INSULATING BOARD AND HARDBOARD FROM FOUR COMMON HARDWOODS OF NORTHEASTERN FARM WOODLOTS

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INSULATING BOARD AND HARDBOARD FROM FOUR COMMON HARDWOODS OF NORTHEASTERN FARM WOODLOTS[1]

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Summary

Sheathing-grade insulating board and class A hardboard were prepared from soft maple, beech, white birch, and hard maple, four hardwoods common to farm woodlots in northeastern United States. The board stocks were prepared in a laboratory-model Asplund Defibrator. Subsequent refining was conducted in an 8-inch disk refiner or in a Valley test beater.

The insulating-board stocks, mixtures of highly refined and unrefined Defibrator pulps, were slow, but were in the acceptable range of freeness of commercial production equipment. No more than 0.5 percent of rosin size, moisture-free pulp basis, was necessary to impart adequate water resistance to all insulating boards.

The flexural strength of the hardboards increased with increased beating of the stock, but beating had no effect on the amount of size required. To produce class A hardboard from refined maple, beech, and birch Defibrator stocks, molding temperatures as high as 240° C., or as much as 2 percent of size, or both, as in case of birch, were necessary.

For experimental purposes it was found that relatively small test specimens sufficed. Tests conducted on specimens cut from boards prepared

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

from the mats formed in the Defibrator freeness tester, when properly tested were found adequate for evaluation of either type of board.

Introduction

This report presents experimental data obtained by the Forest Products Laboratory on the production of insulating board and hardboard from soft maple, beech, white birch, and hard maple. The purpose was to ascertain, on a laboratory scale, the suitability for structural fiberboard of these four species, which are common to farm woodlots in northeastern United States. For this investigation the Asplund Defibrator process (1, 6)[3] was used, because of the availability and suitability, especially for hardboard, of this type of equipment for small-scale operations.

Materials

Wood

The wood used in this work was cut near Ticonderoga, N. Y.[4] It was peeled before shipping and upon arrival was stored in the Laboratory yard in criss-cross piles. A sample of about 100 pounds of each species was selected for these experiments after about 2 years of storage.

Only the white birch and beech showed visual evidence of decay. Of the material selected for this work, however, only the beech exhibited such evidence of decay as zone lines and yellow and white discoloration. In spite of these manifestations, the beech wood was firm and dry. It contained less than 15 percent of moisture.

None of the four woods contained as much as 20 percent of moisture; consequently further degradation of any of these woods was not likely (17) during the course of this investigation.

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[3]Underlined numbers in parentheses refer to Literature Cited at end of report.

[4]The wood was supplied by the International Paper Co., Research Division, Glens Falls, N. Y.

Each of the four woods was converted to 5/8-inch chips, which were screened, sampled for moisture content determination, and stored in enclosed containers before processing.

Sizing Chemicals

The following chemicals were used in sizing: (1) Rosin size, a completely water-soluble material of commercial manufacture; (2) paraffin size, and oil-in-water emulsion made in the laboratory; (3) paper maker's alum; and (4) sulfuric acid. Each sizing chemical was made up in 10 percent solution (by weight) prior to use.

The Laboratory-prepared paraffin wax size consisted of the following components:

Paraffin	100 grams
Oleic acid	20 grams
Concentrated ammonium hydroxide	5 grams
Distilled water	sufficient to make 1 liter of size

The preparation was as follows: The paraffin, melted and mixed with oleic acid, was heated to 80° C. The ammonium hydroxide and then the paraffin mixture were added in rapid succession to 250 milliliters of water at 80° C. The emulsion was vigorously stirred and cooled at the same time. When diluted to 1 liter, the emulsion contained 10 percent of paraffin by weight.

Equipment and Procedure for Preparation of Boards

Fiberization Equipment

The pulps used for the preparation of the insulating-board and hardboard stocks were made in a laboratory-model Asplund Defibrator. The equipment is shown in figure 1. The stainless-steel Defibrator consists of a 2-3/4-gallon cylinder fitted with an axial shaft from which protrude four steel blades. These blades extend radially to within about one-eighth of an inch of the cylinder wall, but only about ten one-thousandths of an inch from any of the five equally spaced longitudinal steel bed plates. The edges of the blades are beveled to the contour of the cylinder, and the shaft is rotated in the clockwise direction, which produces a brushing action. The chip charge is approximately 1 pound, moisture-free basis.

Insulating-Board Stock Preparation

Stock for insulating boards of the approximate density and texture of commercial sheathing grade was made by the following procedure:

(1) High-yield, coarse pulps were prepared from each of the four species (table 1).

(2) A portion of each pulp was then processed to a pronounced degree of slowness by passing the stock through an 8-inch disk refiner.

(3) Insulating-board stock of each species was prepared by blending of the unbeaten and beaten pulps.

The refiner was an 8-inch, single-rotating-disk mill (fig. 2). B-No. 6945 plates were used, and the machine was run in the clockwise or brushing direction. The refining was conducted in the following manner: The plates were adjusted to zero clearance before the pulp and water were fed to the hopper. The mill discharge was caught and drained in a box fitted with a closely woven canvas screen to prevent the loss of fines. The pulp was then remilled.

If necessary, this procedure was repeated to secure a stock with a freeness value in the range of 500 seconds or more on the Defibrator freeness tester (fig. 3).

Hardboard Stock Preparation

A Defibrator fiberizing schedule that produced yields of pulp in the 85 percent range (8) was selected for preparation of the hardboard stock (table 1). The refining of the various pulps was principally conducted in a Valley test beater for periods ranging from 5 to 20 minutes. The test beater was selected instead of the small attrition mill because a measurable control of the processing was desired. The beater was charged with 550 grams of moisture-free pulp at a consistence of 2.5 percent, and the processing conducted for a predetermined period with a 5,500-gram weight on the beater arm. Boards Nos. 1416 to 1427, however, were made from attrition-milled Defibrator stocks. The processing was limited to a light brushing of the four pulps. Both refined and unrefined Asplund stocks were used in making hardboards.

Stock Freeness

The Defibrator freeness tester was used in evaluating all the insulating-board and hardboard stocks. The value obtained by means of this apparatus is the drainage time, in seconds, required for the water in a 10-liter sample of fiber suspension (128 grams per 10 liters) to pass through a screen and for 10 liters of air to pass through the pulp mat formed on the screen.

The 8-1/2-inch-diameter mats of pulp formed on the freeness tester were converted into boards for test purposes.

