care and repair of the house

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care and repair of the house

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FOREWORD

Both old and new houses, even though carefully built, need occasional repair to keep them in good condition and to retard depreciation. Like other kinds of property, houses will deteriorate and decline in value if they are not properly cared for. Alertness to signs of wear can often eliminate the need for major repairs that stem from neglected minor problems. Thus, a defective electrical fixture can cause a disastrous fire; a sticking window can cause breakage of glass; faulty plumbing can cause the failure of a plaster ceiling; or a leak in the roof can cause rot in the framing members of a house. Yet, these and other similar difficulties can be avoided by proper inspection and prompt correction of the usually trivial sources of trouble.

Regular inspection of all parts of the house should therefore be made. Repairs that require special knowledge and skill should be performed only by qualified persons, but some repairs can be undertaken by anyone who is handy with tools.

This Circular was written to assist those who are sometimes faced with problems incident to the care and repair of the house. It points out the more common conditions of disrepair arising from time to time, describes their causes briefly, and indicates what tools, materials, and methods can be used for correction. It also deals with some minor improvements that can be made by the amateur mechanic who wishes to enhance the value of his house and make it more attractive and comfortable.

The introduction of new building materials and construction methods and advances during recent years in the design and operation of mechanical equipment have necessitated the modernization of suggestions on household repairs and the addition of new information. The present volume thus is an enlargement as well as a complete revision of the original edition of *Care and Repair of the House.*

Acknowledgment is hereby made to the many members of the staff of the National Bureau of Standards who have offered valuable suggestions and who have reviewed portions of the text relating to their special fields of investigation. The collaboration of Louise D. C. Nobel and Edward J. Schell in the preparation of this Circular is especially acknowledged. Acknowledgment is also made to Edith R. Meggers for assistance in the preparation of the manuscript, and to George W. Shaw for preparation of the drawings, which illustrate the procedures described in the text.

E. U. Condon, *Director.*

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1. INSPECTION OF THE HOUSE

Some houses are given attention only when a problem arises—when a roof leaks or a pipe bursts—but it is neither wise nor safe to wait until something breaks or gives way completely before taking action. Trouble should be anticipated by making regular inspections and applying remedies before the trouble becomes acute. Many of the inconveniences and discomforts experienced in the household may thus be avoided and considerable money saved.

Residents are often aware of the defects in a house, but sometimes it is necessary to have an inspection made by experienced workmen whose training enables them to discover defects not apparent to the average householder. Some home owners may wish to make their own inspections. For this purpose figure 1 and the accompanying list of the essential parts of a house may be helpful. The inspection should be conducted in a systematic manner beginning with the basement. The remedies for the items mentioned in the following brief descriptions are discussed later.

1. FOUNDATION PARTS

If the foundation walls are of solid concrete, they should be examined for cracks; if they are of unit masonry, the joints should be examined to see that no mortar is loose or has fallen out. The basement floor should be examined for cracks or signs of disintegration, and any evidence of leakage through the walls or the floor should be noted.

Wooden sills on top of the foundation walls should be examined to see that they are sound and that there are no cracks between wall and sills that are not calked to keep out moisture and cold air. There

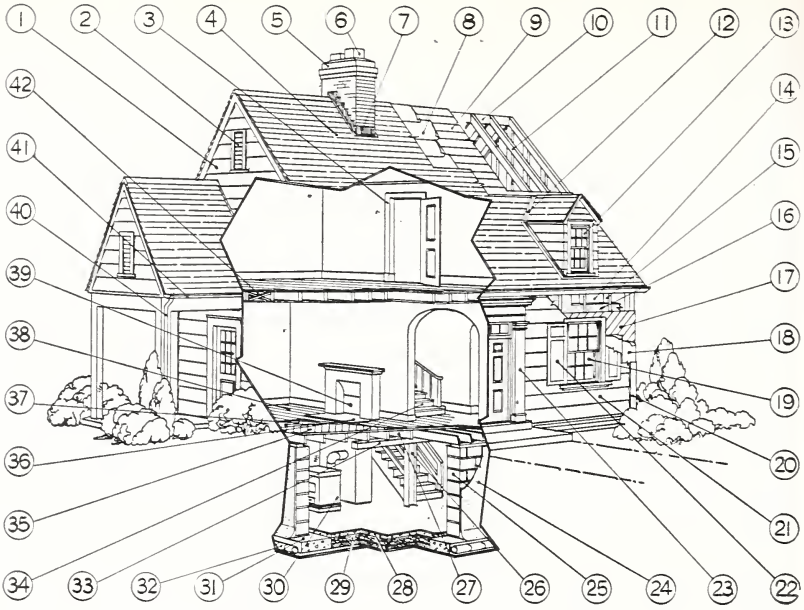


FIGURE 1.—*Essential parts of a house.*

1. Gable end.
2. Louver.
3. Interior trim.
4. Shingles.
5. Chimney cap.
6. Flue linings.
7. Flashing.
8. Roofing felt.
9. Roof sheathing.
10. Ridge board.
11. Rafters.
12. Roof valley.
13. Dormer window.
14. Interior wall finish.
15. Studs.
16. Insulation.
17. Diagonal sheathing.
18. Sheathing paper.
19. Window frame and sash.
20. Corner board.
21. Siding.
22. Shutters.
23. Exterior trim.
24. Waterproofing.
25. Foundation wall.
26. Column.
27. Joists.
28. Basement floor.
29. Gravel fill.
30. Heating plant.
31. Footing.
32. Drain tile.
33. Girder.
34. Stairway.
35. Subfloor.
36. Hearth.
37. Building paper.
38. Finish floor.
39. Fireplace.
40. Downspout.
41. Gutter.
42. Bridging.

should be firestopping on the sills between the floor joists, fitting snugly, especially around pipe openings, as careless firestopping will allow fire to spread.

If the basement has no ceiling, the joists should be examined for signs of sagging or of warping. These defects often occur because the support or bridging is not adequate. Look for excessive shrinkage in the framing.

Girders and beams which support the first floor joists should be examined for settlement, sagging and, if the material is of wood, for

shrinkage. A carpenter's level placed on the finish flooring of the first floor, both along and across the direction of the floor joists near points of support, should indicate whether column or wall footings have settled or whether there has been shrinkage in girders.

Settlement, sagging, or shrinkage of floor supports may distort the shape of door frames in partitions and prevent proper closing of the doors.

Treads and stringers of basement steps should be examined to determine that they are sound and securely fastened. Basement steps should have at least one handrail that is solidly fastened. The steps should be well lighted and should never be used as a catch-all or place for storage.

Coal bins and other built-in storage spaces should be examined for broken or loose planks or damaged framing.

Check for signs of damage in posts, sills, joists, and other woodwork caused by termites or other destructive insects. Look also for evidence of decay from dry-rot, especially in sills and at ends of joists adjoining masonry.

Make sure that all exposed water pipes are protected from freezing, especially if located under a porch or in some other unheated space.

If there are floor drains in the basement or garage, see that there is sufficient water in them to maintain a seal in the traps.

2. HEATING EQUIPMENT

Because there are many types of heating systems, the details of inspection necessarily vary. The most favorable time for this inspection is in the spring when the plant is shut down for the season.

Automatically controlled equipment such as oil burners, gas-fired boilers, mechanical coal stokers, and hot-water heaters should be maintained in accordance with manufacturer's directions. In some communities public service companies offer limited maintenance, but in any event, adjustments and repairs should be made by trained mechanics.

The smoke pipe should be taken down in the spring, cleaned, and put in a dry place until fall. Ashes should be removed from the fire-box and ash-pit, and soot from the chimney. The ash dump of the fireplace should also be emptied. The baffles in the hot-water boiler above the fire box also require frequent brushing to remove soot. The hinges of the boiler doors should be oiled and the doors left open during the summer.

If the grates are warped or broken or if the walls of the fire box are cracked, new parts should be ordered and repairs made promptly. Boilers should be examined for possible cracks or leaks. The coating on the boiler may need patching, or some of the heating pipes may require covering.

Examine the chimney to see whether it needs pointing and whether the cement is sound around the smoke pipe where it enters the chimney. Notice whether woodwork adjoining the chimney requires fireproof covering to lessen the fire hazard.

Stoves and stovepipe should be carefully inspected during the summer and necessary repairs or replacements made before the cold season begins.

3. EXTERIOR WALLS

After the structure and equipment of the basement have been thoroughly examined, the inspection of the exterior parts of the house should follow.

If the walls are of masonry, there may be cracks, broken bricks or blocks, especially above door and window openings. See whether mortar joints need repointing. Look for efflorescence (moldy white blotches or streaks) on the face of the wall, particularly below window sills and near downspouts.

The principal signs of defects or deterioration in stucco are cracks and the chipping off or falling out of particles. The most likely places for such cracks to appear are over doors and windows and near the ground. These surface marks are more readily seen after a rain. Discoloration in the form of dust or rust streaks may also appear below window sills or other ledges.

If the house is of frame construction, examine the siding for loose or decayed boards. Look for blisters on painted surfaces and indications of cracking or paint peeling. Because blisters generally result from moisture back of the paint film, look for possible sources of moisture such as leaky roofs and defective downspouts or water pipes.

4. OUTSIDE OF WINDOWS

See whether flashing is provided over the window caps to turn the water and if so whether the flashing is in good condition.

Look for holes or large cracks at window sills. They will appear if the inside stool or ledge is not well nailed. They may exist where parting strips and pulley stiles meet the sill or where the top sill joins the wood or brick subsill. If backband molding is used around the top and sides of the outside casing, see that it is nailed tightly against the casing. Probe between the frame and the wall at each side of the window to see whether calking is needed to keep out dampness and cold. Examine the windows for broken panes and loose putty. Examine shutters, storm sash, screens, and awnings, including fittings and hardware, for defects.

5. EXTERIOR DOORS, STEPS, PORCHES

The door should be examined for defects in wood or metal paneling, glass, or hardware. The door frames should be inspected to determine their condition and the need for calking around the frames. If there is sheet-metal flashing over the head jambs, it should be examined. Sills and thresholds should be inspected for extent of wear and the soundness of fastenings. Transoms and sidelights of doors should be subjected to the same inspection as windows.

Steps and porches should be inspected for structural defects, deteriorated materials, and insecure fastenings. Masonry may be subject to cracks, spalling, and wear. Metal handrails may require painting, and fastenings may need repair. Woodwork may be subject to warping, cracking, rotting, wear, and may need replacement or repainting.

6. ROOF, FLASHING, GUTTERS

Leaks in the roof are seldom easily detected from the outside. If the attic has no ceiling, holes in the roofing are often readily visible from the inside, which can be marked by pushing wires through the holes to the roof surface. If the attic has a ceiling, there may be stains on the plaster indicating leakage.

If the roof is of slate, tile, wood shingles, or composition shingles, see if any pieces are broken, missing, or loose. Examine wood or composition shingles to see if they are warped, partly decayed, or disintegrated.

Asphalt shingles and roll roofing may be blistered or pitted and they may have lost some of their mineral surfacing. These defects are more likely to occur on roofs with southern exposures or those with a low pitch such as over porches.

The metal fastenings used to hold roofing materials, such as slate, tile, and cement-asbestos, may fail before the materials themselves do.

Sheet-metal roofs should be examined for holes, cracks, corrosion, rusting, open joints, and defective fastenings. If painted, they should be examined for blistering and peeling. Examine the flashing around the chimney and vent pipes and in the valleys of the roof carefully for rust or displacement.

Leaves, rubbish, and birds' nests in gutters may stop up the downspouts. If there are strainers over the mouths of the downspouts, see that they are clear. Notice also the conditions of gutters and conductor pipes, and determine whether they need replacing or require a coat of paint. Where foliage from trees or shrubbery is in actual contact with the roofing, it should be trimmed back to permit the free evaporation of moisture.

Skylights should be examined for signs of leakage. The frames may need repainting, and the putty around the glass may need to be re-

placed. See that the flashing around the base of the frame is in good condition.

In looking over the chimney top, see that all bricks are in place and well pointed. If there is a cap, it should be securely cemented to the chimney. If there is no special chimney cap, mortar should be spread over the top of the brickwork and sloped down from the flue opening to the outside edge of the chimney.

7. THE INTERIOR

Defects in the interior of a house are generally more apparent than those on the outside. A clogged drain, a leaky faucet, a sticking door or window usually attracts the attention of some member of the household, but there may be other faults which go unnoticed unless carefully inspected.

Examine all doors to see how true they hang and to find out if they squeak. The lock or latch should be examined to see that the strike plate is not so far out of line that the door cannot easily be locked or latched. Raise and lower all windows to learn how they slide and whether or not the cords are broken or are of unequal length. Observe how the sash fits, and see if weather stripping is needed around the windows and doors. Notice whether there are any openings in or around the screens where insects can enter.

If baseboards do not fit snugly to the floor, it is usually because they have shrunk, but in some cases the floor supports have settled and caused the condition. Creaking in a floor may be detected by bearing heavily upon various sections of it. Flooring should be examined for wear and looseness, stair treads for loose or defective coverings, and handrails for stability.

Look for cracks in the plaster, particularly over door openings, and see whether the plaster on the ceiling is cracked or loose. Other types of interior finishes such as wallboards should be examined for buckling, loosening, cracking, or breakage.

8. HOUSEHOLD EQUIPMENT

When the structure of the house has been inspected, it is advisable to examine all equipment where trouble is likely to develop.

The heating system should be inspected, preferably during the summer months, to see whether it is in good working order. Check all radiator valves and shut-off cocks for possible leakage and, in the case of a hot-water heating system, see that the boiler and radiators contain sufficient water. Examine the furnace or boiler to see whether grates or burners need repair or adjustment. See if there are cracks in the boiler and whether the firebox, ashpit, and clean-out doors fit tightly.

All soot and ashes should be removed from the furnace, heating surfaces, smoke pipe, and base of chimney to insure maximum heating efficiency. Examine the condition of insulation and fastenings on boiler, furnace, hot-water storage tank, and pipes or ducts to see whether new or additional covering is needed. Filters, humidifier fans, and floor or wall grilles or registers used with warm-air systems should also be inspected for possible defects.

As automatic heating equipment, such as hot-water heaters, coal stokers, oil burners, and gas-fired furnaces, have more complicated mechanisms than hand-fired types, they require inspection and attention by an expert mechanic.

Plumbing facilities, including water-supply and drainage piping, fixtures, and equipment, should be checked to see that all parts of the system are in good condition and functioning properly. Drains and traps should be inspected for possible clogging, faucets for leaks, and flush valves or mechanism in water-closet flush tanks to see whether repairs or new parts are needed. Determine whether exposed piping is properly insulated against freezing in winter or moisture condensation during the summer months.

Inspect the cords on all electrical appliances to see whether they should be renewed, and examine all exposed wires to see that the insulation is in good condition.

Suitable cords are available for each type of appliance, and it is important to select the proper type. As a matter of expediency, the householder will frequently employ an extension cord to supply an area not provided with a convenience outlet. While this is satisfactory for temporary use, it should not be continued as a substitute for a permanent outlet. Be sure that there are extra fuses of the proper amperage for the fuse or panel box in case of emergency.

If gas is used for cooking, the burners on the gas stove may need cleaning periodically or the air vents may require adjustment. A service man from the gas company should be called for such work. Never search for a gas leak with a match, candle, lantern, or other lighting appliance which flames.

2. FOUNDATION WALLS AND BASEMENTS

1. DAMP BASEMENTS

Some basements are damp and unsanitary because moisture condenses on the walls and floors, especially during warm, humid weather. In other basements, water seeps through the walls or floors when there is a heavy rainfall or when snow is melting rapidly.

Causes

If the basement is damp, the difficulty may be traced to penetration of moisture through the walls and floor because of improper subdrainage. More often, however, the damp condition is due to condensation of moisture on chilled wall surfaces.

Flooding is usually caused by defective walls, lack of drain tile, careless backfilling, or improper grading around the walls, allowing surface water to pass into the basement. The condition of the walls themselves should be examined in order to detect cracks or loose mortar and repairs should be made in accordance with instructions contained in section 2 of this chapter.

Diverting Surface Water

Because wet basements often result from water penetrating the walls or floors, this water should be carried off before it comes in contact with the foundation.

Water from roofs should be carried away by adequate gutters, conductors, and downspouts. The downspouts should be connected to a

drain emptying into a storm sewer, dry well, open water course, or other suitable outlet. Many communities prohibit the draining of surface water into sanitary sewers. Where downspouts are not connected to an outlet, it is advisable to place a spatter board or splash block of good size at the outlet to divert the roof water away from the wall.

Quick shedding of water is essential and in many cases this may be accomplished by proper grading. The usual method is to place additional filling against the basement wall and grade it down to a sharp, smooth slope that extends at least 8 or 10 feet from the wall. The slope should be sown with good grass seed or sodded, and then rolled firmly and evenly. If necessary to grade above the basement window sills, a curved or rectangular area wall of concrete, brick, or metal should be built around them. Hinged covers for closing the openings during heavy rains or snow may also be provided. In any case, it is advisable to provide some means of drainage for these areaways and to place a protecting grill or grating over the opening.

Another method sometimes used to turn surface water away from basement walls is to lay a concrete pavement, walk, or gutter, 2 or 3 feet in width around the house with a gradual slope away from the walls. Where the sidewalk joins the wall, the wall surface should be roughened, cleaned, and moistened, and the concrete rounded up to meet the face of the wall. This method will make a good bond and turn water away from the joint between the wall and sidewalk.

The gutter type of construction is used to conduct surface water along the wall to some low spot. The gutter should be at least 2 feet wide, with an outer lip or edge about 5 inches in width. The depression should be about 4 inches deep at the outer edge and sloped gradually up to meet the wall, and the joint should be treated in the manner recommended for the sidewalk.

Drains for Ground Water

In low damp locations or in other places where there is a large amount of water in the subsoil, it is advisable to install drain tile around the footings to lower the water level and carry the water away before it can penetrate into the basement (see fig. 2).

To lay the tile, dig a trench adjoining, and to a depth of a few inches below, the bottom of the basement floor, but not below the footing level. The tile should be at least 4 inches in diameter (although 3-inch tile has proved satisfactory in some cases) and should be laid so that the grade or fall will be smooth and as sharp as possible to avoid mud settling in the pipe. The tile should also be connected to an outlet similar to those recommended for downspouts. The cracks between

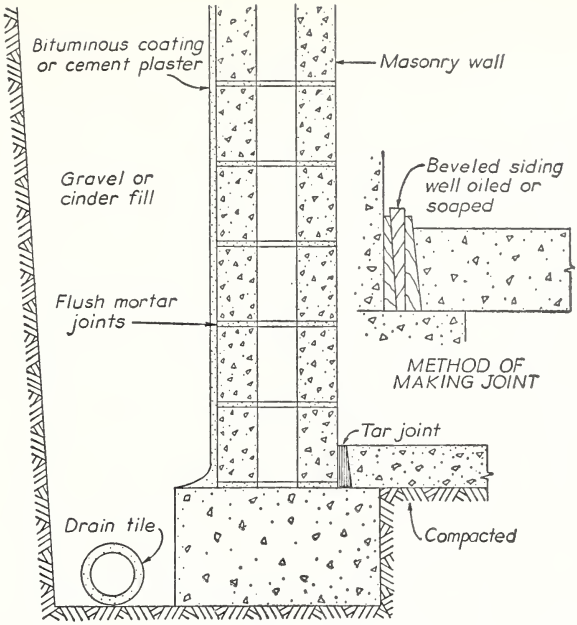


FIGURE 2.—*Cross section of foundation wall showing drain tile and plaster coat.*

the joints should be covered on top with copper screen wire or strips of roofing paper to prevent sediment from running into the pipe. The pipe should be carefully laid and protected against settling or leakage by surrounding it with fine screened gravel or broken stone tamped firmly around it. Following this, coarser gravel up to 1 inch in size should be covered over the pipe to a depth of 1 or 2 feet. Before backfilling with earth to grade level, it is well to spread burlap or bagging or to place sod, grass side down, on top of the stone to prevent fine material falling or washing down into the stone.

If an outside drain is impracticable, some relief from flooding may be obtained by removing the basement floor near its junction with the walls and placing a drain along the inside edge of the footing. The drain should pass through or under the footing to an outlet that is open at all times. An alternate method frequently employed to handle water from leakage is to cut a trough in the floor leading the water to a sump with a drain or pump. The trough may be covered with a perforated cover (see fig. 3). Where conditions are unusually bad, waterproofing may be necessary in addition to the drain.

Exterior Waterproofing

If waterproofing is necessary, it should be applied to the outside face of the wall before backfilling. Different methods can be used, depend-

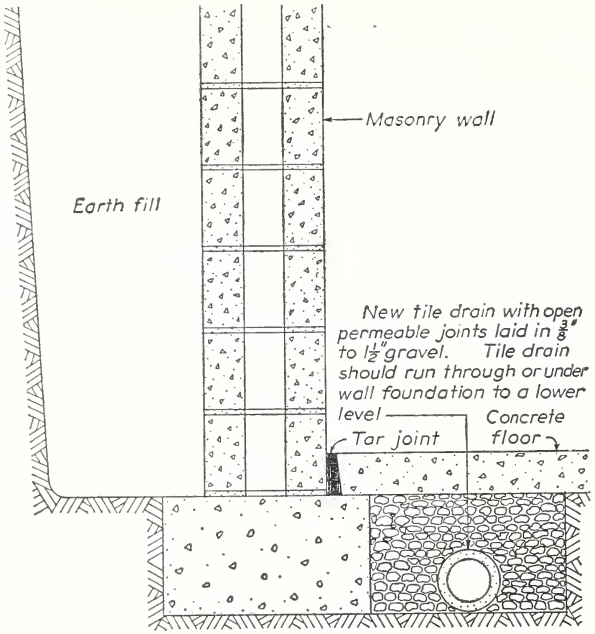


FIGURE 3.—*Cross section of foundation wall showing drain tile inside of wall.*

ing largely upon local conditions. By applying the coating to the outside, water is prevented from entering the wall. The water pressure tends to force the coating into tighter contact. If the coating is placed on the inside, water pressure through the wall may force it away from the wall surface.

Cement-Mortar Coatings

Where ground-water conditions are not a major consideration and protection against dampness only is required, a coating of cement-mortar is usually applied over grout to the outside of masonry-unit walls. This coating consists of one, or preferably two, ⅜-inch coats of cement mortar composed of 1 part of portland cement to 2 or 3 parts of sand by volume. The surface of the wall should first be cleaned and wetted until nearly saturated with water. While still damp, but without water showing on the surface, it should be scrubbed with a grout coat of portland cement and water of the consistency of thick cream. Before this coating has set and while still wet, the first ⅜-inch trowel coat of cement mortar should be applied. Before this coat hardens, it should be scratched with a coarse broom or other tool to roughen the surface and provide a good bond for the second coat. On the following day, the first or scratch coat should be dampened, and the second ⅜-inch coat applied. The wall should be kept damp for 3 days or more.

Bituminous Coatings

Bituminous coatings, either hot- or cold-applied, will give protection where dampproofing only is necessary, provided the surfaces on which they are used are smooth. Rough walls should be given a grout coat of cement mortar and allowed to dry before the bituminous coating is applied. Bituminous coatings should be used only on the outside of either masonry-unit or monolithic walls because such coatings on the inside walls of basements are likely to blister or peel.

Cold-applied coatings may be of heavy-brushing or troweling consistency, with asphalt or coal-tar pitch as the base. Before applying brushed or troweled coatings the wall should be primed, using an asphalt primer with asphalt coatings and a coal-tar or creosote primer with coal-tar coatings. Bituminous coatings may also be applied to cement-mortar coats.

Hot-applied coatings of asphalt or coal-tar pitch when properly applied are superior to cold-applied coatings, because they usually provide more bitumen per unit area than the cold-applied coatings. Walls should be smooth and dry and should be primed, using an asphalt primer for coal-tar pitch coatings. The hot-applied coatings are "mopped-on" with a roofer's mop, in one or more applications, to a thickness of at least one-eighth inch.

When there is water pressure against the walls from a spring or other source, the most effective treatment for the walls is a so-called bituminous membrane. It is made with three or more layers of asphalt or coal-tar saturated felt or fabric, cemented to the wall and to each other, and coated with asphalt or coal-tar pitch. Walls should be prepared as described for single hot-applied coatings.

Interior Waterproofing

Waterproof coatings are more effective when applied to the outer faces of the walls. However, if the water pressure from leakage is small, cement-mortar coatings may be applied successfully to the inside face. Active leaks through cracks may usually be sealed by plugging them with a cement mortar containing an accelerator to hasten hardening. The masonry around the crack should be cut away to a depth and width of 1 or 2 inches. A stiff putty should then be prepared from high-early-strength portland cement, sand, and calcium chloride up to 5 percent by weight of the cement. The mortar mix may be 1 part cement to 2 or 3 parts sand. The putty should be pressed into the opening and held by a small board or form until it has hardened (see fig. 4).

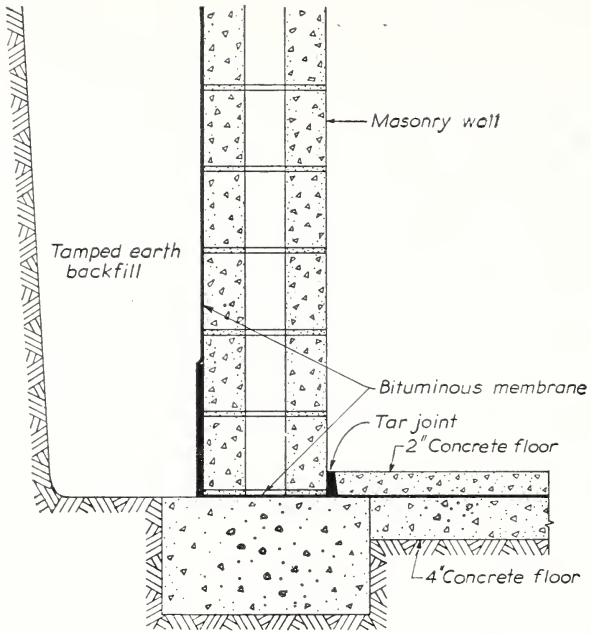


FIGURE 4.—*Cross section of foundation wall showing membrane and double floor.*

Concrete Floors

Concrete floors that are badly cracked may be repaired by topping the existing floor with a 2-inch layer of 1:2:4 mix concrete. This should be reinforced by lightweight steel-wire mesh, not lighter than No. 14 gage, placed in the middle of the new layer. To prevent cracking, the floor should be kept moist for a period of not less than 3 days.

Immediately before new concrete is poured, dry floors should be roughened, cleaned, and wetted and cement-sand grout (1 part cement to 2 parts sand by volume) scrubbed in to form a bond. If the old floor has been penetrated by seepage, either a bituminous coating or membrane waterproofing treatment should be applied to the surface of the old floor before the new concrete topping is placed. (See Bituminous Coatings.)

2. CRACKS AND JOINTS

Cracks or fissures in foundation walls and falling mortar between joints may be attributed to various causes. Cracks between mortar and the material to which it was originally bonded may be caused by shrinkage of the mortar during setting, or soon thereafter, or by the

expansion of mortar through saturation. Often the volume change of the mortar is greater than the material to which it is bonded and this change sets up a movement that destroys the bond.

If the walls are built on ground that will not support an equal weight at all points, uneven settlement may cause cracks to develop. An underground spring or flowing water under one corner or section of a foundation may produce similar results. Small cracks thus started may become larger in time from action of the weather and other forces. Frost has a tendency to attack weak spots. Expansion and contraction caused by extremes of heat and cold increase the damage, and water seeping through the cracks gradually wears away the material, causing it to crumble and fall apart. The disintegration is generally more rapid in mortar joints.

Results of such disintegration are far reaching and if not remedied may cause further damage not only to the walls themselves but to the structure they support. A basement will probably become damp and unsanitary if these inlets for moisture are not closed.

Extent of Damage

If the walls are otherwise in good condition, minor cracks and places where mortar has fallen out may be repaired by an unskilled workman. If, however, a wall is badly cracked and crumbled beyond the aid of minor repairs, it may be necessary to engage an experienced workman to reconstruct all or part of the wall.

The minor repairs in this section require the following tools and materials: hammer, sharp-edged and pointed instrument (such as a cold chisel or screw driver), wire brush or whisk broom, small mixing board, mason's trowel, and water bucket; portland cement, a finely divided material such as hydrated lime, clean sharp sand, and water.

Preparing Old Surfaces

Loose mortar between masonry courses should be chipped and picked out, and the joint brushed thoroughly to remove all dust and loose particles. The cleaned surface should be dampened before new mortar is applied to prevent absorption of water from the mixture.

Mortar

To make repairs, a mixture of 1 part cement to 2½ parts sand, or 1 part cement to 3 parts sand, is recommended in ordinary cases. However, a 1:2 mixture is recommended for damp basements or those exposed to very moist conditions. A 1:2 mixture represents 1 part of portland cement to 2 parts of sand, measured by volume. The proportion to be used will depend entirely upon conditions, a larger

proportion of cement being necessary in cases where excessive moisture prevails.

Enough water should be used to make a fairly dry mortar about the consistency of putty. The mortar should be thoroughly mixed and worked to insure best results. In filling cracks, the mortar should be applied like a calking material, that is, well rammed and tamped in to form contact with all corners and depressions to make a complete bond. When the crack has been tightly packed, the surface should be smoothed off with a trowel. In pointing up joints in masonry, the mortar may be applied with a trowel, and the surface finished to conform with the old mortar.

After the material has hardened the new work should be kept wet for several days to increase the strength of the mortar. If work has been done on the outside of walls, they should be covered by tarpaulins to protect them from direct exposure to the sun and drying winds.

3. IMPROVING BASEMENT LIGHTING

Many basements could be made lighter by enlarging window openings or by putting in additional ones; if this is done, proper lintels should be placed over the openings and precautions taken to insure stability of the wall. Keeping the spaces in front of basement windows clear, especially by removal of shrubbery, grass, and weeds, allows a maximum amount of light to enter. Coating the walls with paint that reflects light will also do much to brighten a dark basement. Paints suitable for this purpose are mentioned in the chapter on painting (ch. 11).

Electrical Outlets

New houses, with the possible exception of basements, are usually provided with adequate outlets for lighting and appliances. Old houses as well as new should have enough outlets to service the necessary lamps and appliances normally required. In basements, it is important to provide adequate lighting, particularly at the steps. If the basement is to be utilized for a shop or for other purposes requiring additional electric light or power, extra outlets should be installed instead of using extension cords. Where such cords are absolutely necessary, they should be suitable for the intended purpose. Portable extension cords should be rubber-jacketed and equipped with lamp guards and insulated sockets. Porcelain fittings are recommended for basement fixtures to minimize the danger of shock.

Ceramic-coated bulbs give more uniform diffusion of light than

plain or frosted bulbs. Two or three 25-watt bulbs properly spaced are better than one 50- or 75-watt bulb for wide distribution. However, it is advisable to use one large bulb for concentrated light, because this is more efficient than an equivalent number of smaller ones.

4. INSTALLING BASEMENT CEILINGS

Although often omitted in basements, a ceiling improves the appearance, does away with numerous corners and spaces between joists where cobwebs and dust collect, and prevents dust from passing through the first-story flooring to the rooms above, especially where the floors are of a single thickness.

Of far greater importance, if the ceiling is of tight-fitting fire-resistant materials, is the safety it affords by delaying the spread of basement fire to floors above and by reducing smoke damage.

If the basement is dry and well built, it can often be made more attractive by installing a ceiling and painting the walls and floor. If the concrete floor is dry, it may be covered with asphalt tile to give a smooth, attractive floor which can be maintained with the nimimum of effort by waxing.

Before putting on the ceiling, all openings through which fire might find quick passage to the structure above should be adequately firestopped. Such openings may be found around service pipes and registers and between joists or studs where they join the foundation. It is best to use incombustible materials for firestopping, such as crushed refuse mortar, plaster, concrete, hollow tile, gypsum block, broken brick, or other similar material that contains sufficiently fine particles to fill the voids. The firestopping can be supported by horizontal wood strips, not less than 2 inches thick, or by metal or wire mesh.

Several materials are used for ceiling purposes: Gypsum or asbestos board, plaster on metal lath or on gypsum plaster board, or properly furred metal ceiling may be used, depending upon the taste of the individual and the amount of money to be spent.

Material within 2 feet of the top of a boiler or furnace, or within 1 foot of a smoke pipe, should be protected by a loose-fitting metal shield, arranged to give an air space of 1 or 2 inches between the metal and the wall surface. The air space may be provided by using small blocks of incombustible material between metal and joists, or by suspending the metal sheets on wires or hooks fastened to the joists. If tin is used for a shield, it should have locked joints, since soldered joints are not reliable. Similar protection should be placed over any woodwork or wood lath and plaster partition, within 4 feet of the sides or back, or 6 feet from the front, of any boiler, furnace, or other heating

equipment. This covering should extend at least 4 feet above the floor and at least 3 feet beyond the heating device on all sides.

5. BASEMENT PARTITIONS

A dry, clean, well-lighted, and well-ventilated basement can be made a most useful part of the house by allotting certain spaces for special purposes. An orderly arrangement in a basement tends to encourage neatness and save work. The coal bin and furnace may be separated by a partition from the rest of the basement, which can then be used as a laundry, summer dining room, recreation room, game room, workshop, playroom for the children, or for other purposes where extra space is needed. It may also be desirable to provide a cold room for the storage of preserves and fruits and vegetables. If a definite storage space is set aside for garden tools, bicycles, and other equipment, they can be kept in good condition and more readily located when needed.

Before partitions are installed, a careful study of the requirements should be made, and a plan outlined. Then, regardless of the order in which the partitions are built, they will conform to the general scheme. The partitions may be of wallboard, lumber, brick, tile, or concrete, depending upon the wishes of the owner regarding permanence and cost.

In erecting a partition to be sheathed with wallboard or lumber, it will first be necessary to construct a framework on which to nail the sheathing. For plates and studs, 2- by 4-inch lumber is generally used, as in ordinary wall construction. If wallboard is used, the studs should be placed on 16- or 24-inch centers depending upon the width of the material. If a tight, neat, wood wall is desired, tongued-and-grooved three-quarter-inch boards may be used. If brick, concrete blocks, or hollow tile are used, the question of thickness is not important, because the wall is not a load-bearing wall. It should, however, be substantial enough to withstand considerable lateral pressure and rough usage.

3. EXTERIOR WALLS

1. MASONRY WALLS

Masonry walls may be of solid brick or stone, brick backed with structural clay tile or concrete block, or concrete block painted or stuccoed.

Dampness

Walls of masonry that have been properly designed and well constructed have proved to be strong and durable, but when they are not well built, dampness may occur and cause disintegration of the walls if faulty conditions are not corrected. Dampness usually originates from one or more of four sources: leakage of drainage water from roofs and adjoining surfaces into the walls; penetration of wind-driven rain into the walls; condensation of moisture on the inside face or within exterior walls; or capillary rise of ground water from the soil.

Leakage

Water that has penetrated the outside face of a wall may appear on the inside face far below the point of entry, making it difficult to locate the source of moisture. It is important, therefore, to check carefully all points where leakage could occur. Poorly designed or defective flashings on roofs, parapet walls, and around chimneys should be replaced when necessary (see fig. 5). Cracks in masonry units or in joints should be filled with mortar.

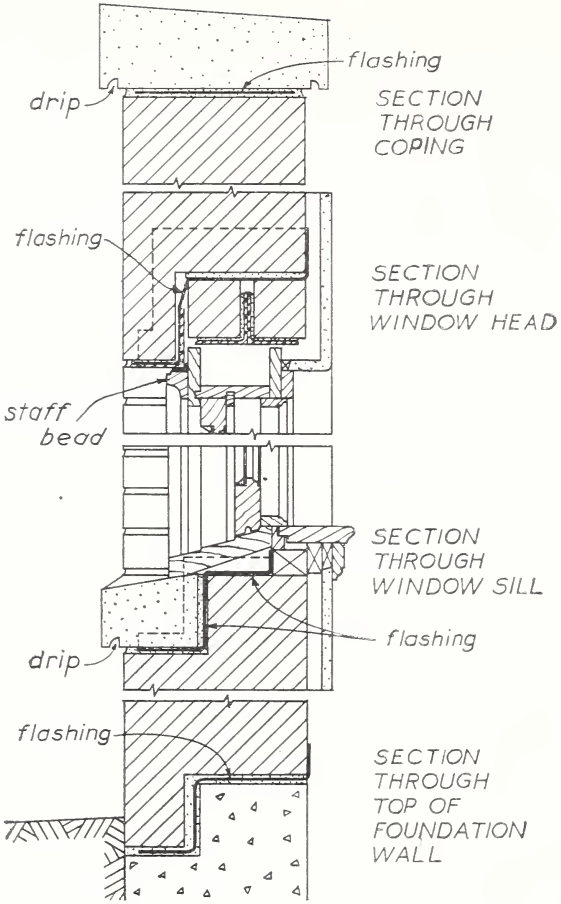


FIGURE 5.—*Typical wall sections showing through flashings.*

Rain Penetration

The possibility of rain entering exposed vertical surfaces of walls in amounts sufficient to cause dampness on interior surfaces depends upon the permeability of the wall, the wind velocity, and the intensity and duration of the rainfall.

Leaky joints that are otherwise in good structural condition may be made watertight by grouting. The grout can be made of equal parts of portland cement and fine sand with enough water to give the consistency of thick cream. The joints should be dampened immediately before the grout is applied with a stiff fiber brush. Excess grout should be removed from the surface of the brick, but care should be taken not to disturb grout which has been deposited between the brick and mor-

tar. This method of treating joints is not recommended for rough-textured brick.

Moisture Condensation

Condensation occurs on the inside face of a wall when water vapor from warm air within the house (resulting from cooking, washing, bathing, and similar sources) forms fine droplets on the windows or wall if such surfaces are colder than the dew point of the air in the room. Water vapor may pass through materials, such as wall paper, plaster, and wood, and condense within a wall.

An accumulation of moisture of this kind is often very troublesome and can be prevented by the installation of a vapor barrier placed at or near the inner or warm surface of the wall.

Vapor barriers may consist of smooth-surfaced asphalt roll roofing, asphalt-saturated and coated sheathing paper, some grades of asphalt duplex papers, and papers backed with metal foil. The effectiveness of the barrier is increased by lapping and sealing the joints. Metal foil should not be placed in contact with either plaster or masonry. There are some types of paints which can be used to provide a vapor barrier when applied to the plaster. Such paints should be applied in two or three coats and include lead-in-oil paints, an outside type of varnish, and paints containing flake-type aluminum and spar varnish.

Masonry walls may be insulated by providing an air space through the use of furring strips nailed to the wall or, if desired, the application of a layer of insulating material between the strips before surface coating is applied. If the exterior surface of a masonry wall has become badly deteriorated, a weatherproof coating, such as stucco, shingles, wallboard, or siding, may be applied over the furring strips. A new finish of plaster or wallboard applied to furring strips on the inside face of a masonry wall will make the surface warmer and prevent condensation on it. Wherever furring is installed, window and door frames and trim will have to be built out to conform to the new surface.

Rise of Ground Water

Dampness in walls above grade is not often caused by moisture rising from the ground. However, where soil drainage is inadequate and the foundation walls have not been waterproofed, a sufficient amount of moisture may be absorbed or drawn up into the walls to cause dampness to a height of 4 or 5 feet above ground level. Conditions might be improved by regrading to divert surface water away from the walls, as explained in chapter 2, section 1.

In new construction, it is considered good practice to install through flashing consisting of an impervious material, such as sheet-metal or

slate, which is inserted through the wall at a height of 5 to 10 inches above the ground as a barrier to prevent the rise of moisture.

