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SELECTION, INSTALLATION, FINISH, AND MAINTENANCE OF WOOD FLOORS FOR DWELLINGS [1]

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INTRODUCTION

The popularity of wood for floors of dwellings dates back to pioneer days, when our forefathers used thick, hewed sections of log smoothed as far as possible on one face with an adz and laid edge to edge to make their puncheon floors. Later, during colonial days, when sawed lumber became available, planking of random widths fastened down with wooden pins was employed for floors. It was not until nearly the middle of the nineteenth century that the planing mill made its appearance, and the first product made in it was flooring, probably of a pattern somewhat approaching that now produced.

When the first planing mill was set up in Philadelphia, the workmen who had been employed in manufacturing flooring by hand congregated around the plant and threatened to burn it down for fear the new machine would throw them out of work. The march of progress, carrying with it continual improvement in commodities of various kinds and in the machinery employed in their manufacture, applies to wooden articles as well as to those of other materials. Today wooden flooring constitutes a product very highly standardized as to quality, moisture content, dimensions, pattern, and use.

In modern dwelling-house construction wood is still the favorite material for floors in most of the rooms above the basement, with the exception of the bathroom and possibly the kitchen. Because wear is heavier or cleaning with water more often necessary in bathrooms, other materials, such as terrazzo, concrete, composition, asphalt, ceramic tile, or a combination of such products, are sometimes employed over a concrete slab. If a wood floor is laid in a kitchen, it is usually covered with linoleum, cork, or rubber tile.

[1] The section of this circular on floor finishing was contributed by Frederick L. Browne of the Forest Products Laboratory, Forest Service.

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Wood possesses so many good qualities that its preeminence as a flooring material, especially for the home, remains unequaled. Its ability to withstand the wear and tear of everyday use year after year is amply proved by the service given by wooden floors in homes built in colonial days and still in service after 200 years. Wood has been found also to give comfort to human tread, wherever pedestrian traffic is heavy, whether it be the home, the office, the promenade at the seashore, the loading platform, the heavy-duty floors in industrial buildings, or the decks of steamers.

The floor in the home should be warm and comfortable, should be resilient, and should contribute an atmosphere of coziness. These essentials of ease and comfort are satisfactorily supplied by the wood floor.

The many species of wood and the various grades of flooring that are regularly manufactured from them present a wide range of material to meet practically any requirement, from the polished brilliancy of the ballroom floor to the plain drab unfinished floor of the attic. The natural beauty of the grain, the color of wood, and the varying shades that can be applied to it artificially make the wood floor a surface easily adapted to any desired scheme of interior decoration. The floor is the background that reflects the decorative motif of the house. The inherent distinctive grain, texture, and depth of color of wood can be made to blend easily and naturally with the color tones of the walls, furniture, drapery, and rugs to present an atmosphere that embodies all that the word "home" stands for.

The wood floor is simple to construct, reasonable in cost, highly serviceable, easy to finish and maintain, and pleasant and comfortable to live with, all of which is attested by the fact that it has been used in countless homes for hundreds of years.

WOODS USED FOR FLOORS

During pioneer days the wood nearest at hand was no doubt employed for puncheon floors. In New England this was usually white pine; in the South, southern pine; in other sections of the United States, oak or some other hardwood. Later, when sawed material became available, more care was exercised in the selection of woods for flooring.

Many of our native woods possess mechanical and physical properties that would make them satisfactory for flooring, but they also possess properties which fit them better for the more exacting requirements of other industries. Because of this fact and because of scarcity, high price, or other economic reasons, the manufacture of flooring in this country has been confined to about a dozen native woods. Information here supplied is intended to cover the upper grades of flooring only, such as are usually employed in the average class of homes.

A wood floor laid over ordinary joist construction should be firm enough to bear without noticeable deflection the weight it receives in service; it should be level, and free of cracks between the ends or sides of individual flooring strips, and it should not squeak. Such a floor can be obtained only by properly laying the finish floor over a suitable subfloor and correctly nailing both the finish floor and the subfloor.

THE SUBFLOOR

Prior to 1900 house specifications did not usually call for a subfloor. Today, however, the advantages of a subfloor are recognized by architects and builders, and modern plans for the better class of homes usually call for this type of floor construction. A subfloor adds much to the warmth of the house and strengthens and stiffens the finish floor. It also greatly reduces nail movement, thereby minimizing any tendency toward squeaking. The subfloor serves as a temporary floor during the erection of the house, affording a safe working surface for the mechanics on the job. The finish floor, therefore, need not be laid and as a matter of fact should not be laid until all plastering and other finishing work has been completed.

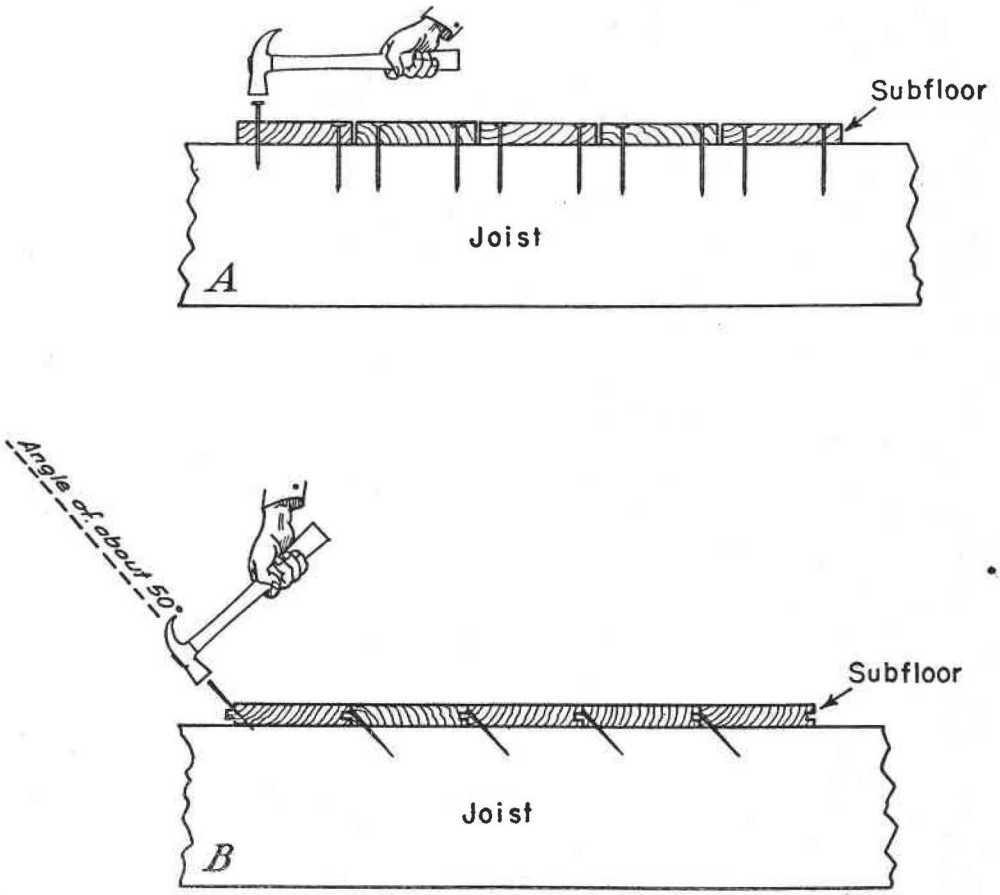

FIGURE 1.—The subfloor: *A*, Square-edge boards, face-nailed at every bearing point. For unheated houses and those in moist climates allow one-eighth to one-fourth inch between boards as shown, otherwise lay with flush-butted joints, close but not exceedingly tight. *B*, Matched boards (tongued and grooved), blind-nailed at an angle of about 50° at every bearing point.

Subfloors may be of any species of wood, but usually coniferous woods of No. 1 or No. 2 common lumber, either square-edged or dressed and matched (tongued and grooved), are employed for the purpose. Boards that are dry (not over 12 percent moisture) and from 4 to 6 inches wide are most satisfactory for subflooring. The effects of expansion and contraction of wide boards are out of proportion to those of the narrower standard finish flooring, and where stock wider than 6 inches is used for the subfloor, squeaking and other undesirable features are liable to develop.

In homes built in moist climates and in summer homes not heated during winter it is best to use square-edge boards for subflooring, leaving about one-eighth to one-fourth inch between them in order to allow for any possible expansion from the absorption of moisture. Tongued and grooved subflooring should be blind-nailed at each joist with eightpenny cut flooring nails, and all butt joints should bear directly on the joists (fig. 1, B). Square-edge material should be solidly face-nailed at the joist with two tenpenny nails (fig. 1, A). All butt joints should rest on bearings; and should it become necessary to use boards wider than 6 inches for the subfloor, extra nailing must be done at each bearing point. Boards 8 inches wide should be fastened at each bearing point with three tenpenny nails, and those 10 inches wide with four tenpenny nails. Under no circumstances should boards wider than 10 inches be used for subflooring. Some softwood manufacturers make end-matched lumber, which is stock that is tongued and grooved on the ends as well as on the sides. The end joints have been found by test at the Forest Products Laboratory to be sufficiently strong to avoid the necessity of having each end joint bear directly on a joist. Consequently when using this type of material for subflooring, end joints may fall at random, providing no two adjacent strips have joints between the same two joists.