Insulating-Board Preparation

Nominal 1/2-inch insulating boards, some 18 inches square and some 8-1/2 inches in diameter, were prepared and evaluated. Two sized boards, 18 inches square, were made from selected stocks of each species. The sized boards were prepared in the following manner: Pulp in excess of that necessary to make two large boards was dispersed in softened water at a consistence of 2 percent. A portion of the stock was then removed for the freeness test. The remainder of the stock was sized, resampled for freeness, and then formed into mats that were removed from their 18-inch-square mold by means of a suction lift. These mats were laid on a 16-mesh wire screen supported by a metal caul, cold-pressed to the desired thickness, and then dried at 150° C. in a forced-draft oven for several hours. In drying, these mats were supported by three equally spaced stickers.

The freeness tests were made in duplicate on both the unsized and sized stocks. The 8-1/2-inch mats formed in these tests were cold-pressed for 5 minutes at pressures ranging from 60 to 100 pounds per square inch. The moisture content of the pressed mats ranged from 62 to 67 percent. Approximately 3 hours were required to dry these mats in a forced-draft oven at a temperature of 150° C. The results obtained with this procedure served as a guide for the cold-pressing and drying of the comparable larger mats. The insulating-board stocks were sized by addition of rosin size, followed by paper-maker's alum, and then sufficient dilute sulfuric acid to lower the pH value to about 4.5. The amounts of size and alum used for each stock are given in table 2.

Hardboard Preparation

Nominal 1/8-inch hardboards were made from both unrefined and refined stocks. For each condition investigated, the unsized or sized residual mats of the freeness test were cold-pressed to remove excess water and then hot-pressed at temperatures ranging from 180° to 240° C. for 10 minutes at a maximum pressure of 500 pounds per square inch.

The pressing schedules for these hardboards are given in the footnotes of tables 5, 6, and 7. The total of the numbers in the schedule is 10 with the first number being the initial period (minutes) at maximum pressure; the second number, the breathing period at a pressure of 100 pounds per square inch; and the third number, the final period at maximum pressure.

Both paraffin and rosin were used for sizing. The size, 1.5 to 2.0 percent on a moisture-free pulp basis, was added to the pulp at a consistence of 2 percent. The size was then affixed to the fibers by the addition of paper-maker's alum of ferric sulfate and a sufficient amount of 10 percent sulfuric acid to lower the pH value to a range of 4.0 to 4.5. In instances where 2.0 percent of rosin size was affixed to the fiber with 4.0 percent of ferric sulfate, sulfuric acid was not needed because the pH values of the slurry ran between 3.5 and 4.0.

Board Testing Procedure

Insulating Board

In each case two nominal 1/2-inch insulating boards were tested according to Forest Products Laboratory procedure (16). Each board furnished two transverse-breaking-load specimens, two tensile specimens, one linear-expansion specimen, and one water-absorption specimen.

Test pieces cut from small boards formed in the Defibrator freeness tester were limited in number, type, and size, and were smaller than specified by the Laboratory testing procedure (16). In each case only four 5- by 2-inch specimens could be prepared, two from each of duplicate boards, and they were tested in static bending. Water-absorption tests were then made on one static-bending specimen from each board.

Hardboard

In each case (exceptions noted) two nominal 1/8-inch hardboards were tested according to Forest Products Laboratory procedure (16), except that the water-absorption specimens were smaller than specified and results for them were reported on a percentage-weight-increase basis rather than on a volume basis. The increase in thickness of the water-absorption samples with soaking was reported.

Each board furnished two 7- by 2-inch static-bending specimens and two 3- by 1-1/2-inch water-absorption specimens, except boards Nos. 1416 to 1427. These boards furnished three 5- by 2-inch specimens, two for static bending and one for water absorption. Boards Nos. 1400 to 1415, inclusively, were not made in duplicate and were used exclusively for water-absorption tests. Each board furnished three 5- by 2-inch water-absorption specimens.

Discussion of Results

Insulating Board

Insulating boards meeting Federal specifications (2) for sheathing grade were made from soft maple, beech, white birch, and hard maple from stocks prepared in the Asplund Defibrator. The data are given in table 2. The stocks were slow, but on the basis of previous Laboratory experiences were not beyond the freeness range suitable for conventional commercial machine operation. It is estimated from the Defibrator freeness values that the drainage rate for these stocks would be about 60 seconds or less on an Oliver freeness tester, a generally accepted limiting value for slow stocks (4). The increase in drainage time with the sized stocks over that of the unsized stocks can be attributed to foam. The drop in the drainage time for the sized stock of board No. 1246 from that of the unsized stock of board No. 1245 can be attributed to the use of kerosene to break up the foam. This practice was not continued.

Preliminary experiments with the four hardwoods in fiberizing, refining, sizing, and board making indicated that: (1) To secure the texture common to insulating board, coarser pulps than those obtained in 80 to 85 percent yield were desirable; (2) refining in a Valley test beater was a slow procedure; and (3) white birch Asplund stock did not size as readily as the pulps from the three other species.

On the basis of these findings, a defibration schedule was selected (table 1) in which the yields of pulp produced were in the 88 to 92 percent range; the refining was conducted in a small disk mill; and for comparative and control purposes, a sizing study was conducted with white birch and hard maple stocks, the results of which are given in table 3.

The sizing experiments indicated that insulating board of adequate water resistance could be made from any of the four hardwood stocks with only 0.5 percent of rosin size, moisture-free pulp basis. Birch boards, however, of comparable water resistance to that of hard maple required 1.0 percent of rosin size. Increasing the size content of both the birch and maple boards from 0.5 to 1.0 percent improved their water resistance but materially decreased their transverse bending strength. These properties of the boards of both species, however, were not materially affected by increasing the alum-size ratio from 1:1 to 3:1.

It is apparent from the data given in table 2 that insulating boards can be prepared from Asplund stock of varying proportions of unrefined and refined pulp, the ratio of one to the other depending upon the degree of slowness of the refined pulp. Furthermore, a relationship exists between the transverse breaking strength and water resistance of small test specimens cut from 8-1/2-inch-diameter boards and those of specimens cut from boards 18 inches square. As shown in table 4, the small test specimens used in this study, on the average, gave values for transverse breaking load and water absorption approximately 14 and 26 percent higher, respectively, than those of specimens of standard dimensions. The unsized small specimens gave, on the average, breaking-strength values about 30 percent higher than those of the standard specimens; the high water-absorption values of these specimens are of no significance other than to indicate the efficiency of the sizing.