Efflorescence

The deposit of crystallized salts on the outer surface of masonry results in efflorescence. The deposit is usually white but may take on the color of salts or impurities present in mortar, brick, stucco, or other masonry materials. The salts are dissolved by moisture in the wall; the solution of salts and water moves to the outer surface and, as the water evaporates, the salts form a deposit. Owing to the excessive amount of water in mortar and the large amount of salts in new materials, efflorescence is more often found on new masonry work. As a building becomes older, the accumulation often disappears without having to be removed. It is usually found in places where the wall is subjected to frequent wetting—below window sills and copings, near gutters and downspouts, or where there is leakage. A prolonged wet spell may also bring out efflorescence in other places.

Efflorescence may sometimes be removed by brushing the spots vigorously with a stiff fiber or wire brush. If satisfactory results are not obtained, an acid wash should be prepared composed of 1 part of muriatic acid and from 6 to 10 parts of water. In mixing the solution, pour the acid very slowly into the water. Care should be exercised in the use of muriatic acid; it is harmful to the skin and particularly to the eyes. When using, it is advisable to wear glasses and gloves. Should the acid come in contact with the skin, it can be removed by the use of large quantities of fresh water.

The spots that show efflorescence should be scrubbed well with a fiber brush dipped in the acid solution. Avoid mortar joints as much as possible during the scrubbing process and, when the work is finished, rinse the surface of the wall with clear water. It is advisable to wash the surface again with a diluted solution of ammonia (1 pint of ammonia to 2 gallons of water) to remove every trace of acid. The deposits may reappearfrom time to time and require additional washings, but will disappear entirely when the supply of soluble salts in the materials has been exhausted.

Because efflorescence is caused by the evaporation of water which has previously been absorbed, it is important that opportunities for absorption be reduced as much as possible if the trouble is to be checked. It is well to examine gutters and downspouts for leaks and to see that window sills and copings have drip grooves cut along the underside to prevent water from running down the face of the wall. If conditions are unusually bad, and it is felt that the expense is warranted, there are a number of colorless waterproofing compounds that may be applied to the surface of the wall to check absorption and and thus tend to eliminate the formation of efflorescence.

2. WOOD-FRAME WALLS

Wood-frame walls consist of studs and other structural members covered on the outside with sheathing, sheathing paper, and an exterior coating of wood siding, brick veneer, shingles, stucco, or wallboard. Such walls, when constructed with materials of good quality, should have long life if properly maintained.

Wood Siding

Wood siding includes two types: drop or rustic siding and bevel or lap siding. Usually the finish siding is applied over sheathing paper and sheathing on wood studs. However, in mild climates or where economy is desired, the finish siding is sometimes applied directly to the studs without sheathing. Where sheathing is omitted or the type of sheathing used does not add strength to the wall in resisting racking loads, the wall framing should be braced at corners and at door frames with let-in or blocked-in diagonal bracing. This bracing should extend from plate to sill and be strongly nailed at each end and at intervening studs (see fig. 6).

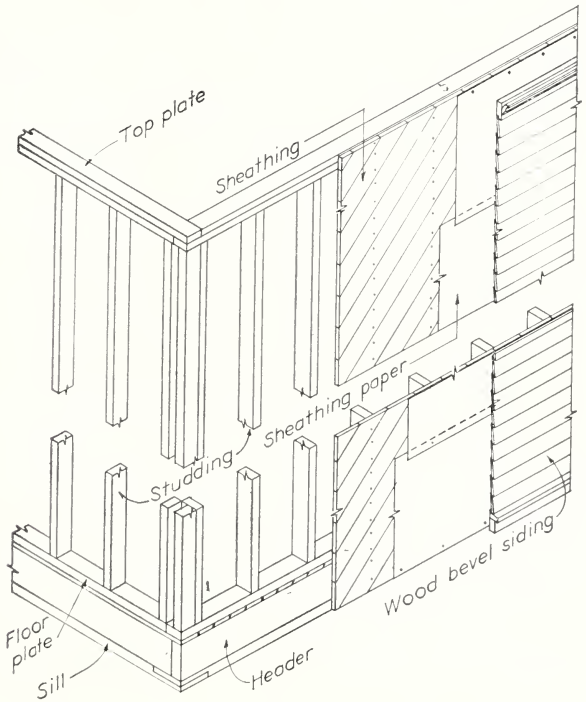


FIGURE 6.—*Typical wall section showing beveled siding.*

If the siding on a house is laid up with tight joints, the trim closely fitted, and window and door heads properly flashed to prevent water from penetrating the siding, the exterior of such a house will need little attention except repainting every 3 to 5 years. However, if water has been allowed to get behind the siding and dampen or rot the wood, the paint film is likely to blister and scale off. If siding is subject to alternate wet and dry conditions as a result of leakage, it is likely to warp, split, or decay. It is important, therefore, that all open cracks or defects which admit water into the wall and behind the siding be repaired and made watertight. Defective siding and trim should be replaced by new material applied to seal the joints, and sheet-metal flashings should be installed where required.

Brick Veneer

Brick veneer may be applied to an existing building in much the same manner as to new construction (see fig. 7). The old finish, except interior casings around doors and windows, need not be removed.

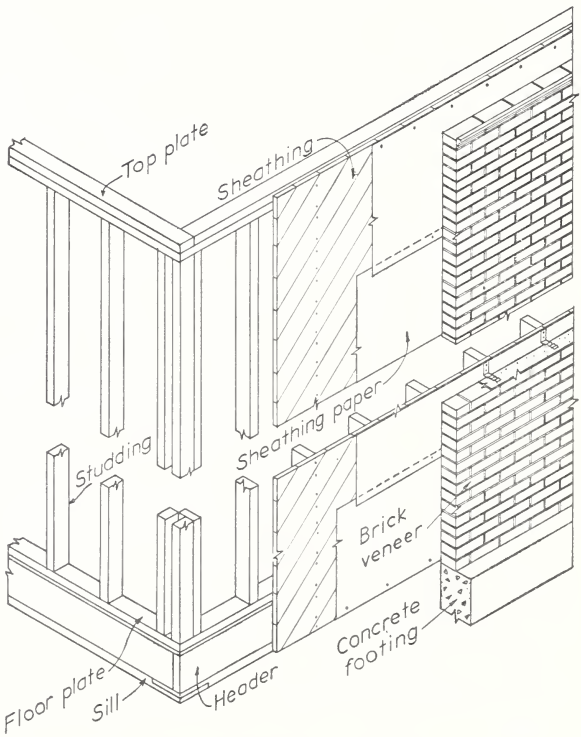


FIGURE 7.—*Typical wall section showing brick veneer.*

On old buildings, the veneer should be started on the projecting portion of the footing, or on a steel shelf angle bolted to the foundation wall, but never on an angle fastened to wood sill or framing members. The steel should be heavily coated with hot asphalt. If desired, a new 8-inch concrete footing may be placed against the outside face of the old foundation wall extending from grade level to below frost line and resting on soil having good bearing qualities.

Brickwork should be laid up to door and window frames and staff-bead molding securely nailed to the frames in the corners formed by the brickwork. Similar molding should be placed at the underside of the roof projection and other places where brickwork joins the existing finish.

If cracks develop in brick-veneer walls as a result of settlement or other causes, they should be repaired, and the infiltration of water prevented. Efflorescence should be treated as described in chapter 3, section 1.

Stucco

Portland cement stucco finishes when properly applied are durable, fire-resistant, and require little maintenance. Skilled craftsmen can produce a variety of effects in color and texture. The usual ingredients of portland cement stucco are portland cement, aggregate, water, and sometimes mineral pigments for color, and plasticity materials to provide increased workability.

The aggregate should be clean fine sand, crushed stone, or crushed slag and should be free from harmful amounts of loam, silt, soluble salts, and vegetable matter. It is important that the aggregate be well graded and have a sufficient amount of coarse particles to produce the densest possible mixture. One of the principal causes of crazing and cracking is an excessive amount of fine material in the aggregate (see fig. 8).

Refinishing Old Stucco

The color or texture of old stucco may be changed by resurfacing. If the old stucco is sound and will provide an adequate bond, one coat of new stucco may be applied directly over the existing surface. To do this, the old stucco should first be washed with clear water and then thoroughly cleaned with an acid solution of 1 part muriatic acid and 6 parts water, applied with a stiff bristle brush. After this treatment, the old surface should be thoroughly rinsed with clear water to remove all traces of the acid, allowed to dry, and moistened again just before applying the new coat.

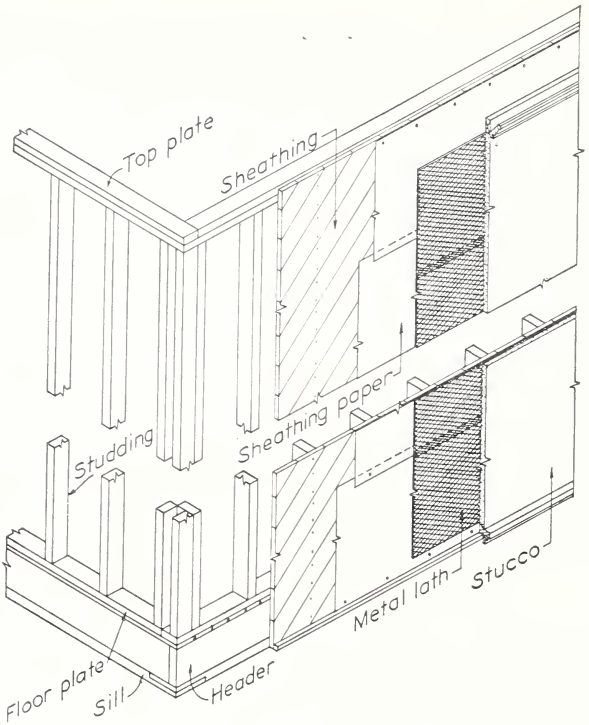


FIGURE 8.—*Typical wall section showing portland cement stucco.*

If the old stucco is unsound, it may be desirable to replace it with a new three-coat job. For this purpose, it is necessary to remove the existing stucco or cover it with waterproof paper and metal reinforcement, applied before the new stucco is put on. Reinforcement is available with paper backing attached if desired. Portland cement stucco should not be applied directly over lime, gypsum, or magnesite stucco. These surfaces should be refinished with the same kind of material as the original finish unless portland cement stucco is desired. The old material should be removed or covered with paper and reinforcement before applying the three new coats of portland cement stucco.

Cracks in Stucco

Cracks are among the most common defects found in stucco finishes. They may be merely hair cracks or they may be large enough to admit moisture which may damage the underlying structure and interior walls.

Hair cracks may develop if a stucco mixture is too rich or if the stucco material is inferior. They may also be caused by too rapid drying of

the stucco. Large cracks are usually the result of settlement of the walls of a house or movement within the walls caused by improperly constructed foundations or poorly designed framing in the superstructure.

Stucco over brick, stone, or similar materials is liable to crack, especially around chimneys, because the stucco has a different rate of expansion and contraction than the material that it covers, and a shearing stress or "crawling" effect takes place in the plane of contact between the two materials.

If cracks are unsightly and large enough to admit moisture, they should be repaired. If they are not noticeable and seem to be doing no damage, repairs may be postponed, since the plastered cracks are liable to look worse than the open cracks.

The following tools and materials are needed: A hammer, a sharp-edged and pointed instrument (such as a cold chisel or screw driver), a wire brush or whisk broom, a mixing board, a mason's trowel, and a water bucket; portland cement, clean sharp sand, hydrated lime, water, and mineral pigments for color if necessary.

Before pointing, clean out the cracks thoroughly and chip them out to the shape of an inverted V in order to key the mortar securely to the old work. The cracks should be brushed to remove all dust and loose particles, and the cleaned surface and adjoining stucco dampened before new mortar is applied, to prevent the water in the mixture from being absorbed.

In pointing, it is desirable to use the same brand of cement and the same mix proportions as the original work. If the previous mixture cannot be determined, it is usually safe to use a 1 to 3 mixture, containing 1 part cement, 3 parts sand, and one-tenth part finely divided materials, such as hydrated lime, measured by volume.

The mortar should contain just enough water to make a fairly dry mixture of about the consistency of putty. It should be applied like a calking material; that is, rammed and tamped in well to make complete contact and form a secure bond. If the cracks show up badly after pointing work is finished, it may be necessary to paint the entire surface with a cement-water paint. The new work should be kept wet for several days after it has hardened to increase the strength of the mortar. It is advisable to hang a tarpaulin or similar covering over the completed work to protect it from direct exposure to the sun and drying winds.

Cleaning Stucco

Stucco may be brightened and discolorations concealed by painting with cement-water paint. Since the cement-water paint will fill hair-line cracks, only serious defects need be pointed up. The surface

should be cleaned according to manufacturer's directions before the paint is applied. In hot, dry weather, the surface should be dampened when applying the paint. If the stucco has previously been painted with an oil-base paint, the cement-water paint will not adhere well, and an oil-base paint or a resin-emulsion paint should be used for repainting. Further information on this subject will be found in chapter 11, section 3.

Exterior Wallboard

Several kinds of wallboard are appropriate for outside application, but the types most frequently used for siding are exterior grade plywood and asbestos-cement board. The most popular size is 4 by 8 feet; it takes less labor to cover a wall with units of this size than to apply smaller units.

Wallboards are suitable for covering old as well as new outside wall surfaces. The old siding and trim may be removed or left in place, but, in either case, the surface should be covered with waterproof sheathing paper before the wallboard is applied. If the old siding is left in

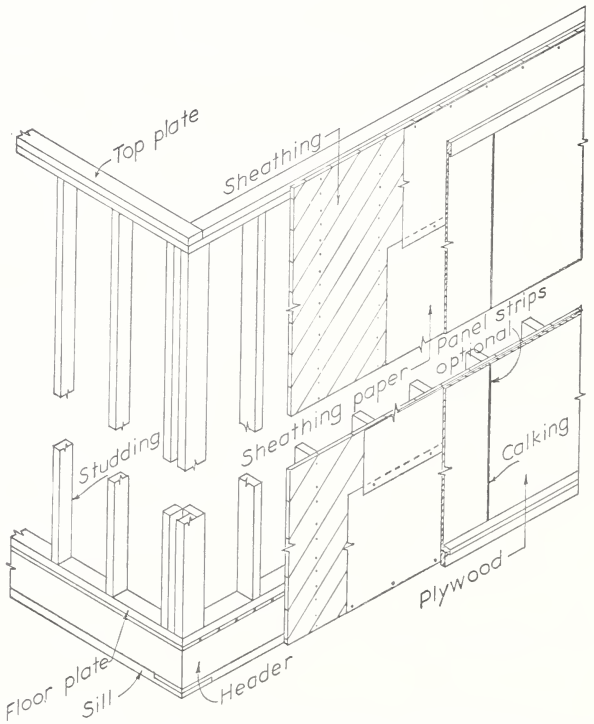


FIGURE 9.—*Typical wall section showing plywood wallboards.*

place, it may be necessary to use beveled strips of approximately the same thickness as the butts of existing siding to provide an even bearing for the new wallboard. Trim around door frames and window sills will have to be extended to meet the new finish surface. Joints between plywood or asbestos-cement panels should be made watertight by calking, and panel strips and fastenings should be sound and secure. It is usually desirable to apply a decorative finish to exterior wallboards (see fig. 9).

Exterior Plywood

Plywood for exterior use is a built-up board of laminated wood veneers in which adjoining plies are bonded together with the grain at right angles, under heavy pressure with waterproof glue. Exterior plywood may be applied over sheathing paper and nailed to the studs or applied over an existing outside wall surface. It should be protected from the weather by coating with good spar varnish or painting with outside house paint.

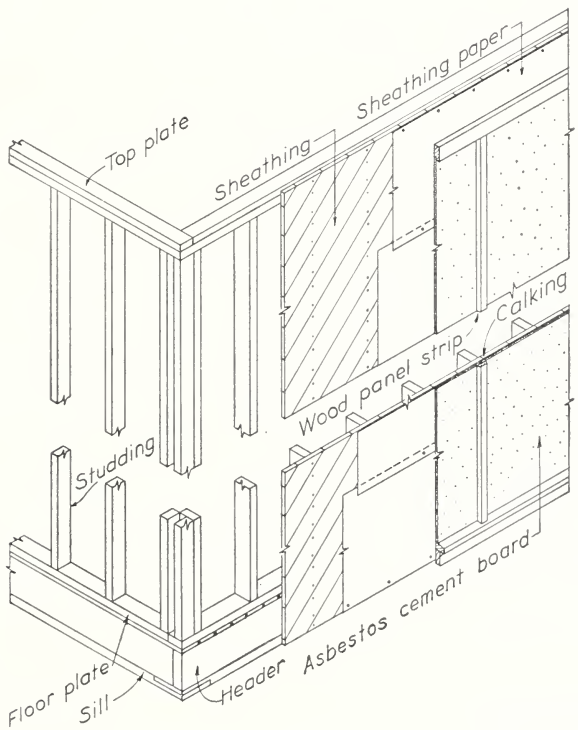


FIGURE 10.—*Typical wall section showing asbestos-cement wallboards*

Asbestos-Cement Board

Asbestos-cement board, applied the same as plywood (see fig. 10), is made of portland cement and asbestos fiber formed under high pressure to produce a hard, durable, noncombustible material. The natural color is stone gray and the exposed side of the panel has a smooth hard finish. Asbestos-cement board is not harmfully affected by water and, while new, does not require special treatment. After a time, especially in some localities, it may become streaked and spotted from soot and dust under the action of wind and rain, and such stains may be difficult to remove. To brighten, the surface should be thoroughly cleaned with water and a hard bristle brush, rinsed with clean water, and a resin-emulsion or rubber-solution paint applied if desired.

Shingles

The more commonly used types of shingles for covering exterior walls are wood shingles and asbestos-cement shingles. Either may be applied by removing the old covering material or by applying the new shingles directly to the existing surface. If the old siding or covering material and sheathing paper is removed, loose or defective sheathing boards should be renailed or replaced before new waterproof sheathing paper and shingles are applied.

If the old covering is not removed, the existing surface should be made as smooth, plumb, and true as possible. All loose siding boards or shingles should be securely nailed, and beveled wood strips of approximately the same thickness as the butts of existing siding material applied to provide a solid bearing for the new shingles. The ends of these strips should be lapped at the corners. The entire surface should be covered with new waterproof sheathing paper before laying the new shingles. New staff molding will be necessary where the application of new shingles over old siding brings the finished wall surface out beyond existing window and door frames. Adequate flashing and drips should be provided over all window and door openings as well as suitable drips under window sills.

Damaged shingles may be removed by means of a nail ripper, which consists of a flat strip of steel with a cross slot in one end and an offset at the other (illustrated in fig. 12, asbestos-cement shingles). The blade is slipped under the broken shingle and the notch hooked around the nail; the offset end is struck until the nail is either cut or drawn out; the broken shingle is then removed and replaced.

Wood Shingles

Wood shingles, if properly laid and of a durable species, will provide

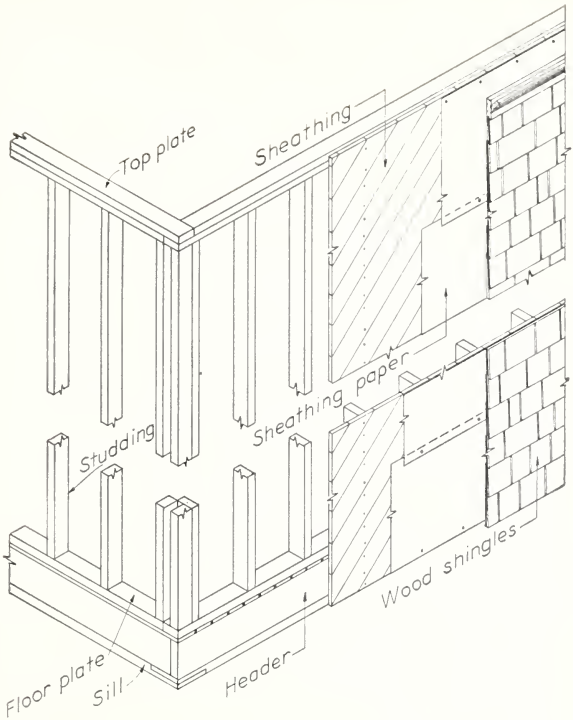


FIGURE 11.—*Typical wall section showing wood shingles.*

a satisfactory exterior wall covering with considerable insulating value. For side walls, they should be vertical or edge-grained, decay-resistant heartwood, such as Western red cedar, Tidewater red cypress, or California redwood, except where a double coursing is used. In the latter case, flat-grained shingles may be used for the under course as a matter of economy. Usual lengths of wood shingles for use on outside walls are 16, 18, and 24 inches, widths from 3 to 14 inches, and thickness, measured at the butt end, about ½ inch. For side walls, the recommended exposures vary from 6 to 11 inches for single coursing and from 8 to 16 inches for double coursing, depending upon the lengths of the shingles being applied. Wood shingles are usually stained to obtain the desired color effects (see fig. 11).

Asbestos-Cement Shingles

Asbestos-cement shingles are made of portland cement and asbestos fiber formed under high pressure; they are hard, durable, and noncom-

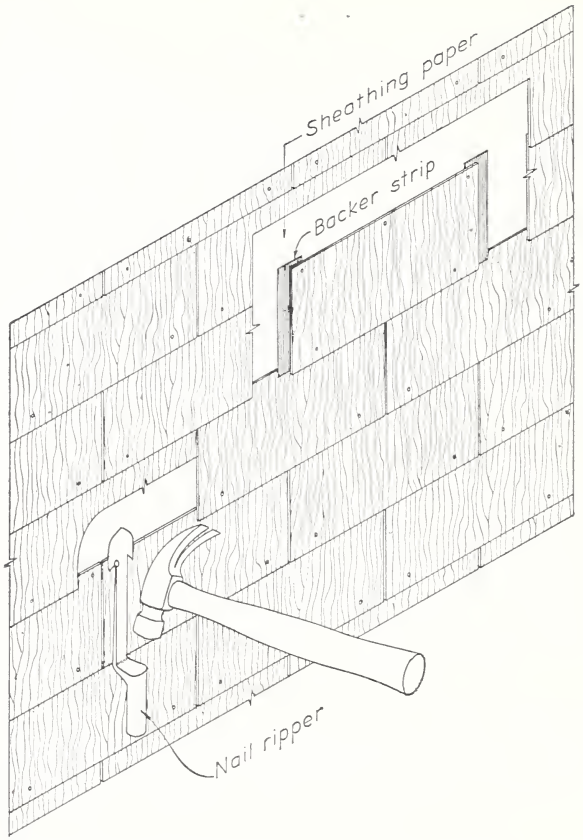


FIGURE 12.—*Asbestos-cement shingle siding showing use of nail ripper.*

bustible; and are available in various designs, colors, and textures, inincluding both uniform-thickness and tapered-butt shingles.

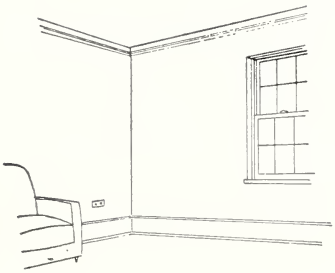
Ordinarily, asbestos-cement shingles require little maintenance. However, some shingles, especially in the lower courses, may become broken or otherwise damaged and need to be replaced. When purchasing shingles, it is advisable to obtain a few extra for this purpose, because it may be difficult later to match those which have been in service a number of years. Paint is not usually applied to asbestos-cement shingles, but a change in appearance may be accomplished by using resin-emulsion or rubber-solution paint, provided the manuacturer's directions are carefully followed (see fig. 12).

Exposed metal parts of a house, such as gutters, downspouts, screens on windows, flashings, fastenings, and electrical conduits, should be kept well painted to avoid staining wall surfaces. Dust and soot deposits may be removed from asbestos-cement shingles with soap and

water or a solution of trisodium phosphate applied with a stiff fiber brush. The wall should then be thoroughly rinsed with clear water.

Deeply embedded stains which are not readily removed by scrubbing with soap and water require special attention. Caution should be observed in using acid solutions. The use of rubber gloves is recommended, and clothing should be protected. Copper stains may be removed by a 5-percent solution of acetic acid or ordinary white vinegar applied by brush and followed by rinsing with clear water. Rust stains may be removed by a 5-percent solution of phosphoric acid or a 2-percent solution of oxalic acid, rinsing with clear water after application. Brown stains caused by contact with unpainted wood during construction may be removed by a good commercial abrasive cleaner or an oxalic acid solution.

Fresh paint spots can be removed from asbestos shingles by carefully wiping them with a cloth soaked in turpentine or other paint thinner. Dry paint spots can be scraped off with a knife and wiped with paint remover. Oil stains are difficult to remove completely. Repeated applications of a volatile solvent, such as carbon tetrachloride, will help to reduce the intensity of the stain. Asphalt and tar stains cannot be completely removed, but wiping with turpentine or other paint thinner will reduce the intensity of the stain.



4. INTERIOR WALLS

The most common types of interior finishes are plaster, wallboard, wood paneling, and wall tile.

1. PLASTER

Plaster consists of hardening material mixed with sand or other aggregates, such as vermiculite and perlite, spread evenly over a prepared base while in a soft, workable state. Plaster is noncombustible and, if made of good material properly mixed and applied to a solid base, the resulting surface should be hard and durable. Plaster may be finished in either a smooth or textured surface, to which a choice of decorative treatments may be applied. The most widely used hardening materials are slaked lime, calcined gypsum, and portland cement. Lime is added to gypsum or portland cement to make the mixture more workable and to produce a smooth finish, but gypsum and portland cement should not be mixed together. Good commercial ready-mixed plasters are also available.

Mixing Plaster

All mixing boxes and utensils should be clean, and clean water should be used in the mix. Particular care should be taken to see that no trace of hardened plaster has been left in the mixing box. Water should be placed in the mixing box, and the dry plaster sifted into the water. The mix should be stirred thoroughly to dissolve all lumps and to bring the plaster to the consistency of putty. It can then be picked up on a broad-bladed plastering trowel and forced into the crack or break in the wall.

Where only a small amount of fresh plaster is needed, plaster of paris alone may be used. Because it hardens so quickly if used without a retarder, only as much as can be put in place within 10 minutes should be mixed at one time.

The addition of small amounts of ordinary glue dissolved in the mixing water will retard the setting of the plaster. Commercial patching plasters containing retarding material are available and may be worked for a longer time than the ordinary plaster of paris. They may also contain other ingredients that improve their working qualities.

The following tools and materials are needed: A small diamond-shaped mason's trowel or broad-bladed putty knife for cracks and small holes; a plasterer's trowel and shallow pan for plastering large areas; plaster of paris or commercial patching plaster, a small amount of ordinary glue, if necessary, and clean water.

Repairing Plaster

Plaster failures are caused by movement of the house framing, resulting from shrinkage or settlement; moisture from leaks in roof, walls, or around window and door frames; and inferior material and poor workmanship. The most common failures are falling ceilings and the appearance of pitting, popping, and cracks in the surface of the plaster.

Structural Cracks

Structural cracks, caused by structural weaknesses in a building, include settlement resulting from inadequate or improperly located footings, the use of undersized or improperly spaced members, omission of bracing, or shrinkage of lumber. These cracks are usually large and well defined, extending across the surface and through the plaster. They may start near the corner of a door or window, or may appear at the corner where two walls join, or along the joints between walls and ceiling. Repair of structural cracks, that is, cracks extending through the plaster to the base, does not require refinishing of the whole surface and may be made by the unskilled workman.

To repair a deep crack, it is necessary that the crack be wide enough to allow sufficient fresh plaster to be forced into it to form a good bond with the old plaster. If the crack is not wide enough, it should be scraped with a knife blade until the opening is at least one-quarter inch across. All particles of loose sand and plaster should be brushed out, and the surface should be thoroughly wetted before the fresh plaster is applied. The plaster should then be pressed well into place and struck off flush with the surface of the main body of plaster. If the old plaster has not been thoroughly wetted, it may draw the water

out of the fresh plaster, which will not set but will dry out and remain in a chalky condition without appreciable strength. The drying-out may be avoided by spraying water onto the surface after the plaster has set and keeping the surface damp for a period of about 24 hours.

Map and Shrinkage Cracks

Inferior workmanship and the use of a poor quality of plastering materials are the main causes of what are known as "map cracks" and "shrinkage cracks" that is, shrinkage in the plaster itself.

Map cracks, less noticeable than structural cracks, are usually caused by improper bonding between the plaster and the base. They penetrate the plaster but do not extend entirely across the surface and are made up of a series of cracks that run at various angles to each other within an area of 6 square inches or more.

Shrinkage cracks resemble map cracks although the cracks themselves and the areas they enclose are much smaller than the map cracks. They do not penetrate the plaster as deeply as map cracks and usually occur in the finish coat only. In a sanded finish, shrinkage cracks are caused by allowing the plaster to dry too rapidly or by not troweling it enough. In a white finish, troweling at the wrong time often produces unsatisfactory results. If a job has not been well done, shrinkage cracks, which are usually the result of careless workmanship, are generally so numerous that it is necessary to have the whole surface refinished by an experienced plasterer.

Loose Plaster

Sometimes the keys or clinches that hold plaster to the base break off or become loosened and cause plaster to bulge and crack. On ceilings especially, plaster will often hang in this condition for a long time before falling off, being held together by fiber in the plaster. Occasionally the nails or fastenings used to hold lath in place may corrode and break, allowing that part of the plaster covering the loosened lath to sag, crack, or fall.

Loose plaster around the edges of holes should be removed, and the remaining sound plaster wetted thoroughly. The new plaster should then be applied in the same manner as for structural cracks. Because more plaster is required for holes than for cracks, it is advisable to retard the setting enough to allow the plaster to be worked.

If plaster is bulged or hanging, it is best to remove all loose plaster and apply new material. In case the lath or backing has drawn away from the joists, it will have to be refastened before new plaster is applied. If a patch is unusually large, it is generally best to employ an experienced plasterer, as this work requires so much skill that it is difficult for an amateur to make a neat-looking job.

2. INTERIOR WALLBOARDS

Wallboards for interior use are manufactured in convenient sizes for application to walls and ceilings. For remodeling, such as finishing a basement or attic, or for covering old surfaces, the most widely used wallboards are gypsum, plywood, fiberboard, and asbestos-cement board.

If the nailing faces of studs and joists are irregular and not in alinement, it may be necessary to use furring strips or shims to provide an even bearing for the new wallboard. Where furring strips are used, they should be not less than 1- by 2-inch strips, spaced not more than 16 inches apart, and nailed securely.

Where old finishes are to be covered with wallboard, the location of studs or furring strips and ceiling joists should be marked and the nails used to fasten the boards should be long enough to penetrate the studs or joists to a depth of not less than 1 inch after being driven through the new wallboard, the furring strips if used, and the old finish. Panels should be long enough to cover the full height of the wall or the entire length of the ceiling in one piece. If they are not that long, blocking of 2- by 4-inch lumber between studs or joists or cross-stripping between furring strips should be installed to provide a solid bearing under the joints.

Gypsum Wallboard

Gypsum wallboard consists of sheets of gypsum plaster covered on both sides with tough paper facing; the exposed side consists of smooth paper suitable for decorative treatment. The material is fire resistant, and the rate of expansion and contraction in the presence of moisture is very low. The board may be obtained in panels 4 feet wide, 4 to 12 feet long, and one-quarter, three-eighths, or one-half inch thick. It can be nailed and sawed in the same manner as wood or cut by scoring the surface with a sharp tool and breaking the board over a straight edge. If desired, gypsum wallboard like other interior wallboards may be used to renew the surface of old walls and ceilings without the removal of plaster, provided the existing wall or ceiling offers an even bearing surface. For this purpose, the board need be no more than one-quarter inch in thickness. Gypsum wallboard should not be used in damp locations because it will disintegrate.

Interior Plywood

Plywood for interior finish is built up of laminated wood veneers, laid with the grain of adjoining plies at right angles to each other, bonded together under heavy pressure with water-resistant glue. It is

satisfactory for inside work unless the walls are exposed to excessive moisture, as in kitchens and bathrooms where exterior-type plywood is preferable.

Sheets of plywood come in widths from 2 to 4 feet, lengths from 4 to 12 feet, and thicknesses from ⅛ to 1 inch. For interior finish on walls and ceilings, sizes should be selected which will produce the minimum number of joints. The thickness should be not less than one-quarter inch. Wall panels may be applied horizontally or vertically, but for ceilings it is desirable to apply the first panel to the middle of the ceiling and work both ways so that the panel pattern will be symmetrical. The edges of panels should overlap at the intersection of two walls and at the intersection of a wall and ceiling.

Panel edges at joints between sheets of plywood may be butted flush, vee-grooved, or covered with decorative or inset moldings. Butted joints should be filled with plastic filler and sanded down to a smooth surface. Where joints occur between studs or joists, backing strips of scrap plywood should be glued to one panel to retain the joint-filler compound. The adjoining panel can then be glued to the backing when put in place.

Taped joints are successful if carefully made. At the plywood joint an opening of about one-eighth inch is left and filled with hard-setting casein base compound. A perforated paper wall tape is imbedded in the filler compound and feathered out several inches on each side. The joint may then be sanded smooth before painting or papering.

Nails for fastening plywood are usually finishing or casing nails that are long enough to penetrate not less than 1 inch into the wood joist or stud support and should be spaced about 8 inches apart along edges of the sheet and 12 inches apart along intermediate points of support.

Plywood may be painted, papered, or, when the surface veneer is of suitable quality, stained and varnished. Plywood is painted or stained and varnished in the same manner as other interior woodwork. If papered, the plywood should be treated with wall size and covered with a lightweight felt or lining paper butted together evenly at the edges before the wallpaper is applied. Wallpaper paste should be used to secure the liner and the wallpaper to the plywood surface.

Fiberboard

The two general classes of fiberboard which may be used as interior finishes on walls and ceilings are hardboard and insulating board. They may be fastened by nails or adhesives after the surface to which they are to be applied has been properly prepared as suggested at the beginning of section 2 of this chapter. For best results, manufacturers recommend that adhesives be used to fasten the fiberboards. Nails

used to support the panels while the adhesive sets can be removed or countersunk later.

Before applying adhesives to an old wall, the surface should be washed clean, all loose paint removed, and the panel fitted to lay flat against the wall with abutting edges in contact but not tight. A waterproof adhesive similar to linoleum cement should be applied at a room temperature of 70° F or above. It should be spread over the entire back of the panel to the edges of the board with a saw-tooth trowel notched to a depth of three-sixteenths inch. Care should be taken to prevent the adhesive from squeezing through the joints onto the exposed surface of the board, because the adhesive is difficult to remove without affecting the appearance of the surface.

After the adhesive has been spread, the panel should be placed in position and the entire surface pressed and tapped until the board is firmly in place. If necessary, braces and supports should be used to hold the panel securely and should be allowed to remain until the adhesive sets.

Asbestos-Cement Board

Asbestos-cement board is made from portland cement and asbestos fiber, formed under high pressure to produce a hard, durable, noncombustible material. Panels for interior finish are made in standard width of 4 feet, lengths of 4 and 8 feet, and thicknesses of one-eighth and three-sixteenths inch. The panels have a smooth hard surface on the exposed side and may be obtained in plain or scored sheets, in their natural color of stone gray, or in colors produced by incorporating mineral pigments in the asbestos mixture at the time of manufacture, or by the application of baked-on enamel. Because they have water-resistant qualities, asbestos-cement boards are frequently used for wainscots or complete finishes in bathrooms and kitchens. For this purpose, the panels need not be more than one-eighth inch thick. They should be applied over waterproof sheathing paper and preferably fastened with waterproof adhesive.

3. WOOD PANELING

Wood paneling is frequently used for refinishing old walls and ceilings or for remodeling or finishing attics and basements. The width of paneling boards may vary from 4 to 12 inches.

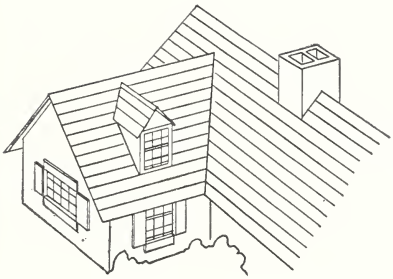
Several methods of application are possible, but usually the boards are applied vertically with either a molding edge on each board or a separate strip of molding inserted between the adjoining boards. Boards may be arranged in panel effects; they may also be all of one width or mixed with other widths to avoid monotonous regularity.

Finish or casing nails should be used to fasten boards and, if boards are not tongued and grooved, they may also be glued together at the edges.

Wood paneling may be left in its natural state and waxed, given a dull varnish treatment, stained and waxed, or painted if concealing the grain of the wood seems desirable.

4. WALL TILE

In addition to ceramic tile, other materials are available for waterproof wall finishes which have bases of hardboard, metal, plastic, or other materials coated with baked-on enamel or other hard, smooth finishes in various colors. These wall coverings, manufactured as single tile or in sheet form, are scored to represent the joints between tile. They are generally used in bathrooms or kitchens but may also be used for wall surfaces in other rooms. Instructions for preparing the wall surfaces to receive the tile and methods of application may be obtained from the manufacturer of the particular product to be installed.



5. ROOFS

The design and construction of roofs is governed to a large extent by climatic conditions, but no matter what the climate the roof structure must be watertight and as durable as possible.

There are a great many kinds and forms of roofing materials and nearly all are intended to be laid over a layer of boards or sheathing supported by roof rafters, light trusses, or joists. The sheathing usually consists of nominal 1-inch boards laid tight, but if wood shingles are to be used, the boards may be spaced a few inches apart. Other types of sheathing material are precast metal-bound gypsum boards, precast reinforced lightweight concrete plank, formed sheet-metal panels, and plywood. Fiberboards are sometimes laid over the sheathing to provide thermal insulation. The principal roofing materials are asphalt-prepared, built-up, rigid, and metal roofings, and wood shingles.

1. REPAIRS AND REROOFING

The roof is generally subjected to the hardest wear of any part of the house. Beating rains and sleet, strong winds, scorching sunshine, and alternate freezing and thawing with sliding snow and ice contribute to the wear and tear on the roof surface.

Roofings of various types may be and frequently are applied over old roofs, but it is usually advisable to remove the old roofing before applying an entirely new roof. The home owner then has the opportunity to have defective or rotted sheathing boards replaced, thus providing a smoother roof deck with opportunity for better nailing.

Actually, there is very little that the average home owner can or should do to his roof. He usually does not have the necessary equipment because it is too bulky to store between intervals of roof repair. The following details are given to provide information which will be pertinent in contracting for roofing, reroofing, or roof repairs.

Repairs

When a leak develops, it is important that repairs be made without unnecessary delay. If repairs are neglected over a long period, plaster may become cracked, loosen, eventually fall, and the framework below the leak may rot. Even small leaks will often cause discoloration of wall coverings and stains on finished floors. Although it may not be possible for the average man to apply a new roof or to do extensive repair work, he may be able to patch up leaky spots until permanent repairs can be made or until the old roof can be replaced with a new one.

It is often difficult to locate the point of leakage from a wet spot on the ceiling, especially if the underside of the roof is not easily accessible, since water may follow along the roof boards or rafters before dripping down. It is equally difficult to locate a hole from the top of the roof. However, if the attic has no ceiling, most holes may be located readily from the inside of the attic on a bright day. Even small holes will be plainly visible, and their location may be marked by pushing wires through to the roof surface.

When making repairs, one should not attempt to walk on a steep roof without a strong rope for support. Using a rope is the simplest way to insure balance when doing small patching jobs. It is advisable to wear tennis shoes or go shoeless. This will provide better footing and prevent possible damage to the roof covering. Avoid all unnecessary walking on any type of roof; unless particular care is taken, walking on a roof may cause considerable damage. This is especially true of old roofs.

In laying roofing or in making repairs, a long straight ladder or a so-called "chicken ladder" may be used to support the person making the repairs. The ladder is made by nailing 1- by 2-inch cleats about a foot apart on a 1- by 10-inch plank or similar long board. Either type of ladder may be hooked over the ridge of the roof, as shown in figure 13. Hooks for this purpose are made by nailing a strong piece of wood to each leg near the upper end of the ladder at an angle with the legs, as shown in the figure. This angle should conform as nearly as possible to the slope of the roof, and the pieces which form the hooks should be braced or stiffened by nailing short boards between them and the legs of the ladder.