In laying the floor great stress is laid upon the necessity of plenty of nailing in both the subfloor and the finish floor. Ample nailing will insure a solid, nonsqueaking, compact floor and will hold it rigid and prevent the creeping that is sometimes caused by the shrinking and swelling of the material used for the subfloor.

All subflooring should be laid diagonally. This makes for greater rigidity of the structure. Added rigidity will be secured if on each succeeding upper floor the subfloor is laid diagonally, in a direction opposite to that on the floor immediately below. The laying of the subfloor diagonally has the further advantage of permitting the finish floor to be laid in the direction of either the sides or the ends of the room.

Sometimes the flooring in an old house becomes so badly worn and splintered as to preclude the possibility of its being satisfactorily refinished, and a new floor is the only solution to the problem. In such cases the old floor should be allowed to stay in place, since it will serve admirably as a subfloor. It should, of course, be made tight and level before applying the new floor. In addition, all doors will have to be shortened slightly more than the thickness of the new floor, and all shoe molding removed and again nailed in place after the new floor is laid. In installing the new floor the strips should run at right angles to the old floor.

THE FINISH FLOOR

About a dozen woods are regularly worked to pattern as flooring. Among these are four hardwoods,[1] namely, oak (including species of both the red and the white oak groups), maple, beech, and birch. The

[1] Although the terms "hardwoods" and "softwoods" are the most generally accepted popular names for the two broad groups of trees cut for lumber, they are rather misleading to the layman, because they bear no relation to the actual degree of hardness or softness of the wood. Cottonwood, aspen, basswood, and yellow poplar are all classed as hardwoods and yet each is softer than longleaf pine, which is classed as a softwood. Similarly, yew is classed as a softwood but is three times as hard as basswood and considerably harder than many of the oaks. The means employed by botanists and wood technologists to separate the two groups are also difficult for the layman to understand. Perhaps the most accurate and most readily interpreted definitions are: "Trees with broad leaves" for hardwoods and "trees with needles or scalelike leaves" for softwoods. The softwoods are also sometimes called conifers, because they bear cones.

rest are softwoods, comprising southern pine, Douglas fir, western hemlock, western larch, redwood, western red cedar, and southern cypress. Redwood, western red cedar, and southern cypress are naturally very durable woods, and such flooring as is regularly manufactured from them is intended mainly for porches, summerhouses, and similar locations where the wood is exposed to the weather and the decay hazard is high. Of the softwoods listed, Douglas fir and southern pine are those most generally used for flooring in house construction. In general, hardwoods make better floors than do softwoods. They are harder, wear more uniformly, are less liable to sliver, take a better finish, and are more attractive in appearance. On the other hand, hardwood flooring is more expensive than softwood flooring. Frequently builders use the former on the first floor and the latter on the bedroom floors, thus considerably reducing the total cost of the flooring item in a house. Similarly, the flooring bill can be lowered by selecting the higher grades of flooring for such rooms as the living and dining rooms, a lower grade for the bedrooms, and a still lower grade for the kitchen, where it will in all probability be covered by linoleum and not be visible.

HARDWOOD FLOORING

Oak and maple are the principal hardwoods used for flooring, with beech and birch ranking next in quantity. Hardwood flooring is commonly side- and end-matched (tongued and grooved on both sides and ends). Each piece of hardwood flooring usually bears the trademark of the association under whose rules it was graded and the name, number, or symbol of the member mill that manufactured it. Each bundle bears a label of the association that certifies the grade.

OAK FLOORING

There are some 20 species of oak in the United States that may be considered commercially important from the standpoint of lumber production. Of these about half are classed as red oaks and the rest as white oaks. This classification of oak into red and white is standard practice commercially among the lumber trade, which rarely attempts to classify oak as to individual species. In the growing tree the differentiation of red oak from white oak is based upon botanical characteristics such as the form of fruit, flower, leaf, and the appearance of the bark. In lumber, identification of oaks is more difficult. It calls for examination of a smoothly cut cross section, under a hand lens magnifying 12 to 15 times, to determine the number and shape of the pores in the summerwood, the denser and less porous portion of each annual ring. If the pores in the summerwood are plainly visible through a lens of 12 to 15 diameters magnification as minute rounded openings, and can be readily counted, the wood belongs to the red oak group. If the pores in the summerwood are somewhat angular and so numerous that it would be exceedingly difficult to count them, the wood belongs to the white oak group. Figure 2 shows a cross section of a piece of white oak and one of a piece of red oak, both highly magnified. For greater clarity, 1 year's growth has been indicated by the heavy black lines, and the springwood is separated from the summerwood by the light dotted line.

Most species of oak cut into commercial lumber are used in the manufacture of flooring. They grow under a wide range of climatic conditions in many different kinds of soil. There is, therefore, much variation in the color of the wood, especially the heartwood; the sapwood usually shades from white to cream color in all species of oak. In the standard grading rules for oak flooring the item of color is entirely disregarded except in the matter of the amount of light-colored sapwood allowed. Sapwood is considered a defect in oak flooring, and the lower the grade the more there is allowed.

Should a reasonable degree of uniformity of color be desired, this can be secured by having the contractor select the flooring strips for each room that more nearly match in color tone rather than to lay them at random just as they come from the bundle. If an absolutely uniform color is wanted, it will be necessary to stress this point by

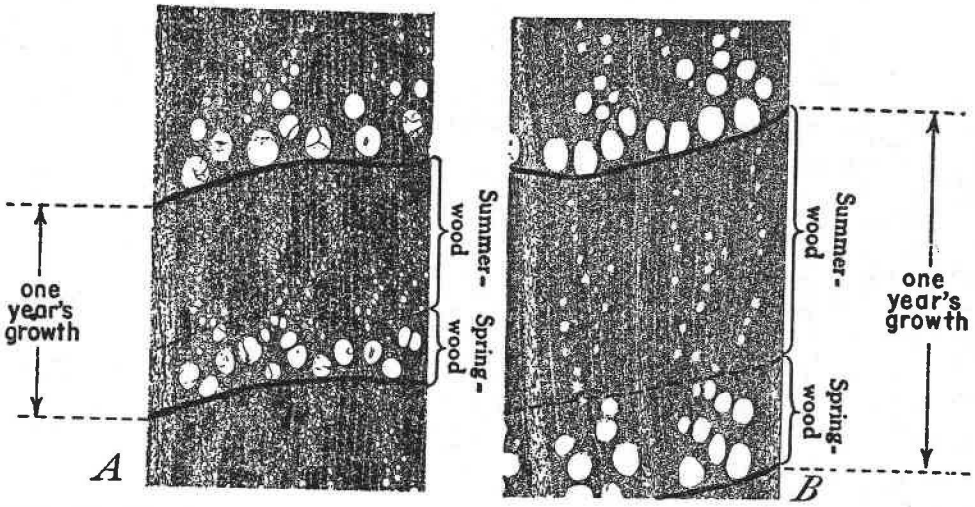

FIGURE 2.—Identification of *A* white oak and *B* red oak lumber can be made under a hand lens magnifying at least 12 times. The cross sections shown above have been magnified 20 times, the vertical distances between the heavy lines representing 1 year's growth, divided into summerwood (dense upper portion) and springwood (narrower section below).

incorporating a clause in the building contract to cover it. The grading rules do not differentiate between red oak and white oak, but the industry is prepared to supply all-red oak stock or all-white oak stock if needed, at a slightly higher cost for selection. As a general rule red oak flooring is lower in price, more uniform in color, and is possibly easier to finish. For the most part red and white oak are about equal in general properties. Both make a very satisfactory floor of attractive appearance when properly finished. In certain parts of the country the preference is for white oak, in others red oak is more in demand. The choice is largely a matter of opinion without any real difference in quality.

Oak flooring is regularly manufactured into plain-sawed and quarter-sawed stock. In width the latter shrinks and swells less than the former. In spite of this fact, however, most of the oak flooring used is plain-sawed. This may be due to the more subdued and uniform grain of plain-sawed oak as compared to the rather striking figure of oak when quarter-sawed or to the higher cost of the latter. Oak flooring is graded under the rules of the National Oak Flooring Manufacturers Association (table 1).

TABLE 1.—*Grades, description, and dimensions of oak flooring* [1]

Kind of flooring	Grade		Standard worked dimensions		
	Name	Description	Thickness	Face width	Length, feet
			Inch	*Inches*	
Quarter-sawed	Clear	The face shall be practically clear of defects except 3/8 inch of bright sap. The question of color shall not be considered.	25/32 25/32 25/32 25/32 15/32 15/32 11/32 11/32	3¼ 2¼ 2 1½ 2 1½ 2 1½	2 and up, not to exceed 20 percent under 4. Average length 5.
Quarter-sawed	Sap Clear	The face shall be practically free from defects but will admit unlimited bright sap. The question of color shall not be considered.	25/32 25/32 25/32 25/32 15/32 15/32 11/32 11/32	3¼ 2¼ 2 1½ 2 1½ 2 1½	2 and up, not to exceed 20 percent under 4. Average length 5.
Quarter-sawed	Select	The face may contain sap, and will admit pin worm holes, streaks, slight imperfections in working or a small tight knot, not to exceed 1 to every 3 feet in length.	25/32 25/32 25/32 25/32 15/32 15/32 11/32 11/32	3¼ 2¼ 2 1½ 2 1½ 2 1½	2 and up. Average length 4.
Plain-sawed	Clear	The face shall be practically clear of defects except 3/8 inch of bright sap. The question of color shall not be considered.	25/32 25/32 25/32 25/32 15/32 15/32 11/32 11/32	3¼ 2¼ 2 1½ 2 1½ 2 1½	2 and up, not to exceed 20 percent under 4. Average length 5.
Plain-sawed	Select	The face may contain sap, and will admit pin worm holes, streaks, slight imperfections in working or a small tight knot, not to exceed 1 to every 3 feet in length.	25/32 25/32 25/32 25/32 15/32 15/32 11/32 11/32	3¼ 2¼ 2 1½ 2 1½ 2 1½	2 and up. Average length 4.

