook performed only slightly better than that dried in the veneer drier, but in the drop test, there was a considerable difference in favor of the kiln-dried shook. Expressed as a percentage with sawn boxes taken as the standard at 100 percent, the kiln-dried shook had a performance rating of 117 percent in the drop test against 69 percent for the material dried in the drier (table 8).

With regard to individual failures, the shook dried in the veneer drier showed a greater tendency to break across grain than the kiln-dried stock. This was apparently due to greater brittleness caused by fast drying at a high temperature.

Comparative results of the performance of sawn and sliced veneer boxes.--In the drop-cornerwise test, the different groups of sliced-veneer boxes gave performances ranging from 54 to 142 percent (sawn boxes taken as the standard at 100 percent). The average figure for all the sliced-veneer boxes was 93 percent. In the incline-impact test, the performances ranged from 79 to 92 percent, with an average of 83 percent. Table 9 presents comparative performances.

There were no significant differences as far as individual failures were concerned, except that the sliced shook showed a greater tendency to shear from and pull from nails than the sawn shook.

Conclusions

The results of these Laboratory tests indicated that slats for box shook (3/16 and 1/5 inch thick) can be sliced satisfactorily from small-diameter, knotty ponderosa pine logs. A cutting temperature approaching 180° F. is better than one of 140° F. because the higher-temperature results in smoother shook and tighter veneer, which performs better in rough-handling tests.

The higher temperature used in the veneer drier apparently had some adverse effect on the strength of the shook, because the kiln-dried stock performed better than the shook dried in the veneer drier. On the other hand, the material dried in the veneer drier was slightly smoother and considerably straighter. The difference in smoothness was not great enough to be of much importance. In assessing the merits of the two methods of drying, however, it will be necessary to consider such factors as strength required in the box and also the degree of straightness required since boxmaking machines that are fed automatically require straighter shook.

Sliced shook shows a greater tendency to warping, splitting, and roughness than sawn shook. To offset the loss from these factors, the slicing process will have to give a correspondingly higher yield from the log to attain a better net yield of good quality shook.

In the rough-handling tests, the average performance of the sliced shook was about 90 percent that of the sawn shook. However, one group of the sliced shook gave better results than the sawn shook. By selecting and improving heating and drying procedures, it might be possible to further improve the performance of sliced shook in comparison with sawn shook. As far as strength is concerned, the sliced shook should be acceptable for use in fruit and similar containers.

Table 1.--Grouping of boxes according to method of preparation of side, bottom, and top slats

Group	Number of boxes	Heating medium for flitches	Temperature of heating medium	Method of manufacture of slats	Method of drying slats
			°F.		
A[1]	10	....	....	Sawn	....
B.1	10	Water	140	Sliced	Veneer drier
B.2	10	....do....	140	.....do......	Kiln
C.1	10	Steam	180	.....do......	Veneer drier
C.2	10	....do....	180	.....do......	Kiln

[1]Ends and centers for all boxes and slats for group A boxes were sawn from 1-5/8-inch, kiln-dried boards.

Table 2.--Slicer settings used to cut ponderosa pine veneer

Veneer thickness	Slicer knife[1]			Pressure bar		
	Bevel	Angle		Bevel	Vertical opening	Horizontal opening
Inches	Degrees	Degrees	- Minutes	Degrees	Inches	Inches
0.210	22	90	20	12	0.035	0.200
.197	20	90	20	12	.035	.187

[1]Rockwell hardness: 60-62; hollow ground 0.002 inch.

Table 3.--Specification for citrus boxes with inside dimensions of 23-15/16 by 11-1/2 by 11-1/2 inches

Shook	Number of pieces	Dimensions			
		Length	Width	Thickness	
				Sawn	Sliced
		Inches	Inches	Inches	Inches
Ends	2	11-1/2	11-1/2	11/16	....
Centers	1	11-1/2	11-1/2	11/16	....
Sides and bottoms	6	26	4-7/8	7/32	1/5
Tops	4	26-1/8	2-3/8	3/16	3/16
Cleats	2	11	1-1/4	7/32	1/5

Table 4.--Moisture content of shook as determined by moisture meter readings[1] and ovendry method

Shook	Meter			Ovendry		
	High	Low	Average	High	Low	Average
Ends	10.1	8.5	9.0	10.8	8.3	9.6
Sides and bottoms	8.6	7.2	7.9	10.6	7.7	9.3
Tops	8.7	6.8	7.8	(2)	(2)	(2)

[1] Corrected for ponderosa pine.

[2] No ovendry determinations were made.

Table 5.--Average weights of citrus boxes and loads

Test	Group	Number of boxes	Average weight		
			Box	Load	Gross
			Lb.	Lb.	Lb.
Drop	A	5	7.2	79.3	86.5
	B.1	5	7.0	79.0	86.0
	B.2	5	7.0	79.0	86.0
	C.1	5	7.2	78.9	86.1
	C.2	5	7.2	78.9	86.1
Incline impact	A	5	7.3	78.0	85.3
	B.1	5	7.0	78.5	85.5
	B.2	5	7.1	78.2	85.3
	C.1	5	7.0	78.3	85.3
	C.2	5	7.2	78.2	85.4

Table 6.--Grading of shook for quality showing percentage falling in each of grades 1, 2, and 3

Group	Treatment	Number of shooks	Percentage of shooks conforming to each grade														
			Warping			Smoothness			Splitting			Slicing break-away			Knots		
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
B.1	Water Veneer drier	129 129	89	9	2	30	47	23	85	12	3	85	14	1	78	18	4
B.2	Water, kiln	125	53	19	28	18	47	35	84	11	5	86	12	2	78	18	4
C.1	Steam Veneer drier	126	88	9	3	78	21	1	84	14	2	91	9	0	60	28	12
C.2	Steam, kiln	119	60	21	19	54	39	7	84	11	5	91	8	1	61	30	9
Room temperature	Veneer drier	59	66	12	22	14	51	35	62	27	11	78	20	2	39	39	22
B.1 + B.2	Water	254	71	14	15	24	47	29	84	12	4	85	13	2	78	18	4
C.1 + C.2	Steam	245	74	15	11	66	30	4	84	13	3	91	8	1	60	29	11
B.1 + C.1	Veneer drier	255	88	9	3	54	34	12	84	13	3	88	11	1	69	23	8
B.2 + C.2	Kiln	244	56	20	24	50	35	15	84	11	5	88	10	2	69	24	7

Table 7.--Numerical results of rough-handling tests on citrus boxes

Group	Cornerwise-drop test			Incline-impact test		
	Box No.	Number of falls to cause failure	Average number falls for group	Box No.	Number of impacts to cause failure	Average number of impacts for group
A	2	5		1	6	
Sawn slats	3	5		4	5	
Boards dried	6	7	5.2	5	10	7.6
in kiln	7	4		9	7	
	8	5		10	10	
B.1	11	2		12	9	
Sliced slats	13	7		14	2	
Water heated	16	2	2.8	15	8	6.4
Dried in	17	2		18	7	
drier	20	1		19	6	
B.2	21	5		23	5	
Sliced slats	22	5		27	9	
Water heated	24	1	4.8	28	9	7.0
Dried in kiln	25	6		29	6	
	26	7		30	6	
C.1	31	5		32	6	
Sliced slats	34	9		33	7	
Steam heated	35	3	4.4	36	6	6.0
Dried in	37	4		39	6	
drier	38	1		40	5	
C.2	42	6		41	6	
Sliced slats	43	10		44	6	
Steam heated	46	8	7.4	45	6	6.0
Dried in kiln	49	6		47	6	
	50	7		48	6	

Table 8.--Performance of citrus boxes in rough-handling tests

Group	Processes used in manufacture of slats	Drop cornerwise	Incline impact
		Percent	Percent
A	Sawn[1]	100	100
B.1	Sliced, water heated, dried in drier	54	84
B.2	Sliced, water heated, dried in kiln	92	92
C.1	Sliced, steam heated, dried in drier	85	79
C.2	Sliced, steam heated, dried in kiln	142	79
Average for B.1, B.2, C.1, and C.2		93	83
B.1 + B.2	Water heated, dried in drier and kiln	73	88
C.1 + C.2	Steam heated, dried in drier and kiln	113	79
B.1 + C.1	Dried in drier, water and steam heated	69	81
B.2 + C.2	Dried in kiln, water and steam heated	117	85

[1] Performance of the sawn boxes, being the standard against which the sliced veneer boxes are tested, is taken as 100 percent.

Figure 1.--Ponderosa pine logs, 6-1/2 to 9 inches

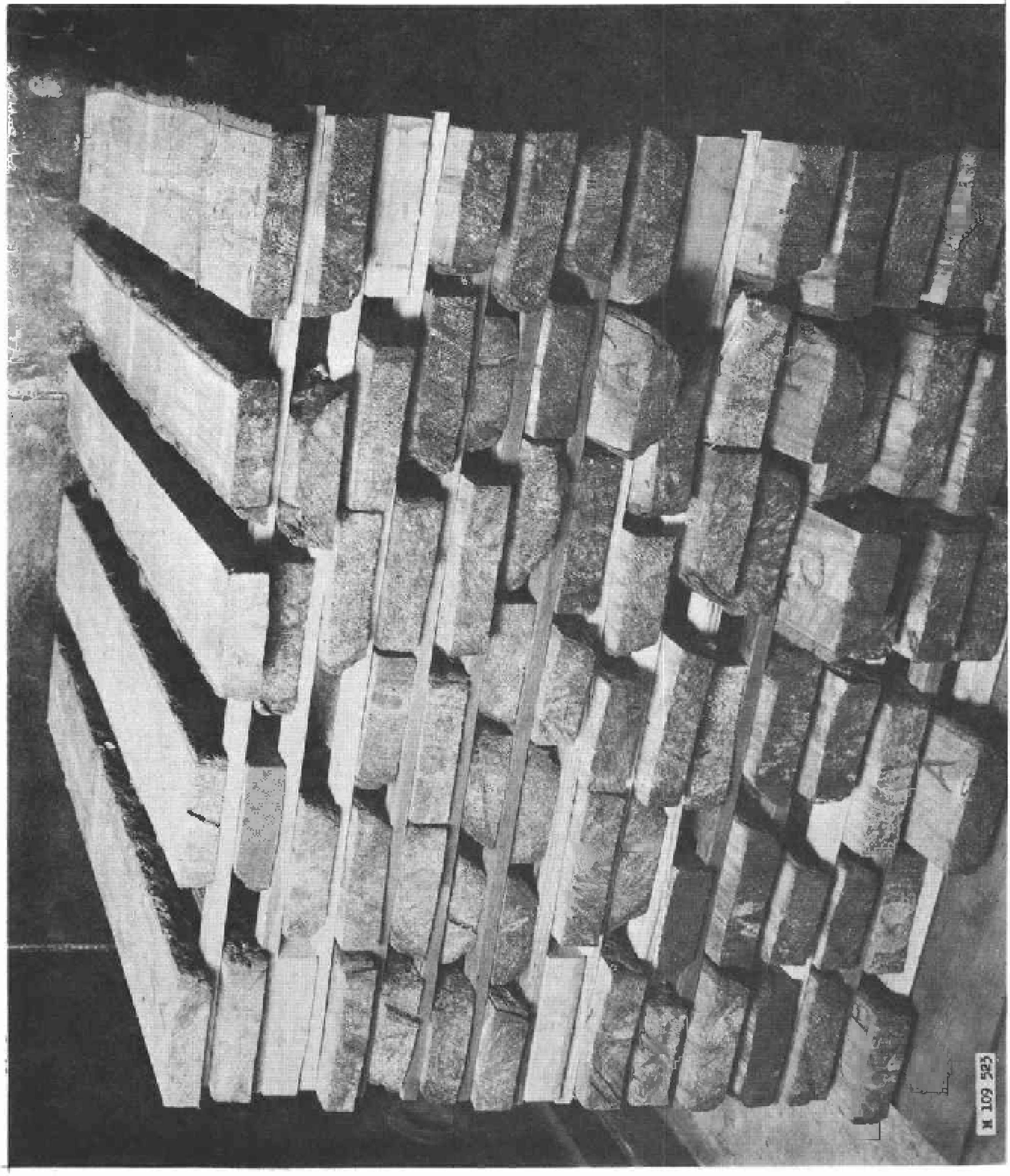

Figure 2. --Boards sawn from ponderosa pine logs, stacked in kiln.