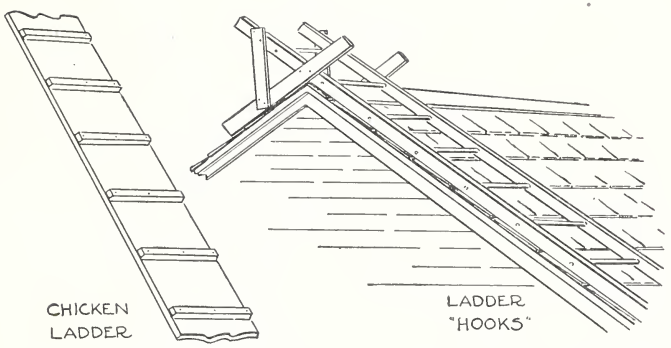


FIGURE 13.—*Two types of support used in roof repairing.*

Reroofing

The type and condition of an old roof covering may make its removal desirable, but many types of roofing can be applied directly over old wood shingles or other coverings. One of the advantages of this method is that it provides insulation, avoids removing the old material, and reduces the amount of cleaning necessary after completion of the work. In case of rain during the period of reroofing, the interior of the house is also protected.

The deterioration of nails used for roofing purposes is the principal cause of many roof failures. Nails often rust and break off, allowing the roof covering to become loose long before the material itself shows signs of wear. The use of rust-resistant roofing nails is, therefore, an important factor in preserving roof surfaces. Large-headed zinc-coated roofing nails are recommended for asphalt-prepared shingles and roll roofing. Very few nails are used for built-up roofing, but the few that are necessary should be zinc-coated. Copper or copper-clad nails should be used for slate and tile roofs, and galvanized five-penny or six-penny nails are used for fastening asbestos-cement shingles. Nails used to fasten metal roofs should be of the same or similar metal as the roofing material; that is, copper nails for copper roofs and large-headed zinc-coated nails for galvanized roofs and terneplate. For wood shingles, blued-steel nails may be used, but hot-dipped zinc-coated nails are preferable. Roofing nails come in different lengths and should be selected according to the thickness to be penetrated.

2. ASPHALT-PREPARED ROOFINGS

Asphalt-prepared roofings are manufactured in three forms: mineral-surfaced shingles, mineral-surfaced roll roofing, and smooth-surfaced roll roofing. Mineral-surfaced asphalt shingles and roll roofing are

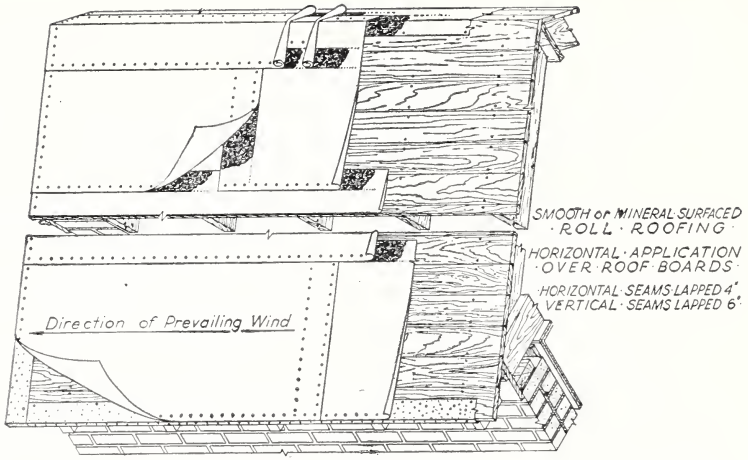


FIGURE 14.—*Asphalt roll roofing.*

composed of roofing felt, made of organic fibers saturated and coated on both sides with asphalt and surfaced with mineral granules on the side to be exposed to the weather. The other side may be dusted with mica or talc. Smooth-surfaced asphalt roll roofing is dusted on both sides with fine mineral matter such as mica, talc, or fine sand and is usually lighter in weight than mineral-surfaced roll roofing. Mineral-surfaced asphalt shingles and roll roofing are available in a variety of colors; smooth-surfaced roll roofing is usually black or gray (see fig. 14).

Mineral-Surfaced Asphalt Shingles

Mineral-surfaced asphalt shingles are made in strips of two, three, or four units or tabs joined together, as well as in the form of individual shingles. When laid, strip shingles furnish practically the same patterns as individual shingles, and both strip and individual types are available in different shapes and sizes (see fig. 15).

The principal damage to asphalt-shingle roofs is caused by the action of strong winds on shingles which have been nailed too close to the upper edge of the shingle. The tabs or individual shingles most likely to be affected by winds are those in the four or five courses near the ridge or in the area extending about 5 feet from the sloping edge or rake of the roof. To fasten the loose shingles securely, use a putty knife or trowel to place a small quantity of flashing cement under the center of each tab or shingle about 1 inch above the lower edge and press down firmly. Too much cement will prevent the tab or shingle from lying flat. Do not seal the lower edge completely.

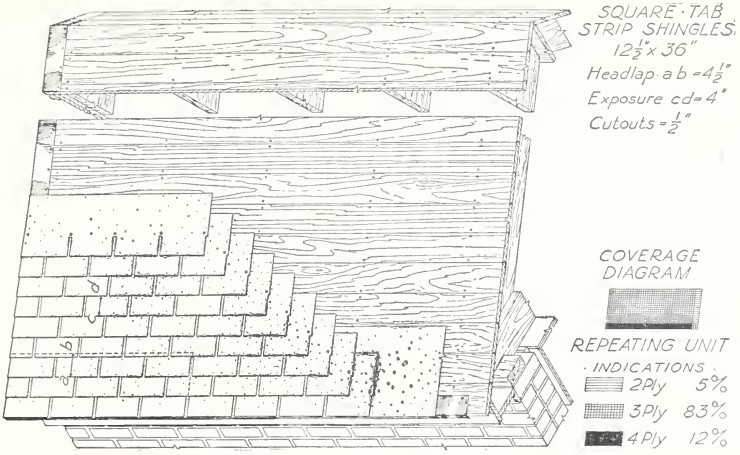


FIGURE 15.—*Asphalt square-tab strip shingles.*

Asphalt shingles are frequently applied over old wood shingles or other roofing provided the surface of the old covering is in reasonably good condition. If not, it should be removed. For a shingled roof, where the deck has not been laid solid there will be open spaces between the wood strips to which the old shingles are nailed. The exact location of these strips should be marked so that the nails used to fasten the new roofing will encounter solid wood. All defective or missing shingles should be replaced and beveled strips, ⅜ by 4 inches or the same thickness as the butts of old wood shingles, should be nailed at the base of the shingles to make the surface uniform.

Where the old covering is completely removed, the roof deck should be made smooth and solid and swept clean of all loose material, especially nails or other objects that might puncture the new roofing. If the sheathing is wood, boards should be uniform in thickness, well-seasoned, dry, free from cracks and knotholes, and securely nailed in place. Tongued-and-grooved boards are preferable, but square-cut boards are satisfactory, provided they are laid close together. Defects in the sheathing, including knotholes, should be covered with tin nailed around the edges. If the deck is not laid tight, wood strips of the same thickness as the existing sheathing should be inserted to fill in the spaces. After the roof deck has been properly conditioned, asphalt shingles should be applied in accordance with the manufacturer's directions.

Mineral-Surfaced Roll Roofings

Mineral-surfaced roll roofings are made in various colors, both solid

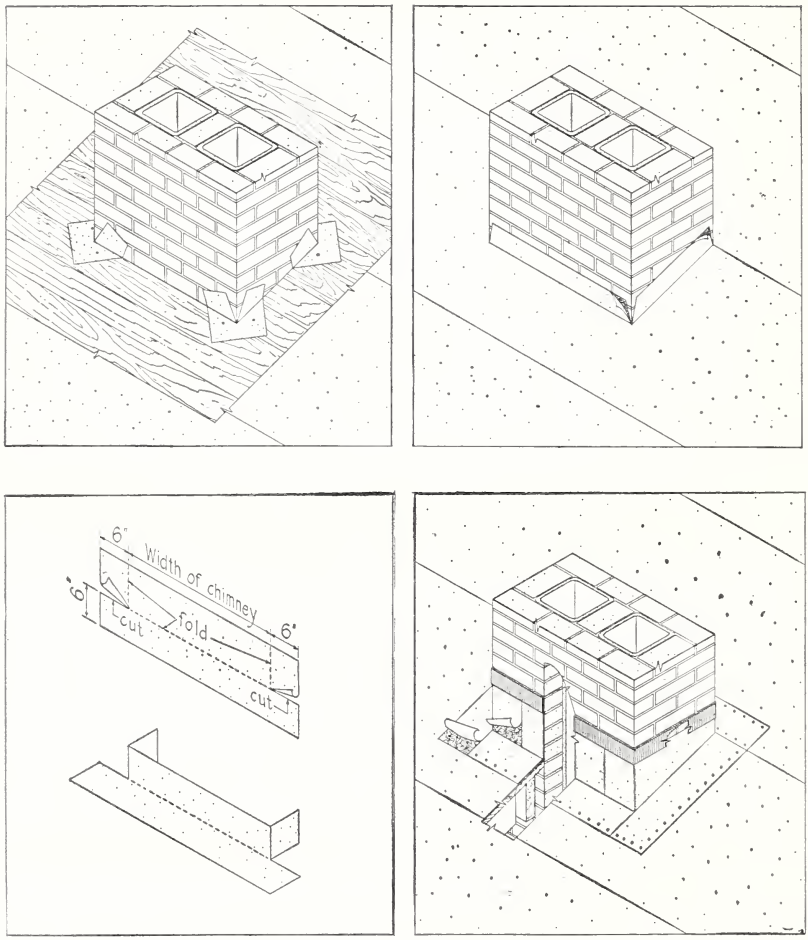


FIGURE 16.—*Asphalt roll roofing flashings.*

and blended. The mineral granules on the surface protect the asphalt coatings from the weather and increase the fire-resistant qualities of the roofings. Manufacturers' directions should be followed with respect to storing, handling, and temperatures at which roll roofings should be laid.

Minor damages to mineral-surfaced roll roofings, such as nail holes or other small breaks, may be repaired by applying flashing cement.

To repair large breaks, the horizontal seam below the break should be opened, and a strip of roofing of the type originally used slipped under it, allowing the strip to extend at least 6 inches beyond the edges of the break. The lower edge should be flush with the horizontal exposed edge. Lap cement should be applied liberally on the upper

surface of the repair strip before inserting it. After the strip has been inserted, press the edges of the roofing down firmly and nail securely. Space the nails 2 inches apart about three-fourths inch from the edge of the break. Apply lap cement to the horizontal seam and renail it.

Where a considerable area has been damaged, remove the damaged area and replace it with new roofing of the same type, using full-width sheets lapped, cemented, and nailed.

Leaks at the seams of roll roofing are caused principally by inadequate nailing and cementing of the roofing, by loose nails, and by buckling of the roofing at the seams. To repair leaky seams, first sweep out the seams to remove accumulated dust and dirt, cut all buckles which terminate at the seams, and insert a strip of roofing in the same manner as for larger breaks.

A method for flashing a chimney with asphalt roll roofing is shown in figure 16.

Roll roofings may be applied over old wood shingles or other roofing materials, provided the surface of the old covering is in reasonably good condition and the surface has been made smooth in the same manner as for mineral-surfaced asphalt shingles. If not, the worn roofing should be removed and the roof deck prepared in the same manner as for the application of asphalt shingles. Manufacturer's directions should be followed in applying the new roll roofing.

Smooth-Surfaced Roll Roofings

Smooth-surfaced roll roofings are less expensive than mineral-surfaced but do not weather as well because the asphalt coatings are not protected by mineral granules from the action of sunlight. If properly maintained, however, they should render satisfactory service. Lightweight smooth-surfaced roll roofings are used for temporary structures and as underlay materials for other roof coverings, such as slate, tile, and cement-asbestos shingles. Instruction sheets, nails, metal caps, and lap cement are furnished by the manufacturer with each roll of smooth-surfaced roll roofing.

To render the best service, smooth-surfaced roll roofings should be recoated at regular intervals with bituminous roof coating. Seams that have opened should be recemented and any small holes in the covering filled with flashing cement. Loose nails should be pulled, resulting holes sealed with flashing cement, and new nails driven where necessary.

Coating materials are usually composed of an asphaltic base and mineral filler, thinned to heavy brushing consistency with a volatile solvent. Fatty acid pitch-base coatings are also available. Manufacturers' directions on the container should be followed in the application of these bituminous coatings.

Smooth-surfaced roll roofing may be applied over other roofing materials, provided the surface of the old covering is in reasonably good condition. If not, the worn roofing should be removed, the roof deck prepared in the same manner as for asphalt shingles, and the roll roofing applied according to the manufacturer's directions.

3. BUILT-UP ROOFINGS

The application of built-up roofing is a specialized operation that requires particular experience and special equipment; it is therefore advisable to employ an experienced roofing concern to lay or repair this type of roofing.

Built-up roofings are used for roofs with a low pitch and consist of several layers of bituminous impregnated felt, lapped and cemented together with a bitumen which is usually heated. Fine gravel or slag is then spread over the top layer to provide a weathering surface. If properly applied, built-up roofings should not require major repairs or renewals for a long time (see fig. 17).

When a leak occurs in a built-up roof, flashings at parapet walls, skylights, and vents should be carefully inspected, because the initial failures usually occur at these locations. Bituminous flashings are made of saturated felt and flashing cement. Flashing cement should be

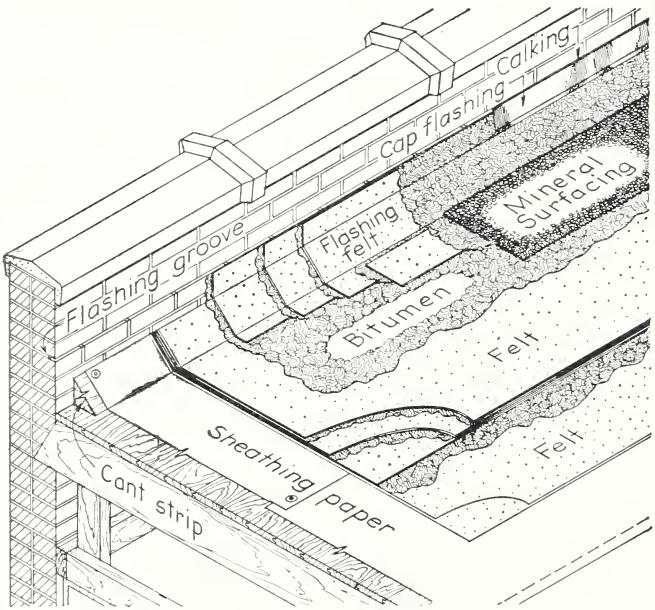


FIGURE 17.—*Built-up roofing.*

forced behind the felt if it has separated from the wall at the upper edge, and the edge sealed with a strip of bituminous-saturated cotton fabric 4 inches wide, embedded in and coated with flashing cement.

A break in the flashing should be repaired by applying saturated flashing felt in pieces extending not less than 6 inches in all directions beyond the break, cementing it to the flashing and coating it with flashing cement. Sheet-metal flashings which have a ferrous-metal base, such as zinc-coated sheet iron, should be painted with corrosion-resistant paint or, if badly weathered, replaced with new flashing.

Bare spots on a built-up roof where the mineral surfacing is not properly embedded should be swept or scraped clean, a heavy coating of hot bitumen applied, and additional gravel or slag spread over the area.

Felts which have disintegrated should be cut away and replaced with new felt of the same kind. The new felt should be mopped in place, allowing at least one additional layer of felt to extend not less than 6 inches beyond the other layers.

When necessary to resurface a built-up roof, the old roofing may be left partly in place or removed entirely. If left in place, the mineral surfacing should be scraped off and removed and the entire roof swept clean. Holes or cracks in the old roof covering should be mopped with hot bitumen and covered with roofing felt followed by another application of bitumen before the new roofing is applied. If the old roofing is to be entirely removed, the deck should be repaired and made ready for new roofing. In either case, the new roofing should be applied according to manufacturer's specifications and directions.

4. RIGID ROOFINGS

Roofing slate, clay tile, and cement-asbestos shingles are rigid roofing materials generally used on permanent buildings with pitched roofs. These materials usually give good service with very little repair.

Slate Roofings

Slate is a comparatively dense, nonporous rock used on roofs to provide a durable covering. Only responsible and experienced slate roofers should be engaged to lay or repair such a roof.

The most frequently needed repair of slate roofs is the replacement of broken slates. When such replacements are necessary, supports similar to those shown in figure 13 should be placed on the roof to distribute the weight of the roofers while they are working. Broken slates should be removed by cutting or drawing out the nails with a ripper (see fig. 12). A new slate shingle of the same color and size as the old

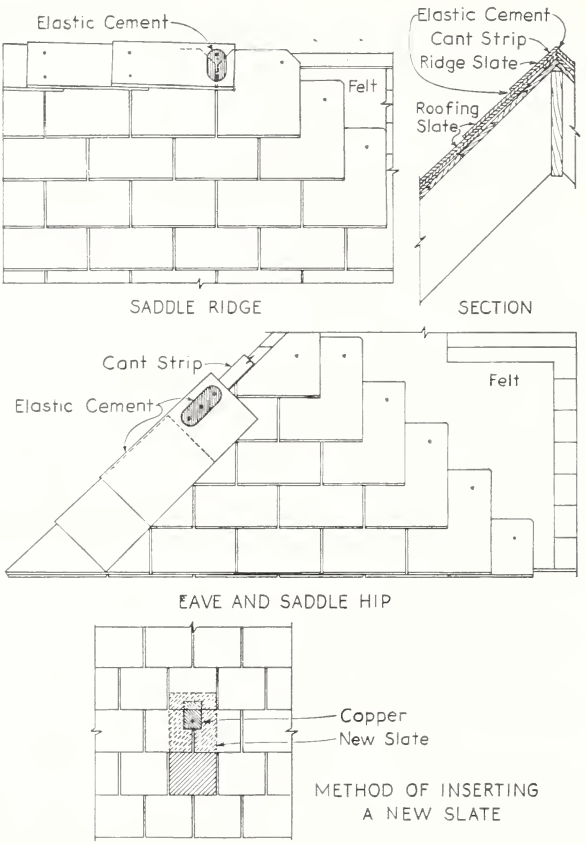


FIGURE 18.—*Slate roofing.*

should be inserted and fastened by nailing through the vertical join of the slates in the overlying course approximately 2 inches below the butt of the slate in the second course above (see figs. 18 and 19). A piece of sheet copper or terneplate about 3 by 8 inches should be inserted over the nail head to extend about 2 inches under the second course above the replaced shingle. The metal strip should be bent slightly before being inserted so that it will stay securely in place.

Very old slate roofs sometimes fail because the nails used to fasten the slates have rusted. In such cases, the entire roof covering should be removed and replaced, including the felt underlay materials. The sheathing and rafters should be examined and any broken boards replaced with new material. All loose boards should be nailed in place and, before laying the felt, the sheathing should be swept clean, protruding nails driven in, and any rough edges trimmed smooth.

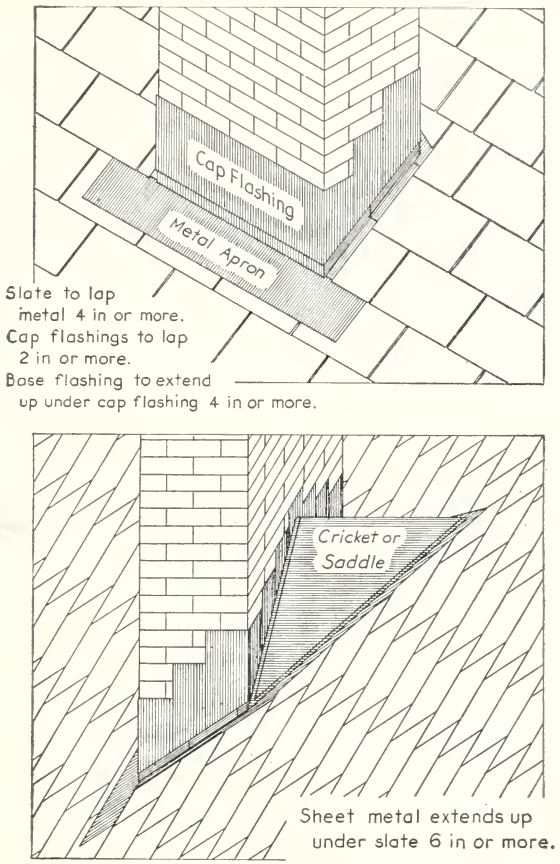


FIGURE 19.—*Typical flashing.*

Asphalt-saturated felt should then be applied horizontally over the entire roof deck, lapping the sheets not less than 6 inches and over ridges and hips not less than 12 inches. The sheets should be secured along laps and exposed edges with large-head roofing nails spaced about 6 inches apart.

If the former roof was slate, all slates that are still in good condition may be salvaged and relaid. New slates should be the same size as the old ones and should match the original slates as nearly as possible in color and texture. The area to be covered should govern the size of slates to be used, and whatever the size, the slates may be of random widths, but they should be of uniform length and punched for a head lap of not less than 3 inches. The roof slates should be laid with a 3-inch head lap and fastened with two large-head slating nails. Nails should not be driven too tightly—the opposite of the method used for

nailing wood shingles; the nail heads should barely touch the slate. All slates within 1 foot of the top and along gable rakes of the roof should be bedded in flashing cement.

Tile Roofings

The most commonly used roofing tile are manufactured products consisting of molded, hard-burned shale or mixtures of shale and clay, but metal tile are also available. When well made, clay tile are hard, fairly dense and durable, and they may be obtained in a variety of shapes and textures. Most roofing tile of clay are unglazed, although glazed tile are sometimes used (see figs. 20 and 21).

Clay tile roofings of good quality that have been properly laid require

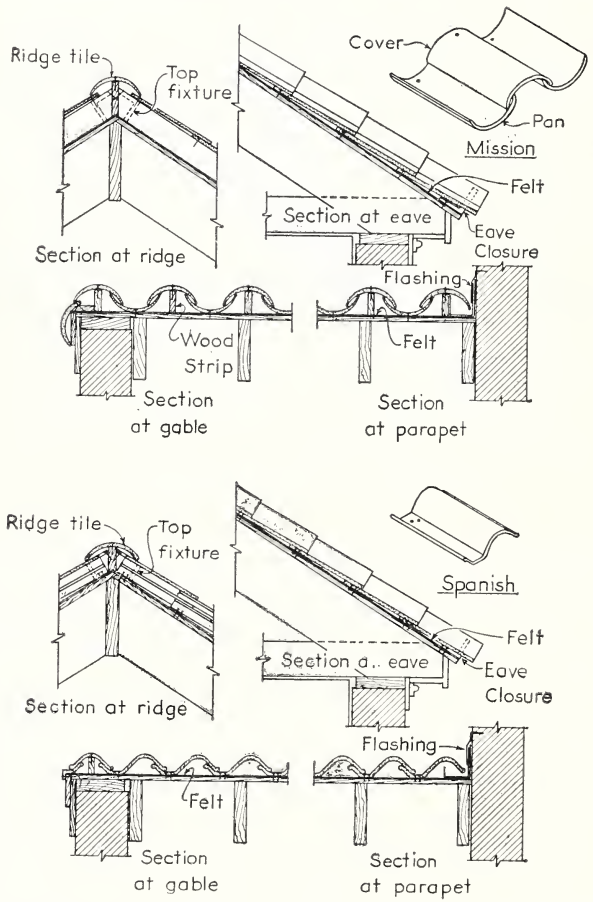


FIGURE 20.—*Typical tile roofs:* (*1*) *Two-piece pan and cover—Mission;* (*2*) *Spanish.*

very little maintenance. If a tile is broken, it should be removed with a nail ripper (see fig. 12) and replaced with a new tile set in roofing cement of the same color as the original tile. Flashings should be inspected periodically, and gutters and leader heads should be kept clean.

Clay tile may be applied over an old roof covering provided the covering is in reasonably good condition. The roof framing should be examined to determine whether or not the additional weight of the tile can be carried safely and, if not, additional framing or bracing should be added. Where the old roofing is left in place, all defective portions should be repaired and the surface made as smooth and solid as possible. If the old roof covering is too worn or damaged to provide a proper laying surface for the new tile, it should be removed and the sheathing or roof decking made smooth and solid to receive the new tile.

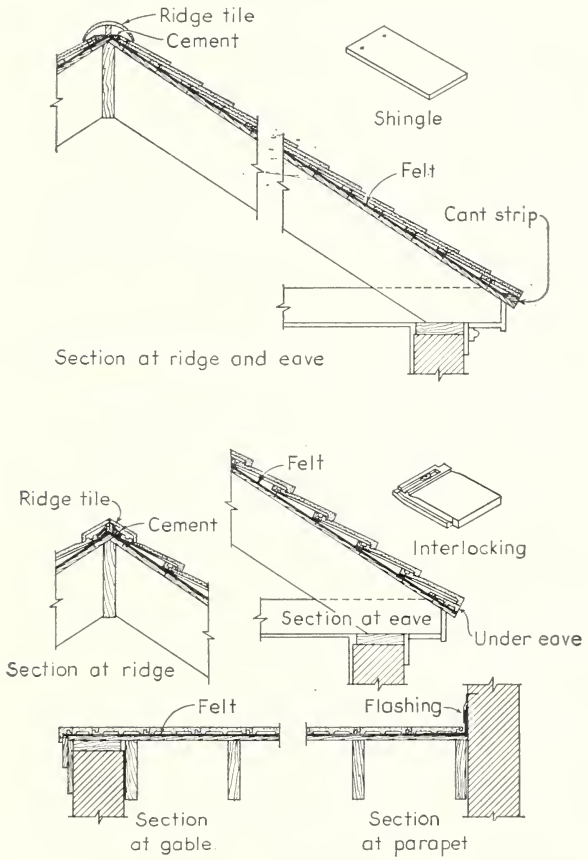


FIGURE 21.—*Typical tile roofs: (1) Flat—English shingle; (2) interlocking tile.*

Asbestos-Cement Shingles

Asbestos-cement shingles are manufactured from portland cement and asbestos fiber formed in molds under high pressure. The finished product is hard, fairly tough, and durable. Asbestos-cement shingles are available in a variety of colors and textures and may be obtained in rectangular, square, and hexagonal shape, in single or multiple units.

Asbestos-cement shingles usually require little maintenance. Occasionally, however, a shingle may become broken and need to be replaced. The broken shingle should be removed by cutting or drawing out the old nails with a ripper (see fig. 12) and a new shingle, similar in all respects to the old one, inserted. The new shingle should be fastened by nailing through the vertical joint between the shingles in

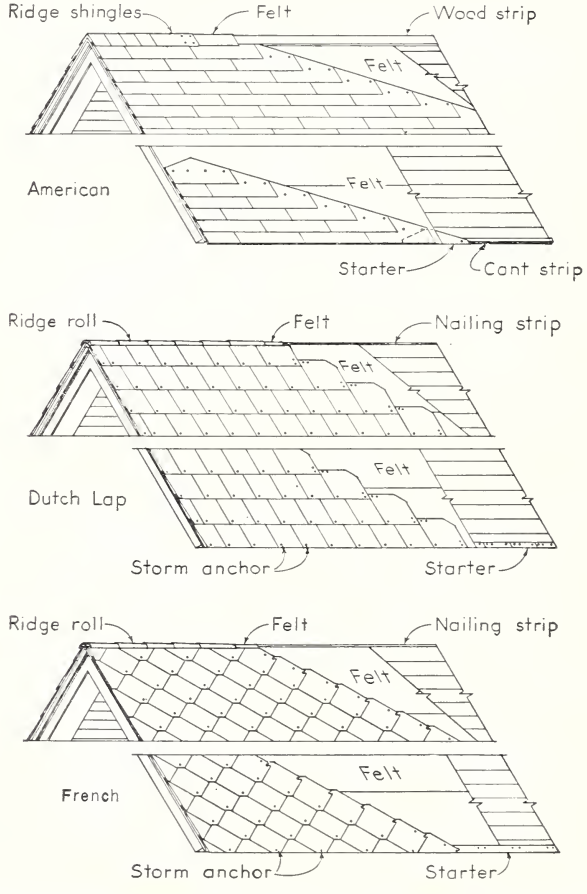


FIGURE 22.—*Asbestos-cement shingles: (1) Rectangular—American; (2) square—side lap or Dutch lap; (3) hexagonal—French.*

the overlying course approximately 2 inches below the butt end of the shingle in the second course above. A piece of sheet copper or terneplate about 3 by 8 inches should be inserted over the nail head and should extend about 2 inches under the course above. The metal should be bent slightly before being inserted to hold it firmly in place (see fig. 22).

Asbestos-cement shingles may be applied over an old roof covering provided it is in reasonably good condition. The framing should be inspected and if necessary reinforced to carry the additional weight of the new shingles with safety. Where the new roofing is to be laid over old wood shingles, loose shingles should be securely nailed, and warped, split, or decayed shingles replaced.

Usually the amount of exposure to the weather for the new shingles will not be the same as for the old and, to make the new shingles lay flat, beveled strips ⅜ by 4 inches should be applied against the butt ends of the old shingles. Wood lath laid end to end may also be used for this purpose.

If the old roofing is in poor condition, it may be more economical to remove it entirely than to make the repairs necessary to provide a sound, smooth surface for the new roofing. If the old roofing is removed, loose sheathing boards should be securely nailed and defective material replaced. If there are openings between old sheathing boards, they should be filled with new boards of the same thickness as the existing sheathing.

Sheet-Metal Roofings

Sheet metals used as roof coverings are galvanized iron, terne (tin), aluminum, copper, monel metal, and zinc. These roofing materials are comparatively light in weight and, if properly laid and grounded, will provide protection against lightning. Some metal roofings require the services of professional roofers for application; others, such as corrugated sheets, V-crimp, and pressed standing seam roofings, are not too difficult for the average home owner to apply. Full instructions for laying are usually furnished by the manufacturer, as well as information on the type of nail to be used, which should be of the same material as the roofing to avoid any "galvanic" corrosive effect.

Small holes in metal roofs may be filled with a drop of solder. Larger ones may be covered with a piece of the same metal as the existing roof and the piece soldered to it. Surfaces to be joined should be scraped clean with a sharp tool or rubbed with emery cloth until the metal is bright. An acid flux should then be applied to both the roof metal and the patching piece, and they should each be tinned with a thin coating of solder. It is best to use a large soldering iron so that sufficient heat will be transmitted to the material to cause the solder

to flow between the patching piece and the roof material. Care should be taken not to apply more solder than necessary.

If soldered seams have been broken or there are breaks in the metal at other points, it is probable that proper expansion and contraction joints have not been provided. In such cases, the only permanent repair is to install the necessary expansion joints.

Leaks sometimes develop from improper installation of the metal or failure of the nailing. Such leaks may be corrected by renailing or replacing all or part of the defective sheets. Leaks resulting from faulty joints may be repaired without replacing the metal. Soldered flat seams and joints may be resoldered. Standing seams may be reformed and calked.

Roofings of galvanized metal and terne (roofing tin) should be painted at regular intervals. The frequency of painting will vary in different locations and under different atmospheric conditions but should not be deferred until rust appears. The surface should be carefully brushed and cleaned of all foreign matter before painting, and rust should be removed as completely as possible with a wire brush. Two coats of iron-oxide paint are suitable for use on terneplate roofs, but this paint will not usually adhere well to new galvanized metal until after the metal has been exposed to the weather for a period of at least 6 months. If painting seems desirable before that time, two coats of zinc dust-zinc oxide paint should be used.

Although metal roofings may be applied over old roofs as well as to new roof decks, it is usually considered better practice to remove the old roofing. If the old roofing is removed, the deck should be repaired so that it will have a smooth, solid surface.

Before laying sheet metal over old roofing, the surface should be repaired so that the new roofing will have a smooth surface. All loose shingles should be nailed tight and warped or broken ones replaced. Many manufacturers recommend that asbestos felt be laid over the deck before roofing is applied to either old a new roofs. Resin felt and asphalt-saturated felts are also used for this purpose. Tar papers or papers which contain any trace of acid should not be used with metal roofing, since they may cause the under side of the metal to corrode.

Wood Shingles

Factors that influence the service life of wood-shingle roofs are pitch and exposure of the roof, durability of the wood in the shingles, preservative treatment of the shingles, and kind of nails used for fastening.

Wood shingles are usually edge or flat grain manufactured in lengths of 16, 18, and 24 inches and in random widths varying from 2½ to 14 inches. On roofs of quarter pitch, shingles should be laid with about

one-fourth of their length exposed and on steeper pitches with slightly more exposure, not to exceed one-third the length of the shingles.

On new roofs, wood shingles are frequently laid on open sheathing or slats to permit ventilating the under side. An open deck not only costs less but permits the shingles to dry out quickly. The slats are usually nominal 1- by 4-inch boards, spaced to accommodate the nailing of the shingles.

Hot-dipped zinc-coated nails of the proper size and shape are generally recommended for fastening wood shingles, although blued-steel nails may be used. Longer nails are required for reroofing over old coverings than for new construction.

Wood shingles that are cracked do not necessarily cause leaks unless the courses are not lined up properly, then they may admit moisture to the nail heads in the course below and contribute to the failure of the nails. To stop the leak, a piece of tin or copper may be placed under the cracked shingle. Shingles should not be face-nailed, since these nails usually work loose and the holes form potential leaks.

Wood shingles may be applied to old roofs as well as new. If the old roofing is in reasonably good condition, it need not be removed. Before applying the new shingles, all warped, split, or decayed shingles should be tightly nailed or replaced. To finish the edges of the roofing, the exposed portion of the first row of old shingles along the eaves should be cut off with a sharp hatchet or saw and a 1-inch wood strip 2 to 4 inches wide nailed in this space with the outer edge flush with the eave line, treating the edges along the gable ends in a similar manner. The level of the valleys should be raised by applying wood strips, over which new flashings should be installed (see fig. 23), and hips and ridges removed to provide a solid base for the new shingles. The new shingles should be spaced between one-eighth and one-fourth inch apart to allow for expansion in wet weather and allowed to project from one-half to three-fourths inch beyond the edge of the eaves. Each shingle

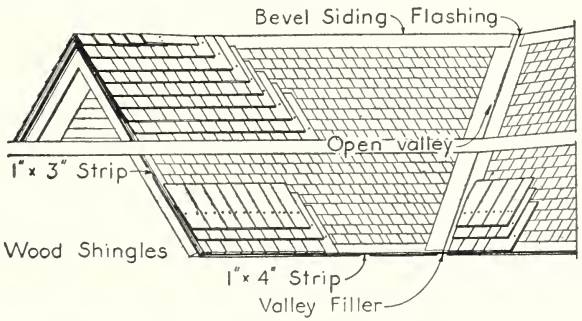


FIGURE 23.—*Wood shingles—reroofing.*

should be fastened with at least two nails placed about five-eighths inch from the edges and about 2 inches under the overlap of the course above, taking care that the nails penetrate the slats to which the original shingles are nailed. The lines of the shingles may be kept parallel to the eaves and ridge by checking the courses with a chalk line.

If it becomes necessary to remove the old roofing, the deck should be prepared in the same manner as for a new roof. New shingles should be doubled at the eaves and should project from one-half to three-quarter inch beyond the eaves. Courses should be properly alined and shingles spaced and nailed as suggested above.

5. FLASHING

By means of a lap joint, flashing may be used to make watertight the angle where a roof meets an intersecting surface. Flashing is installed at junctions between roof and walls, chimneys, skylights, and similar places, and in valleys or depressions where two planes of a roof join. Flashing around walls, chimneys, or other vertical surfaces is designed to shed water from the joint, causing it to seek lower levels; flashing in valleys is intended to conduct the water to the gutters. Corrosion-resistant flashing material should be used wherever possible.

Methods of Application

Several materials (cut in strips or pieces) such as tin or terneplate, galvanized iron, slate, sheet copper, soft lead sheets, sheet aluminum, or flashing felt are used for flashing. The methods of applying the different materials vary according to conditions, and recommendations by manufacturers of roofing materials should be followed if furnished.

There are several different methods of fastening the upper edge of flashing placed against a vertical surface, depending upon the material in the vertical surface. When placed against a brick or other masonry surface, the upper edge is usually bent and inserted into a groove or joint in the masonry, and the crack is sealed with mortar or flashing cement.

Sometimes two pieces of flashing are used in connection with masonry walls. The first is bent in the middle and the upper half is nailed to the vertical surface of the wall; the lower half is then nailed over one thickness of roofing and covered by another thickness. The second piece, known as counterflashing, is hung over the first to form an apron. It is suspended by bending the upper edge and inserting it into a joint in the vertical surface of the masonry. Since the two pieces of flashing are independent of each other, they are not likely to break if parts of the building settle or shrink.

Against stucco or other plastered walls, the upper edge of the flash-

ing may be inserted behind the lath or fastened in such a way that it will be covered by the plaster when it is applied. In frame construction, the upper edge of the flashing is generally run up behind the siding or shingles.

Where the vertical surface intersects another surface in a horizontal line, as at the face of a chimney near the eaves or at a horizontal roof line at the base of a wall, flashing is generally extended down over the top or next to the top course of roofing and nailed down after the space to be lapped has been coated with flashing cement to make a tight joint. Similarly, when a roof covered with roll roofing or other flat roofing material meets a vertical surface in a horizontal intersection, the flashing from the vertical surface usually extends down and is sealed and nailed on top of the roofing. However, where a roof meets a vertical surface in a sloping line, such as along the sides of a chimney on a sloping roof, and the roofing consists of shingles or similarly lapped material, base and cap flashing are generally employed (see fig. 19). The base and cap flashing means that, working upward on the roof, each succeeding piece of flashing extends from the vertical surface down over a shingle on the roof and is then covered by the next higher shingle course. This course is then covered by the next higher piece of flashing and so on up the slope. For an intersection where roll roofing is used, it is either turned up under the side wall material or the flashing is nailed over it, with flashing cement between to seal the joint. A method for flashing a chimney with asphalt roll roofing is shown in figure 16.

At the up-slope face of a chimney which protrudes through a sloping roof a so-called cricket or saddle is usually constructed in the roof's surface (see fig. 19). As the name "saddle" indicates, it is a small ridge formed behind the chimney to divide the water running down the roof and throw it to each side away from the chimney instead of allowing it to dam up back of it. Water accumulating back of the chimney might eventually result in leakage at that point. The joint between the chimney and cricket is also flashed.

Both open and closed valleys are used in roof construction. In an open valley the flashing is applied before the roofing is laid. The roofing material is then extended over the flashing to make a lap joint. The center portion of the flashing is visible for the entire length and the open space is usually wider at the bottom than near the ridge to accommodate the increasing volume of water as it nears the eaves. In the closed valley, the flashing is inserted by the base and cap flashing method to make an unbroken surface which is generally considered more pleasing in appearance. The flashing material in either case should be wide enough to extend under the roofing material a sufficient distance to insure good protection.

Causes of Leakage

Occasionally metal wall flashing may warp and be drawn out of the groove or joint in the vertical surface or, when roll roofing is used, it may break at its junction with the vertical surface, allowing water to run down behind it. The force of the wind may tear flashing loose from the face of the roofing and water will enter during heavy rains. Valley flashings, if too narrow, may allow backed-up water to find its way under the roofing. This seeping sometimes occurs when the valleys are dammed up with snow and ice. Flashing material in valleys may corrode or break, causing cracks or holes through which water may enter and drip through the joint below.