[1] Data from grading rules of the National Oak Flooring Manufacturers' Association, in effect Oct. 30, 1934.

All flooring listed is kiln-dried, grade-marked and trade-marked, hollowed back and side, and end matched. For lower grades than those listed above and for square-edge strip flooring see the latest issue of the grading rules of the National Oak Flooring Manufacturers' Association, 830 Dermon Building, Memphis, Tenn.

"Hollowed-back" flooring has the back hollowed out to a depth of about 1/8 inch and about two-thirds the width of the piece. When hardwood flooring is manufactured all dressing is done on the face side, and in order to relieve any tension that would make the piece cup from this unequal dressing, the back is hollowed out. Softwood flooring is usually manufactured in the same manner, although some of it is produced with merely a 1/8-inch V-shaped groove running down the middle of the back. Such flooring is referred to in the trade as "scratched-back."

"Side- and end- matched" means flooring that has a tongue worked on one edge and one end and a groove worked on the other edge and the other end. This permits the pieces to be tightly interlocked both along the sides and at the ends when laid in place.

MAPLE FLOORING

Maple flooring is made from sugar maple (*Acer saccharum*), and also from black maple (*A. nigrum*) formerly considered as a variety of sugar maple. The production of lumber from these species is centered largely in the Lake States and the Northeastern States. The trade name for both species is "hard maple"; occasionally they are called rock maple. The so-called soft maples—silver maple, red maple, and the western species, or bigleaf maple—are not so hard, heavy, or strong as hard maple and because of this are not commonly used for flooring. In addition to being heavy, strong, hard, and stiff, hard

maple wears well under abrasion and takes an excellent finish. These properties fit it well for flooring.

The heartwood of both species of hard maple is light reddish brown, and the sapwood, which in mature trees is several inches thick, is white, slightly tinged with brown. The contrast in color between heartwood and sapwood in maple is much less pronounced than it is in oak. In the standard grading rules for maple flooring, sapwood is not considered a defect, and the varying natural color of the wood is allowed even in the upper grades. Should the need arise for a maple floor of strictly uniform color, this requirement can be met by special grades which cover respectively clear white stock or clear brown stock especially selected for color. The grade of "Clear White Maple" flooring covers stock that is almost ivory white in color and constitutes the finest grade of maple flooring it is possible to produce. The grade of Clear Brown Maple flooring is also high-quality stock, selected for uniform brown color. It has more grain pattern than other types of maple flooring except that showing bird's-eye. Maple flooring is graded under the rules of the Maple Flooring Manufacturers' Association and also under the rules of the National Oak Flooring Manufacturers' Association (tables 2 and 3).

TABLE 2.—*Grades, description, and dimensions of beech, birch, and northern hard maple flooring* [1]

Kind of wood	Grade		Standard worked dimensions		
	Name	Description	Thickness	Face width	Length, feet
			Inch	*Inches*	
Beech, birch, and maple.	First	Shall have the face practically free of all defects, but the varying natural color of the wood shall not be considered a defect.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
Beech, birch, and maple.	Second	Will admit tight, sound knots and slight imperfections in dressing, but must lay without waste.	25/32	3¼	1½-16, not over 40 percent of 1½-3.
			25/32	2¼	
			25/32	2	
			25/32	1½	
Maple	White Clear (northern hard maple).[2]	Special stock selected for uniformity of color. It is almost ivory white and is the finest grade possible to produce.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
Maple	Brown Clear (northern hard maple).[2]	Special stock, selected for uniform brown color. It has more grain pattern than other types.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
Beech and birch.	Red Clear (northern beech, or Red Clear-northern birch).[2]	Made from all-red-faced stock, especially selected for color.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	

[1] Data from grading rules of the Maple Flooring Manufacturers' Association, in effect Apr. 1, 1935.
[2] Special grade.

All flooring listed is kiln-dried, grade- and trade-marked, hollowed-back and side and end matched. For lower grades than those listed above and for jointed (square-edge) flooring see the latest issue of the grading rules of the Maple Flooring Manufacturers' Association, 332 South Michigan Avenue, Chicago, Ill.

TABLE 3.—*Grades, description, and dimensions of beech, birch, and hard maple flooring* [1]

Kind of wood	Grade		Standard worked dimensions		
	Name	Description	Thickness	Face width	Length, feet
			Inch	*Inches*	
Beech, birch, and maple.	First	Shall have the face practically free of all defects, but the varying natural color of the wood shall not be a defect.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
			1 1/32	2	
			1 1/32	1½	
Beech, birch, and maple.	Second	Will admit tight, sound knots and slight imperfections in dressing, but must lay without waste.	25/32	3¼	1½-16, not over 40 percent of 1½-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
			1 1/32	2	
			1 1/32	1½	
Maple	First (hard white maple). [2]	Special stock selected for uniformity of color. It is almost ivory white and is the finest grade that can be produced.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
			1 1/32	2	
			1 1/32	1½	
Beech and birch.	First (red beech and red birch). [2]	Produced from all-red-faced stock, especially selected for color.	25/32	3¼	2-16, not over 25 percent of 2-3½.
			25/32	2¼	
			25/32	2	
			25/32	1½	
			1 1/32	2	
			1 1/32	1½	

[1] Data from grading rules of the National Oak Flooring Manufacturers' Association, in effect Sept. 1, 1936

[2] Special grade.

All flooring listed is kiln-dried, grade- and trade-marked, hollowed-back and side and end matched. For lower grades than those listed above and for jointed (square-edge) flooring see the latest issue of the grading rules of the National Oak Flooring Manufacturers' Association, 830 Dermon Building, Memphis, Tenn.

BEECH AND BIRCH FLOORING

In comparison with hard maple, beech and birch are used only sparingly in the manufacture of flooring. Only 2 of the 15 or 20 species of birch that grow in the United States are manufactured into flooring. Of these, yellow birch (*Betula lutea*) is by far the most abundant and most important commercially. The other is sweet birch (*B. lenta*). Only one species of beech (*Fagus grandifolia*) is native to the United States. The heart wood of all three of these woods is reddish brown, with a slight variation in color for each individual species. Similar slight variations also exist in the color of the sapwood of the three species, which for the most part is of a lighter shade than the heart wood. As in the case of maple flooring, the natural varying color of the wood is not considered a defect in grading beech and birch flooring. Should a uniform color be required, however, it can be obtained by specifying the grade of Red Clear Beech or Red Clear Birch. These are special grades manufactured from clear all-red-faced stock especially selected for color with a rich, warm tint peculiar to these woods. Beech and birch flooring is graded under the rules of the Maple Flooring Manufacturers' Association and those of the National Oak Flooring Manufacturers' Association (tables 2 and 3).

SOFTWOOD FLOORING

The softwoods that are regularly manufactured into flooring are southern pine, Douglas fir, western hemlock, western larch, western

red cedar, redwood, and southern cypress. Each piece of softwood flooring is usually stamped to show the trade mark of the association under whose rules it was graded, the grade name, and the name or mill identification number of the manufacturer.

SOUTHERN PINE FLOORING

The softwood flooring used in the States east of the Mississippi River and in several States immediately west of it is made principally from "southern pine." Southern pine is a name applied to a group of yellow pines that grow principally in the Southeastern States. The group includes longleaf, shortleaf, loblolly, slash, Virginia pines and several others of minor importance. For many years southern pine supplied the larger part of lumber used for building purposes in the United States. Except in dimension material and structural timbers, no differentiation in species is made commercially in marketing the products from this group of woods. Typical longleaf pine is heavy, hard, and resinous with comparatively narrow annual rings of growth, and it is from this species that the bulk of the high-quality flooring suitable for the better class of houses is made.

The wood of all southern pines is much alike in appearance. The sapwood and heart wood are frequently, although not always, distinctly marked, the former being yellowish white and the latter a reddish brown. The contrast in color between sapwood and heart wood in southern pine is not generally strongly marked in a finished floor, and the standard grading rules for southern pine permit sapwood in all grades of all products manufactured, including flooring, unless otherwise stated. Should flooring of uniform color be essential, it can be obtained by amending the standard flooring specifications so as to cover only all-sap-face stock to secure a light-colored floor, or all-heart-face material to obtain a reddish-brown floor. It should be borne in mind, however, that such a modification of the standard specification for flooring requires special selection of stock for color and therefore entails a cost higher than that of the established grade.