For evaluation purposes, laboratory procedures for determining the suitability of stocks for insulating board may be limited to the preparation of pulp mats in the Defibrator freeness tester. Certain conditions must be complied with, however, if such a procedure is to be used:

(1) The stocks should be free if they are to be comparable to commercial material (4).

(2) The texture of the insulating boards should be similar to that common to insulating board, so that the desired flexibility is secured.

(3) The moduli of rupture of these boards should be determined, and from these data the transverse breaking loads re-required for specimens of standard dimensions should be calculated. The calculated values for unsized and sized specimens will be 30 and 15 percent, respectively, in excess of values obtained by test with sized standard specimens.

(4) The density of the boards should be limited to not more than 20 pounds per cubic foot, or the transverse breaking load should be adjusted to that density value. This adjustment can be made on the basis that the transverse breaking load varies as the square of the density (15). Boards of no more than 20 pounds per cubic foot can be assumed to be sufficiently low in density to meet the thermal conductivity requirement of structural insulating board (18).

(5) The boards evaluated should be dried at temperatures between 140° and 150° C., so that the sizing efficiency is high (9). Under such circumstances the linear-expansion requirements of the boards are generally met.

Hardboard

As shown in table 1, the four hardwoods were processed in the Defibrator to a yield range of 81 to 87 percent. On the basis of related investigations (1, 5, 6, 7, 8, 10, 11, 12, 14), this range is undoubtedly appropriate for investigating the suitability of woods for hardboard. Exploratory investigations with refined, unsized stocks showed that strong boards could be prepared (table 5). In confirmation of previous research (13), exceptionally strong boards were prepared from these stocks at a molding temperature of 240° C. These boards, because of their strength, relatively good dimensional stability in thickness, and fair water resistance could be used in many applications.

A series of sized hardboards of each wood were made from unbeaten and beaten stocks. Unlike previous beating experiments, the entire contents of the beater were used without draining. This procedure prevented the loss of fines and reduced irregularities in stock quality. The boards were sized with 1.5 percent of paraffin. The data given in table 6 disclosed the following facts:

(1) The processing of the stock materially increased the strength of the boards, but the water absorption was not affected .

(2) Boards meeting Federal specifications for class A hardboards (3) were not prepared from any of the woods at 180° C. ; in all cases they lacked water resistance. Furthermore, boards prepared from stocks in the acceptable Defibrator freeness range approximately 40 seconds or less, were generally below standard strength in flexural strength.

(3) The flexural strength standard of 6,000 pounds per square inch was met by all boards molded at a temperature of 240° C., irrespective of species or degree of beating. Only the beech and the hard maple boards, however, were sufficiently water resistant to meet the water-absorption standard of 20 percent or less. The soft maple and the white birch hardboards were slightly to moderately deficient, respectively, in this property.

Using unbeaten Defibrator pulp of soft maple as a criterion, a series of sizing experiments were made to determine means of increasing sizing efficiency and to ascertain the amount of size necessary to increase the water resistance to class A standards (3). As shown in table 7, the specifications were met when the soft maple stock was sized with 2.0 percent of paraffin and 2.0 percent of alum, or with 2.0 percent of rosin and 2.0 percent of ferric sulfate. In both cases doubling the amount of affixing agent produced a slight but not a significant improvement in water resistance.

The processed stocks of each of the four woods were sized with 2.0 percent of paraffin or 2.0 percent of rosin. In all cases the amount of affixing agent was 4.0 percent; alum was used with paraffin size and ferric sulfate with rosin size. The results (table 7) were:

(1) Maple, birch, and beech stocks sized with 2.0 percent of paraffin and 4.0 percent of alum and molded at platen temperatures of 240° C. produced class A hardboard.

(2) Soft maple hardboards sized with paraffin and molded at 195° C. also met class A standards.

(3) Boards sized with rosin and ferric sulfate and molded at 195° C. were stronger and more water resistant than comparable boards sized with paraffin and alum. Soft and hard maple hardboards of this group were of class A grade.

(4) The incorporation of rosin and ferric sulfate in the stocks increased the drainage time of the stocks and changed the color of the boards from a tan or light brown to a gray brown.

Conclusions

Laboratory-scale experiments demonstrated that sheathing-grade insulating board and class A hardboard can be made from beech, birch, and soft and hard maple woods. Tests were made on boards prepared from Defibrator-pulp stocks. For experimental purposes it was found that conversion of the stocks to insulating board and hardboard of relatively small size was satisfactory. Tests conducted on specimens cut from boards prepared from the mats formed in the Defibrator freeness tester, when properly treated, were found adequate for evaluation of either type of board.

The insulating-board stocks prepared and evaluated were generally in the "slow" drainage-rate class. Other means of refining may produce freer pulps that would be more acceptable for commercial production equipment. Furthermore, semichemical or steam cooking and mechanical refining, or mechanical refining alone might produce acceptable and freer insulating board stocks.

Molding temperatures as high as 240° C. or as much as 2 percent of size, or both, were necessary to produce class A hardboard from refined maple, beech, and birch Asplund stocks. Hardboards from these stocks, however, containing less size and molded at lower temperatures could undoubtedly be heat-treated to yield acceptable boards. For a more thorough evaluation, somewhat similar methods of producing hardboard would have to be considered. The Defibrator produces extremely free pulp; consequently it is a desirable machine for the preparation of hardboard pulp. The explosion process, however, falls in the same classification. Slower stocks prepared from purely mechanical milling of steam-cooked chips can be converted to insulating board and then the dried board can be consolidated to S-2-S hardboard in a hot press at an elevated temperature.

Though the insulating board and hardboard potentialities of soft maple, beech, white birch, and hard maple have not been fully explored, their suitability for such products has been demonstrated on a laboratory scale with results promising of commercial adaptability.