To Make Repairs

The approximate location of leaks in flashing may often be determined by looking for wet spots on the walls or ceiling of the house. Carefully examine the flashing above and near such spots to ascertain the exact location and cause of leakage if possible. If the leak is near a chimney or below the junction between the roof and a vertical wall or similar surface, the flashing should be inspected to see whether it has become loosened. It may be found that the flashing needs replacing or that the mortar has fallen out and needs repointing. Flashing cement and similar compounds are useful and effective in sealing cracks around flashing.

If the flashing that extends over the top of roofing—as at the base of a vertical surface—becomes loosened, it should be nailed down after the underside of the lap has been well coated with flashing cement. The flashing cement serves to seal the spaces around nails and the cracks along the edges which otherwise might allow leakage. It is also best to use short nails in order to avoid penetration of roof boards.

When exposed metal flashing shows signs of rusting, it should be cleaned with a wire brush and painted with a good metal paint to preserve it from further corrosion. This paint coat should be examined at regular intervals and renewed when it shows signs of wear.

To make valley flashing watertight, it is advisable to cover the portion to be overlapped with flashing cement immediately before applying the roof covering. This should seal the space between the flashing and roof and prevent water from backing up over the edge of the flashing.

If the flashing in a valley is too narrow or if it is corroded or broken, it will probably be necessary to replace it with new pieces of metal. This is not difficult in an open valley but is rather troublesome in a closed one.

In a closed valley covered with shingles, it is quite difficult to repair

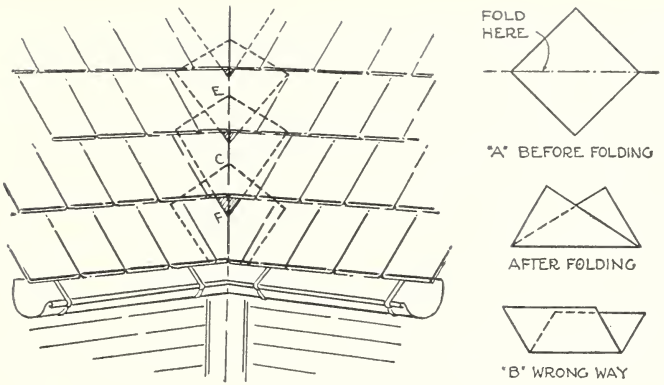


FIGURE 24.—*Method of repairing valley flashing.*

leaks in the flashing unless the metal pushed under the shingles to cover the leaky spots is folded into a wedge-shaped point (see fig. 24). Folding makes it easier to push the sheets past obstacles such as nails. If nails interfere too much, they can be cut off under the shingle or pulled with a sharp cold chisel or nail ripper and later replaced with new nails (see fig. 12). The size of the sheets to be used for flashing depends upon the pitch of the roof and the exposure of the shingles to the weather.

Insert piece *A* (see fig. 24) under top layer of first course of shingles at the eaves and over the top of the old flashing and slide it up until the upper point of the sheet is at least 2 inches above the butts of the second course of shingles shown dotted at *C*. Then insert another sheet under the second course of shingles pushing it up on top of the old flashing until upper point is at *E*. The lower point of this piece will show below the butts of the second course of shingles, as at *F*. Continue this process until the top of the valley has been reached or until all broken flashings have been covered. If good material is used, this method makes a permanent repair and covers the cracks or holes that have rusted out in the angle of the original flashing.

6. GUTTERS AND DOWNSPOUTS

Gutters and downspouts require attention from time to time to keep them in good condition.

Keeping Gutters Clean

Difficulty may arise from the accumulation of leaves, rubbish, and birds' nests in gutters. Such debris, if not promptly removed, may stop up the opening to the downspout and cause water to back up and flow over the edge. This overflow may cause considerable damage if

the gutters are built into the cornice, for water can find its way down inside the walls of the house. Unsightly streaks and stains on the exterior wall surfaces may also result if the overflow is not stopped. To prevent leaves and other refuse from being washed into the downspout, it is advisable to place a wire basketlike strainer over the gutter outlet. Strainers are usually kept in stock by hardware dealers and are inexpensive. Even when there is no stoppage or overflow, it is advisable to keep gutters clean, because rotting leaves will eventually cause the metal to corrode and leak if allowed to remain. Fine ash and dirt should be removed regularly, as cinders in contact with metal will set up a corrosive action. When dirt of this kind is removed, the gutter should be flushed with clean water to remove all traces of acid.

These conditions may be avoided if the householder will remember to clean out the gutters regularly, especially in the autumn after the leaves have fallen.

It is also advisable to remove unusually heavy snow and ice from gutters to aid roof drainage and prevent damage to gutters or their fastenings by the excessive weight of such masses. The life of gutters and downspouts may be extended considerably by painting them occasionally with good metal paint.

Repairing Metal Gutters

Metal gutters may be half-round or shaped like a cornice but repairs are similar for both types. To correct a buckle or fold in the metal it may be necessary to remove the gutter. The creases can then be hammered out with a soft-faced hammer and a block of wood shaped like the gutter. The hammer head should be of wood, fiber, or plastic to keep from marring the surface of the gutter.

Small holes may be repaired with a drop of solder and large ones patched with a piece of sheet metal of the same kind as the gutter. The metal must have a clean bright finish or the solder will not adhere. A temporary patch may be made with a piece of roofing felt or cotton duck fastened with flashing cement. The patching material should be thoroughly clean and dry, and both sides of the patch should be given a liberal but even coating of cement.

Repairing Wood Gutters

If a one-piece molded wood gutter has sagged, it should be forced back into place with a heavy hammer and block of wood and renailed in the proper position. Nails should be set, holes puttied, and unpainted spots touched up. The trough may then be treated with linseed oil or given a coat of asphalt paint.

If there is a split in a wood gutter, it can be repaired by patching with sheet metal. Coated iron, copper, or aluminum sheets can be used. Galvanized iron nails should be used for iron sheets, copper nails for copper sheets, and aluminum nails for aluminum sheets.

The metal should be shaped to fit the gutter and should be wide enough to cover the inside surface of the gutter and the tops of both edges. The area to be patched should be thoroughly cleaned, painted with asphalt paint, and covered with a layer of flashing cement, applied with a putty knife. The metal patch should then be pressed into the cement, nailed at intervals of 1½ inches along all edges, and another coat of cement applied to seal the edges, cover the nail holes, and protect the metal. If patches are over 10 inches in length, additional lines of nails should be used, spaced about 8 inches between lines.

The lining of box- or trough-type gutters, that is, wood lined with metal, should be examined for cracking. When ice forms in a gutter trough which is deep and narrow, it may expand and force the wall of the trough to loosen or break and the metal to split. For this reason, shallow and wide box gutters are advisable since they permit ice to expand over the edge of the gutter without injuring the box. Box-type gutters should be lined with rustproof metal. If other metal is used, the inside of the gutter should be swabbed with bituminous material or painted with metal paint..

Repairing Gutter Hangers

Metal gutters are attached to the eaves by means of straps of sheet metal, long spikes, twisted wire rope, or adjustable and nonadjustable metal brackets similar to those illustrated in figure 25. These hangers may break or pull loose from their fastenings, permitting the gutter to sag and prevent proper drainage. If this occurs, broken straps or hangers should be replaced and adjusted so that the gutter will slope downward with a uniform grade to the outlet end. If supports are too far apart, it may be necessary to install additional hangers to insure a uniform slope for the gutter.

Leaders or Downspouts

Leaders require less attention than gutters, but a certain amount of upkeep is necessary. Slush working down into pipe elbows may freeze, forcing seams and folds to open and allow water to leak through or drip. A leak is more common where leaders are not corrugated to allow for expansion. When a leak starts it should be checked promptly; otherwise the defect may increase until the whole elbow is broken. Recurrent freezing and thawing of a metal leader tube that fills with

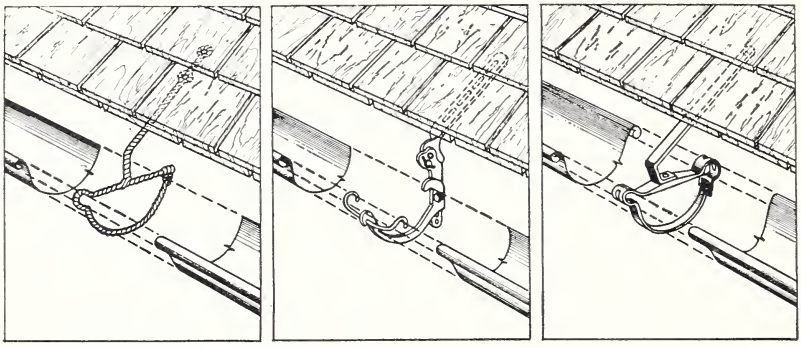


FIGURE 25.—*Typical gutter hangers.*

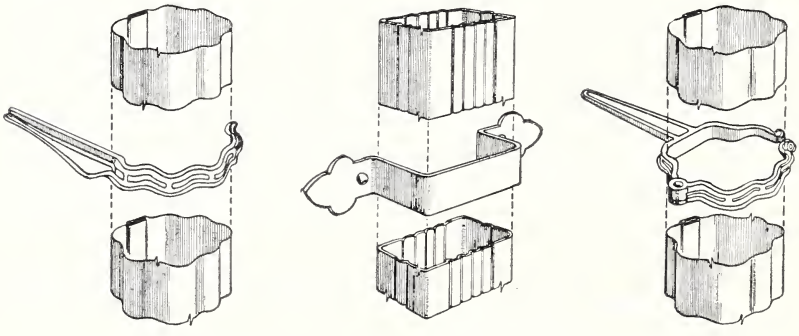
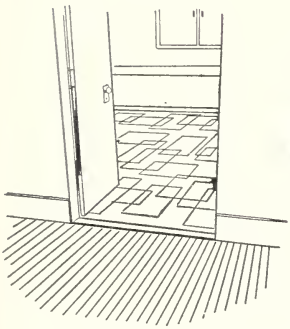


FIGURE 26.—*Typical downspout fasteners.*

water because of stoppage may cause it to split. Small splits or bulges can be pressed back into shape and soldered. However, if a downspout is badly broken or rusted, it may be necessary to replace the entire section. The method of removal will depend upon the type of fastening used, some of which are illustrated in figure 26. The leader pipe comes in sections which fit into each other. To insert a length of pipe, the upper section should be slipped into the lower so that water will flow on the inside and not leak out. To make the installation more secure the sections should be soldered together at the joints.



6. FLOORS AND FLOOR COVERINGS

The two most common types of floor constructions used in residences are wood and concrete, finished or covered in various ways. Repair of floors is discussed in this chapter; surface treatments for floors are described in chapter 11, section 4.

1. WOOD FLOORS

Wood floors on joists usually consist of a subfloor, building paper and a finish flooring of hard or soft wood. In some cases, however, one layer of finish flooring may be applied directly to the joists without subflooring. In the course of time, wood floors may sag or develop cracks, and floor boards may become loose and creak when walked on. Floors may sag if the joists are too light for the length of span; sagging may also occur if there is shrinkage in the wood girder that supports the ends of the floor joists or if there is settlement in the footings or foundations upon which the posts supporting the girder rest.

The amount of sag in joists can be determined by stretching a chalk line or string taut across the floor at right angles to the joists and tacking it to the surface of the floor on opposite sides of the room. If there is access to the space beneath the floor, such as a basement or excavated area, this sag can be corrected by the use of adjustable steel posts which operate as a screw jack to raise the sag in the joists until the surface of the finished floor is in line with the taut string (see fig. 27). These jack posts may be obtained from mail-order houses or hardware

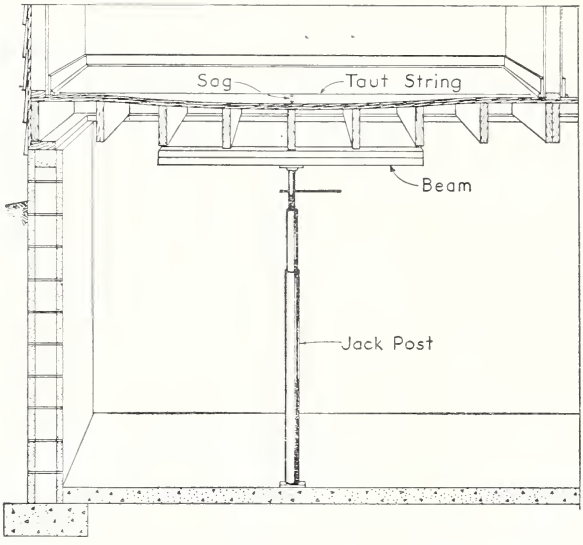


FIGURE 27.—*To level sagging floors.*

dealers at reasonable cost. One or more may be necessary. The bottom of each post should rest on a firm bearing such as the concrete floor in a basement or a concrete or masonry pedestal or base built on the ground in an excavated area. A stout plank or beam of sufficient strength to carry the load and support the sagging joists should be placed on top of each post at right angles to the joists. The steel post may be left in place permanently or may be used as a tool in installing a wood post. If a steel post is left in place, it should be located under the center of the sag. On the other hand, if a wood post is preferred as a permanent installation, the steel post or jack should be placed far enough off center to allow space for the wood post to be inserted. After the wood post has been installed and made secure with hardwood shims or wedges between the top of the post and the bottom of the beam, the steel post can be removed.

The amount of sag in the floor, caused by shrinkage in wood girders or the settlement of the posts that support them, can be determined with a string, carpenter's level, and rule by tacking one end of the string to the surface of the floor at an outside wall in a first-floor room and stretching it taut and level to a point above the girder where the settlement appears to be greatest. At this point, the distance from string to floor can be measured to indicate the exact amount of settlement. To eliminate the sag, the girder can be raised with the steel jack post (described above) placed underneath and close to the supporting post by jacking up the girder until the floor is level. This steel post may be left in place permanently or merely used as a tool to

raise the girder and insert shims. These shims or wedges may be either hardwood or metal placed between the top of the original post and the bottom of the girder. The steel post can then be removed.

Cracks in new floors are usually the result of shrinkage in floor boards which have not been properly seasoned or which have been exposed to excessive moisture before or during construction. Although it will not entirely conceal them, the cracks may be sealed with a filler which will set up hard and be durable.

Creaking Floors

Floors may creak when walked on for several reasons: If floor boards have not been properly laid, if they have not been properly nailed, if the floor boards or floor joists have become warped, or if the floor construction as a whole is faulty. Other causes for creaking floors are shrinkage and warping that results from the finish floor or the subfloor being damp when laid, warping that results from the finish floor being laid in the same direction as the subfloor, and warping that results from the finish floor being nailed directly to the joists, omitting the subfloor.

If the basement has no ceiling, the location and direction of joists under the first floor and whether the floor is single or double may be readily determined. In the case of the second-story floor, however, it is more difficult to be sure whether a floor is single or double. If the finished flooring on the second floor runs in the same direction as that on the first floor, it may be assumed that the same type of construction has been used for both floors.

The following tools and materials are needed: hammer, nail set, and block of wood; small quantities of threepenny wire-finishing nails for $\frac{3}{8}$-inch dressed and matched hardwood flooring, eightpenny cut flooring nails for $1\frac{3}{16}$- and 1-inch common flooring, and tenpenny cut flooring nails for $1\frac{1}{16}$-inch flooring.

The bridging of floor joists should be examined where exposed and strengthened or nailed securely at the points where creaking is evident. Floor boards that have become slightly raised from the joists may be forced back into position by laying a thick covering of old carpet or several thicknesses of paper over the raised portion of the floor to protect the finish, placing a block of wood on top of the covering, and striking the block with a heavy hammer to drive the flooring back into place. If this does not produce the desired results, a few nails may be driven around the loose area to draw the boards down tight. Resin-coated finishing or casing nails long enough to penetrate the subflooring and supporting joists should be used. Care should be taken not to bend the nails and, when the heads are within a quarter of an inch of the floor, a nail set should be used to drive the heads below the surface to prevent

marring the floor with the hammer. The nail holes should then be filled with putty or wood filler and finished like the floor. If the top surface of the joists will not hold nails securely, it may be necessary to fasten blocking to the sides of the joists and drive the floor nails into the blocking.

If the methods described are not successful on the first floor, it may be supported and the creaking eliminated by driving a thin strip of wood between the bottom of the flooring and the top of the joists. Another method to stop creaking is to nail a cleat of wood to the side of the joists high enough to support the flooring. In extreme cases, it may be necessary to remove some of the finish flooring, nail the subflooring securely to the joists, and replace the finish flooring.

2. CONCRETE FLOORS

Concrete floors are usually finished with a smooth surface and ordinarily require little maintenance. If a concrete floor becomes cracked or the surface spalls, little can be done except to refinish the floor with new material. A new concrete finish should be not less than 2 nches thick, reinforced with wire mesh.

The surface of old concrete may be hardened somewhat to reduce dusting, although in the construction of a concrete floor hardening treatments are not a substitute for poor materials and shoddy workmanship. A solution that may be used to reduce dusting consists of two pounds of magnesium fluosilicate dissolved in one gallon of water, applied liberally in two coats with an interval of 24 hours between applications. If the surface is not hardened by this treatment, it may be necessary to paint the floor.

If colored pigments have been mixed in the concrete topping at time of laying, the surface may be treated with a penetrating varnish seal and a bright clean luster maintained by applying floor wax at intervals. Floor dyes or stains for concrete that will penetrate the surface to some extent are also available. They should be applied with a bristle brush, using a scrubbing motion. After these stains have been applied, the surface finish can be maintained with colored wax. The wax should be buffed with a floor polishing machine.

Two types of finishes may be used on concrete floors: enamels that have a varnish base, and rubber-base paints. Where the concrete floor is dry and does not rest on the ground, concrete floor enamels with a varnish base will give good service. Where the concrete floor rests on the ground and may be subject to dampness, rubber-base paints should be used. The floor must be clean and dry when either paint is applied. Paint films should be protected by floor wax.

3. FLOOR COVERINGS

Both wood and concrete floors may be covered with linoleum, asphalt tile, cork tile, and similar materials. Such coverings should be installed by skilled workmen and maintained in accordance with the manufacturer's instructions which usually include thorough cleaning and the application of protective wax coatings. Available in an almost limitless range of colors they will serve as a starting point for remodeling or changing the color scheme of a room.

Linoleum

Linoleum, whether for floor coverings, kitchen counter tops, walls, or other inside surfaces, will stay attractive longer and wear better if waxed and polished. A few simple rules for its care will be found useful: (1) dust daily; (2) use water sparingly; (3) clean with special linoleum cleaner, mild soapsuds, or mild detergent solution; (4) apply wax in a thin, even film; (5) rewax only as needed, usually not oftener than once a month; and (6) never use harsh abrasives other than fine steel wool to take off spots that are hard to remove.

No matter what type of wax is used, always start with a clean surface before waxing. There are some excellent linoleum cleaners which may be diluted with water in accordance with the manufacturer's directions. In using them, clean only a few square feet at a time, going over that area with a fresh cloth wrung out with clear lukewarm water and permit the surface to dry thoroughly and the wax to spread evenly.

Waxes that protect linoleum are essentially of two types: paste and liquid waxes with a volatile-solvent base, and self-polishing waxes with a water-emulsion base. They should be applied in very thin coats to avoid making the floor slippery.

Volatile-solvent waxes may be obtained in either paste or liquid form. The liquid is somewhat easier to apply than the paste because of the large proportion of solvent. Both paste and liquid are suitable for linoleum as well as for wood or concrete floors.

Paste wax should be applied with a slightly dampened soft cloth or with a wax applicator and allowed to dry, after which it should be polished to a lustrous finish. Liquid wax should be spread evenly over the cleaned surface with a lamb's wool applicator using straight parallel strokes. After drying for 30 minutes, it should be polished to a lustrous finish. Waxes of the organic-solvent type must not be used on asphalt tile because they soften and mar the surface of the tile. Self-polishing or water-emulsion base waxes will give a protective coating if used on linoleum, rubber tile, cork, asphalt tile, mastic, and other floorings. The wax should be spread as thinly and evenly as

possible with a lamb's wool applicator or soft cloth mop, using straight parallel strokes. If properly applied it should dry to a hard lustrous film in less than 30 minutes. Although not required, the gloss may be increased by a slight buffing after the wax has become thoroughly dry.

A weighted floor brush or electric polishing machine does an excellent job with little effort. If a polisher is not part of the household equipment, it may be rented in many communities at nominal cost by the hour or the day. For a very hard surface, the linoleum should be given two or three coats of wax, making sure to let each coat dry for at least 30 minutes before polishing.

Care should be taken not to flood linoleum surfaces with water, since any water that seeps through the edges of seams will affect the cementing material and cause the backing to mildew or rot and edges of the the linoleum to become loose and curled. Wiping up water as soon as it is spilled on waxed linoleum will keep light spots from appearing. Grease and other spots should be cleaned as quickly as possible, using a soft cloth or sponge wrung out of lukewarm mild soapsuds or mild detergent solution. Rinse by using a clean cloth wrung out of clear lukewarm water. Floor oils and sweeping compound containing oil should not be used on linoleum, because these materials may leave a film of oil on the surface to collect dust and dirt.

Asphalt Tile and Mastic Flooring

Asphalt tile or mastic flooring may be used to cover both new and old concrete or wood floors and may be obtained in colors suitable for any room in the house. Impervious to water, they are especially suitable for floors on which water is likely to be spilled, such as kitchens, laundries, and bathrooms; they also prove attractive and satisfactory for basement recreation rooms and enclosed porches.

It is usually advisable to have the initial installation made by experienced workmen, as they have the necessary equipment to do the work. When having tile installed, always obtain a few extra tile for replacement or testing, because it may be difficult to match them exactly later on. Missing tiles or those that have become broken or marred should be replaced by cementing them into place.

Floor tile or mastic floor covering of the asphalt type have asphalt, bitumen, or resin as their base and will give excellent service if they are given proper care. There are some "do's" and "don'ts" which are very important. Cleaners and polishes containing abrasives, oils, or organic solvents, such as gasoline, turpentine, or carbon tetrachloride, should not be used to clean asphalt-base coverings. Never use unknown cleaning preparations on asphalt tile without testing them first, unless they are recommended by the manufacturer of the flooring.

To test a cleaning or polishing preparation for use on asphalt tile, moisten a white cloth with the preparation and rub over the surface of a spare tile. If the color of the tile shows on the cloth, the preparation has acted as a solvent, dissolving the surface of the tile, and is not safe to use.

Asphalt tile floors may be washed with neutral soap and soft lukewarm water in much the same manner as linoleum, except that water will not harm the tile unless permitted to stand and seep under edges enough to loosen them from the floor. After cleaning and drying, the care of asphalt tile floors is similar to that recommended for linoleum with one very important exception: Never use paste wax or liquid wax that has a solvent base on asphalt tile—these waxes will soften the tile and mar the surface.

Water-emulsion or self-polishing waxes that are free from oils are suitable and safe for asphalt tile. They should be spread as thinly as possible on the surface of the floor with a lamb's wool applicator, using straight parallel strokes in one direction only. In a short time, approximately 30 minutes, the wax should dry to a hard lustrous finish. While these waxes are self-polishing to a degree, the appearance of the floor will be improved by a light buffing. Before polishing, however, the wax should be completely dry.

Wax should be renewed at intervals, depending upon the severity of wear, but it is not necessary to rewax as long as the floor responds to polishing. Daily dusting and occasional machine polishing will eliminate the need of mopping and extend the life of the wax coating.

Cork Flooring

Many cork floorings are installed without any surface treatment other than sanding. These floorings are commonly referred to as "natural" cork and often may be cleaned by dry sweeping with a hair floor brush. The entire surface is then buffed with suitable pads, a polishing machine, or floor-polishing brush. If the floor cannot be cleaned in this manner, it should be swept with a soft brush, mopped with a lukewarm soapy solution, thoroughly rinsed with clean water, and wiped dry. Water should not be left on the floor.

If cork flooring is subjected to heavy traffic, it should be cleaned and sealed with a varnish-type sealer; it may then be waxed and polished. The same waxes used for linoleum may be used on cork floors.

Stains and spots may be removed from cork floors by rubbing with fine emery paper or No. 00 steel wool. In some cases, the spot or stain may be rubbed with a cloth dampened with acetone (flammable) or with carbon tetrachloride. Cleaned areas should be buffed and waxed.

7. DOORS AND WINDOWS

1. BINDING OR STICKING DOORS

Doors may stick at corners, be difficult to close, or latches may not fit the strike plate if doorframes in partitions have become distorted because floors have sagged. In this case, the floors should be made level, as described in chapter 6, section 1. The binding or sticking of a door against a doorframe may also be caused by loose or ineffective hinges, settlement of the frame, swelling of the door or frame, or warping of the door. Unless one is somewhat skilled in carpentry, it is usually advisable to have a carpenter make adjustments on doors in finished parts of the house.

The following tools and materials are needed: Screw driver, wood chisel, hammer, plane, jackknife, chalk and small paint brush; a few pieces of cardboard, plywood, or thin wood for "shims;" a small amount of putty to finish the woodwork; and stain, paint, or varnish of matching color to touch up bare surfaces after planing.

Loose Hinges

If loose hinges are causing a door to stick, examine the margin or crack between the door and frame when the door is closed to see whether it is even on all sides. Hinges that are loose, either top or bottom, will permit a door to sag, causing the upper outside corner to strike against the side of the jamb and the lower outside corner to drag on the threshhold, making the margin around the door uneven. The hinge fastening

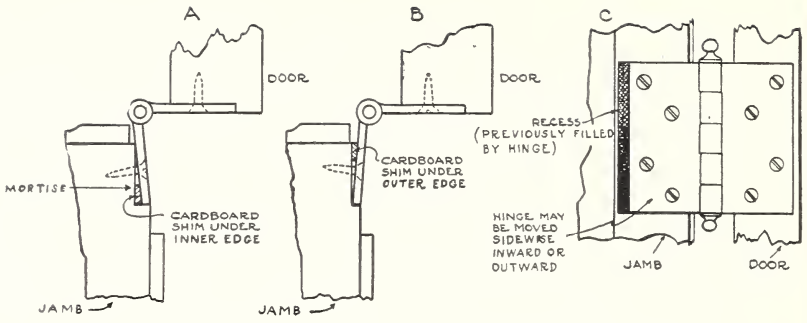


FIGURE 28.—*Hinge readjustments to correct ill-fitting doors.*

may be tested further by taking hold of the door knob at each side, when the door is open, pulling and pushing the door away from and toward the hinges.

If the hinges move, it will be necessary to either tighten the original screws or insert wood plugs in the screw holes and substitute longer screws that will hold the hinges securely. If margins or cracks are not uniform after the screws have been tightened, cardboard shims may be inserted under the hinge leaves. The screws in the leaf of the top hinge which is fastened to the jamb should be removed and a strip of cardboard placed under the inner edge, as shown in sketch *A*, figure 28. Longer screws should then be substituted for the original ones. After tightening the screws, the door should be closed to see whether the upper part has been pulled sufficiently close to the jamb. If it has, the trouble will have been corrected.

If considerable space still remains above the door and along the outside or lock edge after the striking has been corrected, the screws should be removed in the leaf of the bottom hinge which is fastened to the jamb. A strip of cardboard should then be inserted under the outer edge of that leaf, as shown in sketch *B*, figure 28, and longer screws substituted for the old ones. If, after the screws have been tightened, the hinge pins do not move when the door is opened and closed and the crack or margin on all sides is even, the hinges have been properly adjusted. If the hinge pins do move when closing the door, the shims under the hinge leaves may need to be replaced by thinner ones.

If the crack or clearance margin around the door is not even and the door strikes along the outer edge, the door should be removed by lifting out the hinge pins. The hinge leaves should then be unscrewed from the jamb and some wood cut from the outer edge of the mortises in the jamb with a sharp chisel, being careful to taper the cut so that wood from the back edge is not removed. When the hinges are replaced, this beveled deepening of the mortise will tend to pull the door away

from the lock jamb and toward the hinge jamb. If the hinge pins move as the door closes and there is still binding against the jamb, the mortises have been beveled too much. This can be remedied by inserting thin shims under the outer edge of the jamb leaves.

Planing a Door

If side margins are uneven and a door strikes at the top or bottom because the frame has settled, it may be necessary to trim the door by planing. Points of contact are usually indicated by worn places in the paint but, if not, they can also be located by opening and closing the door several times, marking with chalk or pencil the places where the door seems to stick. The edges of the door should then be planed slightly where marked and the door tried by opening and closing it, to see how much, if any, additional planing is needed. Care should be taken not to plane too much from the door as it would then need to be weatherstripped or filled in, especially if it is an outside door.

If the top or front edge of a door requires planing, this can usually be done without removing the door, but if the bottom or back edges need planing the door will, of course, have to be taken off the hinges.

If a door has removable hinge pins, they can be taken out and the door lifted off, but if not, the screws holding one leaf of the hinges will have to be removed to release the door. After planing, bare spots should be stained and varnished or painted to match the finish on the door.

Swelling

In damp weather wood doors may absorb moisture, causing them to swell and bind. Damp weather may also cause the framework to swell and the paint or varnish to soften and become sticky.

If the margin of a door is even along the top and bottom edges and the hinges are firm, either the hinge or lock edge should be planed. Usually it is best to plane the hinge edge, as hinges are easier to remove and remortise than locks. Care should be taken, however, not to plane off too much.

Binding at Hinge Edge

If a door is too tight on the hinge edge and binds against the hinge jamb, the hinges will become loosened unless the condition is remedied promptly. If such a door has plenty of clearance on the lock side and the hinge pin seems to move slightly when the door is closed, both hinges at the frame should be loosened and cardboard inserted under jamb leaves along the outer edges, as shown in sketch *B*, figure 28. If, upon tightening the hinges and closing the door, the margins are uniform and the pins do not move, the door has been properly adjusted.

Sprung Doors

If a door has sprung inward or outward at the hinge edge as a result of warping, it will be almost impossible to close it without exerting considerable pressure against the bulging part. This difficulty may usually be corrected by installing an additional hinge midway between the other two. This hinge should hold the door straight but care should be taken that it has the same margin on the edge of the door and on the jamb as the other two, so that all three hinge pins will be in a straight line.

Before removing the door to attach the additional hinge, it should be closed and two marks made across the crack to indicate the top and bottom of the hinge leaves, so that mortises may be cut in both the door and the jamb exactly opposite each other.

If, for any reason, a new hinge cannot be provided, shifting the old hinges outward on the door jamb will give temporary relief (see sketch *C*, fig. 28). For this, no cutting will be necessary, but the old screw holes should be filled with plugs and plastic wood before boring the new holes for the screws. Depressions left at the sides of the hinges after moving them should be filled with plastic wood or a strip of wood glued to the jamb and stained to match it.

2. DOORS TOO NARROW FOR DOORWAY

If the foundation of a house settles, it may cause one or more doorframes to spread, thus widening the doorways. If this happens, the bolt in the lock may not reach the strike plate and it may be impossible to lock the door securely. A gap may also appear between the door and the frame causing the door to rattle and, if the door is an outside one, allowing cold air, wind, and rain to enter. A door may also rattle because there is too much play between the latch and its strike plate. This can be corrected by moving the plate back toward the stop.

The following tools and materials are needed: screw driver, hammer, nail set, wood chisel, plane, and small paintbrush; narrow thin strip of wood the same length as the door, a few small finishing nails or small wood screws, a little putty, and enough stain or varnish to cover the strip.

To fill the gap and stop the rattle, one of two methods may be followed. A thick cardboard strip of the same width as the hinge leaf may be inserted under the leaves attached to the jamb. This will shift the door toward the lock side and may leave a large crack along the hinge edge of the door which may not be objectionable if the door is an inside one.

Another method, although a little more complicated, should prove more satisfactory, particularly for an outside door. Screws that hold

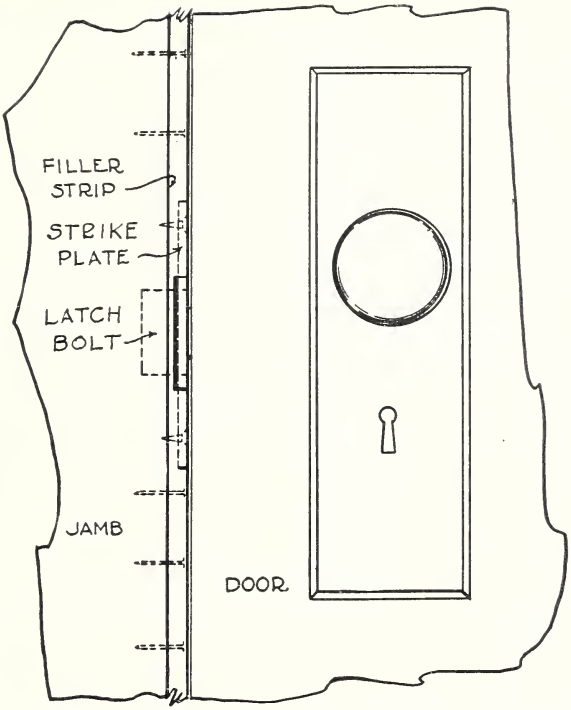


FIGURE 29.—*Door jamb section showing filler strips.*

the strike plate should be removed so that the strike plate can be lifted off. After that, a strip of wood, of sufficient thickness to allow the bolt to catch firmly when the plate is replaced, should be nailed or screwed underneath it. If the door is an outside one, the strip should extend the entire length of the doorframe and have a hole cut in it for the latch bolt (see fig. 29). The nails or screws, which should be slightly longer than those originally used, should be countersunk, the holes puttied, and the strip finished to match the doorframe.

An alternate method, requiring more carpentry skill than the others, involves the removal of the hinges from the door, as well as the strip screwed to the hinge edge of the door and the hinge leaves attached to the door. The hinges should then be replaced after cutting notches or recesses in the strip to receive them.

3. STRIKING LATCH BOLT

If partitions that adjoin or have been built below a doorframe settle or shrink, the frame may move slightly and carry the strike plate with

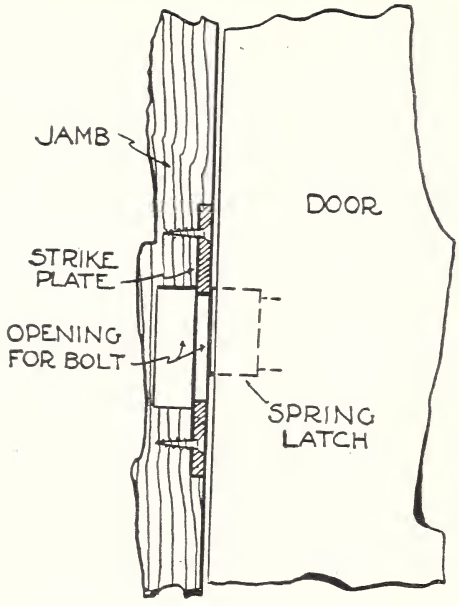


FIGURE 30.—*Section showing striking latch bolt.*

it, while the door and lock remain fixed. This will cause the bolt to strike the plate instead of entering the hole in the latch and will make it difficult, if not impossible, to lock the door.

The following tools are needed: screw driver, slim three-cornered taper file, small wood chisel, hammer, and jackknife.

To remedy a condition where the bolt strikes the plate, first close the door slowly to determine whether the bolt strikes too high or too low on the plate. Then remove the screws, take off the plate, and file the metal opening until it is large enough to accommodate the bolt.

If the bolt strikes squarely on the plate, so that it requires the filing of a possible quarter inch of metal, remove the strike plate and raise or lower it as necessary, chiseling out the mortise above or below the existing opening to set the plate flush (see fig. 30). Replace the plate in the new position so that the bolt will work back and forth freely. If old screw holes interfere, drive small plugs of wood into them before putting in the new screws.

4. SUBSTITUTING GLASS

To give more light, it may be desirable to remove the upper panels from a wooden door and substitute glass. This is not difficult and the expense involved is relatively small.

The following tools and materials are needed: claw hammer, sharp flat chisel, putty knife, and small paintbrush; panes of glass (preferably double strength) to fit the openings after removal of the wooden panels, small finishing nails or brads for renailing the molding, a small quantity of linseed oil or thin paint, and putty to bed the glass.

It will be easier to insert glass in the panels if the door is removed and laid upon a bench or the floor. For an outside door, it is best to cut away the molding on the inside face of the door rather than on the outside to lessen the liability of decay and to make the door more weathertight on the exposed side.

If the molding that holds the panel is not a separate piece, cut around the edges of the molded portion of the rail and stiles to a line, being careful to avoid splitting the four pieces, in order that they may be replaced as moldings to retain the glass. Remove the panel, trim the chiseled edges if necessary, and carefully measure the opening for glass size, allowing a slight margin for putty and expansion space.

When ready to set the glass, the bed in which the glass is to rest should be painted with linseed oil or thin paint for a filler and then a thin layer of putty should be laid around this bed to make the glass weathertight.

The glass should be carefully set in the opening and fastened in place like the glass in a mirror or picture frame by nailing the molding to the stiles and rails. In driving the nails, be sure that they do not touch the glass. If the molding should become broken during the operations described, new pieces of equal size may be substituted. Before rehanging the door, touch up any spots which may have been marred during the progress of the work.

5. BROKEN WINDOWPANES

A broken windowpane can be replaced by the average person without much difficulty. It is usually advisable to remove the sash which contains the broken pane, especially an upstairs window, and lay it on a flat surface such as table or workbench, although if the window is on the ground floor, the pane may be replaced with the aid of a stepladder.

The following tools and materials are needed: Chisel or jackknife for removing putty and for driving in glazier's points, putty knife, rule to measure size of glass needed, small flat paintbrush, glass cutter (if one intends to cut his own glass), and yardstick or steel square; glass of the same thickness as the broken pane, glazier's points, putty, raw linseed oil to soften the putty and be used as a filler, and matching paint for the putty after it has hardened. Good putty suitable for

ordinary household use can be made by mixing the best grade of whiting and pure raw linseed oil or may be obtained already mixed at reasonable cost from local hardware and paint dealers or mail order houses.

Removing Old Glass and Putty

Broken glass should be removed from the sash and the old putty chipped off with a chisel or jackknife. Glazier's points should be pulled and the wood where the new glass is to rest scraped well with an old jackknife or similar tool. The wood should then be given a coat of thin paint or linseed oil to act as a filler and prevent the oil in the putty from being absorbed by the wood and the putty from drying out and crumbling.

Measuring for New Glass

It is usually better to measure accurately the size of the needed glass and to give the dimensions to the hardware or paint dealer, letting him cut the pane to the proper size, than to attempt cutting the glass at home. All four sides from wood to wood in the sash should be measured and one-sixteenth to one-eighth inch deducted to allow for expansion and irregularities. Measuring the four sides is advisable because some sashes are not true and do not form a perfect rectangle. Most of the window glass stocked by dealers is designated as double strength clear American.

Setting Glass

A thin coat of putty, about one-sixteenth inch thick, should be spread on the rabbet or groove in the sash for the glass to rest in and the pane placed in the sash. Care should be taken to have the putty evenly distributed so that unfilled gaps will not appear between the sash and the glass. By pressing gently on the glass to embed the edges of the pane in the putty, the pane can be made watertight and the cushion of putty thus formed will reduce the possibility of cracking the glass when glazier's points are put in. Glazier's points are small flat triangular metal pieces used in addition to putty to hold the glass in place. They should be laid on the glass, about three or four to a side, on the long sides first, and forced into the sash with the side edge of a chisel or screw driver by sliding the tool over the surface of the glass. If the glass is still loose after the points have been set, remove those which do not fit well and replace them pressing the glass more firmly against the bed of putty during the process.

Use of Putty

Putty is usually purchased in a can with lid which provides an air-tight seal. To prepare the putty for use, it should be kneaded on a nonabsorptive surface such as a glass plate until the mass is pliable. Putty that remains in the can after use may be kept for some time by pouring a thin film of linseed oil over the putty to keep it pliable and placing waxed paper or foil immediately on top of the oil as a seal. Upon removing the waxed paper or foil and kneading, the putty will again be ready for use.