Southern pine flooring is regularly manufactured in side- and end-matched (tongued and grooved on sides and ends) stock and also in plain-end stock that is side-matched only. All southern pine flooring, irrespective of how it is worked to pattern, is available in both flat-grain [2] and vertical-grain [3] stock (fig. 3). A class of southern pine flooring intermediate between vertical-grain and flat-grain stock is known as near rift flooring. This is not flat-grain stock and yet the angle of the grain in such flooring does not meet the requirements for vertical-grain material. Because of this fact one of the grade requirements of near rift flooring is that it must show an average of six or more annual rings of growth per inch measured anywhere across the face of the piece. Vertical-grain southern pine flooring, because of its better wearing quality and the more pleasing appearance of its uniform grain, is suited to the rooms on the living floor of the house, while

[2] Flat-grain lumber is that in which the wide surfaces have been sawed in a plane approximately tangential to the annual rings of growth. Synonymous terms: Slash-grain, "bastard" grain, plain-sawed, tangential cut. Lumber is considered flat grain when the wide surface makes an angle of less than 45° with the annual-growth rings.

[3] Vertical-grain lumber is that in which the wide surfaces have been sawed in a plane approximately at right angles to the annual rings of growth. Synonymous terms: Edge grain, rift grain, comb grain, or quarter-sawed. Material is considered vertical grain when the rings (so-called grain) form an angle of 45° to 90° with the wide surface of the piece.

the flat-grain stock adequately meets the requirements of bedroom floors. Southern pine flooring is graded under the rules of the Southern Pine Association. (Table 4.)

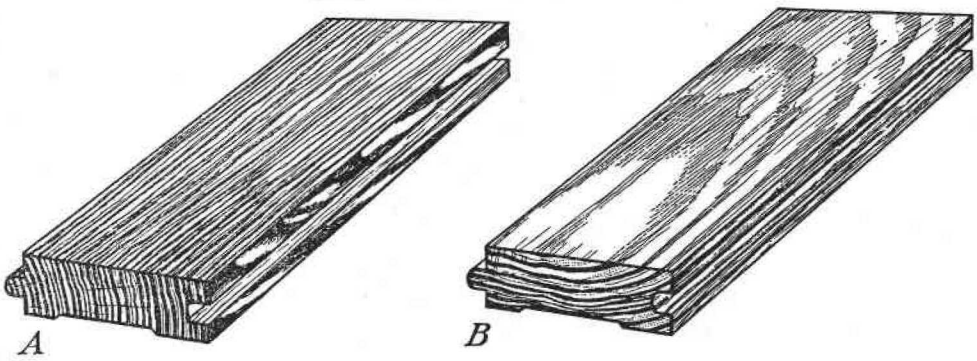

FIGURE 3.—Side-matched, hollowed-back softwood flooring; *A*, Vertical-grain flooring; *B*, flat-grain flooring.

TABLE 4.—*Grades, description, and dimensions of southern pine flooring* [1]

Kind of flooring	Grade		Standard worked dimensions		
	Name	Description	Thickness	Width	Length, feet
			Inch	*Inches*	
Flat grain	A	Practically free of all defects on face side and well manufactured.	25/32 25/32	2 3/8 3 1/4	4–20 with 5 percent of 8 and/or 9.
Flat grain	B	Will admit 2 or any combination of 2 of any of the following defects or their equivalent, on the basis of a piece containing 4 square feet, surface measure: small surface checks; 4 pin worm holes; slight torn grain; 3 pin knots; 2 small knots; 3 very small pitch pockets; 2 small pitch pockets; 3 small pitch streaks; not to exceed 15 percent red heart; not to exceed 5 percent stain.	25/32 25/32	2 3/8 3 1/4	4–20 with 5 percent of 8 and/or 9.
Flat grain	C	Will admit 2 or a combination of 2 of any of the following defects or their equivalent; small surface checks; 12 pin worm holes; medium torn grain or other machine defects that will lay without waste; 6 pin knots; 4 small knots; 2 medium knots; 6 very small pitch pockets; 4 small pitch pockets; 2 medium pitch pockets; 2 medium pitch streaks, or their equivalent; slight shake that does not go through; not to exceed 25 percent red heart; not to exceed 15 percent stain.	25/32 25/32	2 3/8 3 1/4	4–20 with 5 percent of 6 and/or 7.
Vertical (edge) grain.	A, B, and C.	Descriptions are the same as for flat grain except as to the angle of the grain which shall be at 45° or more with the surface of the piece and which shall show an average of 6 annual rings of growth across the face at every point.	25/32 25/32	2 3/8 3 1/4	4–20 with 5 percent of 8 and/or 9.

[1] Data from rules of the Southern Pine Association, in effect June 1, 1936.

All flooring listed is kiln-dried, grade-marked and trade-marked, usually scratched or hollowed-back and plain-end. For similar grades of side and end matched flooring and lower grades than those listed above for plain-end flooring see the latest issue of the grading rules of the Southern Pine Association, New Orleans, La.

DOUGLAS FIR FLOORING

Douglas fir (*Pseudotsuga taxifolia*), which grows in the western part of the United States and Canada, is occasionally called red fir, Douglas

spruce, yellow fir, or Oregon pine. The enormous stands of this wood, the large and splendid form of the tree, and the suitability of the wood for a wide range of building and general construction purposes make Douglas fir one of the most important timber trees of the United States. Douglas fir occupies the same important position in the Western and Pacific Coast States that southern pine does in the Eastern States. It is also a strong competitor of southern pine in many of the eastern markets formerly held by that wood.

The sapwood of Douglas fir is creamy white and usually rather narrow. The heart wood is reddish brown, and as is the case with southern pine, the contrast in color between the two is not so pronounced as to be objectionable in a finished floor. Should a floor of a uniform color tone be of primary importance, this can be obtained by specifying the grade of Clear All Heart vertical-grain Douglas fir flooring, which allows no sapwood and would insure a uniform reddish-brown heart wood color throughout. This grade represents the highest quality flooring produced from Douglas fir.

With the exception of the Clear All Heart grade, which is made only from vertical-grain material, Douglas fir flooring in the upper grades is regularly manufactured in both vertical-grain and flat-grain stock. Clear All Heart Douglas fir flooring, in addition to being produced from vertical-grain stock, is also selected for density, allowing only such material as shows not less than eight rings of annual growth per inch on either end of each piece. The next highest grade of Douglas fir flooring is B and Better, which is made from both vertical-grain and flat-grain stock. Vertical-grain flooring of this grade must show at least six rings of annual growth per inch on either end of the piece and no knots are allowed on the face side. As is the case with southern pine flooring, vertical-grain Douglas fir flooring possesses better wearing qualities than flat-grain stock. Douglas fir is not worked to pattern in the form of end-matched flooring. All flooring of this species is graded under the rules of the West Coast Lumbermen's Association (table 5).

WESTERN HEMLOCK FLOORING

At one time western hemlock was considered an inferior wood, especially in localities where it was not well known. A thorough investigation of its properties, however, has proved this prejudice to be unfounded, and recent lumber-production figures show that this wood is gaining considerable importance as a species for general building construction. Western hemlock grows along the Pacific coast from northern California to Alaska and as far inland as northern Idaho and northwestern Montana. The bulk of that produced comes from Washington. This wood is frequently called west-coast hemlock and also goes by such names as hemlock spruce, western hemlock spruce, western hemlock fir, gray fir, silver fir, and Alaska pine. Both the heart wood and sapwood of western hemlock are almost white with a pinkish tinge and with very little contrast, although the sapwood, which is usually not more than 1 inch thick, may sometimes be lighter in color.

Western hemlock has a combination of properties that make it usable for many types of flooring. Its light, clear color and good finishing qualities are responsible for its use in flooring where good

appearance under moderate wear is the principal requirement. Although it withstands heavy abrasive or impact service, it mars and dents more easily than the hardwoods and the more commonly used softwoods, such as southern pine and Douglas fir. Western hemlock flooring is somewhat easier to lay than other woods more often used for this purpose, as it is less subject to warping, easier to cut and nail, and less likely to split in nailing. Experience with western hemlock as a high-grade finish floor, however, has been confined largely to its use as an alternate for hardwoods in bedrooms. For the most part the use of western hemlock flooring has been confined to the regions of its production. The grades are identical with those of Douglas fir, and it is graded under the rules of the West Coast Lumbermen's Association (table 5).