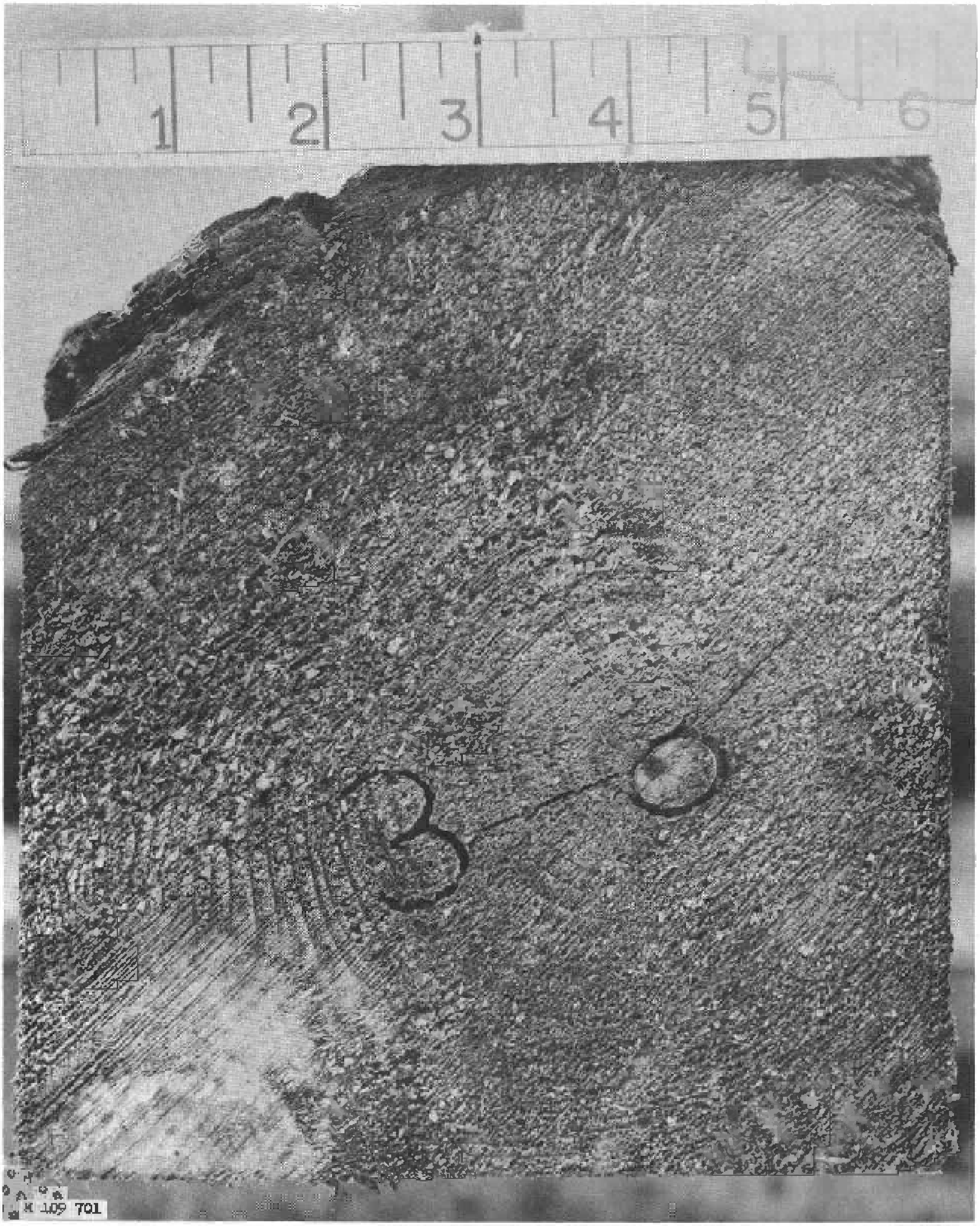

Figure 3. --Flitch sawn on 3 sides, heated in water to 140° F., and ready for slicing.

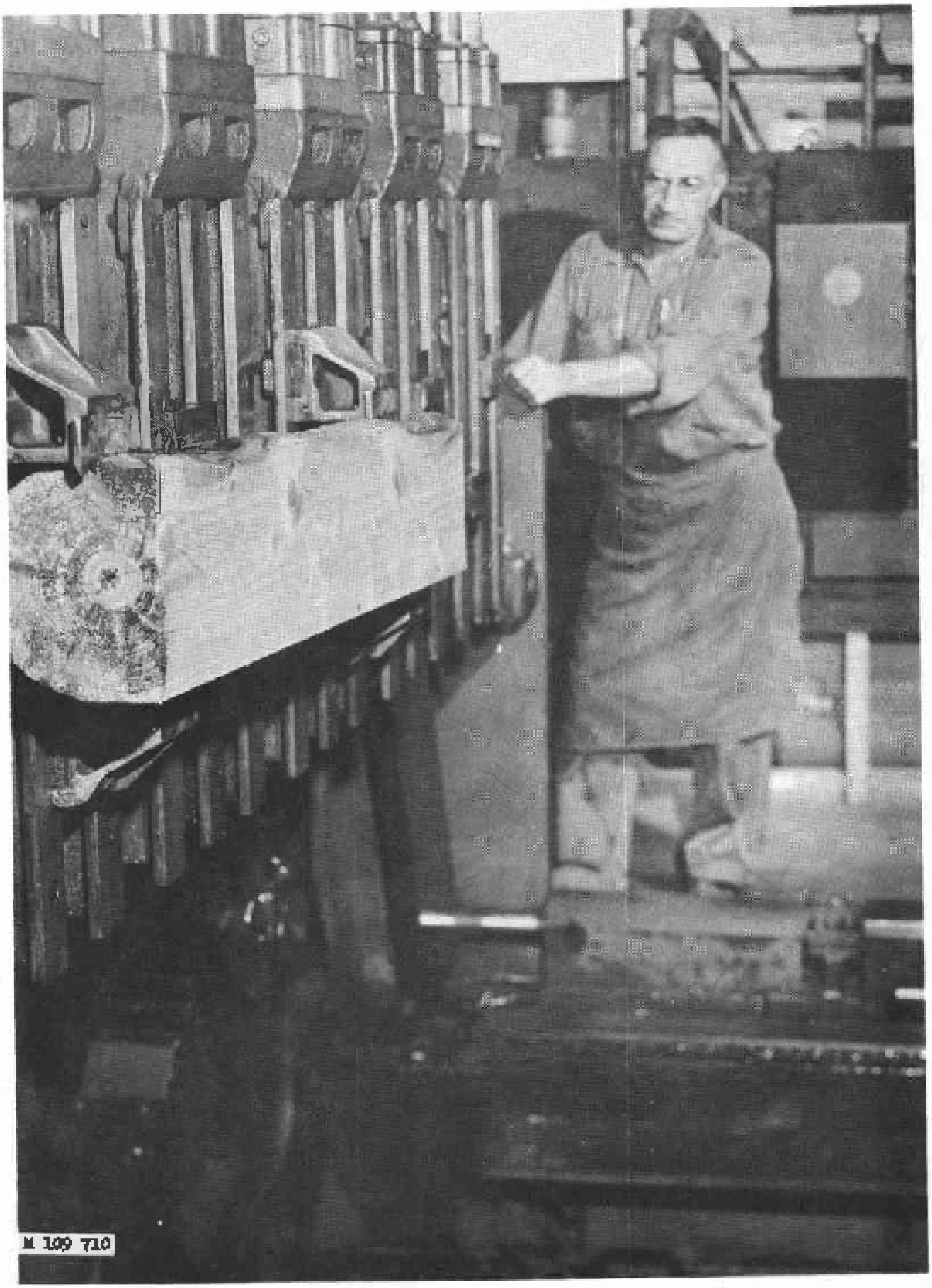

Figure 4. --Flitch mounted on slicer.