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Table 1.--Defibration data on four northeastern hardwoods

Mill run No.[1]	Species	Moisture content: Before soaking	Moisture content: After soaking	Defibration schedule: Steam press	Defibration schedule: Pre-steaming time	Defibration schedule: Milling time	Defibration schedule: Total time	Yield
		Percent	Percent	P.s.i.	Min.	Min.	Min.	Percent
			INSULATING-BOARD PULPS					
46D	Soft maple	12.0	52.9	175	2	1	3	91.0
47D	Beech	10.8	48.0	175	2	1	3	92.2
48D	White birch	16.1	49.8	175	2	1	3	87.6
49D	Hard maple	13.8	47.5	175	2	1	3	91.7
			HARDBOARD PULPS					
13D	Soft maple	13.8	50.9	175	3	2	5	86.6
[2]23D	Soft maple	13.8	50.9	175	3	2	5	86.2
14D	Beech	13.0	45.9	175	3	2	5	86.1
[2]24D	Beech	13.6	48.0	175	3	2	5	86.9
15D	White birch	19.4	50.0	175	3	2	5	81.8
[2]27D	White birch	18.0	50.3	175	3	2	5	80.7
16D	Hard maple	15.3	44.4	175	3	2	5	84.8
[2]28D	Hard maple	16.1	48.5	175	3	2	5	85.8
17D	Mixture[3]	15.8	49.6	175	3	2	5	84.6

[1] From 3 to 5 Defibrator runs in each mill run.

[2] Subsequent duplicate runs given the same mill run No.

[3] The mixture consisted of equal parts of the 4 hardwoods, moisture-free weight basis.

Table 2.--Preparation and property data on nominal 1/2-inch insulating boards prepared from Defibrator stocks of four northeastern hardwoods

Board No.	Stock freeness[1]: Defibrator	Stock freeness[1]: Estimated Schopper-Riegler[6]	Refined pulp[2]: Amount	Refined pulp[2]: Freeness: Defibrator	Refined pulp[2]: Freeness: Estimated Schopper-Riegler[6]	Sizing data[3]: Rosin	Sizing data[3]: pH	Cold-pressing data[4]: Pressure	Cold-pressing data[4]: Moisture content of pressed mats	Board data[5]: Density	Board data[5]: Transverse breaking load (adjusted)[7]	Board data[5]: Tensile strength	Board data[5]: Maximum deflection	Board data[5]: 2-hour water absorption (by volume)	Board data[5]: Linear expansion
	Sec.	Cc.	Percent	Sec.	Cc.	Percent		P.s.i.	Percent	Lb. per cu. ft.	Lb.	P.s.i.	In.	Percent	Percent
							Soft maple - Mill run No. 46D								
[8]1245	94	820	67	352	695	0	7.8	100	61.7	19.6	22.8	...	...	90.8	...
[8]1246	80	825	67	352	695	1.5	4.2	100	61.9	17.9	15.1	...	...	3.2	...
[8]1272	108	805	55	415	670	0	7.6	100	63.0	18.8	18.5	...	...	87.4	...
[8]1273	104	810	55	415	670	.5	4.3	100	64.6	17.5	15.3	...	...	3.3	...
1274	104	810	55	415	670	.5	4.3	100	...	20.5	13.2	212	0.51	3.0	0.36
[8]1275	146	785	42.5	...	570	0	7.7	70	64.4	20.4	20.4	...	...	87.8	...
[8]1276	177	770	42.5	...	570	.5	4.3	70	65.7	18.9	17.7	...	...	3.9	...
1277	177	770	42.5	...	570	.5	4.3	70	...	21.5	16.9	279	.77	3.2	.46
							Beech - Mill run No. 47D								
[8]1281	128	795	55	...	640	0	7.7	60	65.3	18.2	13.8	...	...	85.9	...
[8]1282	146	785	55	...	640	.5	4.3	60	67.2	17.4	12.3	...	...	3.3	...
1283	146	785	55	...	640	.5	4.3	60	...	18.8	10.6	143	.42	2.5	.40
[8]1287	162	775	42.5	...	520	0	7.6	60	64.6	19.3	18.4	...	...	83.8	...
[8]1288	173	770	42.5	...	520	.5	4.2	60	65.3	19.3	16.3	...	...	4.7	...
1289	173	770	42.5	...	520	.5	4.2	60	...	20.9	15.5	292	.67	3.6	.44
							White birch - Mill run No. 48D								
1268	70	835	60	275	730	1.0	4.4	([9])	...	23.2	11.8	253	.57	2.8	.37
[8]1278	150	785	46	...	580	0	7.5	60	65.6	21.2	22.0	...	...	88.1	...
[8]1279	158	780	46	...	580	1.0	4.3	60	66.6	20.8	20.6	...	...	4.5	...
1280	158	780	46	...	580	1.0	4.3	60	...	21.1	17.0	294	.75	4.1	.46
							Hard maple - Mill run No. 49D								
1271	90	820	62.5	272	730	.5	4.4	100	...	21.3	13.5	226	.57	2.6	.38
[8]1284	152	785	52.5	...	625	0	7.7	70	64.7	19.9	21.7	...	...	89.8	...
[8]1285	158	780	52.5	...	625	.5	4.3	70	63.8	19.2	18.7	...	...	4.1	...
1286	158	780	52.5	...	625	.5	4.3	70	...	20.9	15.1	235	.69	2.7	.40
							1/2-inch insulating-board specifications[10]								
Class A and B (Building and lath board)											[11]12	[11]150	[12].85	[12]7	[12].5
Class E (Sheathing board)											[11]14	[11]150	[12].75	...	[12].5

[1]Stocks consist of mixtures of unrefined and refined Defibrator pulps.

[2]Pulp refined in a laboratory attrition mill.

[3]Stocks sized at a consistence of 2 percent. The amount of alum used in all cases was equivalent to the amount of rosin size added.

[4]The dewatering period for all 8-1/2-inch-diameter mats was 5 minutes; comparable data on larger mats was not obtained. The thicknesses of all dewatered mats ranged from 9/16 to 5/8 of an inch.

[5]All mats dried in a forced-draft oven at 150° C. for 3 to 4 hours.

[6]Estimated by means of the data presented by A. Asplund, Northeastern Wood Utilization Council, Bull. 31:28 (Jan. 1950).

[7]Transverse-breaking-load data adjusted to 1/2-inch thickness and a density of 20 pounds per cubic foot on the basis that the breaking load varies as the square of the density.

[8]Boards 8-1/2 inches in diameter; all others 18 inches square.

[9]In excess of 100 pounds per square inch.

[10]Federal Specification LLL-F-321b, amendment 1, 1942.

[11]Minimum allowable value.

[12]Maximum allowable value.