TABLE 5.—*Grades, description, and dimensions of Douglas fir and western hemlock flooring* [1]

Kind of flooring	Grade		Standard worked dimensions		
	Name	Description	Thickness	Width	Length, feet
			Inch	*Inches*	
Vertical (edge) grain.	Clear All Heart.	Practically clear and perfectly manufactured, with not less than 8 rings of annual growth per inch, and free of sapwood. Grain to be at 45° or more with the surface of the piece.	25/32 25/32 25/32	2 3/8 3 1/4 5 3/16	90 percent 8–20. 7 percent 6 and/or 7. 3 percent 4 and/or 5.
Vertical (edge) grain.	B and Better	Shall have not less than 6 rings of annual growth per inch. No knots permitted on face. Otherwise graded the same as B and Better flat-grain flooring.	25/32 25/32 25/32	2 3/8 3 1/4 5 3/16	90 percent 8–20. 7 percent 6 and/or 7. 3 percent 4 and/or 5.
Vertical (edge) grain.	C	Will admit torn grain, 25 percent light stain and 1 of the following: 1 small check; 1 small sound, tight knot, 2 small pitch pockets in 2 3/8-inch width; 2 small checks, 2 small tight sound knots, 3 small pitch pockets in 3 1/4-inch width; 3 small checks, 3 small tight sound knots, 5 small pitch pockets in 5 3/16-inch width; based on 12-foot length. Grain requirements same as Clear All Heart except that pieces of B with angle of grain between 30° and 45° will be allowed.	25/32 25/32 25/32	2 3/8 3 1/4 5 3/16	90 percent 8–20. 7 percent 6 and/or 7. 3 percent 4 and/or 5.
Flat grain	B and Better	Will admit slight torn grain and one of the following: sound tight pin knot, 2 very small pitch pockets in 2 3/8-inch width; 2 sound, tight pin knots, 3 very small pitch pockets in 3 1/4-inch width; 3 sound tight pin knots, 5 very small pitch pockets in 5 3/16-inch width; based on 12-foot length.	25/32 25/32 25/32	2 3/8 3 1/4 5 3/16	90 percent 8–20. 7 percent 6 and/or 7. 3 percent 4 and/or 5.
Flat grain	C	Descriptions are the same as for vertical grain except as to grain requirement.	25/32 25/32 25/32	2 3/8 3 1/4 5 3/16	90 percent 8–20. 7 percent 6 and/or 7. 3 percent 4 and/or 5.

[1] Data from rules of the West Coast Lumbermen's Association, in effect July 1, 1934.

All flooring listed is kiln-dried, grade-marked and trade-marked, usually hollowed-back. The grading rules of the West Coast Lumbermen's Association also cover spruce flooring in the grades of B and Better flat-grain and/or vertical-grain, and western red cedar flooring in the grades of B and Better and C. For descriptions of these and lower grades of Douglas fir and western hemlock flooring see the latest issue of the grading rules of the West Coast Lumbermen's Association, Seattle, Wash.

WESTERN LARCH FLOORING

Such flooring as is manufactured from this species of wood is used mainly within or closely adjacent to the region of its growth in western Montana, northern Idaho, eastern Washington, and northern Oregon. Western larch and Douglas fir frequently occur together in the forests of the territory mentioned and are commonly logged together and sold in mixture under the commercial name of "Larch-Fir," the proportion being about 60 percent of the former and 40 percent of the latter.

Western larch is quite similar in its strength properties to Douglas fir. The wood is strong and stiff, is moderately heavy, and shrinks more in drying than any other of the principal softwoods but less than many of the heavier, commercially important hardwoods. The heart wood is reddish brown and the sapwood, which is not considered a defect in flooring, is yellowish white and generally not over 1 inch in thickness. Western larch ranks high in nail-holding quality, but on account of the tendency of the wood to split it is preferable to use blunt-pointed nails or nails of small diameter.

Western larch flooring is regularly manufactured in flat-grain and vertical-grain stock, and is graded under the rules of the Western Pine Association (table 6).

TABLE 6.—*Grades, description, and dimensions of western larch flooring* [1]

Kind of flooring	Grade		Standard worked dimensions		
	Name	Description	Thickness	Width	Length, feet
			Inch	*Inches*	
Vertical-(edge) grain or flat-grain.	C and Better	Includes much clear stock, but permits, on basis of a piece 1 inch x 4 inches x 12 feet an occasional pin knot or slightly torn or raised grain, small season checks, or very small pitch pockets, but a combination of these that destroys the high quality and appearance is not allowed. Grain must be at an angle of 45° or more with the surface of the piece in vertical-grain flooring.	25/32 25/32 25/32	2¼ 3¼ 5¼	6-20—large proportion of 10-16 with limited amount of 6-9.
Vertical-(edge) grain or flat-grain.	D Select	This grade has a good finish appearance. Permits small knots, light torn grain, but no serious combination in any 1 piece; an occasional high-line piece requiring a cut not to exceed 4 inches of waste is allowed. Grain must be at an angle of 45° or more with the surface of the piece in vertical grain flooring.	25/32 25/32 25/32	2¼ 3¼ 5¼	6-20—large proportion of 10-16 with limited amount of 6-9.

[1] Data from rules of the Western Pine Association, in effect Sept. 1, 1936.

All flooring listed is kiln-dried, and is grade-marked and trade-marked on request. Although western larch is sold unmixed by some mills, the run of the grade permits mixture with "Inland Empire" Douglas fir.

WESTERN RED CEDAR, REDWOOD, AND SOUTHERN CYPRESS FLOORING

Such flooring as is made from these three woods is used mainly for outside porches, or for purposes where they are subject to a minimum of wear, such as storerooms, kitchens covered with linoleum, attics, children's playrooms, closets, or summer cottages. In hardness, western red cedar, redwood, and southern cypress rank considerably

below southern pine and Douglas fir, the softwoods most generally manufactured into flooring; and they dent and mar under the service conditions of the living-room floor. These three woods, however, are highly durable under conditions that foster decay, and are therefore well suited for use in situations exposed to the weather.

LAYING THE FINISH FLOOR

It should be borne in mind that high-grade flooring is a valuable commodity in the manufacture of which considerable care and precision have been exercised. The lumber from which it is made is kiln-dried to the proper moisture content and then cut into strips and accurately worked to pattern. As it leaves the planing mill the flooring is sorted according to quality and is carefully bundled. It is stored in dry, well-ventilated warehouses. Each piece or bundle is marked to show the grade, and bears the trade-mark of the association under whose rules it was inspected. These marks guarantee to the purchaser that the flooring is of the grade specified. It leaves the factory as a carefully manufactured product and is shipped in closed box cars. Such a product merits from the dealer, truckman, and floor layer the same care in handling accorded it by the manufacturer. In order to insure the most satisfactory results from a finished floor, five simple precautions in handling the material should be observed.

1. Do not unload, truck, or transfer flooring in rain or snow. If the atmosphere is foggy or damp, carefully cover the flooring with a tarpaulin.
2. Do not store flooring in leaking or open enclosures.
3. Do not chance unloading flooring on the job outside of shelter.
4. Do not store or lay flooring in a cold, damp building. Wait until the plaster and cement work are thoroughly dry and woodwork and trim are installed.
5. As a final precaution, first heat the building to 70° F., especially in winter construction, and allow the flooring to be loosely piled in the building several days before it is laid, to bring it into equivalent moisture content with the building.

During the course of building the house the subfloor serves as a working surface for carpenters, plumbers, plasterers, and other mechanics engaged in its construction. It is subjected to heavy traffic, probably becomes damaged in places and takes on an accumulation of plaster, lime, bits of brick, nails, and other trash incident to building. Therefore, before starting to lay the finish floor, which should be the last item of construction work, one must examine the subfloor carefully and repair any damage that may have been done. The floor should be thoroughly cleaned with a broom to remove all accumulated dirt and trash. It is important that no water be used in this general clean-up. There may be some warped boards, which should be made level, as should also any high ridges at joints. All raised nails should be driven down and loose boards fastened tight.

A well-recognized practice is the use of building paper between the subfloor and the finish floor (fig. 4). This is especially essential on the first floor, as this paper tends to keep moisture from the bottom of the finish floor which might cause expansion and warping. It also acts as a deadener of sound and helps to prevent squeaks. The type known as 15-pound asphalt-saturated felt in rolls is usually preferred to the

thin, black-sized paper, red rosin-sized paper, or slaters' felt. The paper should be extended from wall to wall, laid in place as the floor laying proceeds, and lapped about 4 inches. For rooms directly over the heating plant it is advisable to use double-weight, 30-pound, asphalt-saturated felt, or a standard insulating board one-half inch thick. This will provide insulation against excessive heat which might otherwise cause floor joints to open up later on. If preferred, this extra insulation can be applied on the basement ceiling rather than between the subfloor and finish floor.

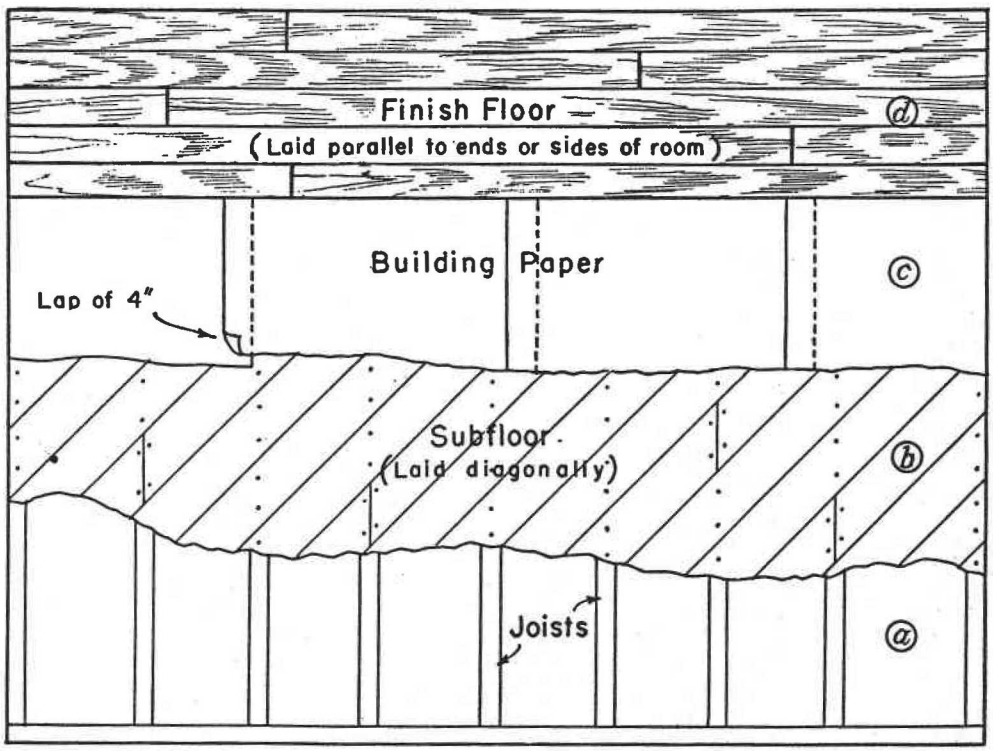

FIGURE 4.—Cut-away view of floor, showing details of construction: *a*, Joists; *b*, subfloor; *c*, building paper; *d*, finish floor.