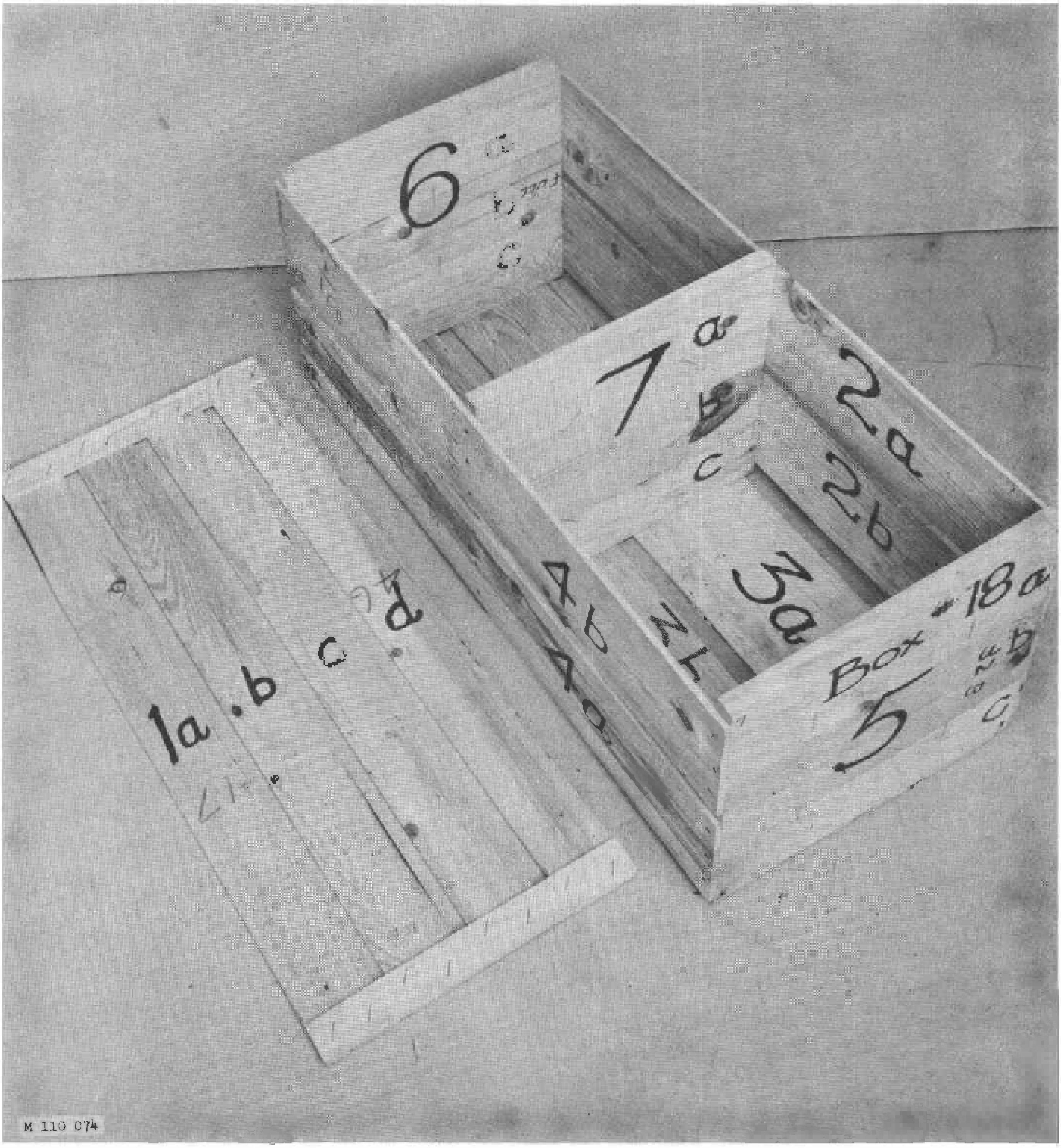

Figure 5. --Citrus box with sliced slats (group B. 1), showing method of marking components.

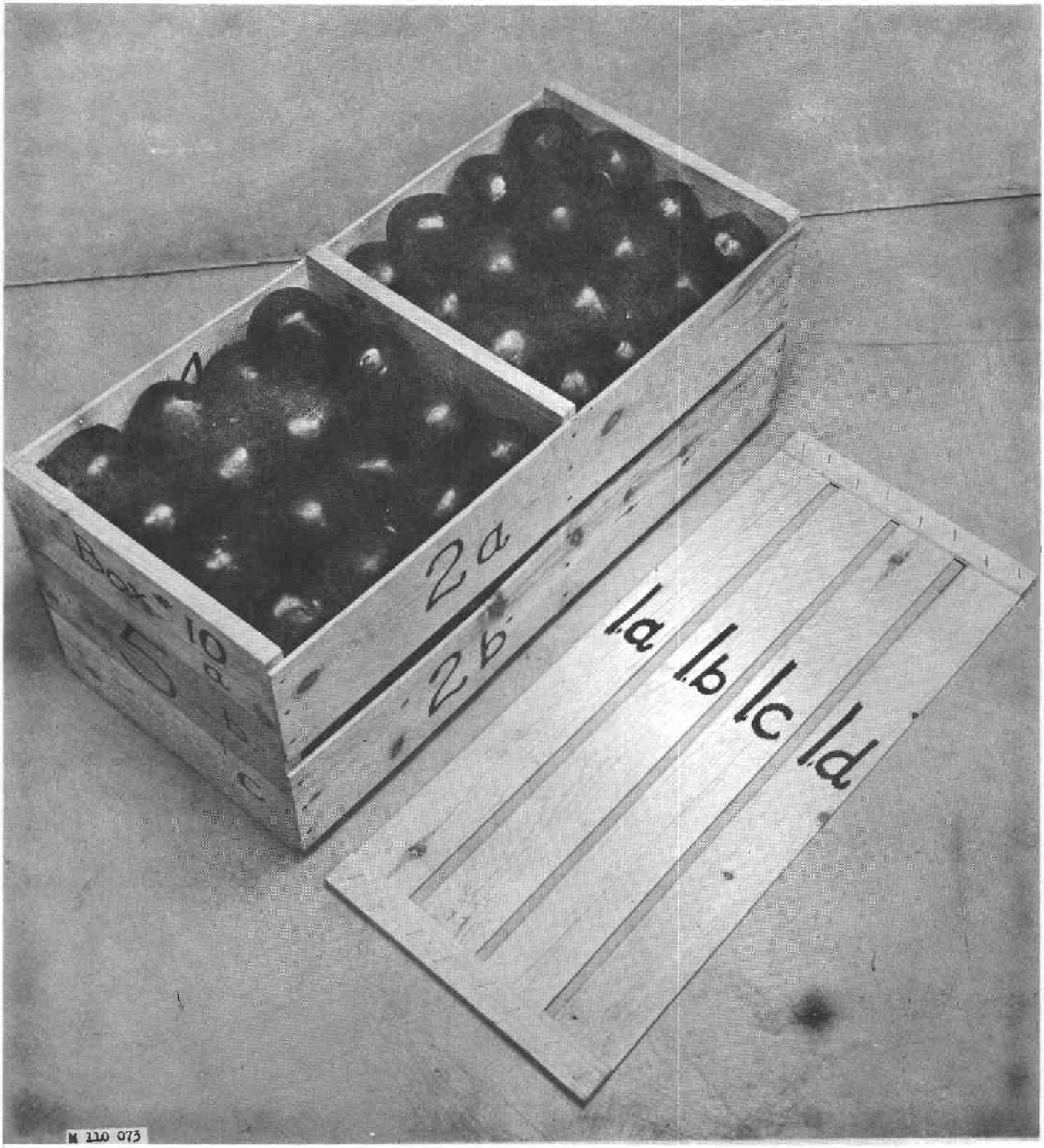

Figure 6. --Citrus box with sawn slats (group A), packed with simulated oranges.

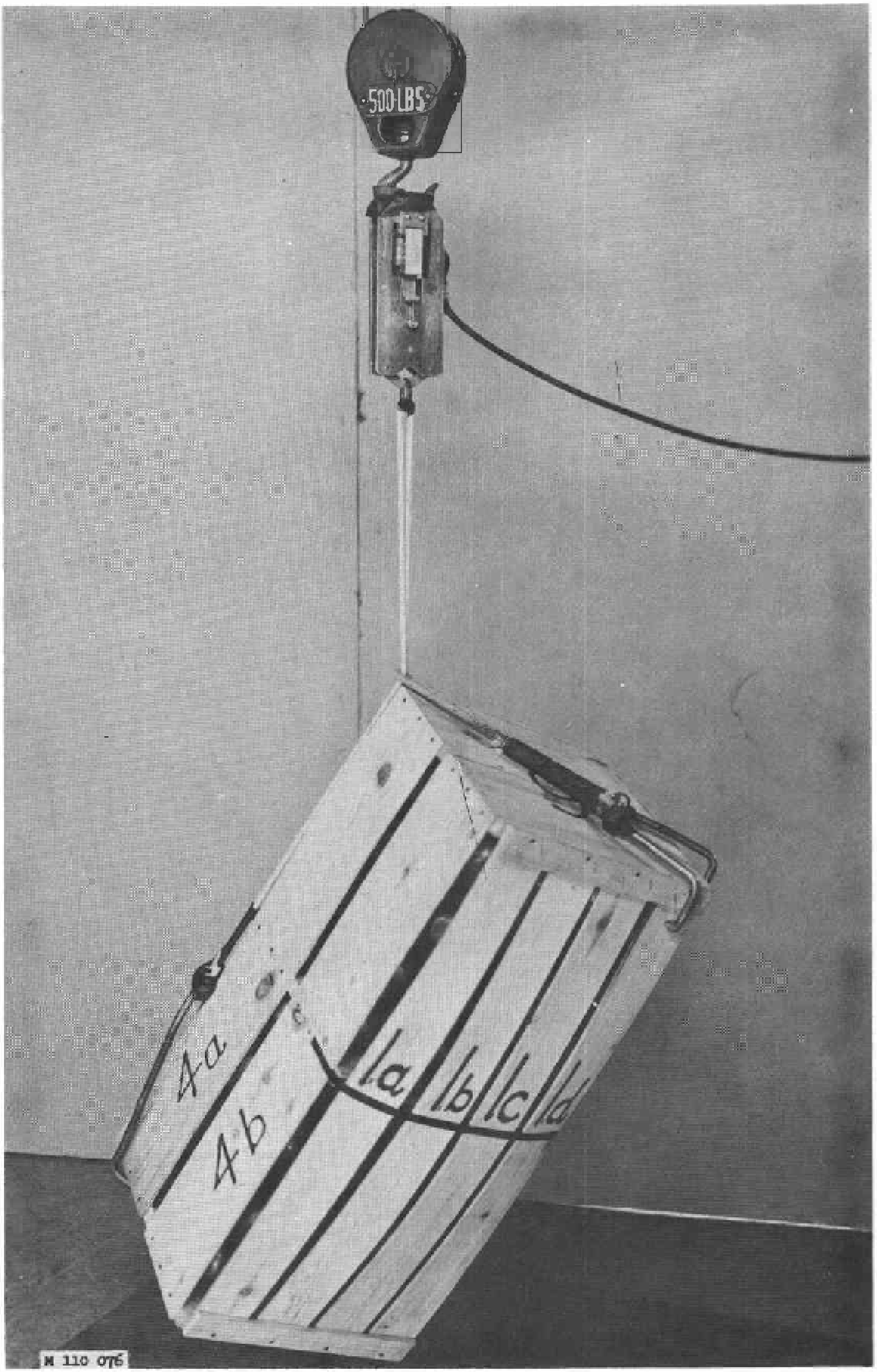

Figure 7. --Citrus box, loaded and lidded, ready to be dropped in cornerwise-drop test.

Figure 8. --Citrus box, loaded and lidded, placed on dolley in incline-impact test. Box strikes bumper at right.