Rept. No. D1931

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Table 3.--Sizing data on white birch and hard maple insulating-board stock[1]

Board No.	Refined pulp freeness[2] (Defibrator)	Stock freeness[3] (Defibrator)	Sizing data[4] Rosin	Alum	pH	Board data[5] Density	Adjusted transverse breaking load[6]	2-hour water absorption (by volume)
	Sec.	Sec.				Lb. per cu. ft.	Lb.	Percent
			WHITE BIRCH - MILL RUN NO. 48D					
1253	276	64	0	0	7.6	18.5	17.9	88.2
1254	276	69	.5	.5	4.3	18.5	17.5	5.9
1255	276	68	.5	1.0	4.3	18.9	17.4	5.0
1256	276	65	.5	1.5	4.3	18.7	16.9	5.0
1257	276	71	1.0	1.0	4.3	19.0	15.8	3.8
1258	276	68	1.0	2.0	4.3	18.9	15.5	3.7
1259	276	65	1.0	3.0	4.3	19.2	15.6	3.8
			HARD MAPLE - MILL RUN NO. 49D					
1260	223	67	0	0	7.6	15.8	17.1	90.0
1261	223	65	.5	.5	4.4	15.9	17.0	3.4
1262	223	62	.5	1.0	4.3	16.0	16.0	3.2
1263	223	58	.5	1.5	4.3	16.2	15.9	3.2
1264	223	64	1.0	1.0	4.2	15.7	14.4	2.8
1265	223	58	1.0	2.0	4.3	16.3	14.7	2.8
1266	223	61	1.0	3.0	4.3	16.3	13.9	2.7

[1] Nominal 1/2-inch boards, 8-1/2-inch diameter.

[2] Defibrator pulps refined in an attrition mill.

[3] Stocks consisted of 40 percent of unrefined and 60 percent of refined Defibrator pulp.

[4] Stocks sized at a consistence of 2 percent.

[5] Mats cold-pressed at 100 pounds per square inch for 5 minutes prior to drying in a forced-draft oven at 150° C. for approximately 3 hours. Moisture content of cold-pressed mats averaged 62.7 percent for the white birch and 64.5 percent for the hard maple.

[6] Adjusted to a density of 20 pounds per cubic foot on the basis that the transverse breaking load varies as the square of the density. Breaking-load data for 1/2-inch boards calculated from modulus of rupture values obtained from 5- by 2-inch static bending specimens.

Table 4.--Comparison of the transverse breaking load and water absorption of undersized and standard-size nominal 1/2-inch insulating-board test specimens

Board No.	Species	Rosin size content	Transverse breaking load: Specimen size	Test span	Amount[1]	Increase over standard test	Water absorption: Specimen size	Amount	Increase over standard test
		Percent	In.	In.	Lb.	Percent	In.	Percent	Percent
				STANDARD-SIZE SPECIMENS					
1274	Soft maple	0.5	14 by 3	12	13.2	....	6 by 6	3.0	....
1277	Soft maple	.5	14 by 3	12	16.9	....	6 by 6	3.2	....
1283	Beech	.5	14 by 3	12	10.6	....	6 by 6	2.5	....
1289	Beech	.5	14 by 3	12	15.5	....	6 by 6	3.6	....
1280	White birch	1.0	14 by 3	12	17.0	....	6 by 6	4.1	....
1286	Hard maple	.5	14 by 3	12	15.1	....	6 by 6	2.7	....
Av.					14.7	....		3.2	....
				UNDERSIZED SPECIMENS					
1273	Soft maple	.5	5 by 2	4-1/2	15.3	15.9	5 by 2	3.3	10.0
1276	Soft maple	.5	5 by 2	4-1/2	17.7	4.7	5 by 2	3.9	21.9
1282	Beech	.5	5 by 2	4-1/2	12.3	16.0	5 by 2	3.3	32.0
1288	Beech	.5	5 by 2	4-1/2	16.3	5.2	5 by 2	4.7	30.6
1279	White birch	1.0	5 by 2	4-1/2	20.6	21.2	5 by 2	4.5	9.8
1285	Hard maple	.5	5 by 2	4-1/2	18.7	23.2	5 by 2	4.1	51.9
Av.					16.8	14.4	....	4.0	26.0
1272	Soft maple	0		4-1/2	18.5	40.2	5 by 2	87.4	....
1275	Soft maple	0	5 by 2	4-1/2	20.4	20.7	5 by 2	87.8	....
1281	Beech	0	5 by 2	4-1/2	13.8	30.2	5 by 2	85.9	....
1287	Beech	0	5 by 2	4-1/2	18.4	18.7	5 by 2	83.8	....
1278	White birch	0	5 by 2	4-1/2	22.0	29.4	5 by 2	88.1	....
1284	Hard maple	0	5 by 2	4-1/2	21.7	43.7	5 by 2	89.8	....
Av.					19.1	30.5	....	....	....

[1] Values adjusted or calculated to that obtainable on a standard-size test specimen.

Table 5.--Preparation and property data on nominal 1/8-inch unsized hardboards prepared from four northeastern hardwoods

Board No.	Freeness[1] (Defibrator)	Molding temperature[2]	Specific gravity	Modulus of rupture	24-hour water immersion test: Water absorption	24-hour water immersion test: Thickness change
	Sec.	°C.		P.s.i.	Percent	Percent
			SOFT MAPLE - MILL RUN NO. 13D			
1035	38	180	1.06	7,500	74	54
[3]1053	44	180	1.00	6,500	88	61
1043	48	240	1.04	8,800	41	21
			BEECH - MILL RUN NO. 14D			
1036	31	180	1.05	6,900	74	54
1054	48	180	1.02	6,500	77	51
1044	53	240	1.03	7,800	43	19
			WHITE BIRCH - MILL RUN NO. 15D			
[3]1037	35	180	1.06	6,600	82	62
[3]1055	46	180	.99	5,600	87	62
1045	52	240	1.04	8,200	46	21
			HARD MAPLE - MILL RUN NO. 16D			
[3]1038	47	180	1.03	7,400	65	45
[3]1056	52	180	1.02	7,400	70	44
1046	58	240	1.05	9,200	37	18
			MIXTURE[4] - MILL RUN NO. 17D			
1057	63	180	1.05	7,600	67	47
1047	71	240	1.06	8,800	37	19
			1/8-INCH HARDBOARD SPECIFICATIONS[5]			
Class A (untreated)........			[6] .96	[6]6,000	[7]20	....

[1]Defibrator pulps beaten for 15 to 30 minutes in a Valley test beater at a consistence of 1.6 to 2 percent with a 5,500-gram weight on beater arm.

The freeness values obtained and recorded in table are not a true reflection of the amount of processing, because the beaten pulp was drained in screen boxes and some loss of fines occurred.