For application to the sash, a small piece of putty should be rolled out between the palms of the hands to form a pencil-shaped roll (see fig. 31). The rolls should then be laid end to end on the glass where it abuts the sash, one side at a time. The putty should be pressed down firmly but gently with a putty knife, drawing it along the sash from one end to the other. To lessen the danger of breaking the glass by strong pressure, the putty should be soft and pliable. The putty knife should be held at an angle, guided by the glass and sash, to form a smooth bevel. Excess putty spreading beyond this bevel should be cut off and used to fill any depressions that have occurred. Care should be taken not to spread the putty far enough over the surface to show on the inside of the window. The same procedure should be followed for the other sides of the sash.

Putty stains may be removed from the glass with a cloth moistened with turpentine or gasoline. After a day or two, when the putty has hardened, it should be painted to match the window sash.

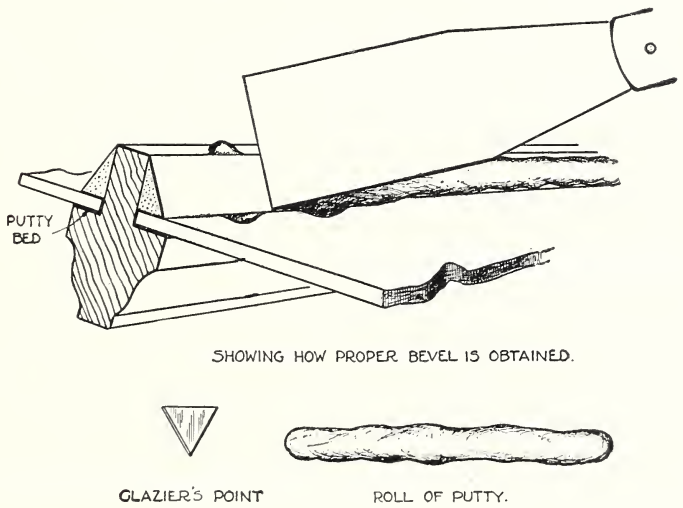


FIGURE 31.—*Glazing.*

6. GLAZING METAL SASH

Most metal sash are constructed so that the glass may be replaced with little difficulty. There are many kinds of such sash, however, and the steps to be taken may vary to some extent. The manufacturer usually issues instructions for using his particular product which should be followed, if available. In case of an emergency, where no such information is at hand, however, one of the following methods may be used.

The tools and materials needed are screw driver, putty knife, and small flat paint brush; double-strength glass or plate glass, putty made of whiting and white lead, and enough paint of the same color as the sash for covering the topcoat of putty.

Some windows are glazed on the outside, while others are glazed on the inside of the sash. In either case, the old putty and broken glass should be removed and the metal sash scraped clean where the new glass is to rest. If wire spring clips were used to hold the glass, they will have to be removed before the glass can be taken out. The new glass should then be embedded in putty to prevent it from being in direct contact with the metal. The putty should be spread over the metal where the glass is to rest and the glass pushed firmly into place so that putty fills every crevice. The glass can then be fastened tightly with wire spring clips, placed in the holes which have already been bored through the sash. When the glass is thus firmly secured, face putty may be applied in the same manner as for wooden sash. After the putty has thoroughly hardened, it should be painted the same color as the sash frame.

In some other types of metal windows, the broken glass may be taken out by unscrewing and removing the metal beading or glazing strips and scraping the old bedding putty from the sash. The new glass can then be embedded in putty, as described above. When it has been placed, the metal beading or glazing strips should be refastened tightly against it. These strips will form a neat frame around the glass, which is usually held in place by brass screws.

7. STICKING WINDOWS

Wood window sash may stick because paint has hardened or because damp weather has caused the wood in the sash as well as that in the adjoining frame to swell and the paint to become soft and sticky. Hardened paint will usually need to be loosened but, in most cases, the difficulty of raising the sash when the wood has swelled will disappear as soon as the wood dries. If wet weather continues, however, it may be necessary to take other measures to obtain relief.

The following tools and materials are needed: Jackknife, screw

driver, plane, medium sandpaper, claw hammer, flat wood chisel, nail set, pieces of cloth or felt for pads to protect woodwork from tool marks, and small paint brush; paraffin, linseed oil, and a small quantity of matching paint or varnish.

Sash Held by Hardened Paint

If a sash is held fast to a frame by hardened paint, it may be loosened by running the point of a knife blade between the edges of the sash and the frame, being careful not to mar the surface. The window can then be raised by pushing up on the center rail of the lower sash, being sure that the thrust is made near the side rails and not in the middle. This avoids the possibility of breaking the slender rail. After the window has been loosened, a generous coating of linseed oil should be applied to the pulley stile in the path of the sash travel.

Binding Sash

To determine where a sash is binding, examine the stops and pulley stiles (see fig. 32). Before doing any repair work, experiment to see if waxing the parts in contact thoroughly with paraffin will correct the excessive friction.

If the inside stops press too tightly against the sash, they can either be removed and planed down along the edge adjacent to the sash or moved away from the sash. If the stops are fastened by nails, it probably will be better to renail them in a new position; but, if they are fastened by screws, it may be easier to plane them off.

To make windows weathertight, it is important to have only a small margin between the inside stop and the bottom sash when the sash is down or closed. A wider margin, however, may be left between the upper end of the stop and the bottom sash when the bottom sash is in the raised position. This will allow the sash to slide readily, since there is no problem of weathertightness when the bottom sash is raised.

When wood window sash swells to the extent that the vertical edges bind against the pulley stile or running face of the window frame, the sash should be removed and the vertical edges planed off a little. They should then be coated with linseed oil and waxed with paraffin after the oil has dried. If paraffin is not available as a lubricant, soap will serve the same purpose although its effect will probably not be as lasting as that of paraffin. A stiff cup grease or vaseline may also be used, but it must be applied very sparingly to avoid soiling the paint.

8. DEFECTIVE WEIGHT CORDS

When a window-weight cord is broken, the window will fall abruptly

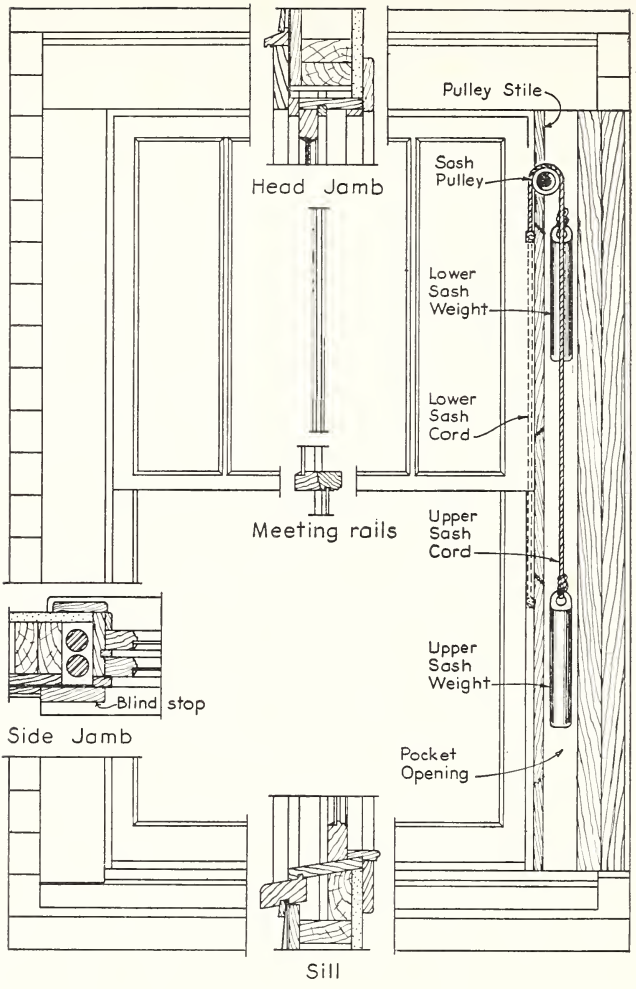


FIGURE 32.—*Double-hung window details.*

if raised without being supported. When the cord is too long or has become stretched, the window will not be carried to the top of the frame and, in case the upper sash is the one with the defective cord, it will need to be forced to the top of the frame and locked to keep it closed. Replacing or adjusting the cord does not require special skill, but it does require patience and care to avoid marring the woodwork.

The following tools and materials are needed: Claw hammer, wood chisel, screw driver, nail set, piece of string, small weight or nail, and pieces of cloth or felt for pads to protect woodwork from tool marks; new sash cord, chain, or stranded wire cable.

To replace a window-weight cord in the lower sash, only that sash will need to be removed; to replace the upper sash, both sashes will have to be taken out. Usually the shutter or blind stop, which holds the window in place, is made a part of the frame and cannot be removed. In replacing the window-weight cord, the first step is to take off the casing stop on the same side of the window as the defective cord, just inside the lower window sash (see fig. 32). If fastened by means of screws, its removal should be accomplished readily; if nailed, a flat wood chisel may be used to pry the stop off, which will reduce the likelihood of damage to the woodwork, especially if the blade is wrapped with a cloth, or a piece of felt is placed as a pad under the blade. Start prying the stop off at the bottom.

If the window is accessible from the outside, reaching through the window opening and prying from the outside will lessen the danger of marring the woodwork where it would show from the inside. If proper care is exercised, the brads will come out with the stop and then, instead of knocking them through and pulling them out in the usual way, they can be bent slightly and pulled through the stop from the back with a claw hammer, thus leaving no unsightly holes on the face of the finish. When nails are driven through in the usual way, the wood may chip out, since it is often fastened to the head of the nail with putty and paint. After the stop has been pried off, the lower sash can be taken out.

To remove the upper sash, lower it to the sill and pull out the parting stop on one side of the frame. The stop is not usually nailed and should be easy to remove but, if painted or otherwise held fast, it may be pried out with a flat chisel, starting at the middle of the stop.

Beneath the casing stop or in some cases adjacent to it, is a small oblong cover concealing a pocket in the sash. This cover is fastened either by screws or nails and when removed permits access to the cords and weights that are suspended in the long narrow slot at the side of the sash. Double-hung windows have four weights, two on each side of the window frame; the two nearest the inside of the house balance the lower sash and the two nearest the outside balance the upper sash.

The cord, one end of which is knotted and anchored in a hole bored in the side of the window sash near the top, passes over the pulley near the top of the window frame and is tied to the weight (see fig. 32). To avoid difficulty in working the new cord over the pulley and down through the slot to the bottom, a small lead fishline sinker or similar weight may be attached to a string, passed over the pulley, and let down inside the slot until it can be reached through the pocket. Then, by attaching the string to the cord, it can be pulled down within reach of the hand and fastened to the weight, before cutting to length. The cord should be pulled over the pulley until the top of the weight is up against the pulley, and the cord should drop about 3 inches below the

knot-retaining hole in the sash when the sash is in the extreme low position. The extra length is provided to form the retaining knot. The knot should be tied, the sash pulled out far enough to insert the knot in the mortise, and the window replaced.

Care should be taken to have the cord the proper length. If too long, the weight will rest on the bottom of the box when the sash is raised to the top, thus reducing its effectiveness; if too short, it will strike against the pulley at the top when the sash is pulled down and, in time, friction may result in a broken cord or damaged pulley. For those not familiar with this work, it is advisable to allow a few additional inches. Then, upon replacing the window, if the sash does not work properly, enough can be cut off so that the sash will be held in place against the top of the frame by the weight.

Before replacing the pocket cover and stop, the window should be raised and lowered a few times to see whether or not it is working properly.

The same procedure may be followed to shorten cords which have become stretched.

9. SCREENS

Screen doors and windows require attention at least twice a year. They should be renovated and put on in the spring, and removed and prepared for storage in the fall. If a good grade of screen wire has been used and the screens have been well cared for, the work involved will not be great. The painting of screens will be found in chapter 11, section 5.

Broken Screen Wire

For the repair of broken screen wire, the following tools and materials are needed: Tinners' snips or old scissors, screw driver to pry off molding, and tack puller or pair of pliers to pull out old brads and tacks, light claw hammer, tacks, and nail set or screen stapler and staples; screen wire, small tacks, and small brads or nails to refasten the molding.

If screen wire is worn out or badly broken, it should be replaced with new, making an allowance on all sides for tacking to the frames, and using tinners' snips or old scissors to cut the screen wire to the right size. To prepare the frame for the new screening, pry up and remove the molding that held the old screening, being sure to remove all tacks.

To tack the new screen wire, the frame should be placed on a support with the ends resting on blocking (see fig. 33). The stiles or side rails of the frame should be clamped to the support at the center of each rail and slightly bowed or bent downward by means of pressure which the clamps provide. The screen wire should then be tacked along the end

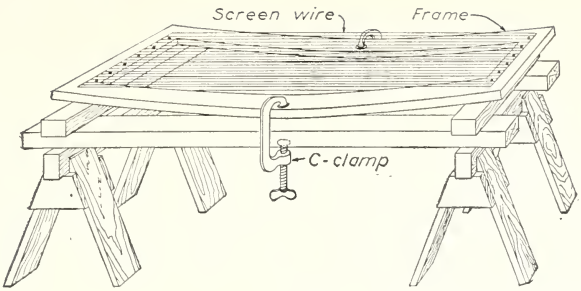


FIGURE 33.—*Tacking screen cloth to frame.*

rails, after which the clamps can be removed. When they are taken off, the stiles will spring back into position leaving the screen wire taut and in place to be tacked along the stiles or side rails of the frame without further stretching. When the sides have been tacked and the molding replaced, any excess wire that protrudes beyond the moldings should be trimmed off.

If a screen stapler is available, the screen wire can be fastened by staples instead of tacks. The stapler is not very expensive and will save time in securing the screen wire to the frames.

Lifts and Reinforcing Angles

Many window screens have no pulls or handles with which to raise the screen, and the screens are usually opened by pushing upward on the upper sash rail. This pressure tends to pull the frame apart.

Handles or pulls that are obtainable at slight expense should be screwed to the lower sash rails. Handles provide an easy method for raising the screens and relieving the pressure on sash rails. The sash may be reinforced and made more rigid by means of small angle irons screwed into each inside corner of the frame or by attaching flat metal pieces across each corner on the face of the frame. If the frames have butt or mitered joints and if there are no rails to interfere, they can be reinforced by driving metal corrugated fasteners across the corners into the face of the frame.

The following tools and materials are needed: Gimlet and screw driver; two handles or lifts for each window, four small angle irons, flat metal pieces or metal corrugated fastener for each window, and a sufficient quantity of small screws.

Protection for Screen Doors

Where screen doors are likely to be damaged by small children or

pets jumping against them, it is advisable to have extra protection for the lower half of the door. Doors may be purchased which are already equipped with guards but, if they are not obtainable, a protective screen of heavy, large-mesh wire may be applied over the regular screen wire in the lower portion of the frame.

The following tools and material are needed: Claw hammer; a quantity of heavy screen wire sufficient to cover the lower portion of the screen doorframe and small staples to fasten screen wire to frame.

To Close Screen Doors Tightly

The following tools and materials are needed: Screw driver and light hammer; screen-door spring or door check. Screen doors that slam are annoying and doors that do not close tightly are a source of trouble. To eliminate these difficulties, devices that are inexpensive and easy to apply may be obtained from hardware dealers or mail-order houses. Instructions furnished by the manufacturer should be carefully followed in making the installation.

A simple but effective way to deaden the sound of screen-door slamming is to tack three small square pieces of felt cloth or rubber to the main doorframe at points of contact. One piece should be placed near the top, another near the bottom, and the third midway between.

Hinges and Closing Devices

Screen-door hinges are generally of two types: Spring, and loose-pin butt hinges. Since, with ordinary spring hinges it is necessary to remove the screws and plug up the holes when the door is taken down, butt hinges with removable pins may be preferred. If butt hinges are used or if spring hinges have lost their pulling power, the door may be made to close tightly by fastening a slender coil spring (obtainable from a hardware dealer) between the screen doorframe and the main door jamb. The spring should be so placed that there will be sufficient pull to close the door tightly when it is released. To accomplish this, one end should be attached to the door jamb with a small screw hook 3 to 5 inches away from the screen door, as space permits; the other end should be attached to the middle cross rail of the screen door by means of a similar hook at a point where the spring will be under enough tension to keep the door closed. If the hook on the door jamb is too near the screen door, the spring will exert too little pull or closing force and the door will remain slightly open.

If the door jamb is too narrow to permit the use of the sort of spring described above, a short heavy coil spring may be employed on the outside face of the screen door. It should be placed at some point between the hinges and diagonally across the crack between the screen

door and the main door jamb. The ends of the spring should be fastened with wood screws to the frame of the screen door and to the front of the main door jamb.

Sagging Screen Door

If joints in the frame of a screen door become loosened, allowing the lower half of the door to sag and the bottom edge to drag on the threshold, a metal rod equipped with a turnbuckle may be used to raise the bottom rail clear of the floor. One end of the rod should be fastened to the face of the frame at the center of the intersection between the bottom rail and the outer vertical rail and the other end should be fastened as high up as it will reach on the face of the vertical rail that carries the hinges. When the two ends of the rod have been screwed on firmly, the turnbuckle may be turned to shorten the rod and lift the bottom rail.

Storing Screens

Screens will last longer if they are taken down in the fall and stored in a dry place for the winter. A good plan, if the basement is not ceiled, is to suspend them from the ceiling in a corner on a framework made of wood, as illustrated in figure 34. The hangers that hold the screens should be nailed to the floor joists about 2 feet apart and hung at an elevation that will permit the screens to lie perfectly flat. This can be achieved by laying two or three boards under the screens to form a shelf.

Screen doors may be placed on the hangers first and the window screens laid on top of them, with lath between to keep the doors and screens separated. They should be covered with paper or canvas to protect them from dust. This method of storage keeps screens free from accidental harm, in a place where they will not gather floor dampness, where they have the advantage of free air circulation, and

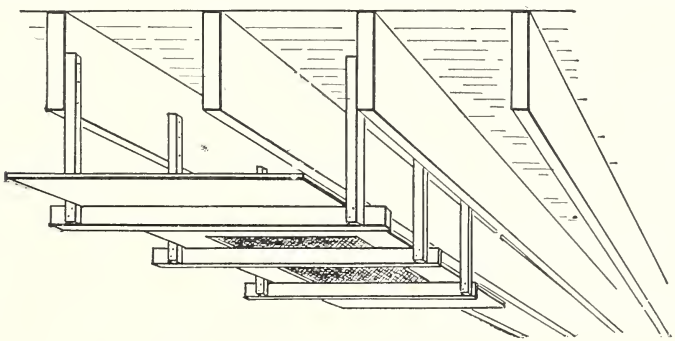


FIGURE 34.—*Screen storage rack.*

where they are not likely to become warped. The screen sash and window frames should be numbered to correspond to each other so that they can be readily matched. They may be inconspicuously marked in Roman numerals with a small chisel or with numbered nails resembling thumb tacks. The nails are furnished in duplicate and can be countersunk and glued to screen sash, window frames, or window sills. For example, one tack numbered 3 may be fastened to the screen sash and another with the same number to the corresponding window frame or sill.

The following tools and materials are needed: Screw driver to remove doors, numbered nails resembling thumb tacks, claw hammer, saw, a few short lengths of boards, and sufficient nails to build the hanging frame of screen-storage rack.

"Knock-Down" Window Screens

Knock-down screen frames which are easy to assemble may be purchased at reasonable prices. The sets include everything but the screen wire, leaving the purchaser free to select the grade he desires. They usually include four pieces of wood making up the two sides, the top, and the bottom. These pieces are properly notched at one end to insure a firm joint. The other end is left square, to be sawed to the proper length to fit the window. Grooves are already cut in the side pieces to permit sliding, and provision is made for tacking the screen wire and attaching the molding. Knock-down frame sets also include four pieces of molding to be tacked over the edges of the screen wire, two sliding rails to be attached to the sides of the window frame, and a metal lift or handle for raising the screen. Sufficient nails and tacks are provided to complete the job. To make the frame hold its rigidity and remain square, small flat angle irons should be screwed into each corner. If the wooden joints are mitered and nails do not interfere, steel corrugated fasteners may be driven into the face of the frame across the corners to make the frame more rigid. The joints should be coated with waterproof glue before nailing, the nails countersunk, and the nail holes filled with putty to make a neat job. A priming coat of paint and one or two finishing coats in the desired color will complete the work.

The following tools and materials are needed: Saw, claw hammer, nail set, and small flat paint brush; complete screen frames, screen wire, small tacks, paint, and small quantity of putty and glue; four angle irons with screws for each frame, if desired.

Inside Screens

In summer cottages, and sometimes in permanent dwelling houses, it

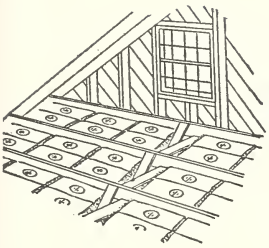
may be desirable to have screens placed inside of the windows. Inside screens are necessary if there are casement windows which open outward.

In the case of double-hung windows, it is possible to use half-length screens. They can be made to slide up and down on runners placed just inside the lower window sash. The screens should be placed as close to the window sash as possible, so that space will not be left between the sash rail and the screen frame for insects to enter.

Full-length screens, suitable for either out-swinging casement or double-hung windows, may be made in two sections, each section being half the width of the window opening. The sections may be made to slide past each other horizontally by placing them on separate runners laid side by side on the window sill and along the top of the window frame. In this case also, care should be taken to avoid leaving cracks between the frames. Roll screens also are available for full-length inside protection.

Interior screen frames may be painted or enameled on the inside to match the woodwork, and on the outside to match or harmonize with the outside window trim. For details of painting, see chapter 11, section 5.

Inside screens are protected from the weather when windows are closed and should last longer than outside ones. They usually slide easier, since they are not so likely to warp from exposure.



8. WEATHERPROOFING AND INSULATING

All houses should be adequately ventilated even in winter, but this does not mean that unregulated drafts of cold air should be allowed to sweep through the house. In cold weather, warm air escapes around loose windows and doors and is replaced by cold out-of-doors air. Outdoor windiness tends to increase the heat loss considerably. The result is that the output of the heating plant has to be increased to maintain the desired house temperature, and on cold windy days, if such leaks are extreme, it may be found difficult to keep the house warm.

1. WEATHERSTRIPPING

The weatherstripping of doors and windows is one method of increasing comfort and reducing the consumption of fuel.

Kinds of Weatherstripping

Many kinds and grades of weatherstripping are available on the market at various prices. They include metal and wood in rigid form and fabric in rigid and flexible form.

Metal weatherstripping, which involves the removal of sash and cutting of grooves, should usually be installed by an expert, but some of the other forms can be applied by the average householder.

Space does not permit a full discussion of all methods for applying the various types of metal weatherstripping. Complete instructions are usually furnished by manufacturers for types which do not require the services of an expert.

Weatherstrips made of materials other than metal are available in

two types: rigid and flexible. They are comparatively easy to apply and are attached in a similar manner. The rigid types are narrow wood strips with rubber or felt edges made in standard-length pieces; the flexible types include the fabric variety with a padded contact edge and the ordinary felt strip which is the most economical of all. Flexible strips are packaged in rolls of various lengths.

The following tools and materials are needed for weatherstripping windows and doors: Rule or steel tape, marking pencil, and light hammer; small saw and miter box if strips are wood; pair of scissors if strips are cloth, felt, or rubber; stripping of required length, wire brads for wood strips, tinned or bronze tacks for padded fabric or felt stripping.

Measure the four sides of the window frame along the face of the sash where it joins the casing as well as across the meeting rail if the windows are double-hung. The door stops should be measured along the top and sides where they abut the door and the width of the door along the bottom should be measured.

To Weatherstrip Windows

To insure best results, the window should be locked to keep the sash and frame in close contact while the weatherstripping is being attached. Care should be taken to see that the contact edge of the stripping presses snugly against the sash and casing at all points before the brads or tacks are driven into the wood.

The weatherstripping for the upper sash should be tacked to the frame adjoining the sash on the outside of the window. If the flexible type is used, one piece can be cut to extend around the two sides and top. If the rigid kind is used, three separate pieces will have to be cut, with the two corners mitered, to make a neat fit.

The weatherstripping for the lower sash is attached on the inside, and four separate pieces are required, regardless of the type used. The two side pieces should be tacked to the face of the top adjoining the sash with the contact edge pressed against the face of the sash and they should extend from the top face of the stool or inside sill to the top of the meeting rail. The piece across the width of the meeting rail should be tacked to the top of the lower sash, so that the contact edge will cover the crack where the upper and lower sash rails meet. This piece will probably have to be cut in two parts to provide space for the window lock. The piece across the bottom should be tacked to the face of the sash with the contact edge placed downward to butt against the top of the stool or inside window sill.

Casement windows of wood are weatherstripped in the same manner as doors, with the stripping tacked to the window stop and the contact

edge of the stripping pressed against the face of the sash when the window is closed. A strip of felt tacked to the inside face of the meeting strip will seal the vertical crack where the two windows meet.

To Weatherstrip Doors

The door should be closed and locked to draw the door and casing together tightly while weatherstripping is being applied. If flexible-type stripping is used, two pieces will be needed; one piece should be as long as the width of the bottom of the door and the other should be long enough to extend around the two sides and the top. If rigid strips are used, four pieces will be required, with the two top corners mitered to make a neat joint. The bottom piece should be tacked to the inside face of the door with the contact edge placed downward and pressed snugly against the top of the threshold. Should the threshold be so badly worn that tight contact cannot be made at all points, it should be replaced. The side and top pieces should be tacked to the door stops on the outside, with the contact edges pressed evenly, but not too tightly, against the face of the door.

It is sometimes desirable to weatherstrip bedroom doors, at least at the bottom, to prevent drafts and the escape of heat from the rest of the house when bedroom windows are open. Weatherstripping applied to doors leading from the living rooms to the basement also helps to keep out cold air, dust, gases, and laundry odors.

2. OUTSIDE OF WINDOW FRAMES

Damp spots may appear on the interior surfaces of walls for various reasons but, contrary to the general impression, they are not always the result of structural defects or of leaks through the walls proper. The trouble may be due to window frames that are poorly built or improperly weatherproofed. Such frames may admit air and moisture causing adjacent interior walls to become unsightly with dirt and water stains.

Water, finding its way into the wall around a window frame, may work along the inside of the wall and make a spot on the plaster surface several feet distant from where it entered. For this reason, it is sometimes difficult to locate the source of trouble.

Casing Construction in Frame Houses

In well-built frame construction, the blind stop behind the casing extends back to the window studs, and the building paper between the sheathing and siding extends over the crack between the blind

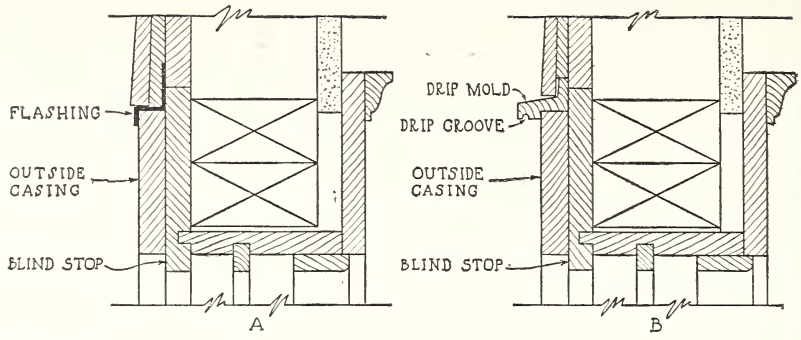


FIGURE 35.—*Window head details, showing methods of flashing.*

stop and the sheathing (see fig. 35). In addition, the outside casing is nailed directly to the blind stop and the siding or shingles are butted against it.

If there is no blind stop, waterproof paper should be used under the joint between the casing and the siding to prevent the entry of wind and rain.

The cap over the window should be constructed to turn water away from the joint between the frame and the siding. In some types of frames, the siding or shingles extend over the cap and a drip groove is provided along the underside of the cap; in case the cap does not have these features, the joint may be covered with metal flashing (see fig. 35).

The connection between the subsill and sill should also be tight. In the newer types of frames, the bottom of the sill is recessed to allow the siding or shingles to extend into the sill a short distance. Near the back edge of the sill a rabbet or offset is cut to make a tight joint with the subsill.

Leaks Around Window Frames

If there are leaks around a window frame, a careful examination should be made to indicate where repairs are needed. Around the lower part of the window, particularly at the top of the window sill, there may be holes or large cracks, or there may be a crack under the inside stool or window ledge, especially if it has not been nailed down securely. If the stool has been cut too short, there may also be cracks at either or both ends. Also, where parting stops and pulley stiles meet the top sill, there may be holes as a result of careless fitting. Such cracks and openings may be closed satisfactorily by driving the stool down firmly and filling the spaces with white-lead putty or calking compound.

Sometimes driving rain or water from melting ice on the sill outside the window may be forced in under the window and stool and down the wall. This seepage usually can be prevented by removing the lower sash and cutting a groove along the bottom of the lower rail from one side to the other with a weatherstrip plane that has a ½- or ¾-inch blade. In this way a cavity is formed to check blowing rain before it can get inside the window.

Good weatherstripping carefully applied, as explained in section 1 of this chapter, will do much to prevent air leakage and keep moisture from entering around windows and doors.

Where the subsill joins the sill, there may be a crack that will admit air and moisture unless it is calked with white-lead putty or calking compound, or covered with metal flashing.

The drip mold and flashing at the top of the frame should be examined to see whether they are in good condition. New flashing, preferably copper, should be installed, if necessary, with the upper edge bent up under the siding or shingles and the lower edge extending over the outer edge of the window cap about one-half inch and bent down to form an apron. Before putting on the flashing, it may be well to seal the cracks around the frame with white-lead putty or calking compound. Sometimes the casing or adjoining molding may become loose and require renailing.

In some instances, the casing may be nailed over the siding or shingles instead of being fastened directly to the blind stop. This method leaves triangular openings between the back of the casing and each shingle or siding board and, if the joints under the outside covering are not properly protected, air will enter.

If air is entering, the casing may be removed and the cracks underneath filled with white-lead putty or calking compound, or the triangular openings may be closed without removing the casing by employing one of two methods: They may either be calked with oakum to within one-half inch of the surface and then filled with calking compound; or they may be covered with a 2-inch strip of wood of the same thickness as the casing, notched to fit the irregularities in the surface and nailed to the siding or shingles adjoining the outside casing.

Frame Construction in Stucco Houses

In wood-frame stucco houses, window frames are usually of the same type as those used in frame houses which have other types of exterior finish and the same instructions for weatherproofing may be followed. To apply flashing over the cap mold at the top of the frame, it may be necessary to cut away a few inches of stucco along the top of the frame. When the flashing has been applied, it should be sealed with calking

compound along the top edge against the backing. The stucco should then be patched as described in chapter 3, section 2.

Frame Construction in Brick Houses

In brick construction, window frames are usually set in a thin bed of mortar and the spaces between the brickwork and frame filled solid with mortar to seal the joints.

If properly flashed, there is seldom any trouble with leaks at the tops of wood windows in brick houses, since the frames generally are set back far enough under the brickwork to prevent water from entering. The leaks that do occur around a window opening are usually found along the sides of the frame at the top or bottom of the sill.

In making repairs, the staff bead or wood molding adjoining the brickwork should be removed and all cracks calked with oakum followed by calking compound or portland cement mortar. Before replacing the staff bead, it is considered good practice to paint the back with preservative paint as a precaution against decay (see ch. 11, sec. 3).

If it is not practicable to remove the staff bead, cracks between the brickwork and the bead can be sealed with plastic calking compound. This material can be applied with a putty knife, calking knife, or calking gun. A high-grade calking compound, which will not shrink, crack, run, or dry out under the action of weather, should be used.

Defects may exist around window sills in brick houses just as in frame houses; they should be repaired in the manner described in chapter 3, section 2.

Waterproofing Dormer Windows

If the sill of a dormer window rests on the roof, and flashing has not been provided, metal flashing should be worked into the underside of the sill and run down over the roofing material so that water will not get into the crevices between the sill and the roofing. As an added precaution, it may be advisable to calk the crack with flashing cement before applying the flashing.

3. MOISTURE CONDENSATION

Moisture condensation is most likely to occur in houses that have been tightly constructed without provision for adequate ventilation. All air contains some moisture and can hold more when warm than when cold. Vapor generated in a house increases the moisture content of the air until, in some cases, it condenses on cool surfaces. This may cause a number of undesirable conditions, only some of which may be visible.

Damp spots may appear on room-side surfaces of exterior walls, dew or frost may form on windows, moisture may condense on basement side walls and floors, outside paint may be marred by water-filled blisters, ice may result from condensation on attic floors or on the underside of roofs, and vapor may condense within walls where it is not easily detected.

Behavior of Water Vapor

Condensation is a process of distillation whereby water is evaporated into the air in some parts of the house and diffuses as vapor in the air to cooler regions, where it may condense, forming drops of liquid water or frost. The sweating on the outside of a glass of ice water and the formation of dew or frost on the inner surface of a window in cold weather are familiar examples of the condensation of water vapor from the air in a room. The tendency of water vapor in air is to move from a warmer to a colder region, appearing in the form of dew or frost when it reaches a surface that is cold enough to cause it to condense.

Humidity

A certain amount of moisture in the air, commonly expressed in terms of relative humidity, is considered desirable by many people and also may be helpful in preventing furniture and woodwork from becoming too dry during the heating season. However, since too much moisture may result in condensation, it is best to avoid extremes.

The measurement of air temperatures by means of thermometers is familiar to the average householder, but the determination of relative humidity or moisture content of the air in a room is a process not so well known. Humidity can be measured with the aid of one of two instruments, the psychrometer and the hygrometer. These instruments may be obtained from dealers in scientific equipment at reasonable prices.

A psychrometer consists of two accurate thermometers, one of which has a wick surrounding the sensitive bulb. When the wick is wet with water and air passes at a moderate velocity over it, the "wet-bulb thermometer" indicates a temperature lower than that of the other thermometer which is used dry and without a covering. The difference in temperature between the wet-bulb and dry-bulb thermometers is a measure of the moisture content of the air and these readings, when used with suitable charts or tables, can be converted into numerical values of relative humidity and moisture content.

Inexpensive hygrometers indicate the relative humidity of air by means of the lengthwise expansion or contraction of one or more

filaments of hair or other fiber which actuate the indicating needle of the device. The length of the fibers depends upon their moisture content which varies with the humidity of the atmosphere surrounding them. Such instruments must be accurately calibrated to be reliable.

Sources of Water Vapor

In addition to the moisture that enters a house in the air drawn in from the outside, water vapor or moisture may be liberated within a building. Water vapor generated within a house may be traced to a number of sources: it can be produced by wet plaster, fresh concrete, wet basements, unexcavated basements, the human body, bathing, cooking, clothes washing and drying operations, unvented fuel-burning devices, humidifiers, growing plants, and open pans of water.

Condensation may occur in a house when there are unusual sources of moisture, such as new plaster and fresh concrete, or in cold weather when the interior humidity is too high. Water vapor readily permeates or passes through most building materials, with a few exceptions; in cold weather, this vapor may condense within the wall structure and in the materials composing it. If this occurs, the wetting resulting from condensation may in time decrease the value of insulation and cause paint and building materials to deteriorate.

Control of Condensation

The four chief methods for control of condensation are: (1) Reduction of the humidity of the air within the house; (2) installation of a vapor barrier on or near the warm surface of the wall so that water vapor cannot pass into the wall structure; (3) insulation in conjunction with a vapor barrier or the provision of storm windows; and (4) ventilation with outdoor air of the inner structure of floors, attics, and outside walls.

Reduction of humidity in the house to avoid excessive condensation may involve reducing the generation of vapor in the house by turning off humidifying devices, venting unvented fuel-burning appliances, etc., which may in itself be sufficient, and reducing the concentration of water vapor in the house air by dilution with the drier outdoor air by means of either natural or forced ventilation. Such ventilation entails the discharge of warmed air to the outdoors and constitutes an addition to the heat loss of the house. For this reason, it should be resorted to only if reduction of vapor generation in the house by all other means is not completely effective in preventing condensation. However, the expense and inconvenience of providing this ventilation may, in many cases, be considerably less than the cost of repairing damage to the interior finish, paint, or structure of a house, that has been caused by excessive condensation.

A practical way of remedying condensation in walls, top floor ceilings, and roofs is to provide a vapor barrier that will retard the passage of water vapor. Vapor barriers may consist of metal foils asphalt-coated felts, laminated kraft papers, or vapor-resistant paint coatings.

Vapor barriers may be installed on the inner face of wall studs or the bottom of top floor ceiling joists before the inside finish is applied at less cost while a house is under construction than after it has been completed. To be effective, the barriers should form a continuous, unbroken membrane and be installed on the room or warm side of the insulation, which in most cases is immediately behind the lath and plaster or other finish material.

If sheet-form vapor barriers are to be placed in the attic above existing top floor ceilings, they should be cut to fit between the joists and laid on top of the ceiling. Loose-fill, batt, or blanket-type insulation may then be placed between the joists on top of the vapor barrier. Some batt or blanket-type insulation has a vapor barrier attached, in which case no additional barrier is required. This type of insulation should be laid between the joists on the ceiling with the vapor-barrier side down.

In an unfinished attic, batt or blanket-type insulation may be installed between the exposed roof rafters. It should be tacked to the side of the rafters so as to leave one air space between the top of the insulation and bottom of the roof boards and another air space between the bottom of the insulation and the bottom of the rafters. If the insulation has a vapor barrier attached, it should be installed with the vapor-barrier side down but, if not, sheet-form vapor-barrier material should be applied to the bottom edge of the rafters, after which ceiling finish may be applied.

If loose-fill insulation is to be used between the rafters in an unfinished attic, sheet-form vapor-barrier material should be tacked to the lower edge of the rafters and the ceiling finish applied before the insulation is blown in.

In a finished attic, if loose-fill insulation is to be blown between the rafters and no vapor barrier exists, the warm side or face of the ceiling should be painted with at least two coats of aluminum paint before wallpaper or other decorative finish is applied.

In any case, when insulation is placed between roof rafters, it is necessary to leave a space between the bottom of the roof boards and the top of the insulating material so that the space can be ventilated with outdoor air. This precaution is particularly necessary when the roof covering (such as metal or asphalt roofing) is in itself quite resistant to the passage of water vapor.

In existing houses, or in cases where it is not practicable to install

sheet materials, two coats of aluminum paint will prove helpful as a vapor barrier, if applied under the decorative wall or ceiling finish. Such coatings may be aluminum, asphalt, or oil paints, as well as some enamels. Before applying the coatings, wallpaper should be removed and the plaster thoroughly cleaned and patched.

In the application of aluminum paint, the plaster should first be given one coat of plaster primer or sealer followed by two coats of aluminum paint. This will reduce penetration of vapor into the wall, and the surface can then be covered with wall paper or other interior finish.

Asphalt paint cannot be used on exposed walls but proves satisfactory if applied to the back of plywood or similar inside finishes, provided enough coats are applied to give a glossy surface.

Oil paints, semigloss wall enamels, or gloss wall enamels may be used on plastered walls if the walls have been primed with two coats of wall primer.

In the case of windowpanes and some wall constructions where the heat loss is high and the temperatures of the inside surfaces are relatively low, condensation may occur. The condensation may be reduced by raising the temperature of the surfaces in contact with the house air by installing insulation in conjunction with a vapor barrier or by providing storm windows. The installation of storm windows is covered in the next section of this chapter.

Ventilation by admitting outdoor air to the inner spaces of floors, attics, and outside walls near the cold side will carry away water vapor and reduce condensation in these parts of a structure. For ventilation of an attic, vents or louvers should be installed in end walls at the roof peak. Care should be taken in locating the louvers to provide good cross-circulation of air through the attic area. Openings or screens in the louvers should not be allowed to become clogged or choked by dust and cobwebs.