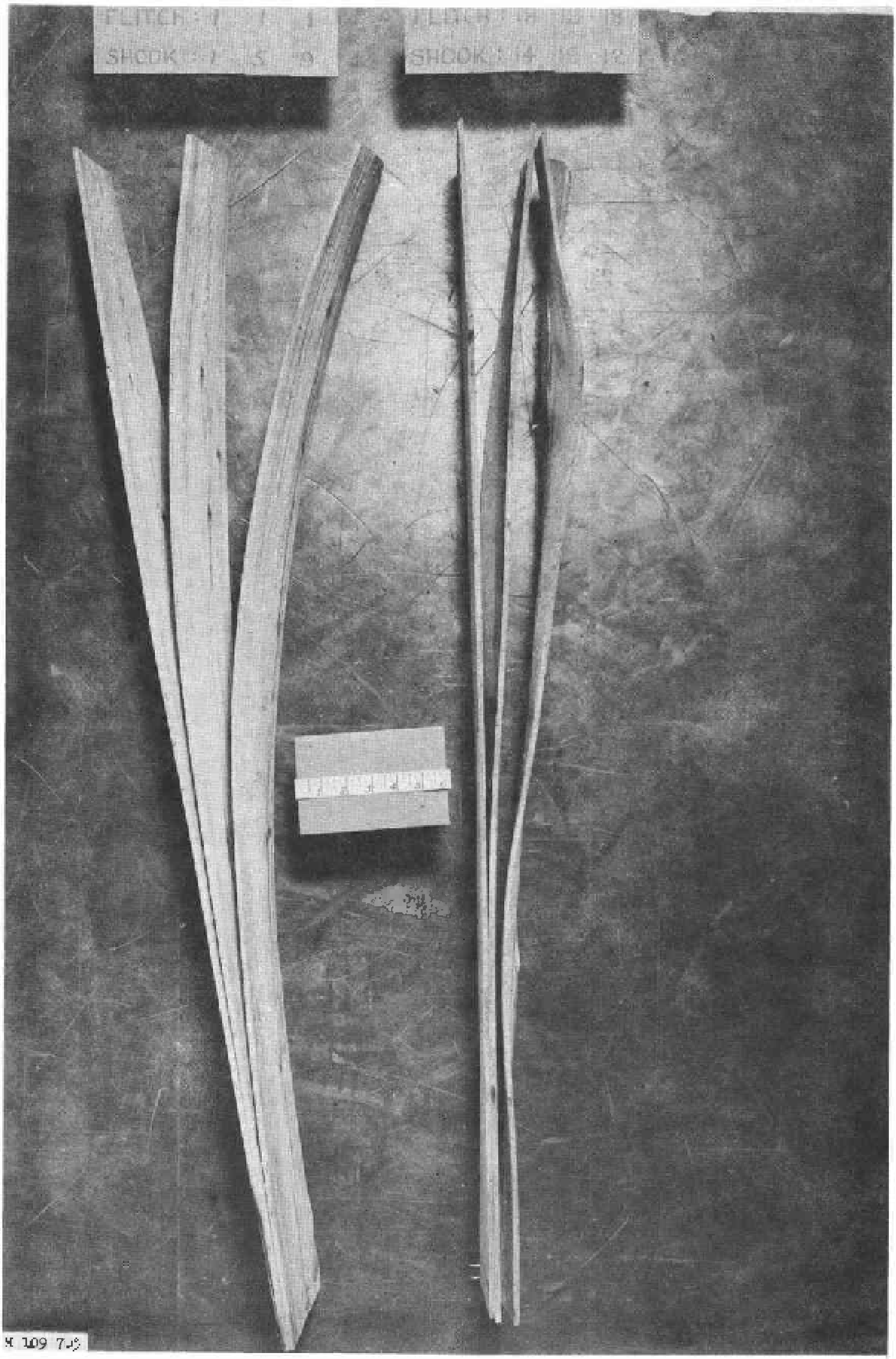

Figure 9. --Grading for warping, with grades 1, 2, and 3 from left to right. Flitch No. 1 was preheated in water, and the shook was dried in the veneer drier. Flitch No. 18 was preheated in steam, and the shook was dried in the kiln.

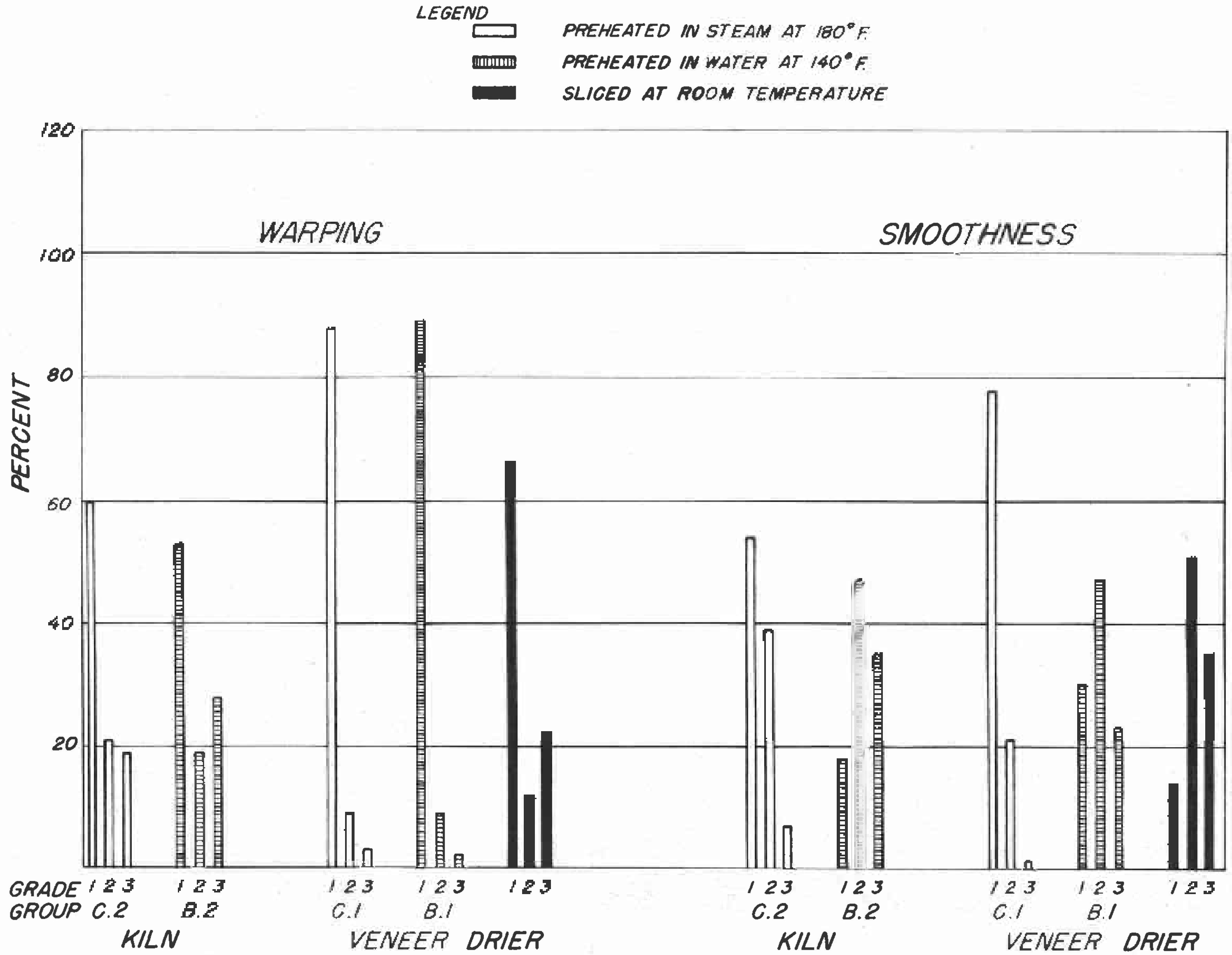

Figure 10. --Grading of shook for warping and smoothness, showing percentage falling in each of grades 1, 2, and 3.

M 110 626

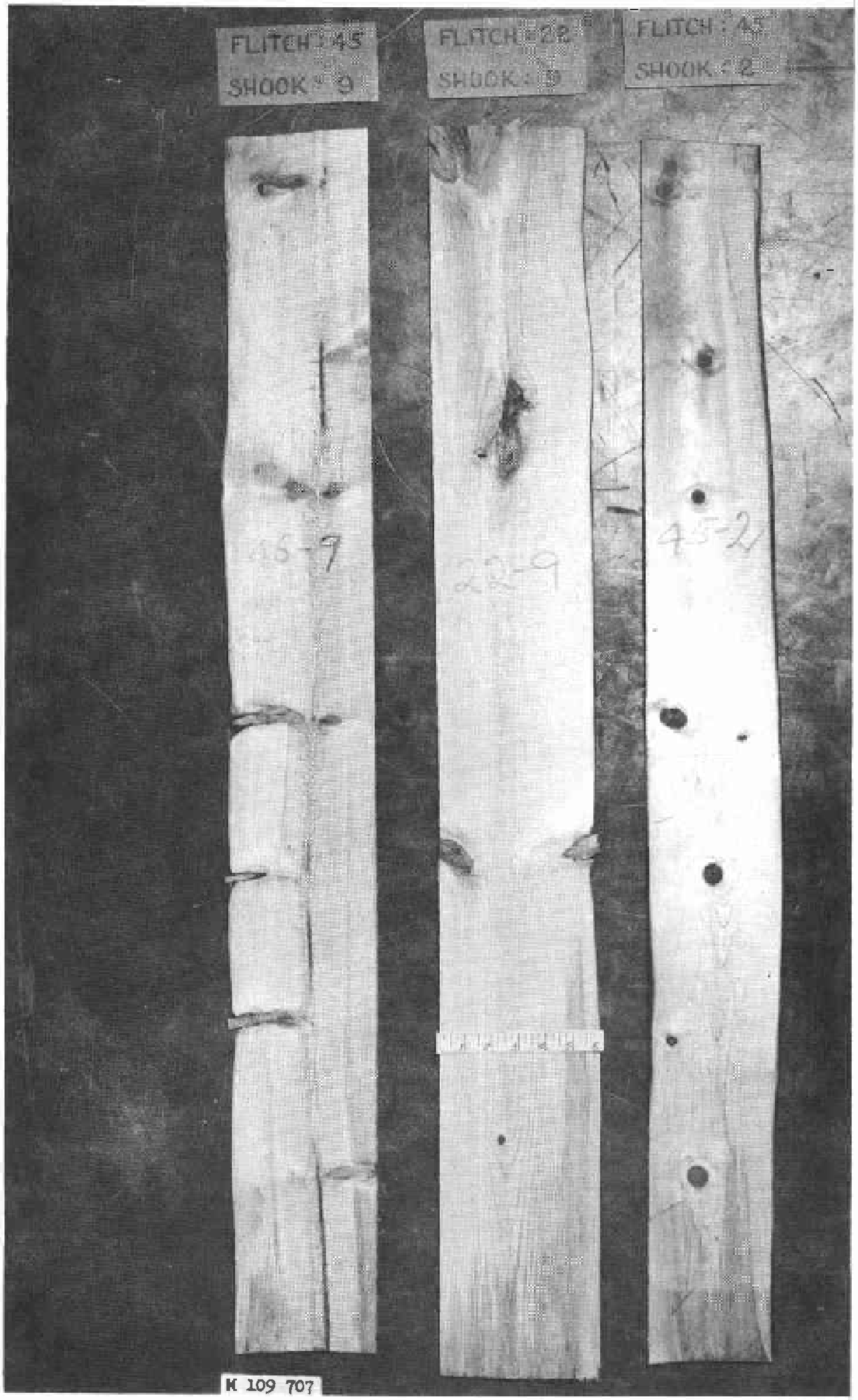

Figure 11. --Knots in sliced shook preheated in steam.