[2]Boards molded for 10 minutes at a maximum pressure of 500 pounds per square inch. Molding schedule at 180° C., 2-1-7 minutes; at 240° C.,1-2-7 minutes. Minimum pressure-100 pounds per square inch.

[3]Only one board submitted for test.

[4]The mixture consisted of equal parts of the 4 hardwoods, moisture-free weight basis.

[5]Federal specification LLL-F-311, amendment 3, 1952.

[6]Minimum allowable value.

[7]Maximum allowable value.

Table 6.--Effect of refining on Defibrator stocks from four northeastern hardwoods and the properties of derived nominal 1/8-inch hardboards

Board No.	Beating time[1]	Paraffin size[2]	Freeness (Defibrator)	Molding temperature[3]	Board data: Specific gravity	Board data: Modulus of rupture	24-hour water immersion test: Water absorption	24-hour water immersion test: Thickness change
	Min.	Percent	Sec.	°C.		P.s.i.	Percent	Percent
Soft maple - Mill run No. 23D								
1102	0	1.5	27	180	1.03	4,500	27.3	23.9
1103	0	1.5	27	240	1.05	7,400	20.9	13.4
1106	10	1.5	45	180	1.02	4,900	23.9	20.0
1107	10	1.5	45	240	1.04	7,600	20.4	12.9
1108	20	1.5	90	240	1.04	9,000	20.9	13.5
Beech - Mill run No. 24D								
1104	0	1.5	23	180	1.02	4,000	24.9	22.3
1105	0	1.5	23	240	1.05	6,300	17.6	12.0
1109	10	1.5	42	180	1.02	4,500	27.0	24.2
1110	10	1.5	42	240	1.04	6,500	17.9	12.4
1111	20	1.5	64	180	1.06	5,500	27.4	22.8
1112	20	1.5	64	240	1.05	6,900	19.2	13.9
White birch - Mill run No. 27D								
1092	0	1.5	24	180	1.04	4,100	31.7	30.1
1093	0	1.5	24	240	1.04	6,200	23.1	15.4
1100	10	1.5	47	180	1.06	5,600	29.5	26.4
1101	10	1.5	47	240	1.03	6,900	22.3	14.3
Hard maple - Mill run No. 28D								
1094	0	1.5	27	180	1.01	3,900	24.3	23.2
1095	0	1.5	27	240	1.02	6,400	17.9	12.4
1096	5	1.5	35	180	1.01	5,400	23.0	19.9
1097	5	1.5	35	240	1.03	7,100	18.9	12.7
1098	10	1.5	46	180	1.02	6,100	24.3	22.1
1099	10	1.5	46	240	1.04	7,700	19.8	14.0
1/8-inch hardboard specifications[4]								
Class A (untreated)					[5] .96	[5]6,000	[6]20	....

[1]550 grams of pulp beaten in a Valley test beater at a consistence of 2.5 percent with a 5,500-gram weight on the beater arm.

[2]Stocks sized at a consistence of 2.0 percent. The amount of alum added equivalent to paraffin size charge. Sufficient dilute sulfuric acid added to lower the pH to a range of 4.0 to 4.5.

[3]Boards molded for 10 minutes at a maximum pressure of 500 pounds per square inch. Molding schedule at 195° C., 2-1-7 minutes; at 240° C., 1-2-7 minutes. Minimum pressure - 100 pounds per square inch.

[4]Federal specification LLL-F-311, amendment 3, 1952

[5]Minimum allowable value.

[6]Maximum allowable value.

Table 7.--Sizing data on nominal 1/8-inch hardboards from four northeastern hardwoods

Board No.	Refining	Sizing data[1]: Size: Type	Sizing data: Size: Amount	Sizing data: Alum	Sizing data: Ferric sulfate	Sizing data: pH	Freeness (Defibrator)	Molding temperature[2]	Board data: Specific gravity	Board data: Modulus of rupture	Board data: 24-hour water immersion test: Water absorption	Board data: 24-hour water immersion test: Thickness change	Board data: Color
			Percent	Percent	Percent		Sec.	°C.		P.s.i.	Percent	Percent	
					Soft maple - Mill run No. 23D								
1400	None	Paraffin	1.5	1.5	....	4.3	29	195	....	....	25.4	19.4	
1401	None	Paraffin	1.5	3.0	....	4.1	29	195	....	....	24.6	19.0	
1402	None	Paraffin	1.5	4.5	....	4.3	29	195	....	....	23.9	18.3	
1414	None	Paraffin	2.0	2.0	....	4.4	29	195	....	....	19.9	17.0	
1415	None	Paraffin	2.0	4.0	....	4.4	31	195	....	....	19.7	16.4	
1403	None	Paraffin	1.5	....	1.5	4.0	30	195	....	....	24.7	19.5	
1404	None	Paraffin	1.5	....	3.0	4.0	31	195	....	....	25.1	19.6	
1405	None	Paraffin	1.5	....	4.5	3.4	28	195	....	....	28.5	20.6	
1406	None	Rosin	1.5	1.5	....	4.4	32	195	....	....	33.7	26.5	
1407	None	Rosin	1.5	3.0	....	4.4	31	195	....	....	28.9	22.6	
1408	None	Rosin	2.0	2.0	....	4.3	32	195	....	....	29.9	25.9	
1409	None	Rosin	2.0	4.0	....	4.4	31	195	....	....	25.8	22.6	
1410	None	Rosin	1.5	....	1.5	4.0	33	195	....	....	20.9	17.8	
1411	None	Rosin	1.5	....	3.0	4.4	39	195	....	....	22.4	18.7	
1412	None	Rosin	2.0	....	2.0	4.3	38	195	....	....	20.0	16.9	
1413	None	Rosin	2.0	....	4.0	3.8	35	195	....	....	18.3	17.0	
1416	(3)	Paraffin	2.0	4.0	....	4.2	43	195	1.05	6,200	17.1	16.3	Light brown
1417	(3)	Paraffin	2.0	4.0	....	4.2	43	240	1.04	6,800	15.2	9.2	Brown
1418	(3)	Rosin	2.0	....	4.0	3.8	50	195	1.04	6,800	16.2	15.5	Grayish brown
					Beech - Mill run No. 24D								
1419	(3)	Paraffin	2.0	4.0	....	4.2	46	195	1.01	4,700	21.2	17.8	Light brown
1420	(3)	Paraffin	2.0	4.0	....	4.2	46	240	1.02	6,100	18.6	12.7	Brown
1421	(3)	Rosin	2.0	....	4.0	4.0	57	195	1.01	5,700	19.6	18.9	Grayish brown
					White birch - Mill run No. 27D								
1422	(3)	Paraffin	2.0	4.0	....	4.3	39	195	1.06	5,300	26.1	21.7	Tan
1423	(3)	Paraffin	2.0	4.0	....	4.3	39	240	1.05	6,300	18.2	12.0	Brown
1424	(3)	Rosin	2.0	....	4.0	3.6	46	195	1.05	5,900	22.3	20.3	Grayish brown
					Hard maple - Mill run No. 28D								
1425	(3)	Paraffin	2.0	4.0	....	4.3	40	195	1.02	5,900	21.4	19.7	Tan
1426	(3)	Paraffin	2.0	4.0	....	4.3	40	240	1.05	7,600	17.0	12.7	Brown
1427	(3)	Rosin	2.0	....	4.0	3.9	51	195	1.02	6,000	19.9	20.4	Grayish brown
					1/8-inch hardboard specifications[4]								
Class A (untreated)									[5] .96	[5] 6,000	[6] 20	....	