4. STORM WINDOWS AND DOORS

Storm windows and doors materially reduce heat losses and in cold regions the less expensive types will, in time, pay for themselves in reduced fuel bills. They are extensively used in cold climates for reasons of comfort as well as fuel savings, and to avoid excessive frosting of single-glass windows.

Storm Windows

When properly installed, storm windows provide a still-air space which reduces heat conduction to the outside and to some degree prevent infiltration of cold air. Storm windows reduce frosting of

inside windowpanes by protecting them from the low outdoor temperatures that cause condensation. If it is impossible to provide storm windows for all window openings, they should be installed on windows on the sides of the house that face prevailing winter winds. To be most effective, storm sash should fit tightly. There are two types in general use: those that are installed permanently, and those that can be put up and taken down as the seasons change.

There are several types of permanent storm sash frames in which storm window or screen sections can be inserted. They may be of wood or metal and are installed but once, installations usually being made by the dealer. In this type of frame, the glass panes are replaced by screens by slipping out the storm sash and inserting the screen sash. The sash frames are not very thick and therefore occupy a minimum of storage space.

Another type of combination storm window and screen permits the screens to roll up automatically on rollers hidden in the window frame when the storm windows are in use and permits the lower half of the window to be raised when screening only is needed. This type presents no storage problem because neither pane nor screen is removed when not in use.

A third type of automatic window disappears into the wall at the flip of a switch, carrying the screen into place as it moves. Double-glazed, it can be installed in old or new homes and requires no storage space.

Removable wood storm sash may be installed in the same manner as full window screens. They may be suspended from the top or side of the casing on hinges or other hangers to swing outward for ventilation or other purposes. They may also be fastened with ordinary wood screws, hooks and eyes, or other devices and sometimes are provided with sliding openings in the bottom rail to admit air when desired. If the sash are hung, rather than fastened in place with screws, care should be taken to obtain a good fit on all sides of the sash. They may be held open, when desired, by means of long hooks inserted in screw eyes or by special devices which are available for the purpose. If storm sash is placed flush with the window casing, it may be supported by loose-pin butt hinges. This will allow removal of the sash by simply pulling the pin of the hinge. If ordinary hinges will not fit, there are special storm-window hinges designed for any type of frame. A local hardware dealer may be consulted as to the type of fastening best fitted for use on a particular house.

Storm Doors

If storm doors for all outside entrances entail too much expense, it

may be desirable to provide them at least for the windward side of the house. If made in the form of a vestibule, the enclosed space will prevent the inrush of cold air when the house door is opened, and will provide a place to remove galoshes or rubbers and shake off snow.

Combination storm and screen doors have a large center opening in which panels of glass and screening may be interchanged by means of a few clamps or screws. For separate storm and screen doors, time can be saved by using two pair of interchangeable loose-pin butt hinges; two leaves of one pair to be attached to the door jamb to serve both types of doors.

Summer Storage

Storm windows and doors should be kept well painted and stored in a dry place when not in use. In some cases, it may not be feasible to suspend a wood rack from the basement ceiling, as shown in figure 34, to store storm windows and doors during the winter. To avoid stacking them, ready-made metal storage racks may be procured which hang from first-floor joists in the basement. They have adjustable hooks on which to hang the window sash, which they engage directly without extra screws or other holding gadgets, fixing them securely and firmly. The sash may be hung sidewise or lengthwise, whichever is most convenient.

5. THERMAL INSULATION

Although any closed structure can be kept at a desired temperature in cold weather if enough heat is supplied, there are obvious advantages in having houses arranged so that heat losses are reduced to a minimum. The structural parts of a house, designed chiefly for strength, weatherproofness, and appearance, have some resistance to heat flow, or insulating value, which may be ample for ordinary purposes in moderate climates. However, in cold climates and where heating seasons are long, it is desirable to incorporate or install in the structure of walls, and other exposed parts of houses, materials made especially to provide thermal insulation. Materials for this purpose have several times greater resistance to heat flow than ordinary building materials of equal thickness. Apart from the fuel savings resulting from the use of insulation, the size and cost of the heating plant can be reduced.

Insulating Materials

While no material will entirely prevent the passage of heat through a wall or roof, there are insulating materials which are efficient in

reducing the flow under the same temperature conditions. Some are made of soft, flexible fibrous materials such as mineral wool and vegetable or animal fiber. Others are available in the form of blankets and batts, which are designed to be stretched and tacked between the studs, floor joists, and rafters. Still others are available in loose or shredded form to be blown or packed into hollow spaces, while still others are made in stiff board form having some structural strength to be used as sheathing, plaster base, or merely as insulation. The batt and blanket forms are usually furnished with a vapor-barrier facing made of asphalted paper and should always be installed with the vapor barrier on the warm side of the insulation. Such reflective metal surfaces as bright aluminum foil, that are used as a boundary for an air space wider than about one-half inch, are effective as insulation, especially when the air space is horizontal to the direction of the downward heat flow. Only one boundary of the air space need be reflective. It is preferable to place reflective surfaces which are also vapor barriers, such as metal foils, on the warm side of the air space.

The manufacturers of insulating materials are usually glad to cooperate with prospective users by furnishing literature that describes their products and gives instructions for application.

The various kinds of fibrous insulation are substantially alike in insulating value, which varies directly with the thickness of insulation installed. Batt, blanket, and loose-fill fibrous insulations are approximately equal in insulating value when used in the same thickness. Insulating fiberboard has less insulating value per inch of thickness than fibrous insulations, but is preferred in cases where structural properties are needed.

Insulating Frame Walls

The walls of frame houses can be insulated by several methods. For existing frame houses that have not been insulated, loose-fill insulating materials, such as mineral wool or vermiculite, can be poured into the spaces between the studs or joists, where these are accessible. Loose-fill insulating materials can also be blown into place by means of a special blower and air hose designed for the purpose, in which case, it is advisable to have the work done by a reliable firm that has the proper equipment. A guarantee should be required from the installer that no empty pockets exist upon completion of the work. If firestopping prevents the space between walls being filled from the attic, openings must be cut in the outside wall covering to admit the hose. After the insulation has been blown into the wall, the holes can be repaired.

Furring and Waterproofing

Whether or not insulating material is used, it is advisable to use

furring strips on the inside face of exterior masonry walls, especially in localities that are subject to low temperature, high winds, heavy rains, or extreme humidity. The wood furring strips form an air space which acts as moderate insulation and as a separation between wall and interior finish. Brick or masonry walls that have already been plastered on the inside face may be insulated by installing furring strips directly over the plaster and fastening the new inside finish to the furring strips. The old trim will have to be removed while the furring is being applied. Door and window frames should be blocked and cased out to meet the line of the new finish, after which the old trim may be put back in place or new trim installed. Where plaster is applied to a masonry wall without furring or other form of insulation, condensation may occur and, unless the walls are waterproofed, moisture that penetrates the joints may appear as wet spots on the surface of the plaster.

Brick walls which have been furred on the inside may be satisfactory without further insulation unless the climate is severe. If more insulation is required for fuel economy or comfort, the inside finish may be removed and blanket or other type insulation placed between the furring strips. Lath, composed of either gypsum board or fiberboard with or without aluminum foil on the back, may be used as a plaster base; where a foil-backed board is used, a reflective air space is formed which has two or three times the insulating value of an ordinary air space, or about that of two-thirds of an inch of blanket insulation. If desired, various types of wallboard with or without metal foil on the back may be used instead of lath and plaster.

Attic Insulation

The roof, subject to strong cold winds in winter and to the direct rays of the sun in summer, is the most exposed part of the house. If an attic is uninsulated, a considerable amount of heat is lost through the roof during the winter months. Rapid melting of snow on the roof is evidence of this. In summertime, the roof is heated by the sun, which in turn heats the attic and raises the temperature in the upper part of the house. It is therefore desirable, for reasons of comfort, to insulate either the roof or the floor of the attic.

If the attic is unoccupied and it is unnecessary to keep the temperature in that space at comfortable level, insulation in the form of batts, blankets, or loose-fill material may be laid between the floor joists of the attic, on top of the ceiling below. If the attic is not floored, boards should be laid across the floor joists to walk on while laying the insulation.

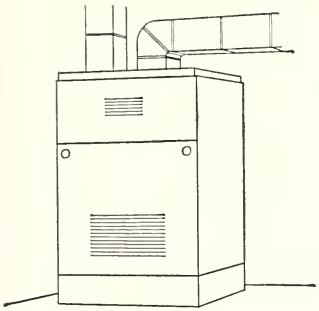
Unoccupied attics with insulation in the floor should be provided with screened louvers or vents to permit good cross-ventilation with outdoor

air in winter as well as summer. Fine-mesh screens may require occasional cleaning to permit uninterrupted air flow.

If an attic is to be occupied and it is desirable to keep the attic temperature comfortable throughout the year, insulation may be applied to the underside of the roof between the rafters, and to the end walls. A good vapor barrier should then be placed on the underside of the rafters, especially if the roof is of a type that offers resistance to escaping water vapor, such as one with metal or asphaltic roofing.

It is very desirable to install roof insulation so that there is a space of 2 or 3 inches between it and the underside of the roof boards, and to provide openings for moderate ventilation of this space with outdoor air. This can often be done by leaving small openings or cracks at the eaves and by installing louvers in the end walls communicating with a triangular space between the roof and a false ceiling over the attic. The necessity for the vapor barrier and the ventilation between insulation and roof is to prevent condensation of moisture in winter which may wet and damage the roof structure; furthermore, ventilation will be helpful in summer in carrying away solar heat.

If the attic is to be finished for occupancy, the enclosing walls and ceiling should be insulated and vapor barriers installed, after which the finish surface material may be applied.



9. HEATING AND VENTILATING

Many kinds of heating and ventilating equipment, including both hand-fired and automatic fuel-burning devices, are in domestic use. In general, these systems give satisfactory service if their capacity is adequate to serve the heat demands of the house, if they have been properly installed, and if they are efficiently maintained and operated.

To be sure that a heating system will work successfully, the home owner or occupant should procure fuel suitable for his particular equipment and be familiar with its mechanical operation. He should not tamper unnecessarily with the controls or mechanism of his installation but, if competent, can make minor adjustments and, sometimes, small repairs. Major repairs, replacements, or seasonal overhauling, should be done by reliable and qualified heating mechanics.

1. GRAVITY OR PRESSURE HOT-WATER SYSTEM

Ordinarily, it is desirable to leave the water in a steam or hot-water heating system from one year to the next to minimize corrosion, to prevent the introduction of air, and to minimize the accumulation of salts or sediment in the system. Air may accumulate in some radiators of a hot-water system during normal operation; if the accumulation becomes too great, circulation is retarded and inadequate heating of the room or house may result.

Filling a hot-water heating system is easier if two persons are present, one to control the flow of water into the boiler and the other to operate the radiator relief valves.

All radiator shut-off valves should be opened, being sure that the air valve on each radiator is closed. The draw-off cock at the lowest point in the system should be closed, and the valve in the supply pipe which feeds the boiler opened. As soon as the water in the pipes begins to rise, the air valve on each radiator should be opened, beginning at the one nearest the boiler, in order to release the air so that the radiators may fill with water. When water begins to spurt from an air valve, it should be shut and the operation repeated until all radiators become free from air and full of water.

When adding water to a boiler with fire under it, the fire should be low and the water should be allowed to flow in gradually, since a large volume of cold water suddenly injected into a hot boiler might cause it to crack.

Expansion Tanks

To fill a hot-water heating system equipped with an expansion tank, the water supply valve should be shut off when the water has risen to such a height that the expansion tank at the top of the system is about one-third full. The expansion tank is usually located on an upstairs closet shelf or in the attic, preferably near the chimney, to protect it from freezing. The height of water in the tank is usually indicated on a water-gage glass attached to it. The water should be kept at the level mentioned to insure complete circulation throughout the system. An overflow pipe attached to the expansion tank and leading to the outside of the house or to a drain should be provided to carry off excess water.

Reducing Valves

In water systems operating under pressure, two automatic valves are usually provided to control the pressure of water in the system. A reducing valve is used to admit city water when the pressure in the heating system falls below the normal level and a relief valve is used to discharge a small amount of water from the system automatically, when the pressure becomes higher than normal due to the expansion of the water upon being heated. Occasionally, these valves become slightly corroded and fail to work properly. Under such conditions, they should be dismantled and the moving parts polished with fine emery cloth, then cleaned and reassembled.

Because of the danger that someone may build a fire in a dry boiler, it should be kept filled with water when not in use. Air can be expelled from a steam boiler by raising the water level to the steam outlet. A hot-water system is usually left filled to the expansion tank. Rusting or corrosion is most severe at the water surface so that keeping the boiler completely filled during the summer will prolong its life.

Altitude or Pressure Gage

The purpose of the altitude or dial gage on a hot-water boiler is to indicate the level of the water in the system. On the first filling, the water level is raised to the proper height in the expansion tank and this is checked by inspection. The red hand on the dial gage is then set in the same position as the black hand. Thereafter, proximity of the black hand to the red hand will indicate proper filling of the system.

Steam-Heating and Hot-Water Boilers

During operation, steam boilers should be kept filled with water at least to the center of the water-gage glass or to the level indicated by the manufacturer. The instruction card furnished by the manufacturer should be kept nearby and directions followed carefully.

All accessories of the boiler should be in good working order and regulator parts oiled. A coat of paint applied to the external parts after the boiler is thoroughly cleaned will enhance the appearance and promote durability of the metal. Silicone-aluminum and other suitable paints are available for this purpose.

Boiler-Water Treatment

In localities where the water supply is unusually hard or where large amounts of fresh water are introduced into the system, boiler water may require treatment. Commercial compounds are available for this purpose but should be used with discretion, depending upon the hardness of the water supply.

Fresh water is frequently treated with lime and soda ash (sodium carbonate) to precipitate scale-forming salts, and disodium phosphate or trisodium phosphate may be added to boiler water to produce nonscale-forming precipitates. Commercial water-treating compounds often contain some of these chemicals.

Blowing Down a Boiler

Sometimes an excessive amount of dissolved salts or the presence of oil or organic matter in the boiler water causes foaming or priming of the water; that is, the carrying of small drops of water out of the boiler with the steam. Trouble thus caused can usually be relieved by replacing part of the boiler water with fresh water. Foaming may also be eliminated by blowing the surface water along with the foam from the boiler, while it is steaming, through a special pipe or hose that has been connected to a threaded opening in the boiler at or near the

level of the water line. This process should be continued until no visible foam is discharged from the boiler. This work should probably be done by an experienced heating mechanic.

Repairing Boiler Sections

Occasionally, sections of a cast-iron boiler crack from sudden heating or other causes. If this occurs, it is sometimes possible to mend a crack by brazing or welding, particularly if it does not pass through a machined surface. Brazing is more often used since the welding of cast iron is comparatively difficult. It is usually desirable to employ experienced workmen to repair a cracked boiler.

For sealing leaks in boilers, there are many effective compounds on the market similar to those used in automobile radiators, but they should be regarded as temporary expedients. Flaxseed meal has also been used for this purpose.

Repacking a Leaky Radiator Valve

If a radiator valve leaks around the stem, it should be promptly attended to, in order to avoid damaging the floor and possibly the ceiling below the radiator. Worn or insufficient packing inside the nut or a loose packing nut at the base of the stem may cause a leak (see fig. 36). To remedy this, the nut should be tightened. If the leak does not stop, it will be necessary to repack the valve.

Many radiator valves are so constructed that the packing nut can be raised without lowering the pressure in the radiator. In a hot-water

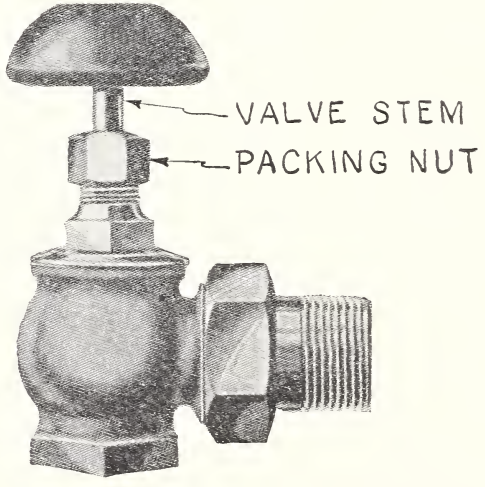


FIGURE 36.—*Typical radiator valve.*

system where the type of valve used permits water or steam to escape after the valve is closed and the packing nut loosened, the level of the water must be lowered below the height of the valve by opening the drain cock of the system; with a steam system, the pressure should be reduced by allowing the boiler to cool.

Two forms of packing may be used to pack a valve stem; washers of different sizes, or packing cord. If washers are used, the valve handle should be removed by loosening the screw that holds it. After the handle is removed the packing nut can be withdrawn from the stem. The old packing should be taken out and the new packing washers slipped over the stem. The new washers must be of the right number and size to fill the packing space in the nut. If cord is used, a sufficient amount should be wrapped around the valve stem to fill the packing space in the nut. The nut should be tight enough to prevent water and steam from escaping, but not so tight as to produce excessive friction on the stem when the valve is turned.

For a steam-heating system, it is advisable to let the fire go out, or at least to have a low head of steam, before starting work on the valves. After the system is cool enough to work on, the valve should be closed tightly and the packing nut unscrewed at the base of the stem, to permit packing the space between the inside of the nut and the stem with metallic packing compound, using a small screw driver for the purpose. This compound may be purchased in small quantities from a dealer in heating supplies. It may be easier to pack the nut, if it is removed from the stem. To do this, remove the handle and lift the nut from the stem. After the nut has been well packed, screw it down tightly and refill the system, as described in section 1 of this chapter.

2. CARE OF HEATING SYSTEM

A heating system should be maintained in good condition not only for operating economy but also to prolong the life of the equipment. Even during the heating season, the interior of the furnace should be inspected occasionally and cleaned if enough soot and dust have accumulated to materially lower the efficiency of the furnace. If the amount of soot collected seems excessive, it may be that the wrong kind of fuel is being used, that the furnace is not adjusted properly, or that the dampers are not set to produce complete combustion.

Furnace and Chimney

At the end of the heating season, all heating surfaces of a furnace should be cleaned thoroughly of soot, ash, and other residue. The smoke pipe should also be cleaned and the chimney, if necessary. In most localities, heating and plumbing concerns clean furnaces with

vacuum systems which do not spread dust to other parts of the house. Professional chimney sweeps may be employed to inspect, clean, and repair chimneys.

The smoke pipe of a furnace should be inspected for holes or perforations caused by the corrosive action of flue gases. It should be assembled with sheet-metal screws and held in place, if necessary, by wire or other incombustible supports. After cleaning, the smoke pipe should be placed in a dry place until the furnace is to be used again. Unless properly cared for, it may be necessary to replace a smoke pipe every 2 or 3 years.

The inside of the furnace should be cleaned through the clean-out door with a wire brush and scraper. After cleaning inside and out, the heating surfaces of steel boilers should be given a coat of lubricating oil on the fire side to prevent rust, provided the furnace is not to be used during the summer. If desired, the oil may be applied by spraying. All machined parts should be coated with oil or grease. Broken or defective parts should be replaced and all loose joints made tight. Furnace door hinges should be inspected, and warped or broken grates replaced. The grates and ashpit should be cleaned.

Clogged Grate

If a furnace burns coal, the fire should be shaken down at least twice a day to remove the ashes and to afford a better draft through the grates. The ashpit should be cleaned out daily, because, if it is permitted to fill to a level where ashes touch the grate bars, there is danger of warping or burning out the grates.

In most furnaces and stoves, there are clean-out doors just above the grate surface through which a poker may be inserted to break up and pull out clinkers. If unusually large or hard clinkers lodge between the grate bars so that it is impossible to shake the grate or turn it over, the fire should be allowed to die out and the fire pot cleaned to give free access to the grate and permit removal of the obstruction. When the fire pot has been emptied, the poker can be used to better advantage and the obstruction dislodged or broken up. The grate should not be turned forcibly, as this might break it.

Soot Removers

Soot removers are intended to free heating surfaces of the furnace or boiler, the smoke pipe, and the chimney from soot. Certain metallic chlorides, which can be vaporized by a hot fire and deposited on the surface of soot to lower its ignition temperature, may be used for this purpose. These chlorides are copper chloride, lead chloride, tin chloride, zinc chloride, chloride of lime, and sodium chloride (table

salt), of which copper chloride is the most effective and sodium chloride the least.

Finely divided metals, such as lead, copper, or tin may also be used to reduce the amount of soot, but they are not as effective as the chlorides of the metals.

Some commercial soot removers contain a certain percentage of the metallic chlorides mentioned above and will assist in the reduction of soot in the heating plant, but will seldom have much effect in the smoke pipe or chimney.

The burning of soot in the furnace, smoke pipe, and chimney should preferably be done on a rainy day by someone familiar with such work. The removal of soot requires such a high temperature that, unless the soot fire is carefully handled, it can easily get out of control. Combustible materials in the attic and shingles on the roof should be carefully watched for an hour or two after application of the soot-burning treatment to observe any indications of fire and to be in position to take whatever action may be necessary, in case fire should occur.

Furnace Water Pipe

The water pipe frequently found in the combustion chamber of coal furnaces for heating domestic hot water may need replacement at intervals of a few years. These pipes may become burned on the outside from overheating or clogged on the inside with scale precipitated from the water as it is heated. They may be renewed by draining the domestic hot-water system and replacing the original coil with lengths of standard pipe, bent or coiled to fit.

Repairs to Chimneys

Most cities require that masonry chimneys with 4-inch wall thickness be lined with a fire-clay flue lining, but unlined chimneys may be used if the walls are 8 inches thick or more. The chimney should be examined to determine the soundness of mortar joints. Sometimes, mortar crumbles, leaving openings in the joints and, unless these openings are repaired, they become a dangerous fire hazard, especially in cold weather when drafts are strong and the furnace is being fired to capacity. Joints, in which mortar has crumbled, should be raked out to solid mortar before repointing. If the mortar has deteriorated too much, the chimney should be taken down and rebuilt.

Flue Openings

Only flue openings that are in use should be left open; no more than one opening per floor should be used. It is common practice, however, to connect gas and oil hot-water heaters to the same flue that serves the

house-heating equipment even when they are on the same floor. Hot-water heaters should be connected to the flue from 18 to 24 inches above the connection for the heating plant. If the smoke pipe extends into the flue space, it should be cut back flush with the flue wall. If the smoke pipe enters the chimney on a descending slope, its position should be changed to enter at an ascending slope.

3. INSULATING HEATING SYSTEMS

Insulation on the boiler and pipes of a heating system will increase the efficiency of the system and reduce the cost of operation. Heat loss from a furnace or piping that is not properly insulated is not entirely lost as it warms the basement and first floor and, in some cases, may contribute a large share of the heat required in a house. However, in summer, if a boiler is operated to provide domestic hot water, such heat losses serve no useful purpose and are, in fact, undesirable and uneconomical, making insulation advantageous.

The small amount of heat that escapes through the insulating material on hot-water pipe, combined with radiation from doors or other exposed parts of the boiler, will warm the basement slightly, if it is well constructed and properly weatherproofed, but ordinarily not enough to provide a comfortable temperature in cold weather.

The extent of insulation is usually governed by the type of heating system and the conditions that exist. The boiler and pipes through which water or steam is distributed to radiators should be covered, but the advisability of covering the return pipes depends upon the type of system and the amount of heat desired in the basement.

In hot-water heating systems, covering the return pipes is recommended in order that water may be returned to the boiler with the minimum of heat loss. In vacuum and vapor steam-heating systems, it is considered better to leave the return pipes bare, to aid in the condensation of any steam which might escape into the returns through defective thermostatic traps.

Properties of Insulating Materials

Insulating materials for covering a furnace or hot-water distribution piping should be fire-resistant and poor conductors of heat. Materials used for the purpose are corrugated or air-cell asbestos, 85 percent magnesite asbestos, and mineral wool and similar coverings. The insulation may be obtained in preformed shapes, as flexible rolls, or as a dry powder to be mixed with water to form a plastic cement coating which dries in place.

A description of how to apply some of these materials follows: An

FIGURE 37.—*Applying split pipe covering around hot-water heating pipes.*

air-cell pipe covering is made of layers of corrugated asbestos sheet wrapped in canvas. It is manufactured in sections 3 feet long in the shape of hollow cylinders split lengthwise on one side so that each section may readily be placed around the pipe (see fig. 37). The covering is made in several thicknesses and for various sizes of pipe. Each section has a canvas lap to be pasted over the longitudinal joint and a canvas flap at one end to be pasted over the joint between sections. To further bind the covering and make it neat-looking, metal bands are placed about 18 inches apart, over the joints between sections and around the middle of each section.

For insulating boilers and pipe fittings, such as valves, L's and T's, where the use of fabricated coverings is not practicable, asbestos cement or other refractory insulating cements may be used. They serve the same purpose as the pipe coverings because of their insulating and fire-resistive qualities.

The following tools and materials are needed: Steel tape measure, plasterer's trowel, hand saw, sharp pocket knife, pliers, metal tub or similar container for mixing cement, pan or dish for paste, and small, flat paint brush; asbestos air-cell covering for insulating pipes, asbestos cement, wire mesh, canvas, and paste.

The asbestos air-cell covering should be four-ply or 1 inch thick. To estimate the quantity needed, the pipe between fittings to be covered should be measured and the measurements combined for each size of pipe to obtain the total linear feet for each size of covering. Metal band fasteners are furnished with the covering.

To estimate the quantity of asbestos cement needed to cover the boiler and the pipe fittings, the entire surface of both the boiler and fittings should be computed. A 100-pound bag of cement will cover from 20 to

25 square feet of surface to a thickness of 1 inch. Some brands of cement are also available in 10-pound bags.

Sufficient 1-inch wire mesh or "chicken wire," to cover the surface of the boiler is necessary; the canvas should be of the same weight as that on the air-cell covering and large enough to enclose the cement covering around pipe fittings; the paste is the type sold by manufacturers of the covering material for pasting the canvas laps on air-cell coverings and for fastening canvas jackets over pipe fittings.

The paste may be purchased ready-to-mix to which cold water is added. If preferred, a paste may be made by mixing 1 part of powdered alum and 50 parts of sifted white flour in a small amount of cold water until smooth and then adding hot water gradually to the mixture; after which, it should be boiled until it reaches a paste-like consistency.

Asbestos Cement

Asbestos cement should be mixed thoroughly in a tub or large container, using only enough water to make the mixture workable. At least two coats should be applied to the boiler and pipe fittings and this should be done at a time when the pipes are warm to insure best results. The first coat on the boiler should be one-inch thick and the second coat one-half inch thick; each coat on the pipe fittings should be one-half inch thick. In all cases, the first coat should be applied roughly with the hands or with a plasterer's trowel, scratching the surface to insure a good bond with the second coat.

Boiler Insulation

When the first coat of asbestos cement on the boiler is fairly dry and before applying the second coat, the wire netting should be stretched

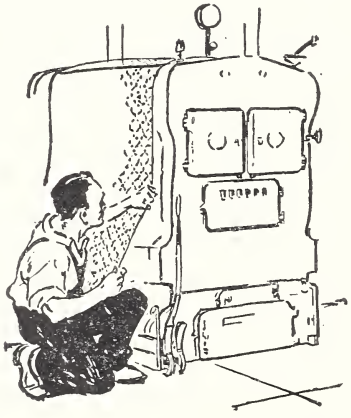


FIGURE 38.—*Applying "chicken wire" netting reinforcement.*

and fastened over the surface to hold the first coat. This will probably cause some cracking, but the wire will serve as reinforcement for both coats (see fig. 38).

Insulating Heating Pipes

Before hot-water and steam-heating pipes are covered, they should be clean and in good condition. The canvas lap on the pipe covering should be loosened and brushed along the edge with paste to refasten the lap. The pipe should then be encased with a section of covering placed with the open side up and with the end which has no canvas-joint overlap placed tight against the fitting and pressed closely together, pasting the lap securely over the longitudinal joint. The second section should be applied in the same manner, and pushed tightly against the first. The joint between the two sections should be sealed by pasting the overlap attached to the first section over the joint. The pipe covering should be continued in this way until the next fitting is reached. When a short section is needed, the covering can be cut with a sharp knife and handsaw.

For the fittings, the first coat of asbestos cement should be applied with the hands to a thickness of about one-half inch. The second coat on the boiler should be troweled smooth as it dries.

The next step is to finish covering the fittings by the application of a half-inch second coat or one of the same thickness as the pipe covering. This coat should be troweled smooth and beveled down to meet the surface of the pipe covering.

Asbestos cement on the fittings will be protected and will present a neat appearance if covered with a canvas jacket. The canvas should be of the same weight as that used on the pipe covering, and should be pasted down smoothly. To look well and preserve the canvas, it should be sized and painted with two coats of lead and oil in a suitable color.

Metal bands to hold the pipe covering should be applied after all other work is completed, so they will be clean and present a neat finished appearance. The bands should be placed about 18 inches apart, over the joints and midway between. They should be pulled up tightly and fastened with the pliers.

Warm-Air Furnaces and Ducts

A warm-air furnace and its ducts may be insulated to prevent the basement or utility room from getting too warm. Should a warm basement be desired, the supply ducts may be left uninsulated. In any case, it is not necessary to cover the return ducts.

The following tools and materials are needed: Steel tape measure, pencil, heavy shears or sharp knife, wire-cutting pliers, small trowel, and container for mixing asbestos cement; corrugated asbestos pipe covering, black or galvanized wire, and asbestos cement.

The quantity of corrugated asbestos paper should be sufficient to provide a three-layer covering for all pipes and the furnace, if not already insulated. The material is sold in rolls about 37 inches wide that contain about 250 square feet of material. For the average 7- or 8-room house two rolls are sufficient.

The wire should be No. 16 or No. 18 gage, black or galvanized. One small roll will be needed to hold the covering in place. A 100-pound bag of asbestos cement should be sufficient to cover the sloping shoulder of the furnace; about 20 to 25 square feet of surface to a thickness of 1 inch. Some brands of asbestos cement are also sold in 10-pound bags.

Insulating Materials for Warm-Air Systems

Insulating materials suitable for use on warm-air heating systems may be corrugated-asbestos paper or similar insulators designed to form a tight-fitting jacket and asbestos insulating cement to cover the irregular surfaces of the furnace.

The corrugated-asbestos paper should be wrapped around the ducts and the cylindrical surface of the furnace and laid on top of it. Asbestos insulating cement may be used to cover the sloping shoulder of the furnace.

Application to Straight Ducts

Before ducts are covered, they should be clean and in good condition. To get the measurement of the covering, add an extra 1½ inches to the distance around the duct to allow for thickness of the material and cut a strip of that length from the roll, wrapping it around the duct and tying it in place with a cord or wire in the middle and at each end (see fig. 39). After this, measure around the outside of the covered duct and add 1½ inches to get the length of the second piece. Tie this piece around the duct over the first piece, staggering the end and longitudinal joints, and proceed in the same way to apply the third or top layer. Finally, the three layers should be bound together by fastening bands of wire around the covering at intervals of about 18 inches.

Bends in Ducts

It is not absolutely necessary to cover the bends in ducts because they form but a small part of the system, but it is not a difficult task

FIGURE 39.—*Covering warm-air furnace ducts.*

and will add to the efficiency and appearance of the covering. A 90° bend will require two or three pieces cut especially to fit, depending upon the number of separate sections in the bend. These pieces should be diamond-shaped to conform to the surface to be covered. The dimensions may be obtained by measuring the widest and the narrowest parts of the bend, as illustrated in figure 40. When all of the ducts and bends have been covered, a smooth-finished appearance may be secured by pasting strips of asbestos covering over the joints.

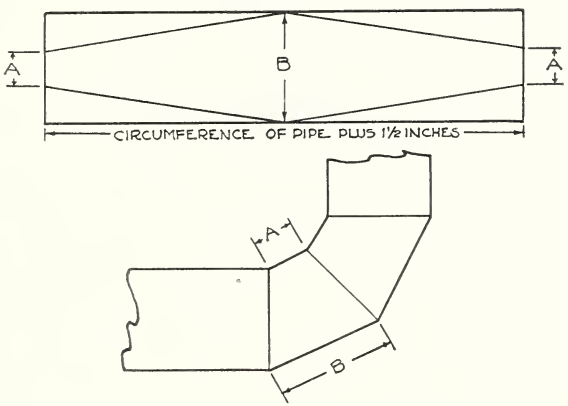


FIGURE 40.—*Pattern for cutting pipe-bend covering.*

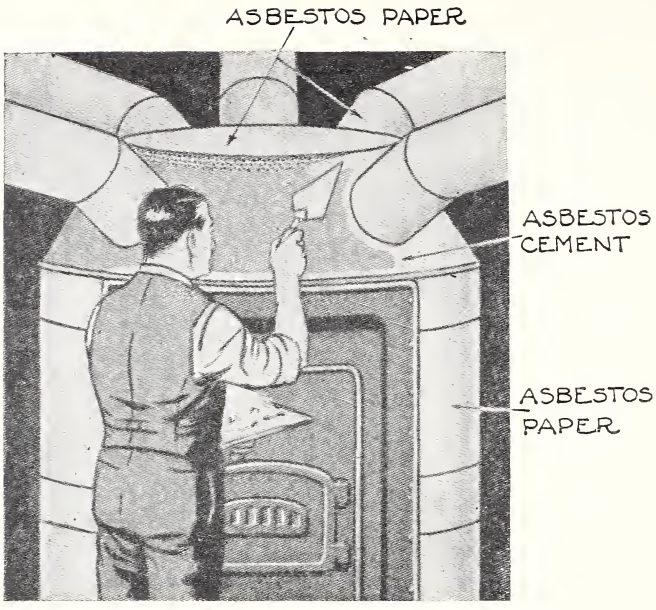


FIGURE 41.—*Covering a warm-air furnace.*

Furnace Insulation

To cover the vertical surface of the furnace, wrap from one to three layers of corrugated-asbestos paper covering around it, and fasten with bands of tie or stove wire (see fig. 41). The ends of the wires may be attached to bolts or other projections at or near the furnace doors. Obviously, holes for doors and other attachments should be cut in the covering.

The top of the furnace may have a hollow shape and be filled with sand. The furnace top can also be insulated by laying three or four layers of corrugated asbestos paper over it. These pieces may be held in place by extending the asbestos-cement shoulder coating up over the edges of the covering, as shown in the illustration.

The sloping shoulder of the furnace from which the ducts lead can be insulated with a covering of asbestos cement to a thickness of ½ to 1 inch. The cement, which comes in powdered form, should be mixed with just enough water to make it workable, applied to the furnace, and troweled smooth.

4. INSULATING HOT-WATER TANKS

Hot-water tanks heated by pipe coils in a coal furnace or by a water-back in a coal cooking range should not be insulated because such tanks are more likely to become overheated than uninsulated tanks.

Domestic hot-water heaters are usually insulated, thicker insulation being used on electric than on gas or oil heaters because electricity is ordinarily more expensive than gas or oil. If a domestic hot-water tank is not well insulated, it may cause discomfort in summer because of heat radiation.

Tank covers may be bought ready-made to fit tanks of standard sizes. They are made of incombustible heat-insulating materials, similar to those used for pipe and boiler coverings. Some have the appearance of a large section of pipe covering, split lengthwise on one side, so that they may be readily wrapped around the tank. If connection pipes are in the way, openings for them can easily be cut in the covering at the joint edge. Metal bands, laces, or other forms of fasteners are furnished to hold the covering together. The top of the tank may be covered with asbestos insulating cement.

5. EQUIPMENT FOR WARM-AIR SYSTEMS

Filters

Filters are often used in forced warm-air heating systems to insure cleaner air in the living space. They require occasional cleaning, however, or replacement if they are the throw-away type. Should the filters become overloaded with dust and dirt, the amount of air circulation will be diminished, the air overheated and, in severe cases, the efficiency of the heating plant will be reduced.

The frequency of cleaning or replacement of filters will depend upon the amount of dust which accumulates. Permanent-type filters may be cleaned by tapping the filter frame to shake the dust out or by washing the filter medium with soap and water or cleaning fluid. Throw-away type filters are not intended to be cleaned and are made of inexpensive materials so that they may be replaced at nominal cost.

In gravity warm-air heating systems where air filters cannot be used or in forced warm-air systems that have no filters, dust may accumulate on the heating surfaces of the furnace, and in the warm-air supply ducts. In such cases, the accumulated dust on the heating surfaces may give off an unpleasant odor when the furnace is being fired to capacity. If this odor becomes objectionable, the furnace and piping should be cleaned by commercial vacuum cleaning methods. If such services are not available, it may be necessary to dismantle the furnace and piping, in order to properly clean them. Where possible, an air filter should be installed to avoid recurrence of this trouble.

Humidifier Pans

Manually and automatically supplied humidifier pans are used in warm-air heating systems. In the automatic type, the mechanism for

regulating the water flow to the pan sometimes fails to work properly because of the continuous evaporation of water. Precipitates, scale, or solids may form on parts of the mechanism, eventually preventing free movement of the levers and pins. Thorough cleaning of all parts should restore normal operation. The valve that controls the flow of water into the pan may also become worn after long usage and require replacement. If excessive dust, dirt, or scale have accumulated in a humidifier pan it should be cleaned to avoid unpleasant odors.

Grilles

Floor grilles or registers may require frequent cleaning, since dust and small objects can easily fall into a register. This cleaning can usually be done from above the floor with a vacuum cleaner. If large objects have become lodged in the warm-air supply pipe, however, it may be necessary to dismantle the pipe in order to remove the objects.

Wall grilles or registers are not directly subjected to dust or other accumulation as are floor grilles, but may require dismantling for cleaning if they become clogged.

6. HEATING EQUIPMENT

Hand-fired heating equipment seldom needs adjustment other than to keep the system in good working order. Automatic heating equipment, such as hot-water heaters, coal stokers, oil burners, and gas-fired furnaces have more complicated mechanisms and sometimes need adjustment or repair that the householder is unable to make. If trouble occurs, the adjustments and repairs should preferably be made by the contractor or dealer who installed the equipment or by the utility company that services it.

Electric Motors for Automatic Systems

Electric motors used for driving blowers, pumps, or oil burners should be inspected and oiled at least once every heating season. Some single-phase motors, which are the type generally provided, use a pair of brushes in the starting mechanism; they may wear out and require replacement after several years' operation. Motors that are not totally enclosed often accumulate dust inside the casing which, in time, may interfere with the operation of the starting mechanism. Sometimes they can be cleaned sufficiently by forcing a jet of air through the casing, but often the motor has to be disassembled and washed with a solvent, such as carbon tetrachloride, to remove the accumulated dust and grease on the interior.

Blowers also require seasonal lubrication and may require cleaning where filters are not used in the system. The belts connecting blowers to motors may wear out in a few years' time and need replacement.

Coal Furnaces or Boilers

Too much fly ash in the flue gas passages and smoke pipe may cause smoking and improper heating. After several years' operation, it is not unusual to burn holes in the heating surface of a warm-air furnace allowing smoke or flue gas to mix with the warmed air which is circulated throughout the house.

If the water level is allowed to become low in a steam or hot-water boiler, the heating surface of the boiler directly over the fire may be burned or warped, causing a serious leakage.

Ashes should not be permitted to accumulate in the ashpit to a depth where they can touch the bottom of the grate, as by so doing the passage of air will be blocked. This may cause the grate to overheat and become warped or burned.

With certain kinds of coal, clinkers may form in the firebox and, if not removed, can appreciably reduce the amount of combustion air passing through the grate so that the heating plant will not properly heat the house.

Formation of clinkers is caused by excessive stirring of the fire in such a way that the ashes become mixed with the active fuel. Care should be exercised in removing clinkers so as not to damage the grates. Some furnaces have clinker doors just above the grate level, but in others, clinkers have to be removed through the firing door.