The flooring strips should be started square with the room. Since in modern house construction interior doorsills are no longer used, all flooring is laid in one direction in order to avoid the unsightly break that would occur at the threshold of each door if the direction were varied in each room or in the hall on the same floor. Ordinarily flooring is laid in the direction of the longest dimension of the house. For example, if the house has a floor area that measures 24 by 36 feet, the flooring lengths should be laid in the direction of the 36-foot dimension.

In laying the finish floor the start is made by placing the first strip parallel to the wall with the tongue edge out. It should be so located that the groove edge will fall slightly short of being in line with the outside vertical face of the baseboard (fig. 5). The groove edge of the first strip is face-nailed, the nails being driven so that they will later be hidden by the quarter-round shoe molding. Some builders also blind-nail the tongue edge of the first strip, the nails, eightpenny steel-cut flooring nails, being driven at an angle of about 50°. This nailing of the first strip of flooring, in the manner described, provides

a space for expansion and contraction of the floor under the shoe molding. A similar space is also provided on the opposite wall of the room and on the other two sides where the ends of the flooring terminate. By keeping the lower edge of the baseboard slightly above the finished floor level and by laying the floor so that it does not extend under the baseboard, it becomes an easy matter to nail the

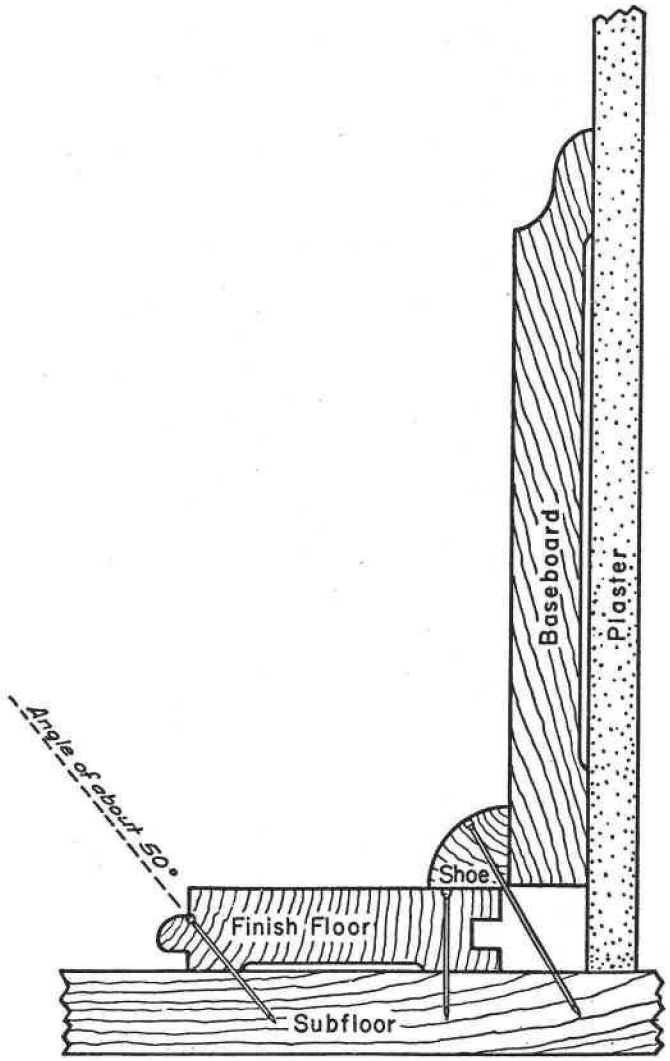

FIGURE 5.—Laying the first strip of finish flooring. The finish molding is usually not put down until all the flooring strips have been laid. It is shown in place here merely to indicate its position in reference to the first strip of flooring.

shoe molding to the subfloor through the crack between the baseboard and the finish floor. Figure 6 shows three methods of nailing the shoe molding in place. In *A* it is nailed to the baseboard, and any shrinkage will cause a crack to open up between the shoe molding and the floor. In *B* it is nailed to the floor, and shrinkage of the floor will cause a crack to develop between the shoe molding and the baseboard. If it is nailed directly to the subfloor as shown in *C*, any movement of either the baseboard or the flooring due to seasonal moisture changes is less likely to affect the shoe molding and open up unsightly cracks along it.

After the first strip of finish flooring has been nailed in place, the work of laying the rest of the flooring strips begins, all of these being blind-nailed. Do not try to hammer each individual strip of flooring into its final position as it is nailed, but after laying three or four pieces, place a short length of square-edge hardwood against the tongue of the outside strip and drive up snugly but not excessively tight. Repeat this operation as the work progresses, care being taken not to damage the tongue. By this method the strips are driven into their final position.

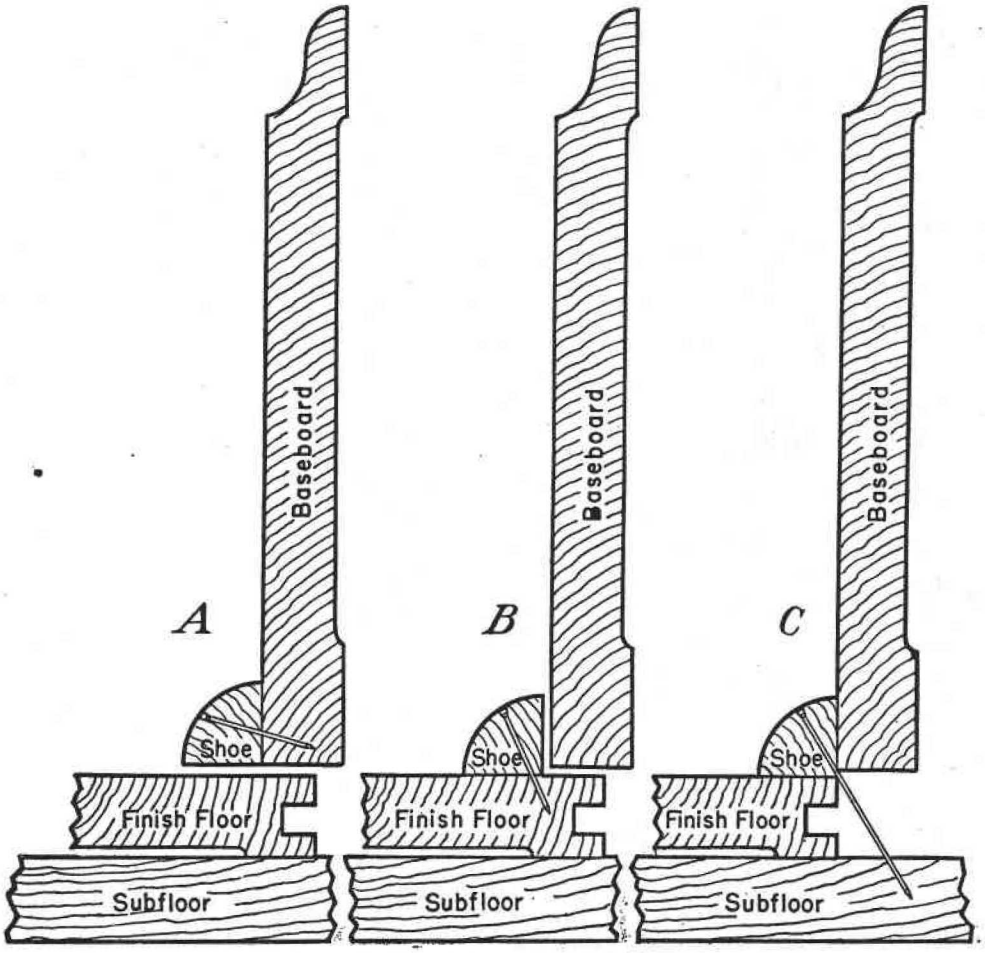

FIGURE 6.—Three methods of placing the first strip of finish flooring and nailing the shoe molding: *A*, Shoe molding nailed to baseboard; *B*, shoe molding nailed to finish floor; *C*, shoe molding nailed to subfloor.

The use of proper nails and correct and careful nailing holds the flooring in place, gives it rigidity, and is largely instrumental in preventing squeaks. The nails should be started where the tongue leaves the shoulder and should be driven through the finish floor into the subfloor at an angle of about 50°. The head of each nail should be carefully countersunk with a steel set. Where a finish floor is laid over a subfloor, it is not essential that the nails be located immediately over the joists, but it is important that the distance between nails be uniform, usually not over 10 inches apart for both hardwood and softwood flooring.