[1] Stocks sized at a consistence of 2.0 percent. Dilute sulfuric acid was added in most instances to bring the sized slurry to a pH range of 4.0 to 4.5. The exceptions were those stocks containing large amounts of ferric sulfate. The pH of these stocks were in the select range or lower.

[2] Boards molded for 10 minutes at a maximum pressure of 500 pounds per square inch. Molding schedule at 195° C., 2-1-7 minutes; at 240° C., 1-2-7 minutes. Minimum pressure - 100 pounds per square inch.

[3] Stock lightly processed in a laboratory attrition mill.

[4] Federal Specification LLL-F-311, amendment 3, 1952.

[5] Minimum allowable value.

[6] Maximum allowable value.

Rept. No. D1931

Z M 90873 F

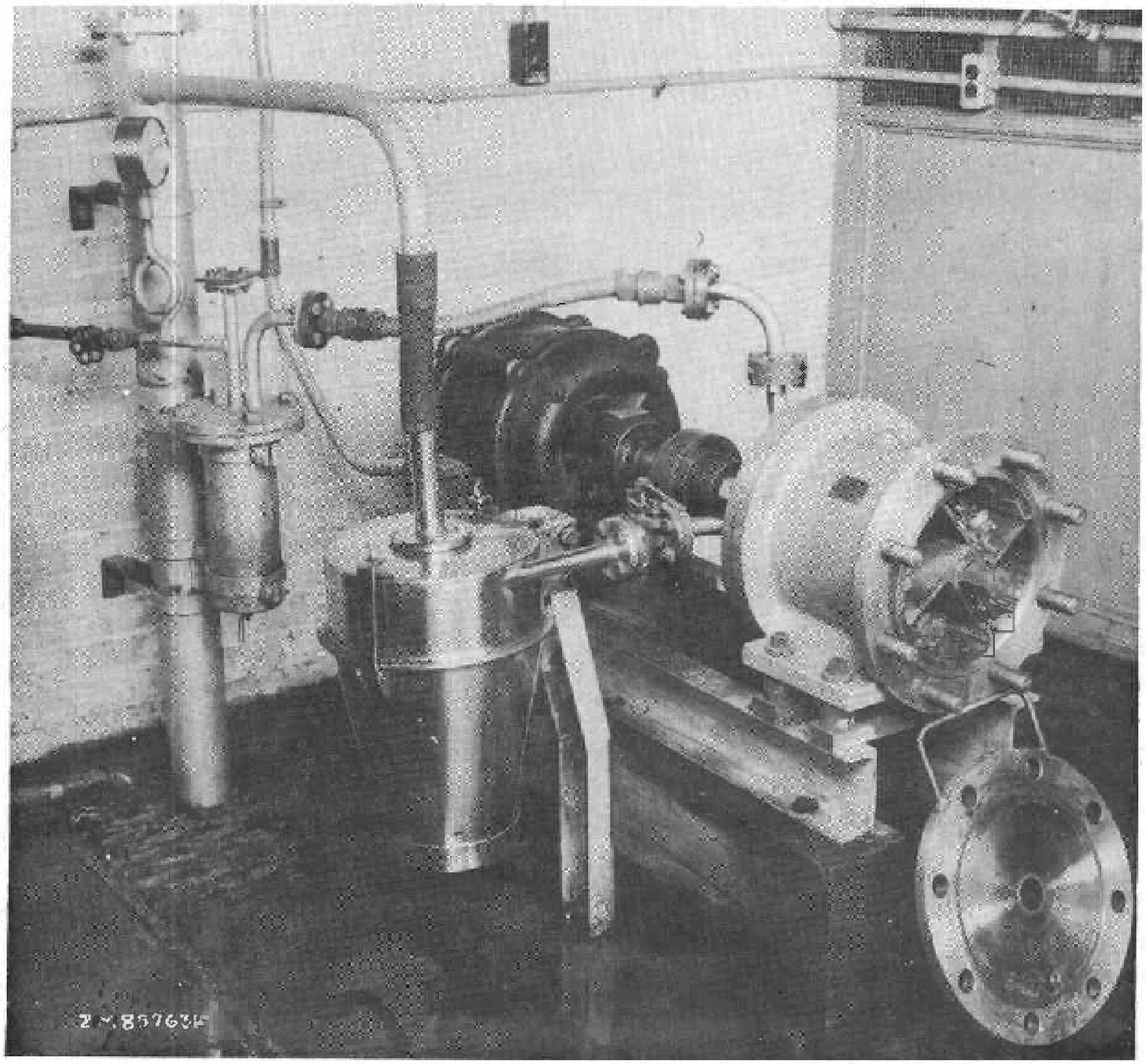

Figure 1.--A laboratory-model, stainless steel, Asplund Defibrator.