Automatic Coal Stoker

Stokers are intended to feed coal automatically into a furnace or boiler. The most common residential stoker is the underfeed type where a coal-feed screw, driven by an electric motor, supplies fresh coal from either a hopper or a storage bin into the firepot of the furnace. Air necessary for combustion is forced by a motor-driven fan through openings in the firepot.

A shear pin is usually provided in the shaft of the coal-fired screw to protect the other parts of the mechanism in case the feed screw becomes jammed with large pieces of coal or other solid material which may be in the coal. If this occurs, the obstruction should be removed and the shear pin replaced.

Sometimes the "hold-fire" control, the purpose of which is to maintain the fire in the firepot, whether or not heat is required, feeds too little coal allowing the fire to go out, or feeds too much coal causing the house to be overheated in mild weather. Adjustments to correct this condition should be made by someone experienced in such matters.

While an anthracite stoker is in operation, the ashes are being pushed to the outside edge of the fuel bed to fall into the ashpit for removal. If bituminous coal is used in the stoker, however, clinkers which form may be removed through the furnace door.

When the heating season is over, coal, ash, and clinkers should be removed from the system and the stoker cleaned. The coal-feed screw and inside surfaces of the hopper should be coated with oil to prevent rust. Before the system is again put in operation, the stoker should be inspected, repaired if necessary, and adjusted by a competent service man.

Automatic Oil-Burning Equipment

For mechanical service during the heating season, firms that supply oil for domestic burners have a yearly basis plan for repair and replacement of worn burner parts by which they agree to respond to emergency service calls, inspect boiler and burner, vacuum clean boiler, adjust controls, clean strainers, lubricate burner, analyze flue gases, adjust burner flame, and inspect burner for leaks.

Gun- and Rotary-Type Oil Burners

If the above service is not available, the home owner will find that the usual sources of trouble with gun- and rotary-type oil burners are clogged strainers, nozzles, and fuel lines, and improperly located ignition electrodes. Most oil burners have a strainer or filter attachment in the oil line at the inlet to the burner, the filter element or strainer of which is readily removed by taking off the housing or cover plate after the oil supply line has been closed. Use of a wire brush or jet of compressed air often proves the most effective means of removing the foreign matter from the strainer. Filters are not often cleanable and usually require replacement of the filter element or strainer. The nozzle and electrodes in most gun-type burners can be removed as one assembly through the rear of the burner. The nozzle can be removed by the use of suitable wrenches and should be carefully cleaned and reassembled. The electrode spacing is often about one-fourth inch, but is not the same for all burners and the manufacturer or his representative should be consulted for exact information. The electrodes should be near the oil spray, but far enough forward and above or below the nozzle so that the spray will not strike them.

Pot-Type Oil Burners

To avoid a smoky, sooty flame in a vaporizing pot-type oil burner, the proportion of fuel and air should be properly adjusted. In the case of

improper draft or wrong adjustment of the combustion air, the burner may need cleaning more frequently than once a season, and sometimes as often as every few weeks. A chimney of at least 15 or 20 feet in height is usually required to produce enough natural draft to operate a pot-type burner. An automatic draft regulator, placed between the oil burner and the chimney, is often used to maintain a steady draft at the proper level. Draft regulators will not function, however, if the chimney is not of sufficient height, in which case a small forced-draft fan can be used. The pot-type burner is usually cleaned by hand through the inspection door of the heater.

Soot in Oil Burners

Commercial soot removers (described in sec. 2 of this chapter) may assist in removing the soot from the burner and combustion chamber, but ordinarily they will not remove the hard carbon that forms on the bottom of the firepot. The oil-feed pipe between the float valve and the burner sometimes becomes stopped with carbon and must be cleaned by forcing a rod through it. In any case where a soot remover is used to burn the soot from a heater that has a smoke pipe, the chimney should be carefully watched for an hour or so because a soot fire may develop in the chimney which might ignite combustible materials adjacent to the chimney.

Gas Burners and Automatic Gas Furnaces

The most frequent difficulties with gas burners are the sticking of the plunger of the main gas valve, the accumulation of gum or other foreign matter in the pressure regulator, and the extinguishing of the pilot light. Repairs to the gas valve and regulator should be made only by the utility company's representative. A pilot light may be relighted by the home owner after ample opportunity has been given for the combustion chamber to be aired out and after making certain that the main gas valve of the appliance has been closed. In case the pilot light becomes extinguished for an unknown reason, the furnace operation should be watched carefully for a time after relighting it to determine whether further maintenance or repair may be necessary.

Another source of trouble is improper adjustment of the primary air nozzle. If too much air is supplied, the flame will burn above the burner ports and not be in contact with the burner ports as it should be. If, on the other hand, too little air is supplied, the flame tips may become yellowish. Adjustments of the primary air shutters should be made by a representative of the utility company.

Pilot lights on gas-fired furnaces are sometimes left lighted during the summer to prevent condensation and rusting inside the furnace.

Gas Heaters

While unvented gas heaters are permitted for some installations, and those approved by the American Gas Association are not expected to produce enough carbon monoxide to be hazardous, it is recommended that unvented gas heaters not be kept lighted in bedrooms during the night or when the occupants are sleeping. Asphyxiation can occur without arousing the sleeper.

For repairs to the piping, radiators, and duct work, a plumber or heating mechanic should be called.

Electrical Heating Equipment

In most localities, heating the entire house by electricity is too expensive to be generally used. Portable electric heaters, however, are a convenient source of heat for bathrooms or other areas where occasional heat is needed.

Electric heaters require little maintenance except for the replacement of burned-out heating elements or defective switches. In some cases, switches may be repaired by polishing the contacts that have become pitted or corroded by repeated arcing. Portable electric heaters should be supplied with extension cords of ample capacity, having adequate protection for the wire. Portable electric steam radiators should be checked occasionally to determine whether they contain sufficient water to cover the electric heating element. Radiant electric heaters should not be located too near furniture or drapes as the radiation may overheat and ignite combustible materials. Laundry should not be dried over radiant heaters because of the fire hazard involved.

7. STOVES

Cracks in a Stove

A crack in the iron casing of a stove can be repaired by filling the crack with stove putty or commercial iron-repair cement made of iron filings and water glass (silicate of soda). Enough of the filings should be used to form a thick paste. The paste should be forced well into the crack with the aid of a small trowel or putty knife, and the surface of the crack plastered over with the same material. Heat from the stove will harden the cement and make a tight joint.

Another iron mender can be made of iron filings, flowers of sulphur, and water, mixed to a stiff paste and applied to the crack in the same manner as described above. The mixture burns when heated and turns into iron sulphide, which fuses and welds into one mass with the iron of the stove.

Summer Storage

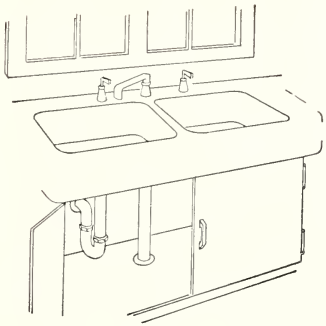
Stoves for heating are usually stored during the summer months. Before being placed in storage, however, they should be cleaned and polished and, if possible, wrapped with newspaper, burlap, or old carpet to protect them from dust and rust. They should then be stored in a dry place.

It is well to examine the grates and lining as soon as the stove is taken down and to have any needed repairs made at that time. If parts are found to be defective, an order should be placed promptly for replacements. The make and number of the stove is usually marked on the part which needs replacing and the identification should be given to the hardware or heating-equipment dealer when the order for the new parts is placed.

Stovepipe

Stovepipes need frequent cleaning, especially if the draft is poor. Soot collects in the pipe, particularly if soft coal is burned. Before taking down the pipe, it is well to cover the floor beneath and around the stove with newspapers or a drop cloth to protect the floor covering. The pipe should then be taken out of doors and away from the house before cleaning it of soot. Care should be taken, when handling the pipe, not to pound, dent, or bend the ends so as to make it difficult to fit them together again.

Stovepipe is usually made of sheet iron and should be kept polished to prevent rusting. When being put away for the summer, each length should be wrapped in paper and stored in a dry place.



10. PLUMBING AND WATER SYSTEM

1. WATER SUPPLY

The plumbing of a residence includes pipes for distributing the water supply, fixtures for using water, and drainage pipes for removing waste water and sewage, together with fittings and accessories of various kinds.

Each part of a plumbing system is designed for a specific purpose and should be used only for that purpose.

Grease or refuse should not be thrown into closet bowls, sinks, or lavatories; faucets should be tightly closed when not in use; and waste pipes should be flushed frequently with hot water to keep them in good working order.

Some local or State plumbing regulations permit only licensed plumbers to make major installations or repairs. However, although the average householder cannot be expected to perform all of the work of an experienced plumber, it is possible for him to make many small repairs. Trouble and unnecessary expense will be avoided by promptly repairing a leaky faucet, or by cleaning out a fixture drain at the first signs of clogging. If difficulty involving the pipes arises, a plumber should be called in. In some localities, plumbing shops on wheels furnish quick service to the householder.

Shutting Off Water

The flow of water in a house is controlled by means of stopcocks or

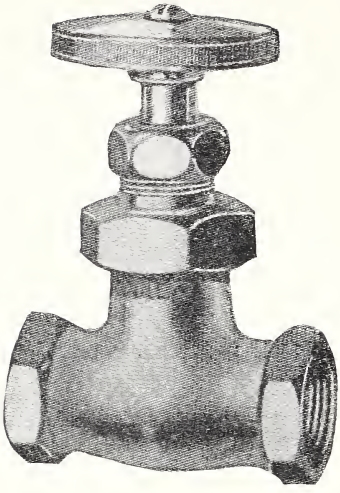


FIGURE 42.—*Typical water shut-off cock.*

shut-off valves in the pipes. To shut off the main supply of water, as it enters the house, it is necessary to close the wall cock or valve which is usually in the main pipe in the basement. This cock may have a handle, or a wrench may be needed to turn it. It may be of the ground-key type with a small hole bored in its side for draining the pipes after the water is shut off, or it may be a compression-stop type with a cap nut covering the drain opening. In either case, this opening should be closed when the water is turned off, for, if not closed, a stream of water will shoot from the hole with considerable force.

Where means have not been provided for shutting off a drain opening, a small wooden peg driven into it will temporarily stop the flow of water until the pressure is relieved by draining the pipes through the faucets.

If a house is left vacant during the winter months, it is safest to have the water shut off at the curb cock to prevent freezing between the cellar wall and the main shut-off or wall cock.

Separate shut-off cocks are sometimes provided below the sink, lavatory, water closet, or other fixtures for convenience when repairs are to be made, so that the flow of water may be cut off from any one fixture without disturbing the flow to the other parts of the system (see fig. 42). It is important that all members of the family know where these various shut-offs are located, especially for use in cases of emergency.

Draining Pipes and System

For minor repairs, such as the replacing of a washer in a faucet, the

temporary shutting off of the water from the branch shut-off described above is sufficient. Where extensive repairs such as pipe changes are proposed, the main water supply should be cut off and the pipes drained. If a house is to be vacated, with no heat provided during cold weather, it is advisable to drain the entire water system. A reliable plumber should be engaged to perform this service and to do whatever else is necessary to protect the piping and fixtures against freezing and possible damage.

To drain the pipes, first shut off the water, as previously described. Then, starting at the top floor, open all faucets on the way down. When water ceases to run from the faucets, the small cock or cap in the main pipe valve may be opened or the plug removed to allow what little water remains to drain into a bucket or tub.

In addition to draining the pipes, the water that remains in the traps under sinks, water closets, tubs, lavatories, and showers, should be removed by opening the traps and draining them, by forcing the water out with a force pump, or by drawing it out with a suction pump or siphon hose.

The water-closet tanks should also be emptied by flushing, after the water has been turned off, and any surplus water taken out with a sponge or cloth. The water-closet traps can be cleared of water by means of a sponge tied to a stick or wire.

The traps may then be filled with kerosene, crude glycerine, or some similar nonfreezable liquid to form a seal against bad odors from waste pipes. Alcohol and kerosene mixed is a good solution to use, since the kerosene will rise to the top and prevent evaporation of the alcohol.

If a house is to be left unoccupied and there is danger of freezing, the hot-water supply tank should be emptied by opening the faucet at the bottom of the tank. To facilitate the flow of water all hot-water faucets should be open while tank is being drained.

If the house is heated by hot water or steam and is to be left unoccupied during winter months, the system should be drained unless an automatic oil or gas burner is used to maintain above-freezing temperatures in the house. To drain the system the fire should be out, the main water supply shut off at the wall or curb, and the water from the boiler drawn off by opening the draw-off cock at the lowest point in the heating system. The water-supply valve to the boiler should be opened so that no water will remain trapped above it. After that, in any hot-water system, beginning with highest radiators, the air valves on all radiators should be opened as fast as the water lowers. In a one-pipe steam system every radiator valve should be opened to release the water or condensation. After a heating system has been drained, never start a fire under the boiler until it has been properly refilled (see ch. 9, sec. 1).

If a house is to be left vacant in the summer, it is not necessary to drain the water supply pipes or system although the water should be shut off at the basement wall as a precaution against waste of water from a dripping faucet or possible leak in the piping.

Faucets

Faucets generally used in dwelling houses are of three types: compression, Fuller ball, and ground-key.

The compression type of faucet is usually fitted with a lever, T, or four-ball handle which offers firm resistance to efforts to turn down the spindle much beyond the point where the flow of water stops. The stem of the spindle may be seen to move in or out of the body of the faucet when the handle is turned. A self-closing faucet is usually of the compression type.

Fuller ball faucets are generally fitted with a lever handle and the stem does not move in or out of the body of the faucet when the handle is turned. When a Fuller ball is in good condition, the handle should require but one-quarter turn to open or close the flow opening.

The ground-key faucet is easily distinguished by the lever handle and plunger, which is made in one piece, and by the exposed nut or screw at the lower end which holds the plunger in place.

It is sometimes impossible to determine the type of faucet from the outside appearance. If so, the only way to find out will be to dismantle it. At the same time, the kind and size of washer or Fuller ball may be determined and the condition of the brass screw examined to see whether or not it needs replacing.

Compression.—In the ordinary compression-type faucet illustrated in figure 43, the flow of water is regulated by turning a lever, T, or four-ball handle which is attached to a threaded spindle. When the spindle is turned down, the washer or disk attached to its lower end is pressed tightly against the smoothly finished ring or "ground seat" which surrounds the "flow opening," thus shutting off the flow of water. If the washer and the seat do not make a firm contact at all points, water will leak through and drip from the faucet. A leak usually results from a worn-out washer. If washers wear out rapidly, it may be because a poor grade of washer is being used, because the ground seat has become sharp and rough as a result of corrosion, or because the seat has become scratched or worn by grit.

Moderate force on the handle of a compression-type faucet in good repair should stop all flow and drip. If a leak develops, it may be caused by faulty washers which are not difficult to replace. It is important that faucets be tightly closed after they are used because dripping faucets tend to produce or aggravate leaks, waste water, and result in rust stains on porcelain surfaces. Soon after a hot-water

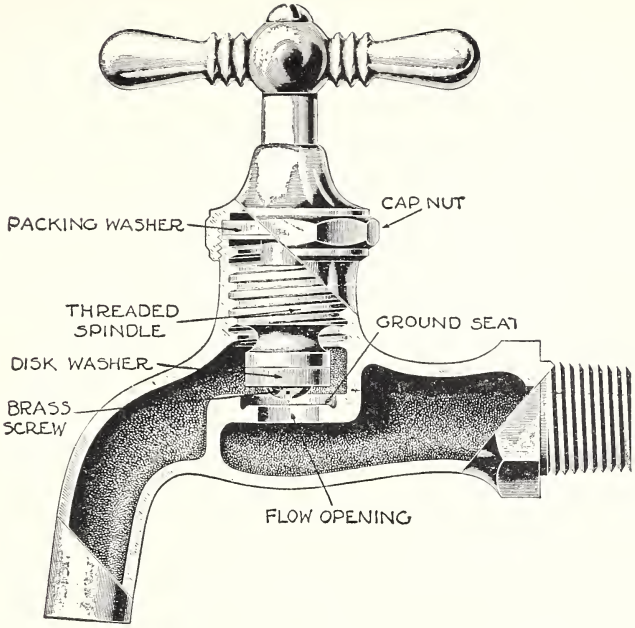


FIGURE 43.—*Cross section of compression-type faucet.*

faucet has been shut off and the water cools, contraction takes place which may cause a drip to develop. Should this occur, the spigot handle should be tightened without opening while the faucet is still cool.

The following tools and materials are needed: Monkey wrench, screw driver, and pliers; fiber or special composition washers for compression-type faucets.

To avoid frequent renewals, a good grade of washer should be selected. The sizes most frequently used are ⅜-, ½-, and ⅝-inch and it is well to have a supply of each size on hand. Composition washers have one side flat and the other side slightly rounded. A good contact is made with this type of washer because, by fitting partly down into the seat of the faucet, it is subject to both horizontal and vertical pressure. Some faucets require specially shaped washers the size and type of which should be determined for replacement.

To renew a washer, shut off the water directly below the fixture or in the main water supply pipe. If the water is shut off by the valve in the main pipe and there are fixtures located higher than the one in which the washers are to be replaced, the riser pipes to the higher fixtures should be drained before disassembling the faucet. If this is not done, it may be impossible to control the flow of water issuing from the faucet when taken apart. If shut-offs located directly below the fixture are

used, this precaution will not be necessary. Then, with a wrench (using a cloth to protect the fixture from being marred), unscrew the cap nut of the faucet to allow the spindle to be unscrewed and removed. Carefully remove the brass screw that holds the washer to the bottom of the spindle, and replace the worn washer with a new one. If the head of the brass screw is badly worn, it will be difficult to remove and may be twisted off, unless handled carefully. A drop or two of kerosene and gently tapping the screw may help to loosen it in the stem. The screw driver should have a good square edge and should be turned with a strong steady pressure. If the head of the screw chips off or breaks so that it does not hold the screw driver, the slot will have to be deepened by cutting into the head with a hack saw. A badly worn screw should always be replaced with a new one.

A worn or roughened washer seat can often be ground true and smooth with a faucet seat-dressing tool. Such a tool is inexpensive and will probably more than pay for itself within a reasonable time. One type consists of a stem with a cutter at the lower end and a wheel handle at the top to rotate the tool. It is fitted with a spiraled cone to be inserted into the body of the faucet and screwed down firmly for the purpose of centering and holding the cutter on the washer seat. When the tool is properly placed, it should be carefully rotated back and forth several times with the wheel handle until the seat is ground free of irregularities. When the grinding is finished, all metal cuttings should be wiped out with a cloth before the faucet is reassembled. If the seat is in such bad condition that it does not respond to this treatment and continues to cut the washers, it will be necessary to substitute a new faucet.

If water leaks around the stem when the faucet is open, it may frequently be stopped by tightening the cap nut, but the nut should not be made so tight as to cause the faucet to bind. If tightening does not stop the leak, it is probable that the packing washers under the cap nut are worn out and need renewing. To put in new washers, remove the handle and cap nut and substitute new washers for the old. To stop the leakage temporarily, wrap a small piece of oil-soaked candle-wicking or soft string around the stem under the cap nut where the stem enters the body of the faucet.

Fuller ball.—In the Fuller ball faucet, a hard rubber or composition ball-like stopper, known as the Fuller ball, is fastened by a small nut or screw to a shaft with an eccentric end (see fig. 44). When the faucet handle is closed, this ball is drawn firmly against the opening, shutting off the flow of water; when the handle is opened, the ball is pushed away from the opening, allowing the water to pass through. The best grade of Fuller ball should be used; the sizes range from $\frac{3}{8}$ to 1 inch.

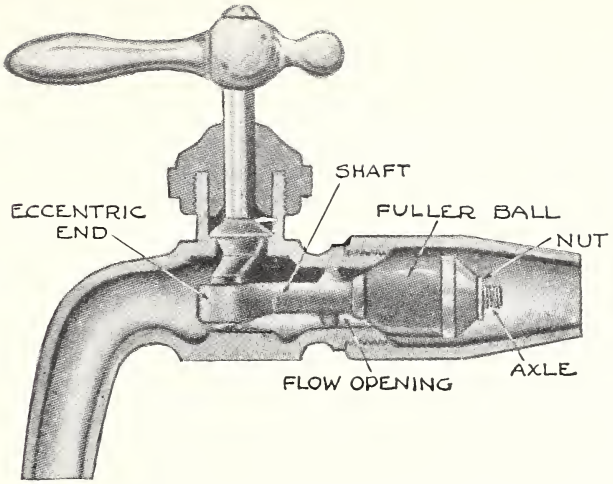


FIGURE 44.—*Cross section of a Fuller ball faucet.*

To replace a Fuller ball the water should be shut off and the faucet unscrewed and separated from the supply pipe. The nut or screw should be taken off with pliers or a screw driver and the ball removed and replaced with a new one.

Sometimes the metal axle which holds the Fuller ball or the eccentric part becomes worn, making it impossible to pull the ball tight against the seat, and allowing leakage between the ball and the seat. If this happens, it will be necessary to purchase new metal parts to replace the worn ones. If water leaks out around the stem when the faucet is open, repairs can be made in the same manner as prescribed for similar leakage in compression-type faucets.

Ground-key.—The ground-key faucet has a tapered cylindrical brass plunger or plug which should fit snugly into a sleeve, bored vertically through the body of the faucet (see fig. 45). The plunger, which is rotated by a handle, has a hole or slot bored horizontally through it, to coincide with a similarly shaped horizontal opening in the body of the faucet. When the handle that rotates the plunger is parallel to the body of the faucet, the two openings are in line with each other and allow the water to pass through. A short turn of the handle to the right or left throws the opening out of line and cuts off the flow.

The plunger or its sleeve may become grooved or worn by sand particles rubbing against the metal and allow the water to leak through. This requires repolishing of the rubbing surfaces. Also, the nut or screw at the bottom may become loose, permitting the plunger to move out of its proper position, allowing leakage. On the other hand, if the nut or screw is too tight, the plunger will bind and will be difficult to turn.

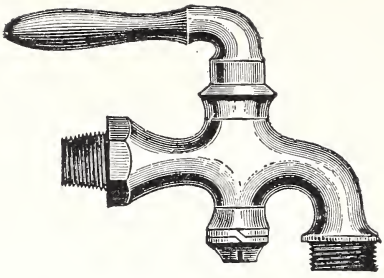


FIGURE 45.—*Ground-key faucet.*

Noise in faucets.—Sometimes when a faucet is partly turned on or suddenly closed, a water hammer, tapping, or pounding noise is heard. In a compression-type faucet, this may be caused by a loose cap nut, a worn spindle, or a defective washer. In a Fuller ball faucet, the ball may become loose, or the metal eccentric connecting the handle to the Fuller ball may become worn.

The following tools are needed: Monkey wrench, screw driver, and pliers.

To eliminate noise in a compression-type faucet, shut off the water and remove the spindle and washer so that they may be examined. If the washer is found to be loose, the brass screw should be tightened; if the washer is worn, the brass screw should be removed and a new washer attached. If the threads on the spindle or in the body of the faucet are badly worn, letting the spindle rattle, it will be necessary to purchase a new faucet.

If the faucet is of the Fuller ball type, shut off the water and tighten the small nut or screw which holds the Fuller ball; if the ball is badly worn it should be replaced. If parts of the eccentric are worn and tend to rattle, the faucet should be taken to a plumber. If the eccentric is beyond repair and new parts cannot be obtained, it will be necessary to install a new faucet.

2. PROTECTION OF PIPES

Water pipes which are exposed to freezing temperatures should be covered, especially if located out of doors or in unheated spaces. Smaller water pipes are more likely to freeze than larger waste or sewer pipes, since the latter carry water which has usually been warmed to some extent, and which flows off quickly leaving the pipe empty.

Insulating Pipes

For pipes located in an unheated basement, attic, garage, or out of doors where they are likely to freeze, it is well to apply insulation

similar to that used on hot-water and steam-heating pipes described in chapter 9, section 3. In severe climates, it is advisable to apply two thicknesses of this insulation and to break or stagger the joints and seams in order to make the insulation tight. If exposed to the weather, insulation should be protected by wrapping it spirally with cotton fabric tape or strips of saturated felt, followed by two coats of asphalt-varnish. Insulation may also be protected from the weather by constructing a water-tight box around the pipe.

Underground Pipes

When pipes are laid underground they should be buried deep enough to be protected from damage by heavy vehicles passing over them and to eliminate the danger of freezing. The depth depends on climate and local soil conditions.

Frost protection in the central and northern latitudes of the United States usually requires that pipe be placed from 2½ to 3 feet in the ground. In the extreme Northern States, it is well to go as deep as 4 to 6 feet, and in the Southern States a depth of from 1½ to 2 feet is usually enough covering to protect the pipe from damage.

Thawing Pipes and Drains

If water-supply pipes become frozen, they should be promptly thawed out to avoid possible bursting. In lead and soft copper pipes, a bulge in the pipe will disclose the location of the frozen area, whereas, in other metals, no such bulge will appear.

Some form of heat will be required to melt the ice in the pipes. The heat may be applied to the exterior of a frozen pipe by electrical resistance, direct flame, or hot applications of water or steam. In thawing out water pipes, it is best to work toward the supply end keeping a faucet open to indicate when the flow starts. When thawing out a waste or sewer pipe, it is best to start at the lower end and work upward, to allow the water to flow off as the ice is melted.

In heating frozen water-supply pipes by electrical resistance, a source of low voltage, such as a welding generator, should be connected directly to the water pipe with the two electrical conductors clamped to the pipe to span the frozen section. As soon as a section has been thawed out, the conductors should be moved along the pipe to thaw another section. A welding shop, or plumber who has welding equipment, and the necessary plumbing experience, should be called to perform this work.

Direct flame may be applied to frozen pipes with a gasoline blow torch, provided there is no danger of burning the adjoining woodwork. The flame should be played gradually along the pipe to spread the heat evenly.

Hot applications on a frozen pipe do not produce as quick results as direct flame, but are much safer because they lessen the fire hazard and the possibility of bursting the pipe.

Other methods of hot application may be used if the water pipes are accessible. They can either be wrapped with cloths and saturated with boiling water or the boiling water can be poured directly over the pipe. In both cases, a receptacle should be placed below the pipe to catch the water.

Steam, used by plumbers to thaw out pipes, is provided by a steamer resembling a 5-gallon oil can, having a hose and nozzle attached. The steamer is heated by a plumber's furnace.

Frozen traps, waste pipes, drains, and sewer pipes may be opened by pouring boiling water into them through the drain opening or trap. If this is not successful, a can of lye or drainpipe cleaner dissolved in two gallons of cold water in a porcelain container should be poured carefully into the drain opening or trap. Do not use hot water with lye or cleaner and avoid splashing the solution on face, hands, or clothing.

Condensation on Pipes

It may be desirable in some cases to insulate cold-water pipes to prevent condensation of moisture on them in hot humid weather. One type of insulation for this purpose is a cylindrical-shaped split pipe covering of wool insulating felt with a canvas jacket. This pipe covering comes in 3-foot lengths, is of various thicknesses, and is made for standard pipe sizes. It may be applied in the same manner as the insulation for hot-water and steam heating pipes described in chapter 9, section 3.

To prevent water vapor from reaching the outside surface of the pipe, a vapor-resistant covering should be applied to the surface of the canvas jacket.

If appearance is important, two coats of spar-varnish aluminum paint can be applied to the canvas jacket followed by one or two coats of paint in any desired color. Instead of aluminum paint, the jacket may be wrapped with aluminum foil, such as is sold for kitchen use, and painted. If the basement is damp, the paint should contain a fungicide to prevent mildew.

If appearance is not important, the canvas jacket may be wrapped and sealed with aluminum foil or with asphalt-impregnated paper, or it may be painted with an unbroken coating of asphalt.

In addition to the above, tape-form insulating coverings are also available which may be wrapped spirally around the cold-water pipes to a thickness of about one-fourth inch, as well as thick paints mixed

with insulating materials to be applied to the pipes in a coating of about one-fourth inch thickness.

3. DRAINAGE SYSTEM

Plumbing fixtures from which waste water is discharged are equipped with traps designed to retain enough water to form a seal and prevent gases and bad odors from entering the house through the drain. In general they cause little trouble, but occasionally they may become clogged by accumulations of hardened grease and dirt that need to be removed.

Traps

Before traps were manufactured as separate fittings, a single or double U-bend was made in the lead drain pipe below the fixture to provide for a water seal. Plumbing fixtures are now equipped with either a P or S form of separate trap fitted with a screw clean-out plug on the lower side of the bend (see fig. 46).

In the manufacture of water closets, suitable bends are cast in the lower portion of the bowl.

Drum and bottle-type traps for bathtubs or kitchen sinks consist of a cylindrical-shaped metal box or settling basin attached to the waste pipe. They are generally provided with a screw-cap cover, which can be removed when cleaning is necessary.

Causes of Stoppage

When waste water gurgles and seeps away slowly from a sink, washbowl, or bathtub, or backs up in the water-closet bowl, there is evidently foreign matter in the waste line that is retarding the flow of water. For example, the trap on the kitchen sink may be filled with hardened grease and settlings, or the waste pipe beyond the trap may be clogged by more solid material. Water-closet drains are often

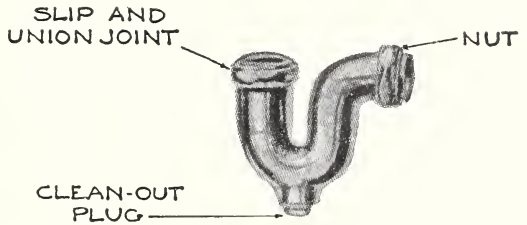


FIGURE 46.—*The "P" type trap, showing clean-out plug and joints.*

stopped up by toilet articles or other objects, which have been accidentally dropped into the bowl, or by cloth, or heavy paper.

For repair work, the following tools and materials are needed: Monkey wrench, screw driver, stiff wire with hook bend at one end, force cup or "plumber's friend," coil spring steel auger, small funnel, and galvanized water bucket; commercial drainpipe cleaner.

Removal of Stoppage

Stoppages in traps and waste lines may be removed by means of a force cup or plumber's friend, chemical drainpipe cleaners, by opening the trap, or by using a flexible coil spring steel auger.

Plumber's Friend

To open a clogged waste line, it is usually best to try a force cup or plumber's friend first. The plumber's friend is a stiff rubber bell-shaped cup about 5 inches in diameter fastened by its top to a stick about the size of a broom handle (see fig. 47). In using this tool, the sink or bowl should be partly filled with water, and the rubber cup placed over the mouth of the drain opening. After this the stick of the plunger should be worked forcibly up and down several times. The alternate compression and suction thus created will usually loosen minor obstructions.

The operation should be repeated until the pipe is cleared, after which boiling water should be poured into the drain to thoroughly clear the waste line. The force cup or plumber's friend is equally effective in removing obstructions from water-closet waste lines. Place the cup over the outlet in the bowl, and force the handle up and down until the passage is clear.

Chemical Cleaners

If flow through a trap, waste line, or drain becomes sluggish, and the use of a plumber's friend fails to remove the obstruction, a chemical drainpipe cleaner may be used.

Drainpipe cleaners may be lye (caustic soda or sodium hydroxide),

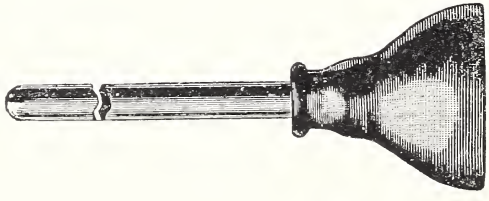


FIGURE 47.—*Force cup or "plumbers' friend."*

either as is or mixed with aluminum or zinc-coated aluminum turnings or chips. Mixtures of lye with sodium nitrate and aluminum turnings are also used for this purpose. Lye acts on the accumulated grease and insoluble soap curds that have formed in and are clogging the pipe. When water is added to mixtures containing aluminum and lye, they react vigorously, forming a gas, the stirring or agitating effect of which facilitates removal of the waste matter.

Warning.—Lye (caustic soda or sodium hydroxide) is a caustic poison. While handling this material or drainpipe cleaners containing it, the eyes, skin, and clothing should be protected from splashings. Be sure to keep water out of the can and do not let the material get on wood, painted surfaces, floor coverings, or aluminum. Flush with cold water only, and do not use a plunger.

If drainpipe cleaner gets into the eyes or into the mouth, call a physician at once and apply the following emergency treatments: For eyes; flush copiously and quickly with water and then wash with a 5 percent solution of boric acid in water. For internal treatment; drink one-fourth cup of vinegar diluted with two cups of water or two glasses of lemon, orange, or grapefruit juice, following this with two or three tablespoons of olive oil, butter, or other cooking oil. For external treatment; flood with water, wash with vinegar, and apply vegetable oils or butter.

If drainpipe cleaner has been spilled on floors, floor coverings, or clothing, the spot should be quickly flooded with water, then treated with vinegar, and finally rinsed with water.

The Federal Caustic Poison Act requires products containing caustic soda to be labeled "Poison," with directions for treatment of external or internal personal injury to be printed on the container.

Trap Clean-Out Plug

If use of the plumber's friend or chemical drainpipe cleaner do not clear the waste line, it is possible that the trap is clogged with refuse which must be removed. For cleaning purposes, a removable clean-out plug is sometimes provided in the lower side of the bend in the trap see fig. 46). Before opening the trap, a bucket should be placed under it to catch surplus water. The plug should then be unscrewed with a wrench and when the water has drained out, a bent wire should be inserted into the trap opening to pull out the accumulated grease and dirt. If possible, the trap should be brushed out well with a bottle brush and flushed by pouring boiling water into the fixture. If the washer or gasket around the plug is broken, it should be renewed before the plug is replaced.

Where the trap has no clean-out plug, it should be removed at the

slip joint provided for that purpose. The trap and adjoining pipes should then be cleaned out with the wire hook and bottle brush, as previously described.

Coil Spring-Steel Auger

In most cases, cleaning out the trap will allow water to flow freely, but there may be an obstruction in the pipe beyond the trap. In this case, a coil spring-steel auger should be inserted through the trap opening, and the obstruction either pulled out or bored through and forced out. The coil spring-steel auger is especially effective in opening clogged water-closet traps, drains, and long sections of waste pipe lines (see fig. 48).

Cleaning Drum or Bottle-Type Trap

In a drum or bottle-type trap, the screw cap is fastened in either the top or bottom, and may be removed when cleaning is necessary. In some cases, this cap is just as accessible as the plug on a U-bend trap but, when used in connection with bathtubs, the trap may be placed below the level of the floor and covered by a metal plate, which must first be removed before the cap is exposed. When the cap has been taken off, the grease and dirt can be removed and the trap and its openings washed out with boiling water.

The various methods recommended for cleaning out U-bend traps can be used with equal success on the drum or bottle trap.

Toilets

If water continues to run into the closet bowl after a toilet is flushed,

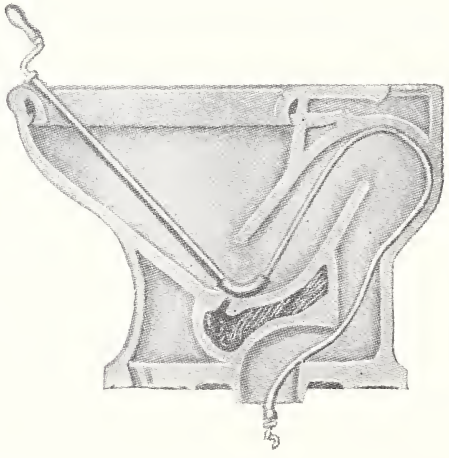


FIGURE 48.—*Water-closet bowl showing use of coil spring-steel auger.*

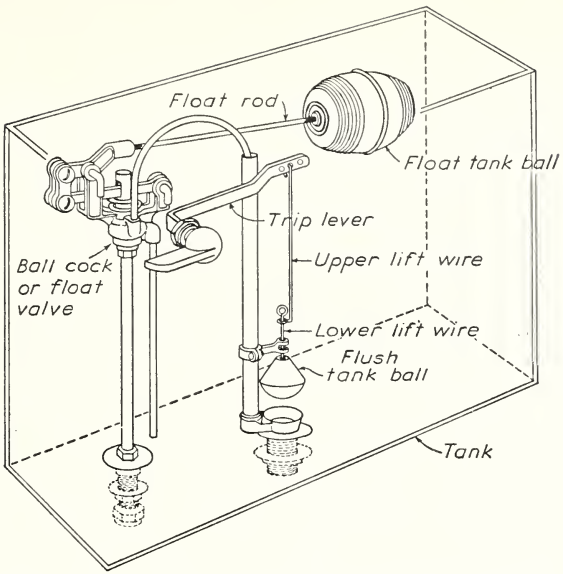


FIGURE 49.—*Flush valve mechanism for filling flush tank.*

it is evident that some part of the mechanism of the flush tank or flush valve is out of order and needs adjustment or renewal.

Flush tank.—The supply pipe that fills the flush tank is fitted with a lever ball cock, which operates somewhat like a compression-type faucet having a plunger with a rubber washer to close the opening (see fig. 49). The water supply to the tank is turned on and off by the raising and lowering of a hollow ball float connected to the plunger by a lever mechanism. When the flush valve is opened, and the water level goes down, the ball float goes down with it and the lever raises the plunger, allowing a fresh supply of water to enter the tank. When the flush valve is again closed, the incoming water gradually refills the tank and in rising carries the float up with it, slowly lowering the plunger into its seat and stopping the filling process. An overflow tube or pipe is provided in the flush tank to carry off the water should it rise above its proper level. This pipe empties into the closet bowl.

The opening and closing of the outlet from the tank to the closet bowl is accomplished by the raising and lowering of a rubber ball stopper suspended by lift wires, which are attached by another lever to the push button or handle on the outside of the flush box. When the button is pressed or the handle turned, the rubber ball stopper is lifted from its seat on the outlet pipe allowing the water in the tank to rush into and flush the toilet bowl. In the meantime, the stopper remains suspended until the tank is empty, when it again sinks to its seat where it is held in place by water pressure.

Leakage may occur either from the supply cock or the outlet valve and is usually caused by improper seating of the plunger in the first case or of the rubber ball stopper in the other.

If the water in the tank rises high enough to flow off through the overflow tube, the supply cock is out of order; if water leaks past the rubber ball stopper and out through the outlet valve, the fault lies with the valve. In either case, water will continue to run into the closet bowl after it has been flushed.

The tools needed in repair work are a small monkey wrench, pliers, and screw driver.

A rubber ball stopper that does not fit tightly over the top of the outlet pipe, a defective ball, an irregular stopper seat, or bent lift wires may cause an outlet valve to leak. Sometimes a ball may be covered with a slimy coating which can be wiped off. If the ball is worn, is out of shape, or has lost its elasticity and fails to drop tightly into the hollowed seat, it will have to be replaced. To replace the ball, empty the tank and, if there is no supply shut-off, place a prop under the lever arm of the copper-ball float to hold it up, thereby shutting off the intake cock and preventing the tank from refilling. Then unscrew the ball from the lower lift wire and attach a new ball of the same diameter as the old one.

It may be found that the top of the outlet pipe is corroded or covered with grit in such a way as to make an irregular seat for the stopper ball. If this is the case, the valve seat should be made smooth, if possible, by means of emery cloth or other abrasive, or replaced if this is not successful.

Sometimes the handle and lever fail to work smoothly, or the lift wires get out of plumb, causing the ball stopper to remain suspended or to incompletely cover the outlet pipe opening. The lift wires should be straightened and made plumb so that the ball will drop squarely into the hollowed seat of the outlet. The lower lift wire can be adjusted by means of the adjustable guide arm, which is usually fastened to the overflow pipe. The thumbscrews should be loosened to raise, lower, or rotate the guide arm until it is centered directly over the outlet seat. There are various ways in which the intake cock can get out of order: The seat washer on the bottom of the plunger may become worn, the seat itself may be irregular, or the intake cock may be in good condition but may not work properly because of faults in the copper-ball float or its attachments.