GPO 803104-4

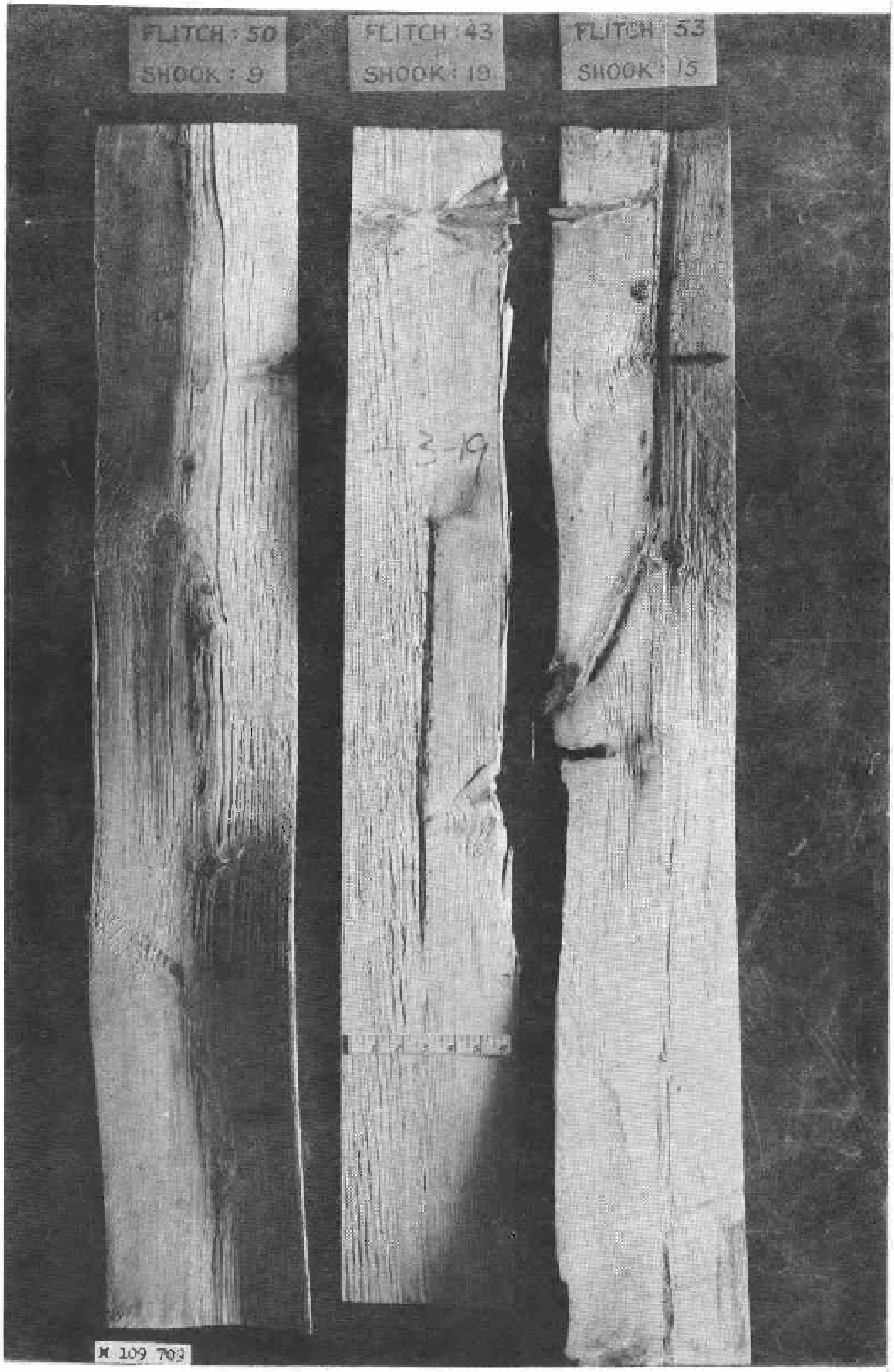

Figure 12. --Combination of defects, showing warping, roughness, splitting, slicing-breakaway, and knots.

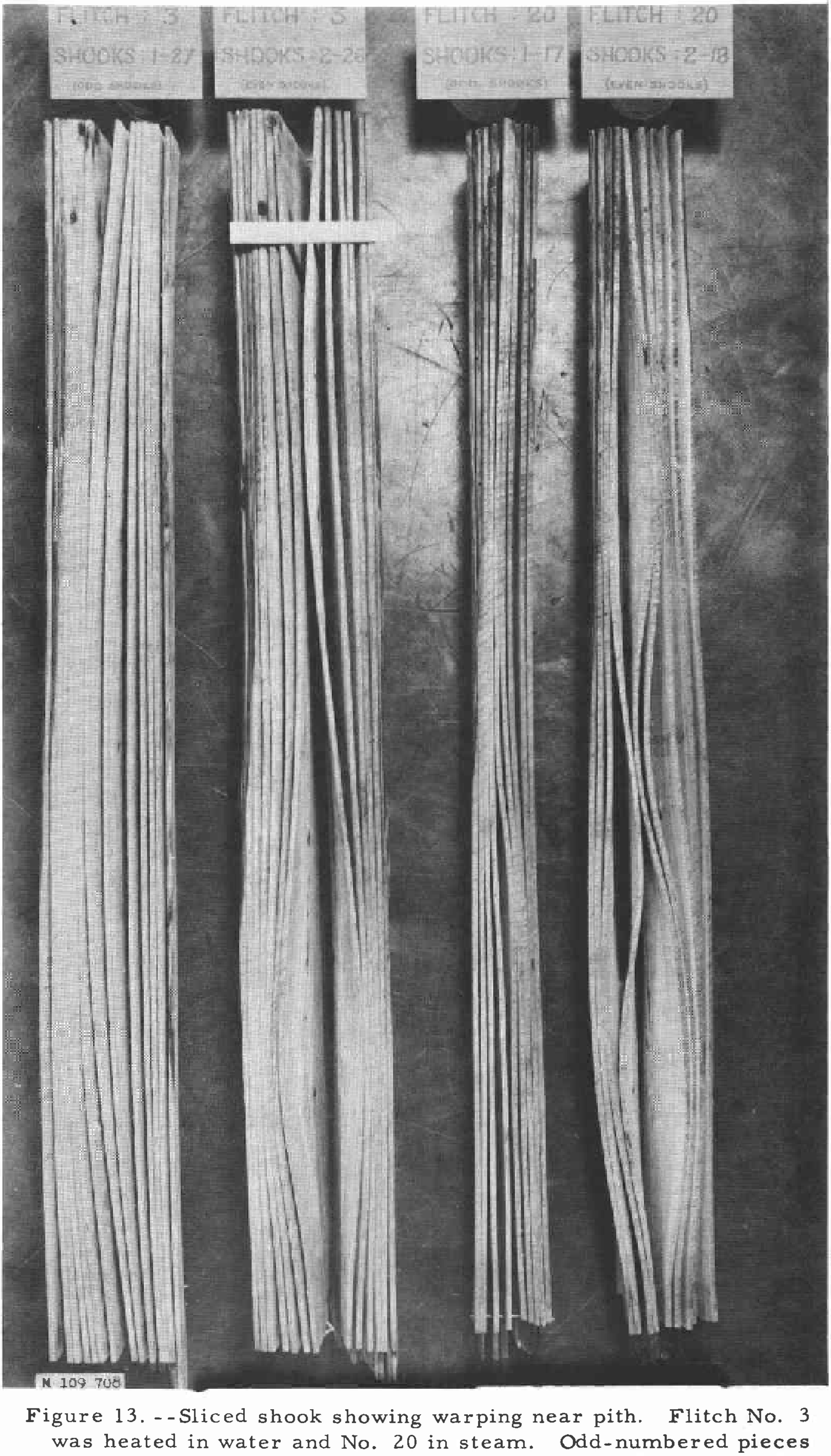

Figure 13.--Sliced shook showing warping near pith. Flitch No. 3 was heated in water and No. 20 in steam. Odd-numbered pieces were dried in a veneer drier and even-numbered ones in a kiln.

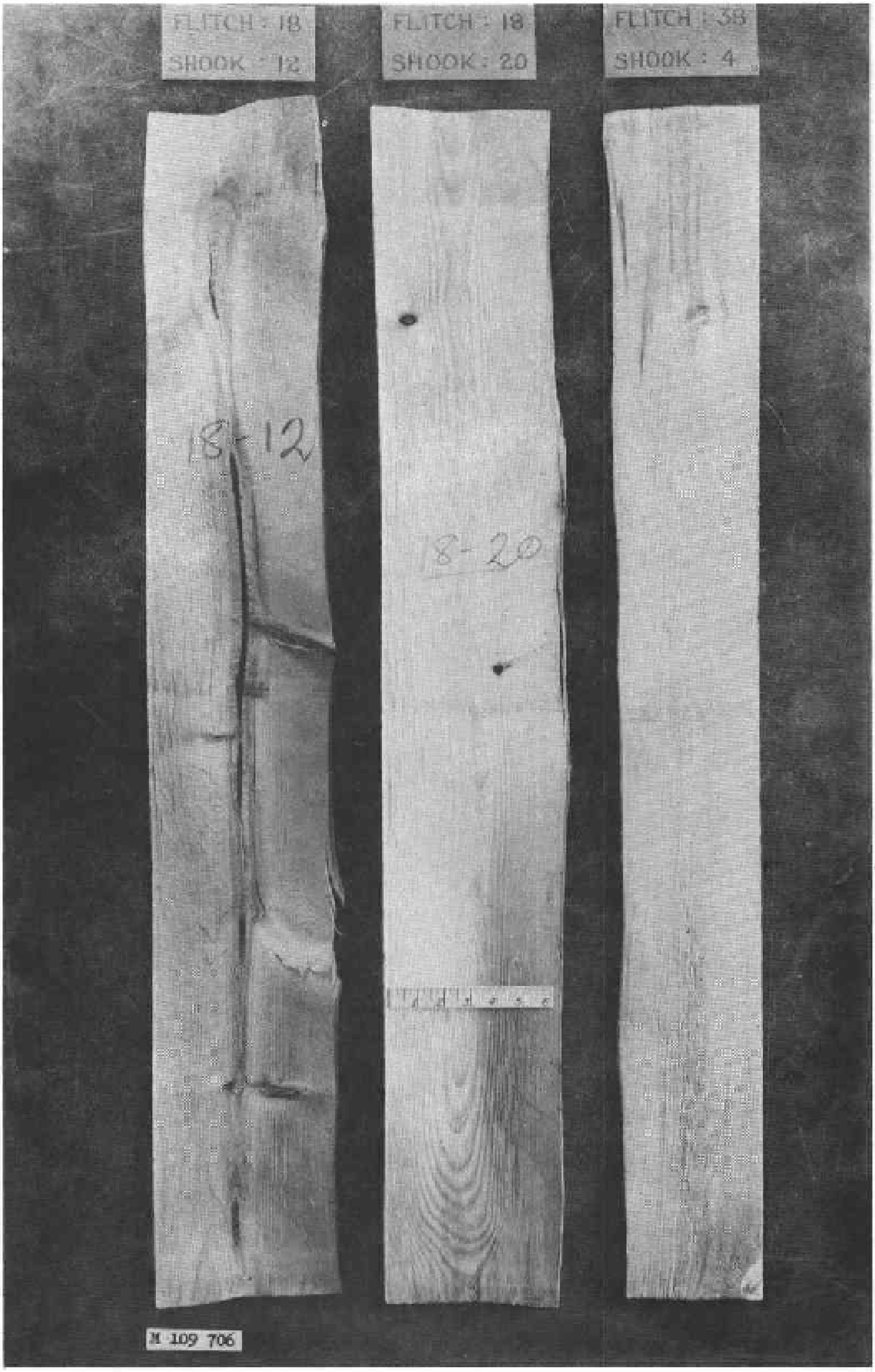

Figure 14. --Shook preheated in steam, dried in kiln, and graded for smoothness, with grades 3, 2, and 1 from left to right.