All hardwood flooring and some softwood flooring is tongued and grooved on both sides and ends, referred to by the trade as side and end matched. The run of the grade of such flooring includes strips of various lengths. They are so accurately manufactured that they fit perfectly both sidewise and across the ends. In the finish floor laid over a subfloor, end joints do not necessarily have to come over the joist or bearing point, since the combination of the properly installed subfloor and the side- and end-matching of the flooring strips afford support to the finished floor. Such joints, however, should be staggered to avoid having several of them closely grouped together. It is good practice to sort over the flooring strips before starting to lay the floor and lay aside the shorter lengths. These can be used inside closets, in hallways, or other places where they will be less conspicuous, leaving the longer lengths for the larger areas.

FLOOR FINISHING [4]

Years ago floors were commonly finished with repeated applications of hot linseed oil, each application buffed by hand; and when the surface was saturated with oil, it was waxed and maintained by waxing at suitable intervals. Because unbodied [5] drying oils such as linseed penetrate into wood relatively deep, a good many applications were necessary, making the process rather laborious; but the finish was correspondingly durable, did not show scratches, and was readily patched at places of maximum wear without refinishing the entire floor. The pure linseed-oil finish dried hard enough to be free from any tackiness and made a floor that was very easily kept clean by dry mopping. In time the finish darkened, partly because of the change in color of the wood itself and partly because drying oils and varnishes become discolored with decomposition products as they age. Since the finish saturated a substantial layer of the wood, this darkening effect was more serious than it is with a superficial coating of varnish.

As time passed, the drying-oil finish was increasingly adulterated with nondrying mineral oils until at the present time floor oils have become cheap products often containing no drying oil at all. The mineral oils prevent proper hardening of linseed oil, thereby keeping the finish tacky, so that it clings to dirt and the finish ultimately becomes very dark in color or even black. Largely because of the adulteration of floor oils the old oil finish fell into disrepute and for a long time has been replaced by varnish, shellac, shellac and varnish, or shellac and wax finish. There is now, however, a growing trend back to the old oil finish, except that in place of linseed oil, specially designed products known as floor seals are being used because they are obtainable in satisfactory quality and are more economical in labor of application than unbodied linseed oil. According to a recent estimate, 70 percent of the floors in large cities in the East are being finished with shellac, 20 percent with floor seals, and 10 percent with varnish, in spite of the fact that nearly all who give technical advice about floor finishing rate shellac as the least desirable of the three.

[4] By FREDERICK L. BROWNE, Senior Chemist, *Forest Products Laboratory*.

[5] An unbodied oil is an oil that has not been heated or treated chemically to such an extent as to increase the viscosity substantially. Raw, refined and boiled linseed oils, raw and refined soybean oil, tung oil, and perilla oil are all unbodied oils.

The varnish and shellac finishes form coatings of substantial thickness over the surface of the wood in contrast to oil and seal finishes, which penetrate into and are embedded in the surface of the wood without forming a definite coating over it. When a coating wears through in a traffic channel, it can rarely be patched without showing the edges of the worn place; and even if the whole floor is recoated there is usually a difference in color between the worn area and the areas where old coating discolored by age remains underneath. For fully satisfactory refinishing, the old coat must be removed completely either by sanding or scraping or by use of suitable liquid removers. The necessity of removal can be avoided by taking care to renew the coatings before traffic channels wear through, but with varnish finishes particularly the color gradually darkens as thicker layers of old varnish accumulate. Shellac has much less tendency to darken with age than varnish but, on the other hand, water causes it to turn white if the water stands on it very long before being wiped off thoroughly.

The modern floor seals may be regarded as thin varnishes or bodied drying oils prepared to penetrate less deeply into the wood than unbodied drying oils. Fewer applications are required, yet they penetrate more deeply than ordinary floor varnishes so that a surface layer of the wood can be saturated and the finish can be embedded in the wood rather than coated over it. Some of the seals contain emulsified water for the purpose of controlling the degree of penetration and the spreading rate at which the seal is applied. The seals are relatively new products on the market; composition and properties vary widely; and inadequate instructions for application are often given. Inasmuch as the seal finish differs fundamentally from the varnish finish in method of application, it is very important that those who use seals for the first time make sure that they learn exactly how the products should be used to obtain the excellent service of which the finishes are capable.

SELECTION OF FINISH

Wood floors can be maintained in good condition by any one of various types of finishing methods, if good materials are properly applied and if maintenance methods appropriate for each type of finish and for the degree of wear to which the floor is subjected are employed. No one type of finish can be said to be superior in all respects and none will long continue to give good service unless it is suitably maintained. The secret of good floors lies in thorough understanding of the nature and limitations of the particular kind of finish chosen and in careful following of the appropriate maintenance program.

Where the owner's chief requirement is a maximum interval of time between refinishing jobs, during which the floors will be merely kept clean by sweeping and dry mopping, or where the highly lustrous appearance obtainable only by using a substantial coating of resinous material is desired, coatings of varnish or shellac are likely to prove most satisfactory. The coatings should be cleaned and renewed when they begin to become thin in the channels of maximum traffic but before they wear through to bare wood at these points. Dissatisfaction with such finishes arises most often where recoating has been too

long postponed; and this is particularly likely to occur, because those who choose such programs do so largely to escape the burden of watching their floors carefully. After three or four renewals of the coating, when it has become dark in color, it should be removed completely by scraping, sanding, or with varnish remover and a new coating applied to the bare wood.

Shellac is used so widely for floors chiefly because it dries so rapidly that a floor may be finished or refinished and put back in service within 24 hours. Varnishes, even the quick-drying kinds, require longer intervals between coats and remain tender for some time so that the floor should be kept out of service for several days when varnishing is being done, although they are often used within 24 hours. Painters and landlords are inclined to favor shellac finishes; the owner-occupant is likely to prefer varnish.

Where floors can be kept out of service long enough to apply varnish finishes properly, varnish is commonly chosen instead of shellac because of its better resistance to water that may be spilled upon it. Varnish finishes are also tougher and less easily scratched than shellac.

The shellac and varnish finish, in which shellac is used as the first coat on the bare wood and the varnish put on over it, is a compromise between the shellac and the varnish finish. Like so many compromises, it retains many of the disadvantages of both sides with some new shortcomings of its own. Water may still turn the shellac white under the varnish; the floor still needs to be kept out of service long enough to dry thoroughly; and the finish is usually very easily marred by scratches from shoe nails or scraping chair legs.

The durability of coatings can be improved by keeping them waxed, renewing the wax every 4 to 6 months according to the amount of wear on the floor. Well-waxed floors are also more easily kept clean by dry mopping. Wax over a substantial coating of shellac or varnish, however, tends to make a slippery floor unless the coating of wax is kept very thin. For that reason where wax is to be used, the shellac is often limited to one or two coats and sanded or buffed off so that it acts more as a seal to support the wax than as a coating. Some of the modern floor waxes are made with resinous ingredients in a further effort to make then less slippery. Those who choose coatings to relieve them of the necessity of paying fairly frequent attention to floor maintenance, however, are not generally inclined to renew wax often enough to gain much benefit from it in extension of the intervals between recoatings, and they might therefore do well to consider the newer floor-seal finishes with or without wax.

The modern floor-seal finishes are well suited to the needs of those who wish to keep their floors well waxed at all times, with a minimum of slipperiness, and those who do not like the appearance of the very lustrous coating finishes, or who wish to pay a minimum of attention to floor maintenance except at an annual or semiannual houselceaning time and then want to be able to clean and patch worn spots without the trouble of moving all the furniture out of the room and keeping the room out of service for a day or more.

FINISHING NEW FLOORS

In the house under construction, floor finishing should be the last operation performed after all other interior work has been completed. It is advisable to have the floors protected by a covering of heavy paper from the time they are laid until the finishing is to be done. The first and most important operation of finishing is scraping or sanding. Scraping by hand has been displaced almost entirely by sanding with electrically operated sanding machines. The sanding machine should be well designed, of rugged construction, with its bearings well aligned and kept in good condition. A machine with badly worn bearings may do more harm than good. It is usually advisable to have the sanding done by a man who specializes in floor sanding, not by a carpenter or painter. If part of the work is to be done by relatively unskilled labor or by the owner, let it be the application of the finish rather than the sanding.

In sanding, the floor should be gone over several times, first across the grain and then in the direction of the grain. On the first traverse No. 2 sandpaper is usually used on the machine, graduating down to No. ½, No. 0, and No. 00 on succeeding traverses. On softwood floors, however, No. ½ sandpaper is often the finest grit practicable. After the last sanding, the floor may be buffed with No. 3 steel wool. For working close to walls or corners or in closets, where the large machine cannot be used, there are small, power-operated machines. After the floor has been sanded, it should be swept clean and carefully inspected, looking at it across the floor toward the light from a window and remembering that any scratches, undulations, or other blemishes will appear greatly accentuated when the finish is applied. The floor should not be walked on until the first coat of finish has been applied and finishing should be done as soon as possible after sanding.