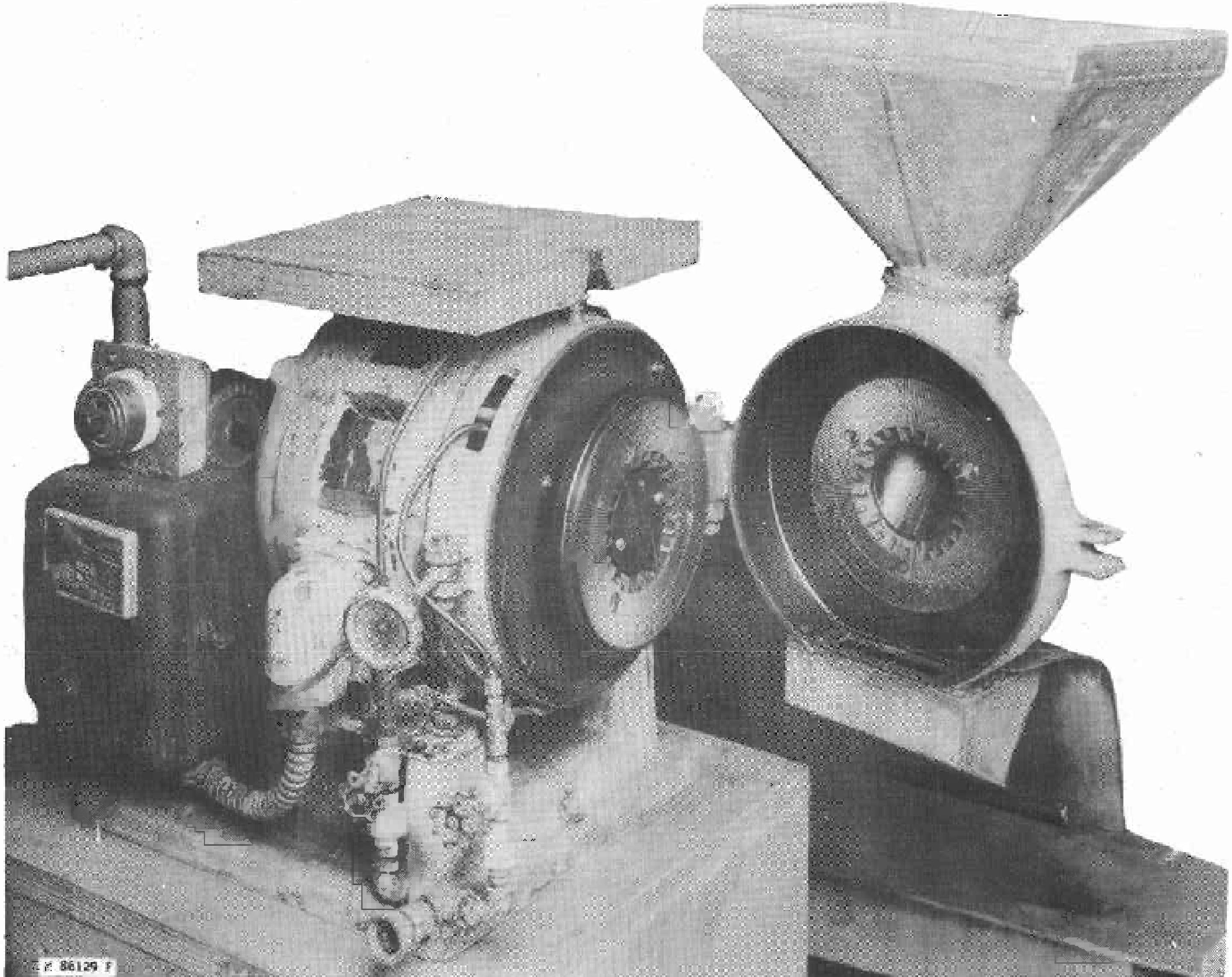

Figure 2.--Single-rotating-disk attrition mill used in refining Asplund stock.

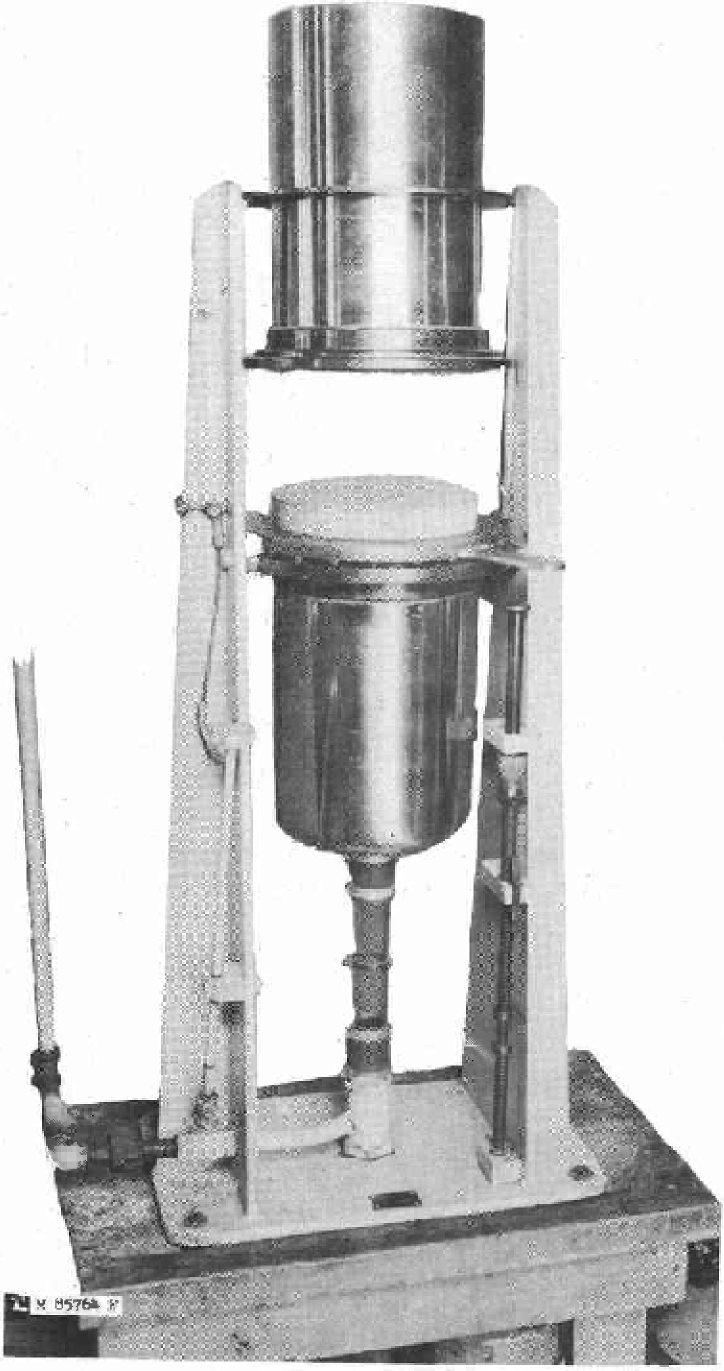

Figure 3.--A Defibrator freeness tester and mat-forming machine.