M 109 706

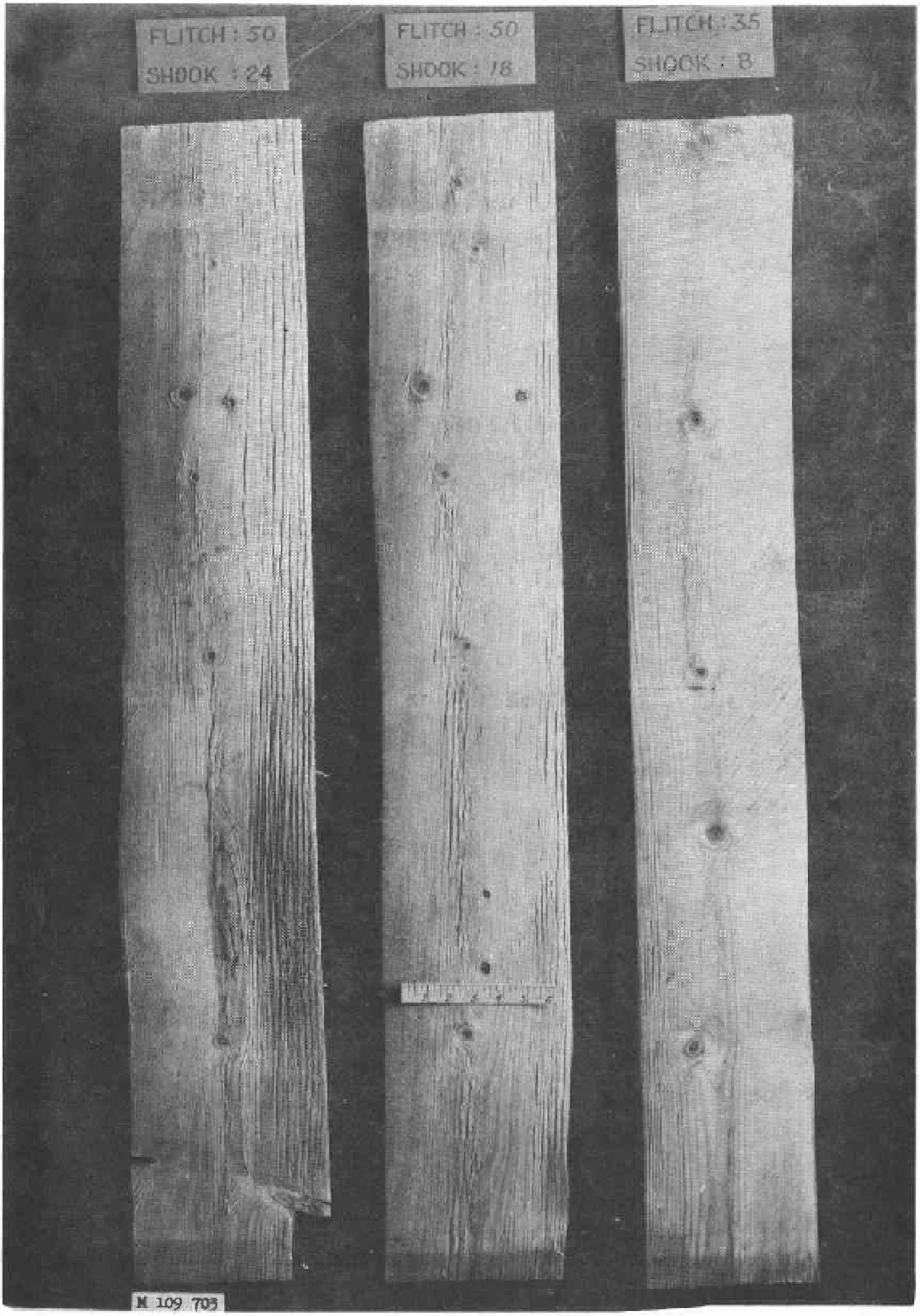

Figure 15. --Shook preheated in water, dried in kiln, and graded for smoothness, with grades 3, 2, and 1 from left to right.

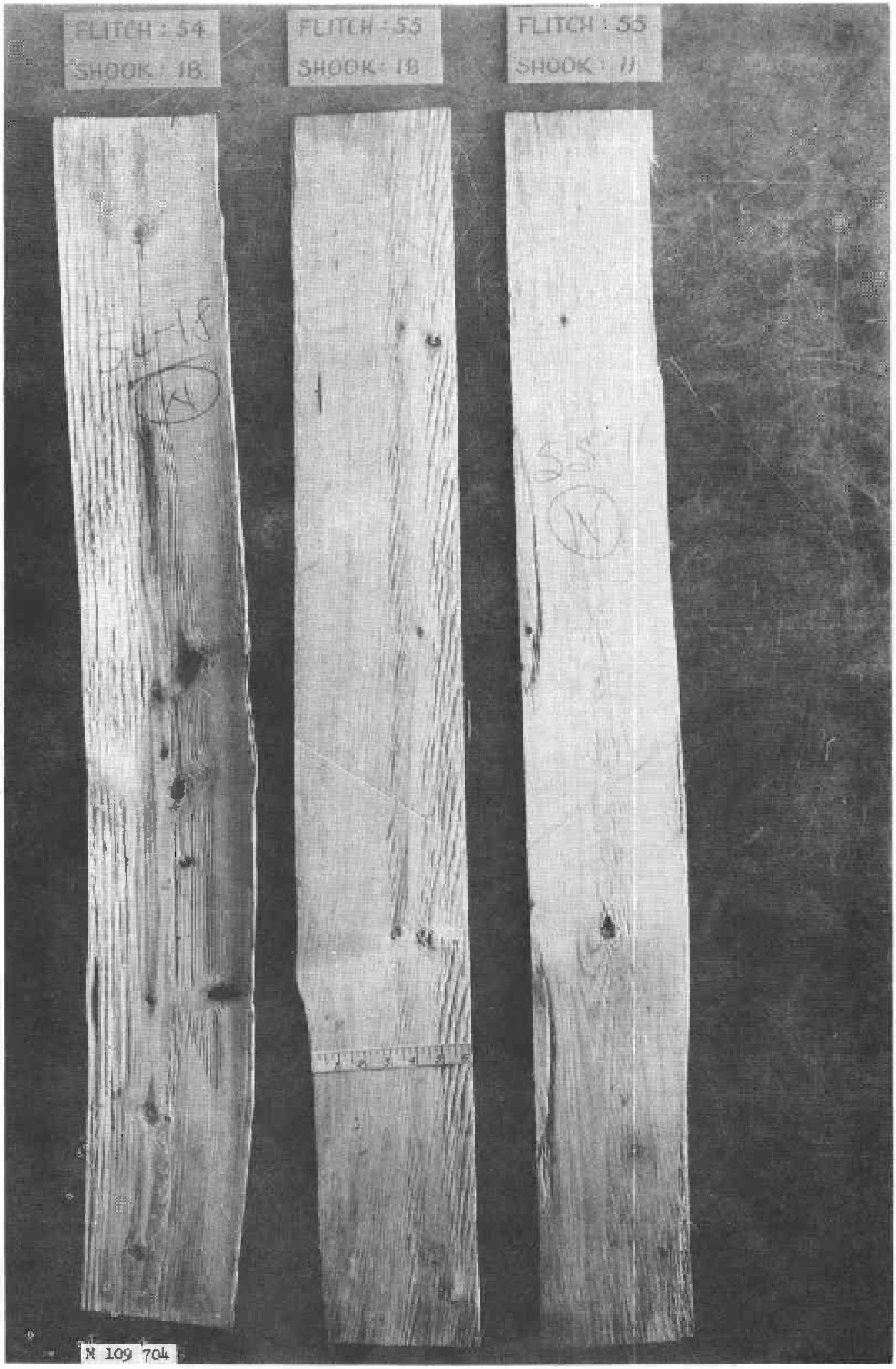

Figure 16. --Shook sliced at room temperature, dried in veneer drier, and graded for smoothness with grades 3, 2, and 1 from left to right.