If the floor is to be stained, this should be done with a penetrating oil stain at this time. Where floor seal is to be used, however, the stain may be incorporated in the first coat of seal. Some commercial floor seals are put out in colors as well as in the colorless form. Stained floors require particularly careful maintenance to avoid wearing traffic channels deeply into the wood. No stain penetrates very deeply with uniform color and if a patch becomes light in color through wear, it is very difficult to repair it to match in color the unworn areas of the floor. On the other hand, some stain may penetrate very deeply in the large pores of some hardwoods so that the owner if he subsequently wishes to sand the floor down to get rid of the stain, may have to remove a considerable layer of the board. Stain incorporated in a first coat of floor seal is less likely to result in such deep penetration in local spots.

Floors of oak or other hardwood with large pores may require filling with paste wood filler before proceeding with the subsequent finishing. The filler may be colorless or it may contain pigment if it is desired to bring out the grain of the wood more contrastingly. Paste filler is almost always used on oak floors before applying shellac or varnish coatings, but with floor seals the practice varies. Some manufacturers of seals recommend that filler be used; others recommend its omission. When filler is used, care should be taken to see that the excess is wiped off very thoroughly to avoid an uneven, smeared appearance of the final finish. Any imperfections left by poor sanding make it difficult to do a clean job of filling.

Varnish.—Methods of applying floor varnish are commonly understood and are usually described on the labels of the containers. Only floor varnishes should be used for floor finishing. Varnishes made for other purposes and the so-called all-purpose varnishes are not so durable for floors as varnishes made specifically for the purpose. At least two coats are needed over paste filler or over a first coat of shellac and at least three coats where the varnish is applied directly to the bare wood. The chief precautions to observe are cleanliness and reasonable control of temperature and circulation of air. The floor should be clean when varnish is applied, and the brush must be clean to avoid leaving grains and lumps in the coating. The room should be kept at 70° F. or warmer and plenty of fresh air should be provided, since oxygen is taken from the air when varnish dries. Low temperature and high relative humidity greatly retard the drying of varnish.

Shellac.—Shellac for floors should be purchased in the form of 5-pound cut shellac varnish and should be pure shellac unadulterated with cheaper resins. It should either be freshly manufactured or put up in glass containers. Shellac that has stood long in contact with metal may contain salts of iron that discolor oak and other woods containing tannin. The correct thinner for shellac is 188-proof No. 1 denatured alcohol. For application, 5-pound cut shellac should be thinned with 1 quart of thinner per gallon. It should be applied with a wide brush that will cover three boards of strip flooring at one stroke and should be put on with long, even strokes, taking care to join the laps smoothly. The first coat on bare wood requires 15 to 20 minutes to dry. It should then be rubbed lightly with steel wool or sandpaper and the floor swept clean. A second coat should be applied, allowed to dry 2 or 3 hours, then gone over with steel wool or sandpaper, swept, and a third coat applied. The floor should not be put back in service until next morning if possible but may be walked upon in about 3 hours after finishing, if necessary. If wax is to be used, it should not be applied less than 8 hours after the last coat of shellac and should be a paste wax, not a water-emulsion wax, since water may turn the shellac white.

Floor Seals.—Manufacturers' directions for applying floor seals vary widely and in some cases are very inadequate. In general, floor seals may be brushed on with a wide brush or mopped on with a squeegee or lamb's wool applicator, working first across the grain of the wood and then smoothing out in the direction of the grain. After an interval of 15 minutes to 2 hours, depending upon the characteristics of the seal, the excess is wiped off with clean rags or a rubber squeegee. For best results the floor should then be buffed with No. 2 steel wool although the buffing is omitted by those who are willing to sacrifice something in appearance and service to save the labor of buffing. If possible, the buffing should be done by a rugged power-driven machine designed specifically for buffing with steel wool. The next best procedure is buffing with steel wool pads attached to the bottom of a sanding machine. The buffing may be done by hand if a machine is not available. One application of seal may be sufficient, but a second application is generally recommended for new floors or floors that have just been sanded. The floor should be swept clean before making the second application.

A correct interval of time between application of the seal and buffing is exceedingly important. If the interval is too short, the appearance and durability suffer; while if it is too long, the excess seal "gums" the steel wool badly, is removed from the floor with difficulty, and where not removed becomes blackened with detritus from the steel wool. If the manufacturer of the seal does not specify the correct interval of time clearly, the user should determine it for himself by trial on samples of flooring or in some inconspicuous places where imperfect results will not prove too disappointing. Once the user has learned how to work successfully with one brand of seal he will do well to stick to it, since he might have to learn the technique all over again with another brand.

Floor seals are now offered by a number of manufacturers of floor-finishing materials and equipment, who are usually able to give precise and reliable instructions for the proper application and maintenance of their products. Seals are also sold by most of the larger paint and varnish manufacturers, although the preference of their dealers is usually for floor varnishes.

Waxing of floors is done to best advantage with paste floor wax and an electric polishing machine designed for the purpose. For best appearance and durability there is no satisfactory substitute for the polishing machine; polishing by hand is far too laborious for the modern household and too expensive for the business building. The paste wax is mopped on the floor, allowed to stand until the volatile thinner evaporates, which may take 15 to 30 minutes, and the floor is then polished with the machine. The most modern type of floor-waxing machine applies the wax and polishes in the same operation. For those who wish to get along without a polishing machine and are willing to accept a somewhat less attractive and less durable wax finish, there are water-emulsion floor waxes that are merely mopped on the floor and allowed to dry.

REFINISHING OLD FLOORS

Where floors have become badly discolored and worn by neglect or improper maintenance, the most practicable procedure and often the only one that will restore a fine finish is to have the old finish removed and the floor reconditioned by power sanding. Where the floors have been reasonably well maintained but the finish has become dingy with age, refinishing without power sanding may be practicable. The method of removal of the old finish depends upon the kind of finish that was used.

FLOORS ORIGINALLY FINISHED WITH OIL

An old oil finish, since it is embedded in the wood, may cause some difficulties. If a steel-wool buffing machine is available, an attempt should first be made to clean the floor sufficiently merely by buffing with No. 3 steel wool. If this is not feasible or proves ineffective, a chemical treatment will be necessary. Through the action of mild alkalies, the oil is changed to soap. The alkali used may be a water solution of trisodium phosphate, washing soda, or a commercial cleanser. If lye is used, care must be taken not to have the solution too strong because strong alkali swells and softens the wood. (If the

oil contained mineral oil, however, there may be no practicable way of removing it, since alkalies do not saponify mineral oil.)

In applying the alkali, flush a small area of the floor at a time and allow to stand for a few minutes, then scrub with a stiff brush or No. 1 steel wool. Next flush with clean water and scrub to remove the soap that has been formed, and finally remove all the water possible by mopping and let the floor dry thoroughly. If the floor turns gray in color as a result of the action of the alkali and water, it may be necessary to bleach it with a saturated solution of oxalic acid in water (oxalic acid is poisonous and must be handled with great care). Rinse off the oxalic acid thoroughly with clean water, mop, and let the floor dry completely. Any raised grain or roughening of the surface of the boards as a result of the drastic treatments should be smoothed off with sandpaper or steel wool before new finish is applied (p. 22).

FLOORS ORIGINALLY FINISHED WITH VARNISH

Old, discolored varnish finish is usually removed most easily by power sanding; but if desired it can be done with liquid varnish remover. Alkaline solutions in water and removers sold in powder form to be dissolved in water should not be used. The directions for using the liquid remover should be followed carefully. Since some old, discolored varnish remains embedded in the wood, complete restoration of the natural wood color should not be expected. Traffic channels where the old varnish has long been worn through and dirt ground into the wood should be cleaned by sanding.

FLOORS ORIGINALLY FINISHED WITH SHELLAC

Old shellac and wax finishes that have merely become soiled by dirt clinging in the coating of wax may be cleaned by going over the floor with steel wool saturated with clean turpentine. Any white spots in the shellac caused by contact with water may be taken out by rubbing lightly with a soft cloth moistened with denatured alcohol diluted half and half with water, but the alcohol must be used with care to avoid cutting the shellac coating. On floors where the dirt is ground into the shellac itself or white spots penetrate all the way through the coating, more drastic treatment is necessary. First, wash the floor with neutral or mildly alkaline soap solution followed by clear water, using as little water as possible in each operation. Then scour the floor with No. 3 steel wool and denatured alcohol diluted half and half with water. If the floor boards are level and are not warped or cupped, the scouring can be done to advantage with a floor-polishing machine fitted with a wire brush to which a pad of the No. 3 steel wool is attached. After the scouring, the floor should be rinsed with a minimum amount of clean water and allowed to dry thoroughly before refinishing with shellac.

FLOOR MAINTENANCE

Wood floors with fine finishes should never be scrubbed with water or unnecessarily brought in contact with water except in connection with refinishing old floors as already described. Sweeping or dry mopping should be all that is necessary for routine cleaning. A soft

cotton floor mop kept barely dampened with a mixture of 3 parts of kerosene and 1 part of paraffin oil is excellent for dry mopping. When the mop becomes dirty it should be washed in hot soap and water, dried, and again dampened with the mixture of kerosene and paraffin oil. Exceptional patches of dirt that cannot be removed in this way may be removed by rubbing lightly with fine steel wool moistened with turpentine. Where the finish is a floor seal, badly soiled spots, such as gray spots where water has been allowed to stand on the floor for a time, can be sanded by hand, patched with seal, and buffed with a pad of steel wool. Varnish finish if kept in good condition offers better protection against water scars; but if it does become stained it is not so easily repaired.

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