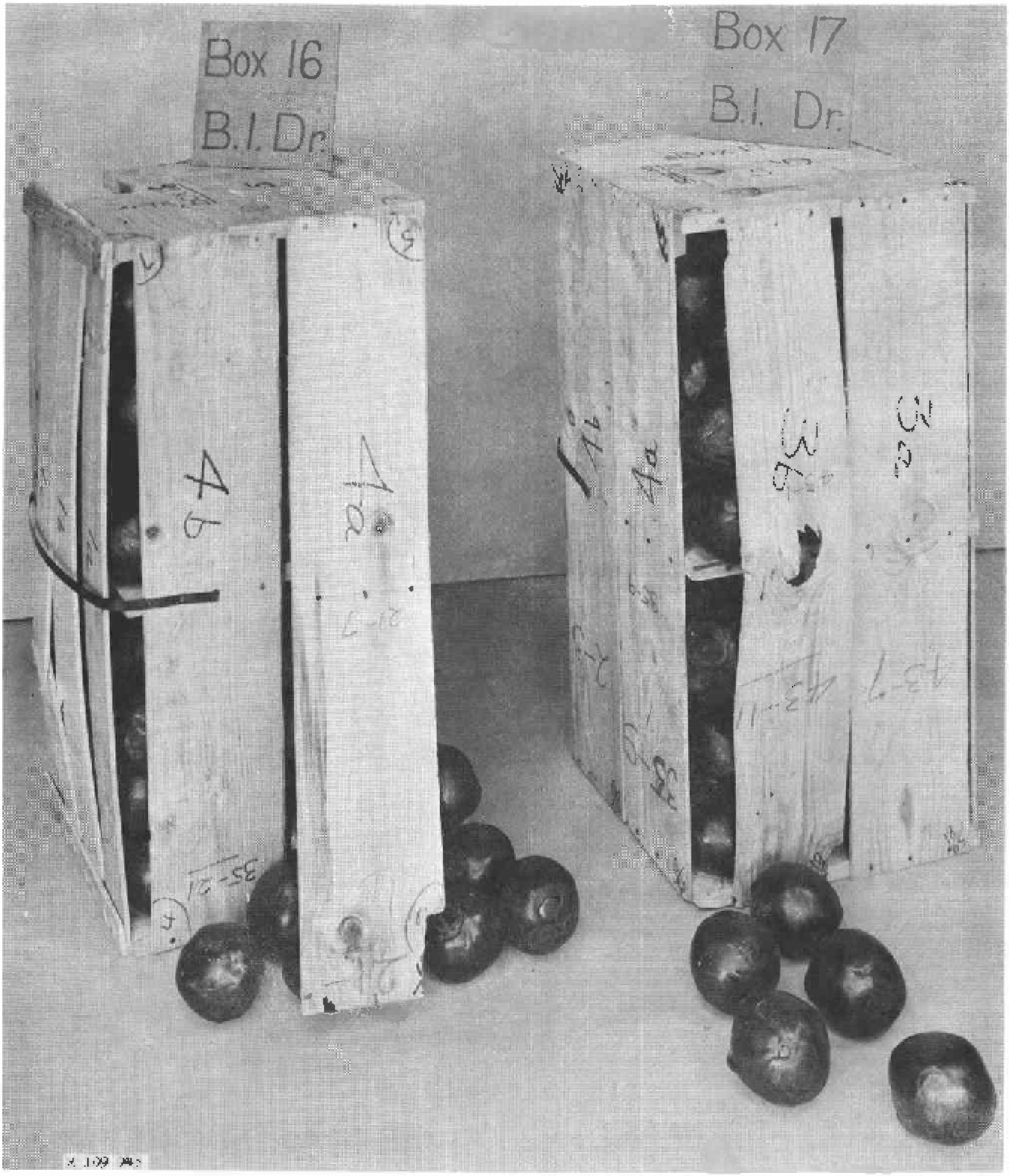

Figure 17. --Boxes from group B. 1 (heated in water, dried in veneer drier) subjected to the cornerwise-drop test and showing typical failures such as shearing from nails at ends, pulling from nails at center, and breaking across grain.

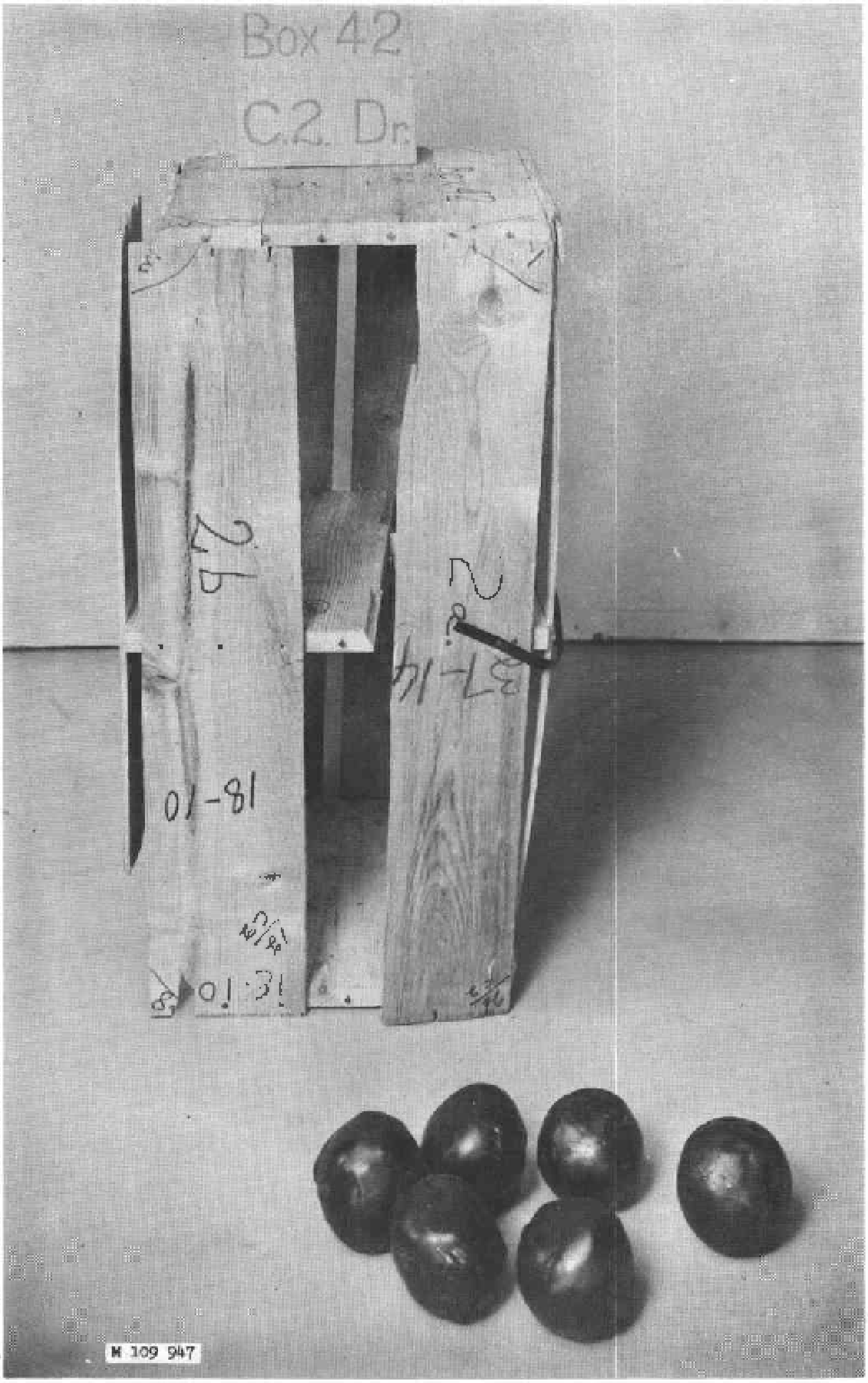

Figure 18. --Box from group C. 2 (heated in steam, dried in kiln) subjected to cornerwise-drop test and showing shearing from nails and splitting of center between fasteners.

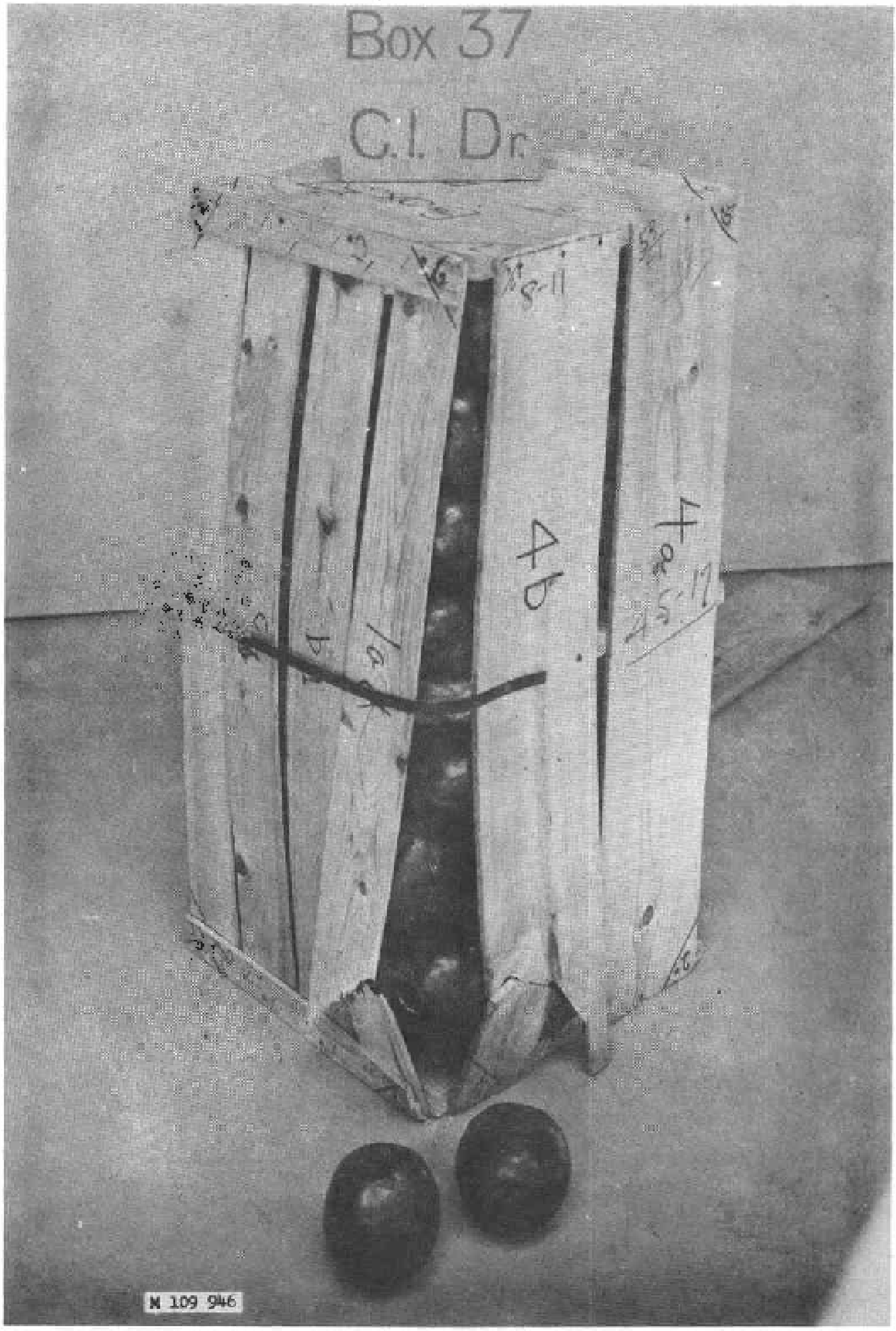

Figure 19. --Box from group C. 1 (heated in steam, dried in veneer drier) subjected to cornerwise-drop test and showing breaking across grain.

M 109 946

GPO 803104-3

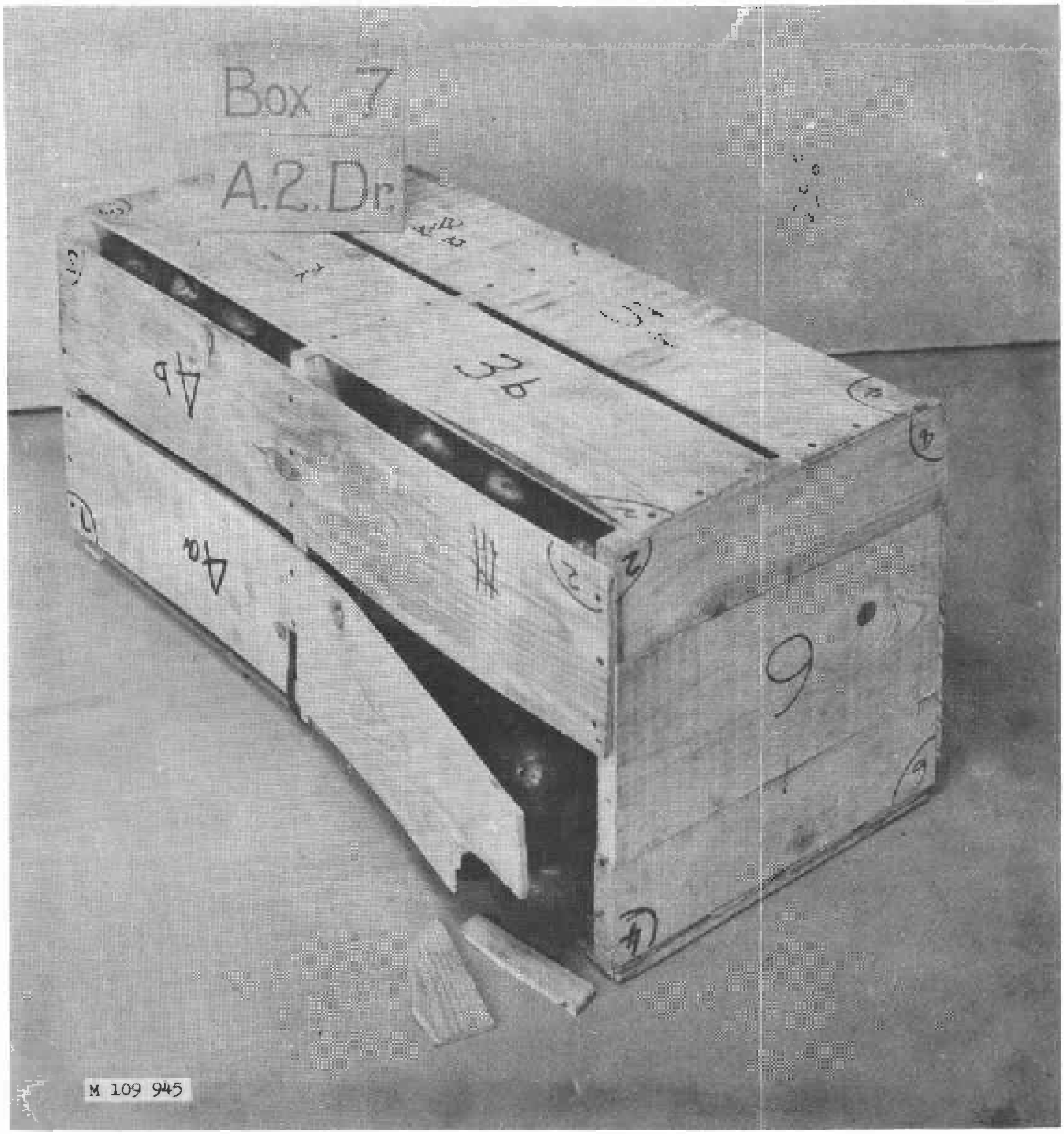

Figure 20. --**Sawn** box (group **A)** subjected to cornerwise-drop test and showing breaking across grain.

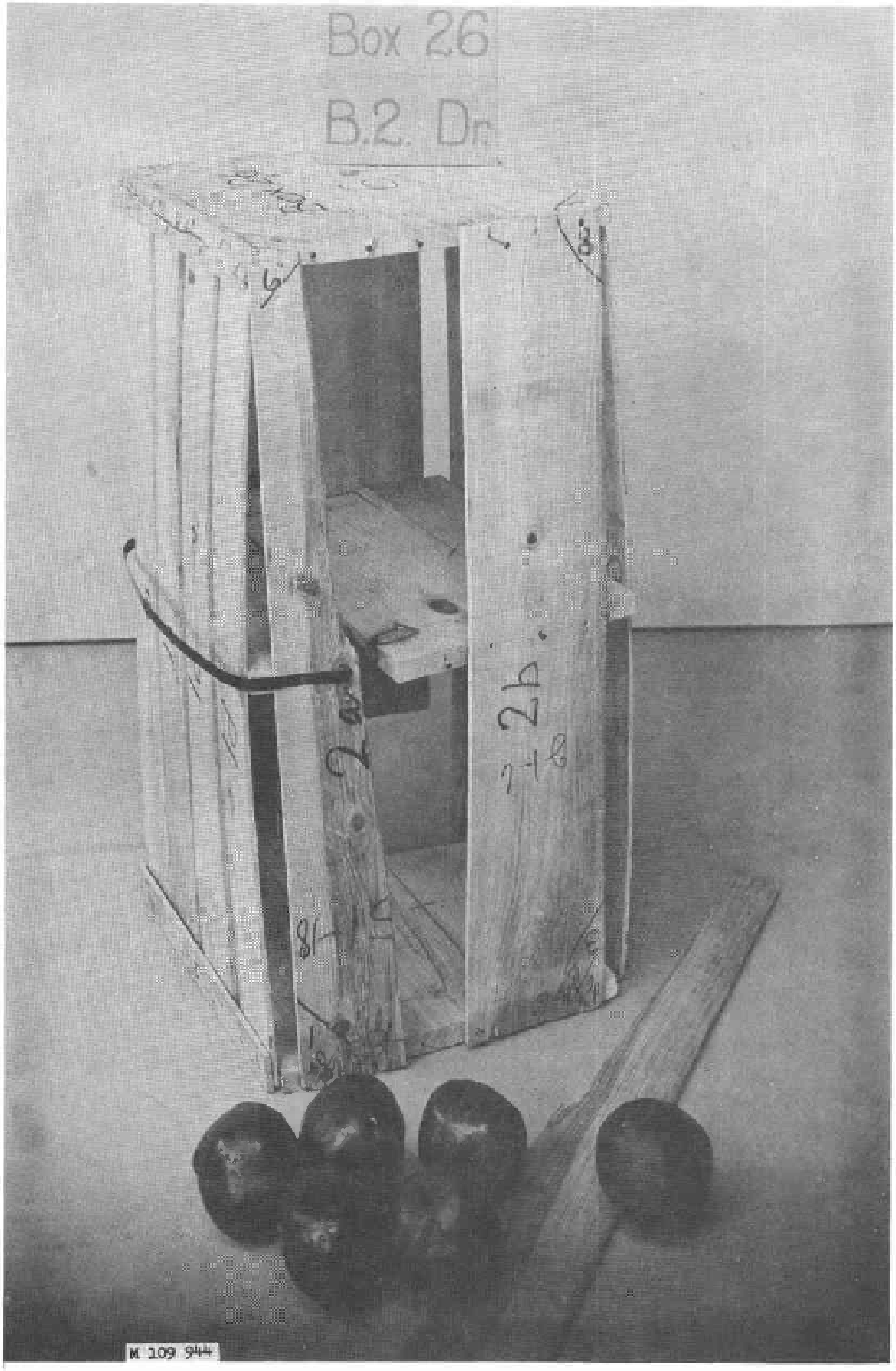

Figure 21. --Box from group B. 2 (heated in water, dried in kiln) subjected to cornerwise-drop test and showing splitting of side and center and shearing and pulling of nails. Top cleat split but did not fail.

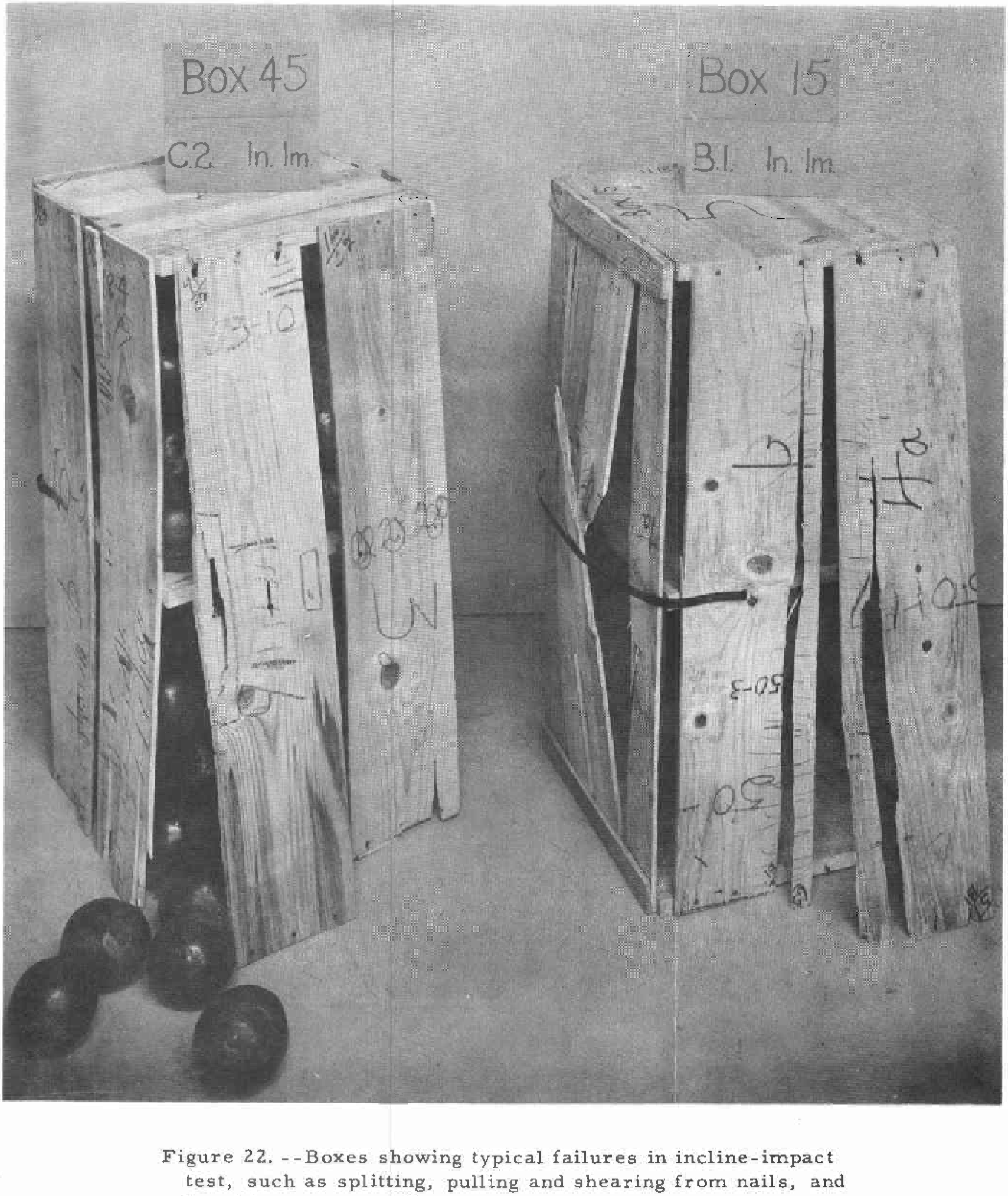

Figure 22. --Boxes showing typical failures in incline-impact test, such as splitting, pulling and shearing from nails, and breaking across grain.

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GPO 803104-2