A leaky water-logged float will hold the plunger up and fail to shut off the water completely. If there is a leak in the ball, it is advisable to buy a new one. If the rod that connects the float to the plunger lever has become bent, it may allow leakage by not lowering the plunger sufficiently to completely shut off the flow of water. In this case, the rod should be removed and straightened.

Sometimes, because of faulty installation, the tank will overflow or may not fill sufficiently. This can be corrected without disturbing the supply cock by bending up or down the rod which is attached to the copper float. If the rod is bent up, the water will rise higher in the tank, but if bent down, the water will not rise so high.

To replace a washer on the plunger of the intake cock, the water should be shut off by means of the shut-off valve, which is usually located below the flush tank, after which the tank can be drained and bailed out. The two thumbscrews should then be unscrewed to release the plunger. The old washer, held in place by a nut and brass ring cap, can be removed and the washer replaced. The brass ring cap, into which the washer fits, may be corroded and break while being taken off. If this occurs, a new ring should be substituted. Be sure that the seat upon which the plunger rests is free from nicks and grit; if not, it should be smoothed off with emery cloth or other abrasive.

Flush valve.—In some houses, a flush valve instead of a tank is provided to flush the water-closet bowl. There are several kinds of flush valves, but the adjustments required for each are much the same. The type shown in figure 50 is one commonly used and will therefore be taken as an example.

In this type, the rubber segment diaphragm *A–56* separates the valve into an upper and lower chamber, with the pressure the same on both sides equalized by the bypass *A–24*. The slightest touch of handle *B–3* in any direction pushes in plunger *B–8*, which tilts relief valve *A–19*, releasing the pressure in the upper chamber. The pressure below then raises the entire working parts including relief valve (*A–19*), disk *A–15*, segment diaphragm (*A–56*), and guide *A–13*, allowing the water which flushes the bowl to go down through the barrel of the valve. While this is occurring, a small amount of water passes up through bypass (*A–24*) and gradually fills the upper chamber and closes the valve.

If the valve is out of order, water may continue to run into the bowl after the handle has been pressed. In valves similar to the type shown in figure 49, this flow may result from stoppage of the bypass (*A–24*) or from a deposit of grit on the relief valve seat. If the bypass is clogged, water cannot pass into the upper chamber to close the valve. If there is sediment on the relief valve seat or if the seat is badly worn, the valve may not close tightly, allowing the water to escape. The segment diaphragm (*A–56*) may also deteriorate in time and need to be replaced. The relief valve seat or washer and the segment diaphragm are made of rubber and are usually sold together, as it is generally advisable to replace both at the same time.

To repair a flush valve, it is not necessary to cut off the entire water supply if the water-closet supply alone can be cut off by means of a shut-off valve in the supply pipe near the fixture.

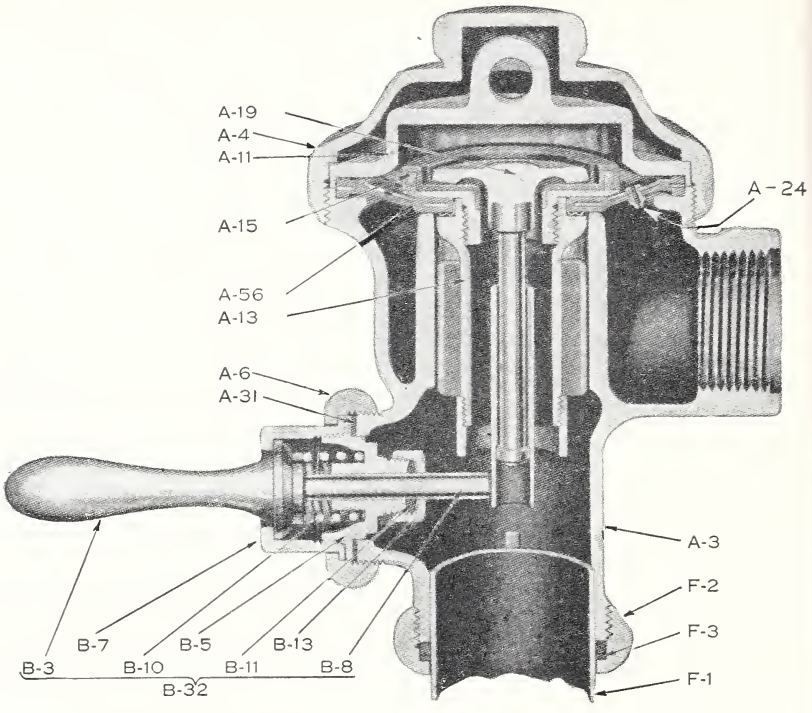


FIGURE 50.—*Cross section of a water-closet flush valve.*

A–3, Body only.
A–4, Outside cover.
A–6, Handle coupling.
A–11, Inside cover.
A–13, Guide.
A–15, One-piece molded disk.
A–19, Relief valve.
A–24, Bypass tube.
A–56, Segment diaphragm.
A–31, Handle gasket.
B–3, Metal grip.
B–5, Bushing.
B–8, Handle plunger.
B–10, Handle spring.
B–11, Handle felt washer.
B–13, Handle packing nut.
B–32, Metal handle assembly.
F–1, Outlet.
F–2, Outlet coupling assembly.
F–3, Friction ring.

To reach the parts mentioned, unscrew the outside cover *A–4* being careful not to mar the nickel finish. The inside cover *A–11* can then be lifted out together with the relief valve (*A–19*) complete.

The bypass (*A–24*) and the corresponding hole in cover (*A–11*) can be cleaned by running a fine wire through the openings.

To replace the rubber washer (relief valve seat) insert a screw driver under the washer at the hole in the center and pull the washer out. Then, with a spanner wrench, unscrew the disk ring which holds the washer in place and clean the surface of the seat on which the washer rests. Insert a new washer and replace the disk ring, screwing it down until firm, but not too tight.

When the disk (*A–15*) is unscrewed, the segment diaphragm (*A–56*)

can be lifted out. In replacing the diaphragm, it should be laid in with the cup down and the copper gasket on the under side. It will be noted that the dowels and tube holding the diaphragm in position are unequally spaced, to prevent it from being placed in the valve upside down. It may require a few trials to find the correct position, but when that position has been determined, the segment diaphragm should be fastened by screwing the disk (*A–15*) into guide (*A–13*).

If the above suggestions are not applicable in a particular case, directions for repairing the valve in question may be obtained from the local dealer or from the manufacturer.

Where a vacuum breaker is located between a flush valve and water closet, a leak may develop, due to improper functioning of internal parts. If this occurs, do not tape up the air ports, since that will render the device ineffective and may possibly permit back siphonage to take place if a partial vacuum develops in the supply line. In this case, a plumber should be called for maintenance or replacement.

Toilet Seats

Toilet seats are finished with plastic coverings, paint, or enamel. If the finish on a painted or enameled seat and cover is marred, it may be renewed by taking off the finish with paint remover and recoating with quick-drying (4-hour) enamel. If plastic coatings have become unsightly or the seat itself is cracked and the joints have become loosened, the seat and cover should be replaced.

Septic Tanks

The septic tank is a simple and effective means of sewage disposal for houses which have running water but are without access to public sewer systems. When properly installed, it provides a satisfactory and relatively inexpensive method of preparing sewage for final disposal. Bacterial action within the septic tank disintegrates the sewage so that it can be absorbed into the ground.

The essential parts of a septic tank system are the house sewer, the septic tank, the outlet sewer line, the distribution box, and the disposal field. The house sewer is the pipe line that carries household wastes from house to septic tank; the septic tank is the watertight container wherein sewage is disintegrated by bacterial action; and the outlet sewer line, which is made of tile, carries liquid wastes from the septic tank to a distribution box that discharges liquid wastes into the disposal field through drain-tile lines and permits them to seep into the soil.

The location of the septic tank as well as the disposal lines should be plotted for purposes of cleaning and repair, and a record of inspections and cleanings should be kept.

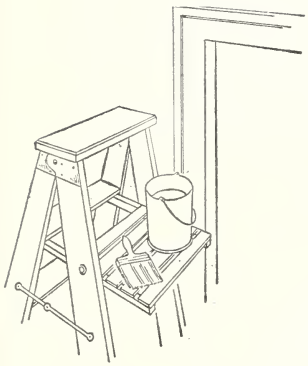
Clogging of the disposal field is the most common trouble and may be caused by the tank being too small for the volume of sewage, by failure to clean the tank regularly, by improper arrangement of the interior so that slow flow through the tank is not provided and scum or sludge is allowed to pass out with the effluent, or by a disposal field which has been incorrectly located or is too small.

The frequency of cleaning will depend upon the size of the septic tank and the volume of sewage flowing into it. When the space between the scum and the sludge becomes one-half of the total depth of the tank, cleaning is advisable.

If a disposal field is clogged, it may be necessary to dig up and clean the tiles and re-lay them 3 or 4 feet to one side or the other of their original position. Sometimes it is possible to clean a tile line by opening the line at each end and flushing it thoroughly with a hose. In this case, provision should be made for disposal of the water used. If flushing is not successful, it may be necessary to use a flat steel sewer rod to remove roots or solid obstructions.

Tile lines which are laid with an improper slope will permit the effluent to collect and saturate the soil, and cause unpleasant odors. As bacteria cannot work in such areas, the lines must be relaid on the correct slope. A disposal field that is too small may also cause odors or a water-logged soil.

The house sewer and the outlet sewer line become clogged more often by roots than by waste material which has been discharged with the sewage. Grease may also cause trouble, particularly if the slope of the pipes is inadequate. While drain solvents are effective in clearing the pipes of waste material, it may sometimes be necessary to use a flat steel sewer rod to dislodge a more solid obstruction. If these methods are not successful, the lines may need to be uncovered for the purpose of rodding from two directions. If stoppage is caused by an excessive growth of roots, the lines may need to be relaid with root-tight joints or moved to new locations.



11. PAINTING AND VARNISHING

Painting and varnishing in the home is a necessity that involves many different kinds of materials and practices. A good paint can be expected to preserve the surface, add to the attractiveness, and increase the value of a house. These benefits result from three primary characteristics found in a quality paint: Color retention, opacity, and durability. Thus, a good paint will provide a tough, protective, decorative film.

The success of a painting job depends principally upon the condition of the surface to be painted, the condition of the preceding paint coat in a repainting job, prevailing atmospheric conditions, and the quality and suitability of the paint for the service expected. Disregard of these factors is probably the chief cause of most paint failures.

Much useful information on painting may be found in the directions printed on the container labels and in booklets distributed by dependable manufacturers of quality paints. Their instructions should be carefully followed, since different materials usually require different treatments to produce the best results.

1. PAINT MATERIALS

The term paint includes paints, varnishes, enamels, shellacs, lacquers, and stains. Paints are composed of mineral pigments, organic vehicles, and a variety of thinners; varnishes are resins dissolved in organic

thinners; enamels are pigmented varnishes; shellac is lac gum dissolved in alcohol; lacquers may be both pigmented or clear—the liquid portion usually is treated nitrocellulose dissolved in thinners; stains may be pigmented oil or a penetrating type. Many of these materials, such as paints, varnishes, and lacquers, are formulated for specific purposes: Outside house paints and exterior varnishes are intended to give good service when exposed to weathering; interior wall paints are formulated to give excellent coverage and good washability; floor enamels are made to withstand abrasion; and lacquers are formulated for rapid drying. There are also formulas which provide extra self-cleaning, fume-resisting, waterproofing, hardening, flexibility, mildew-resisting, resistance to fading, and breathing qualities.

Paint Selection

Most paints are purchased ready-mixed but, in their selection, consideration should be given to the fact that surfaces vary in their adaptability to paint and atmospheric or other conditions have an adverse effect on paint performance. In addition to the normal weathering action of sun and rain, outside house paints are sometimes exposed to other attacking elements, such as corrosive fumes from factories or excessive amounts of wind-driven dust. For localities where such conditions exist, self-cleaning paints should be selected. These paints are usually so designated on the label. Concrete, plaster, and metal surfaces each present special problems in painting. For instance, paint for use on masonry or new plaster must be resistant to dampness and alkalies, and paints used on steel must have rust-inhibitive properties.

Brushes

For best results, a type of brush suitable for the specific use should be chosen. The five general types illustrated in figure 51 will fill ordinary painting needs: A sash brush for narrow edges, a 2-inch brush for trim, a 3- or 4-inch brush for exterior work, a chisel-edged brush for varnish or enamel, and a flat, straight-edged brush for walls or painted floors.

Good animal-bristle brushes have a large number of "flags" or split ends and the more flags the better the brush, for they aid in holding paint and spreading it in an even film.

A brush should not be too coarse or be fanned out at the painting end, and the bristles should be springy and elastic. Brushes ought to be at least 3 or 4 inches wide for painting large areas.

One way of checking the quality of a brush is to separate the bristles and see if there is a plug strip in the center. If this wooden strip is narrow, it will improve the working qualities of a brush, but if this strip

FIGURE 51.—*Typical brush set.*

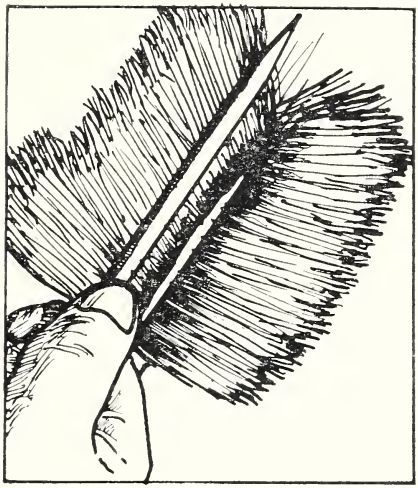


FIGURE 52.—*Checking width of wood plug strip in brush.*

in the heel of the brush is wide, it is an indication that the brush is inferior. As the width of the strip is increased, the number of bristles will be decreased, and such brushes will not hold enough paint (see fig. 52).

Mixing

Paste paints, such as aluminum, resin-emulsion, and lead-in-oil, should be stirred with a stiff paddle and reduced to painting consistency with the liquids recommended on the manufacturer's labels.

Paints in powdered form require the addition of a liquid to prepare them for use. The manufacturer's directions as to the amount of oil, varnish, water, or other vehicle required should be followed.

Boxing is a good method of mixing paints. Since paint is a mixture of solids and liquids, it is important that it be mixed thoroughly before using. To do this, the greater portion of the liquid contents of the can should be poured into a clean bucket somewhat larger than the paint can. Then, with a stiff paddle, the settled pigment in the original container should be loosened and the lumps broken up. After this, mix the material in the container thoroughly, using a figure 8 motion, and follow with a lifting and beating motion. Continue stirring the mixture vigorously while slowly adding the liquid that was previously poured off the top. Complete the mixing by pouring the paint back and forth from one container to the other several times until the entire amount is of uniform consistency (see fig. 53).

Paste and powder paints should be mixed in quantities sufficient for immediate use only, as these materials become unfit for application if allowed to stand for three or more hours.

If paints have been allowed to stand and hard lumps or skin have formed, the skin or scum should be removed, after which the paint can be stirred and strained through screen wire or through one or two thicknesses of cheese cloth.

If a desired shade is not obtainable in custom- or ready-mixed paints, white paints may be tinted with colors-in-oil. To do this, mix the color-in-oil with a small amount of turpentine or mineral spirits and stir this

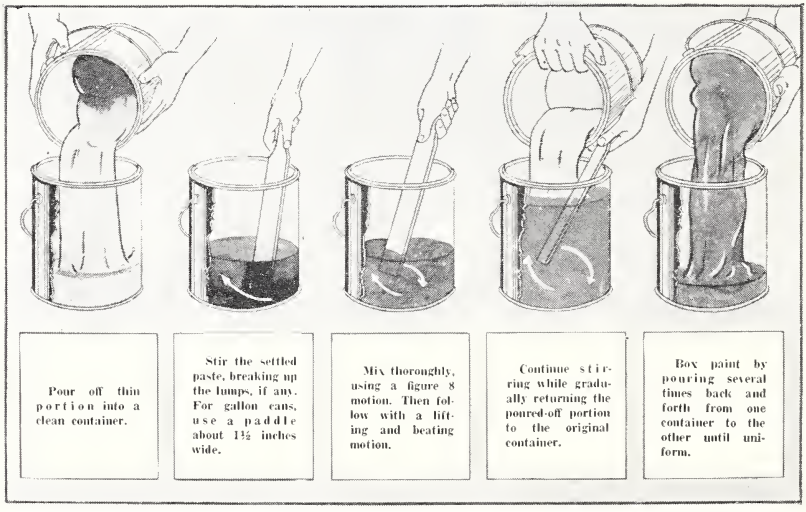


FIGURE 53.—*Method of "boxing" or mixing paints.*

into the white paint, a little at a time. If a blended color is desired, more than one color may be added, such as a blend of chrome green and chrome yellow for lettuce green.

2. APPLICATION

For all major painting jobs, the services of an experienced painter should be obtained for, although painting may look quite simple, it is in reality hard work. Even so, small maintenance items can often be performed by the householder.

Preparation of Surface

A satisfactory paint job requires that a great deal of effort be expended in cleaning, scraping, sanding, and puttying the surface prior to application of the paint. Do not try to cover chipped or cracked paint on woodwork. If dirt and rough spots are painted over, the new coating may peel, crack, blister, or wrinkle.

To prepare a surface for repainting, all loose paint should be removed with a putty knife or wire brush, rough spots sanded, and bare spots given a priming coat after the edges of the old paint film have been "feathered" or tapered off with sandpaper or steel wool. Nail holes should be filled with putty after the priming coat has been applied and, where a surface has been patched, the new surface should be primed before succeeding coats are put on.

To clean a painted surface that is cracked, checked, or "alligatored," paint remover should be applied with an old brush and allowed to stand until the paint loses its adhesion. It can then be scraped off with a putty knife or paint scraper and wiped off with turpentine or mineral spirits. The spot can then be repainted, using as many coats as necessary to bring it to the surface of the surrounding area

Methods of Painting

The usual methods of applying paint are by brush or spray. Either method will produce satisfactory results, the choice of application depending upon the equipment available to the householder.

Brushing

New brushes usually have a few loose bristles. To remove them, before dipping the brush in oil or paint, roll the brush handle rapidly between the palms of the hands and the loose bristles will drop out.

A new brush should be suspended in linseed oil overnight before being put into paint. This makes the pigment less difficult to remove from

the bristles later on. When ready to use the brush, the oil should be squeezed out with a wood strip and the brush swirled in a container of mineral spirits or turpentine to wash out the remaining linseed oil. The brush handle can then be rolled again in the palms of the hands to evaporate the thinner in the bristles. Brushes that are well broken in give much better service than those that have been given careless treatment.

A paint brush should not be allowed to stand on its bristles or left to soak in water. It should be cleaned after each job by using the proper thinner: Turpentine followed by naphtha or mineral spirits should be used for oil paint, enamel, varnish, or oil stains; alcohol for shellac or alcohol stain; lacquer thinner for lacquers. The brush should be soaked in the proper thinner and worked against the side of the container squeezing the bristles to force out the paint, working from the ferrule to the end of the bristles. Repeat this several times, finally rinsing the brush in fresh thinner. If paint has hardened, the pigment may be loosened with a wire brush. An adequate amount (2 quarts) of thinner should be used. It can be saved in a sealed container and used more than once. The brush should then be washed with mild soap and warm water followed by rinsing in clear water. After the water is squeezed from the brush, it should be combed lightly, so that the inside bristles are straight. It can then be wrapped in absorbent paper, such as a paper towel, and allowed to dry. After the brush is dry, it should be wrapped in several thicknesses of paper and stored in a cool, dry place.

Neglected brushes full of hardened paint can sometimes be salvaged by soaking them in turpentine or in commercial liquid brush cleaner for a day or two, working the bristles occasionally to loosen the paint. A scraper may be used to remove hardened paint, after which the brush can be soaked for several hours in hot, soapy water.

If this treatment does not clean the brush, sprinkle soap powder on a washboard and rub the brush across it, using the same motion as for washing clothes. If bristles remain stiff, add sand to the soap powder.

Finally, the brush should be rinsed in warm water until all traces of soap and paint have been removed from the bristles and the rinse water remains clear. The bristles should then be combed and dried. Brushes salvaged in this way may be used successfully but they are not as satisfactory as brushes that have been given proper care.

In using brushes, dip them lightly into the paint, covering not more than half the length of the bristles. Dipping the brushes deeper into the paint not only wastes paint but may ruin the brush by permitting hardened paint to accumulate in the heel. Excess paint should be slapped off against the side of the container so that the brush will not drip. Lay the paint on with light, short, slightly curved strokes, lifting

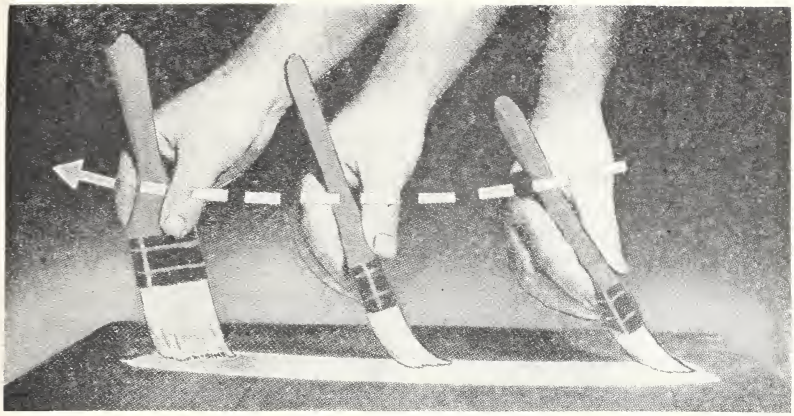


FIGURE 54.—*Correct method of using brush in applying paint.*

the brush gradually so as not to leave a thick edge of paint. Grip only the handle and the metal ferrule and apply paint only with the end of the bristles, reversing the brush often (see fig. 54).

To apply enamel or varnish, use short, light strokes, letting the finish flow together with as little brushing as possible. Check the enamel during the first half-hour after application to catch runs or sags before they dry. If they appear, brush them out with light strokes.

Flat wall paint should be applied rather heavily and not cross-brushed, since it flows together naturally. Start each brushful on a dry surface, working toward a wet edge. On walls, start at the top and carry each swath down to the baseboard by painting narrow strips from ceiling to floor so that edges will not have time to dry out and show lap marks.

An old brush should be kept handy to work paint into corners as the shape of a good brush will be distorted if used for this purpose.

Always use the flat side of a brush, even when painting a narrow strip. Painting with the edge makes a brush divide into clumps. If these clumps are left in a brush overnight, the bristles will take a permanent set. A sash brush should be used for narrow surfaces.

Spraying

Applying paint with a spray gun is faster than with a brush but the smoothness of finish will depend upon how the spray gun is used.

The simplest motorized spray gun is one that may be attached to the vacuum cleaner. The air pressure on this type of spray gun is low and therefore works best on thin liquids.

Many paint stores rent a pot-type spray outfit which holds 3 gallons of paint and is well suited to spraying exterior surfaces of a house since it can be used for 2 hours without refilling.

In ordinary pot-type spray guns, the container holds a quart of paint and is attached to the spray gun. The gun is connected to the motor and compressor with a hose, and a trigger controls the paint flow. Three spray tips are needed, one to throw a round pattern for spotting, one to give a flat fan-shaped pattern for flat surfaces, and one bent at an angle for ceiling work.

Before starting to spray, the surface should be thoroughly cleaned and all rough spots smoothed with sandpaper and wiped free of dust. Everything in a room that might be marred by settling spray should be covered with old sheets or canvas drop cloths.

Before starting to spray, door knobs, wall switches, and light fixtures should be covered with masking tape which can be obtained in paint and hardware stores in widths from one-half inch up.

Masking tape should also be laid along the frames of windows and mirrors. The glass should be coated with masking compound which may be obtained from paint and automotive supply stores. In bathrooms, use tape and newspapers to mask tub, lavatory, and toilet.

If masking is not feasible, a piece of metal or stiff cardboard may be used as a shield, moving it along as the spraying proceeds. This is a convenient way to separately spray screen wire and screen frames.

All paint materials used in a spray gun should be strained through a clean, relatively lint-free cloth before using.

When spraying paint, always wear a respirator. It gives valuable protection against paint poisoning and should be worn even for outdoor work with a cap to keep drift spray out of the hair. Do not smoke while spraying. If the respirator is worn, this will be impossible. Also make sure that ventilation is adequate for health as well as fire safety. Never spray near an open flame, or where there is a possibility of sparks flying, as spraying mixes paint and air to an explosive proportion; and, when painting indoors, always have the windows open wide and never spray in a closed room unless an exhaust fan is in operation that will change the air every 3 minutes.

Before actual painting operations are started, adjust the gun and practice spraying on scrap material to obtain the proper flow of paint. Hold the gun in one hand and with the other keep the hose clear of the surface that is being sprayed. The spray tip should be held six or eight inches from the surface to which the paint is being applied.

If a large panel or wall is being sprayed, begin at the upper corner and work from right to left. Move down as each swath is laid on. Since the center half of the last sprayed strip gets the thickest coat, lap the upper fourth of each new stroke over the lower fourth of the preceding stroke.

On each stroke, begin swinging the gun from a point to one side of where the spray is to begin. When the starting point is reached, press the trigger and hold it until the other edge of the panel sweep is reached. Always sweep the spray stroke so that the tip of the gun stays the same distance from the surface and so that the spray will strike at right angles. The pace of the stroke should not change. Any hesitation or halt without releasing the trigger will let too much paint pile up, and a sag or run will result. Holding the gun too close to the work will also produce a sag or run, and holding it too far away will fog the finish and produce a dull effect. Meeting points of surfaces, such as corners and sharp edges, are spots that tend to catch too much paint and are sprayed best with short successive spurts, aiming the gun so that each spurt is at right angles to the nearest surface. This technique applies to any finish. A few specific suggestions follow:

In spraying paint, varnish, and enamel, the material should first be thinned in accordance with the manufacturers' instructions. The first coat should then be "fogged" on, holding the gun a little further from the surface than the suggested 6 to 8 inches. One coat of primer and one coat of finish may cover a surface, but two finish coats are better. Allow the paint to dry thoroughly between coats, and on small objects a better finish is obtained if the surface is lightly sanded between coats.

Lacquers are rather thin materials which dry very rapidly. They should be applied in three to five coats, using the thinner recommended by the manufacturer. Lacquer cannot be successfully applied over paints, varnish, or enamel.

Among the common faults in spray finishes are sags (finish laid on so thick that it flows downward in drapes); runs (longer drops streaking down, usually from sags); holidays (spots left bare); orange peeling (bumpy finish); and fogging (dull, pebbled finish resulting from the gun being held too far from the surface).

Painting Conditions

For exterior wood and metal surfaces, painting should be done only in clear dry weather and the temperature should not be below 50° F. When the weather is cold, work should be stopped early enough in the afternoon to allow the paint to set before a sudden drop in temperature occurs. Woodwork should be thoroughly dry and seasoned before paint is applied and the temperature conditions should be the same for painting exterior masonry as for wood and metal. Masonry surfaces must be dry if oil base paints are to be used, while other masonry paints such as cement-water, resin-emulsion, and rubber-base paints may be applied to damp surfaces.

Interior painting may be done at any season of the year provided the house is warm and has ample ventilation to carry off the fumes from paint solvents.

Drying

Sufficient time should be allowed between coats so that the paint film will dry hard before more paint is applied. Oil paints on exterior wood should dry at least 24 hours, several days' drying time being preferable. Most paints suitable for metal, plaster, wood trim, and floors may be re-coated after drying 18 hours.

3. EXTERIOR PAINTING

The condition of the surface to which exterior paint is applied is just as important as the quality of the paint. The surface should be clean and defects that would adversely affect the paint coating should be repaired before painting is started. These defects include cracks in the surface, exposed nail heads, crumbled putty, rotted boards, pitted or corroded metal, mold, or mildew.

Wood Surfaces

Prepared house paints for exterior use are mixtures of pigments in oil vehicles. If of good quality, they should weather by chalking. In repainting, care should be taken to brush away this powdery material before new paint is applied. Careful preparation of the surface will do much to insure long service from a paint coating.

If peeling or flaking has occurred, the paint should be removed and the cleaned area spot-painted. This entails building up the spot with primer and finish coats to the same level as the surrounding area. Knots should be coated with shellac or aluminum paint; decayed or split boards should be replaced; protruding nails should be countersunk and the holes filled with putty; and gaps between ends of siding and corner boards or small cracks around window and door casing should be filled with calking compound.

To Stop Rot

To stop rot, liquid wood preservatives which can be applied by brushing, spraying, or dipping may be obtained at hardware and paint stores. The preservatives, which are sold under many brand names, contain either pentachlorophenol, copper naphthenate, or zinc naphthenate in a light volatile oil solvent. They are not like creosote which must be applied under pressure to be effective.

Pentachlorophenol solutions are sold in two types; the clear to be used above grade, the crude oil for below-ground protection. Both types may injure young plants; therefore, they should not be used in places where roots can come in contact with them. It is not advisable to paint over these solutions.

Copper naphthenate solutions are green, and can be used without paint if a green color is desired. Wood treated with this solution is harmless to plants. If the treated surface is to be painted with a light-colored paint it should first be sealed with aluminum paint or shellac.

Zinc naphthenate solutions, which are clear, are somewhat more expensive than the other two. They can be used under varnish, if it is desired to preserve the natural grain of the wood. They can also be applied on bare or unpainted basement walls or on concrete to curb mildew.

Two coats are advisable but one coat will give some protection. The second coat should be applied before the first is dry. One gallon will cover up to 400 square feet of clean, dry, unpainted wood. All three preservatives are offensive to fungi that cause rot and unpalatable to boring insects such as ants, wood wasps, and powder post beetles. These insects should not be confused with termites which require more positive control.

Use of preservatives.—Preservatives should be used where wood touches the ground; in joints between wood and other building materials such as masonry, brick, concrete, or metal; in places where two pieces of wood fit tightly together; and in areas where moisture collects. Gloves should be worn when using the preservatives, so as not to irritate the skin.

Porch steps.—When building or remodeling porch steps, new or bare wood should be treated with preservative before painting. For outside steps which have already been painted, the preservative should be brushed into joints before repainting. A gooseneck or bent-spout oilcan will reach otherwise inaccessible places.

Window frames and doorsills.—A few drops of preservative applied to joints of a window frame with a medicine dropper will be enough to protect them. This treatment is especially valuable for the inside of window frames, particularly if moisture condenses on the pane.

Places that are hard to reach are often the spots that need preservative most. To apply preservative to small, inaccessible joints, such as in shutters or other outside blinds, use a fly sprayer, avoiding overdosage as this might interfere with the movement of the slats. The bent-spout oilcan may also be used to apply preservative to the front edge and underside of a doorsill.

Shingle or wood siding.—A preservative should be applied to the exposed edge of the bottom row of shingles or wood siding with a small block

of wood covered with a pad of burlap or similar material to which a handle has been nailed, to avoid stooping. The preservative-soaked burlap should be held against the lower shingle or siding edge for at least one minute.

Garage doors.—The bottom edge of the garage door is especially susceptible to rot and should be given a liberal coat of preservative, using a brush for an overhead door, an oilcan or absorbent pad on a hook for other type garage doors.

Wood gutters.—The entire inside length of wood gutters should be treated as well as the rim, including both the inside and under side of the gutter where it meets the metal downspout. If accessible, the joints between the gutter and the house should be treated using an oilcan to apply the preservative.

Garden furniture.—Wood that touches the ground or is exposed to weather is susceptible to rot and should be given protection with a preservative. The bottom of the legs as well as the joints of garden or lawn furniture will last much longer if treated with a preservative.

Fence posts.—Fence posts should be treated from the lower end to a point at least 6 inches above the ground, allowing the posts to soak from 48 to 72 hours in the preservative.

The lower ends of pickets should be dipped to a depth of 1 foot or more, to protect them from dampness and accumulated leaves. The rails to which pickets are attached and the backs of the pickets where they are fastened to the rails will last longer if treated with preservative.

Before driving nails all the way in, preservative can be put under the nail heads. If screws are used, the preservative can be squirted in the holes which have been drilled for the screws. After preservative has been applied, the surface can be painted.

Mildew

All badly mildewed surfaces should be washed prior to repainting with a solution of one pound of trisodium phosphate or sodium carbonate dissolved in one gallon of water. After thorough scrubbing, the areas should be rinsed with clean water and allowed to dry before painting. Commercial fungicides are available for controlling mildew on exterior painted surfaces.

Two-Coat Paint System

A minimum of three coats was formerly the accepted practice for initial painting on exterior wood, and this practice is still largely followed. However, by using special primers, two-coat paint systems for wood have been developed that are durable and satisfactory. The principle of the two-coat paint system is that as much paint is applied

in two coats as normally would be applied in the three-coat method of painting. On smoothly planed wood, the usual spreading rate for three-coat painting is about 550 to 600 square feet per gallon for the first or priming-coat paint and about 600 to 650 square feet per gallon for each of the next two coats. In the two-coat paint system, the primer is spread at the rate of about 450 square feet per gallon and the finish coat about 550 square feet per gallon. Rough surfaces and weather-beaten wood require much more paint than is indicated for smoothly planed wood.

Three-Coat Paint System

Mixed-pigment prepared paints are available for three-coat work, in addition to linseed-oil white-lead paints which may be mixed on the job or purchased ready-mixed. The manufacturer's directions appearing on the label should be followed in thinning the first and second coats. It is sometimes advisable in moist atmospheres, particularly at the seashore, to add a small amount (1 pint to a gallon) of good exterior varnish to the top coat of paint.

The varnish should first be tried in a small amount of paint to make sure that the two are compatible and that the varnish will not cause the paint to thicken. In general, dark-colored paints (red or brown iron oxide) are more durable than light-colored or white paints.

Shingle Stains

Shingle stains are pigmented oil stains, similar to very fluid paints, which can be applied by dipping, brushing, or spraying. They are intended for application to comparatively rough exterior wood surfaces where it is not necessary to bring out the grain and texture of the wood to which they are applied, and they dry to a matt or semitransparent finish. Durable pigments, such as iron oxides, are used for the colors red through brown; chromium oxide, for green; and zinc oxide or white lead tinted with lampblack, for gray.

Shingle stains should not cake or change color in the container and when stirred should settle very slowly. With the exception of some dark brown stains, which are simply refined coal-tar creosote with volatile thinners, shingle stains are usually made from very finely ground pigments, drying oils, and volatile thinners. Many commercial shingle stains contain some creosote oil from coal tar or water-gas tar which is intended to act as a wood preservative. While pressure treatment with creosote is one of the most effective methods of preventing wood from rotting, the small amount that penetrates the wood from a single dip or brush treatment probably has very little effect (see page 162, To stop rot).

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Paint applied over creosote stain is likely to be ruined by the creosote bleeding through. To avoid this difficulty, pigment oil shingle stains without creosote should be used.

Masonry Surfaces

Paints for masonry wall surfaces may be divided into four types: Cement water paint, resin-emulsion paint, oil paint, and paint containing rubber in the vehicle. These paints are also suitable for use on such masonry surfaces as foundations, gate posts, and fence or enclosure walls, but they should not be used on floors which are subject to abrasion. For such surfaces, a very hard-drying paint with good water resistance and gloss retention is recommended.

Use of Masonry Paints

Cement water paints are water-dilutable paints in which portland cement is the binder. They are particularly suitable for application on damp, new, or open-textured masonry surfaces. These surfaces include those walls that are damp at the time of painting, or that may become damp after painting as a result of structural defects; new structures (less than 6 months old) which normally contain water-soluble alkaline salts; and open-textured surfaces such as cinder, concrete, and lightweight aggregate block. These paints are not recommended for stopping leakage through porous walls that are exposed to water pressure, particularly if the paint is applied to the inside of the wall. For such conditions, a coating of hot bituminous material applied to the outside of the wall is preferable. Close-textured surfaces which are relatively dry, such as cast concrete, asbestos-cement siding, and tile, may be painted with resin-emulsion paint or paints containing rubber in the vehicle. Walls which are dry at the time of painting, and are so constructed as to remain dry after painting, may be decorated satisfactorily with oil paints.

Cement-Water Paint

Cement-water paints are water-dilutable paints, packaged in powder form. They are composed chiefly of portland cement or portland cement and lime and possess good decorating qualities of hiding power and color. However, when wetted, as by rain, they become somewhat translucent and darker in color. When again dry, the film returns to its original opaqueness and color.

To clean a surface for the application of cement-water paint, thoroughly remove all dust, dirt, and efflorescence. Dust and dirt can be removed by brushing, followed by washing with clean water;

efflorescence, old coatings of whitewash, and flaking or scaling cement-water paint by brushing vigorously with a wire brush. Firmly adhering coatings of cement-water paint or cement-water paints which are "chalking" or "dusting" need not be removed, but should be brushed with a stiff bristle brush to make the surface uniform. If the old coating is organic paint it must be completely removed. This can be done most effectively by sandblasting.

Before applying the paint, whether initially or on a previously painted surface, the masonry should be thoroughly wetted, preferably with a garden hose adjusted to produce a fine spray. A superficial dampening with a brush dipped in water is not adequate for exterior walls but may be satisfactory for cool basement walls. Usually, wetting the walls in one operation not more than an hour before painting is sufficient. The water should be applied so that each part is sprayed three or four times for about 10 seconds each, time being allowed between applications for the water to soak into the surface. If the surface dries rapidly, as it may in hot weather, it should be redampened slightly just before painting. The wall surface should be moist but not dripping wet when the paint is applied.

Cement-water paint powder should be mixed with water in accordance with the manufacturer's directions. Paints may be tinted by adding suitable amounts of coloring pigments but, due to the difficulty of producing uniform colors by hand mixing, it is suggested that commercial brands of tinted paints be purchased which have been mill ground in the factory.

Cement-water paint should be applied in two coats. Preferably not less than 24 hours drying time should be allowed between coats. The first coat should be slightly moistened with water before applying the second.

Most portland cement paints cannot be satisfactorily applied with the ordinary hair-bristle paint brush. Proper application requires a brush with relatively short, stiff, fiber bristles such as fender brushes, ordinary scrub brushes, or roofers' brushes.

While thick films are to be avoided, there is a tendency to use too much water in cement-water paint and to brush it out too thin. Coatings applied in this manner may look well at first but will generally lose their opacity and protective value much sooner than thicker films. The proper spreading rate is difficult to estimate for portland cement paint because of the difference in the texture of the masonry to be covered. However, on smooth masonry, 1 gallon of mixed paint should be sufficient to cover 100 square feet with two coats; and, for rough masonry, 1 gallon should be sufficient to apply two coats to 50 square feet of surface.

After painting, it is desirable to sprinkle the freshly painted surface

two or three times a day with a fog spray, such as is used for dampening walls prior to painting, and it is recommended that this be done between coats and for 2 days after the final coat, starting as soon as the paint has set, usually 6 to 12 hours after application.

Resin-Emulsion Paint

Resin-emulsion paints are water-thinned materials whose dry-film properties closely resemble those of a flat oil paint. They may be used on most porous masonry surfaces, including asbestos-cement siding, which has not been previously coated with a waterproofing compound. They should not be used on magnesite stucco.

To prepare the surface for resin-emulsion paints, remove by brushing or washing all dust, dirt, efflorescence, and loose particles from the surface; and also remove any flaking or scaling paint by scraping or wire brushing. Glossy areas should be dulled by sanding; oil, grease, and wax should be removed by scrubbing with mineral spirits. Then wash with water containing trisodium phosphate (about 2 ounces to the gallon), and rinse thoroughly with clean water.

Resin-emulsion paints are packaged in paste form and need to be thinned with water before being applied. They should be mixed in clean metal containers (not wood) in accordance with the directions given on the manufacturer's label and not allowed to stand after mixing for more than a week.

Resin-emulsion paint may be applied by brush or spray. Two coats are recommended and the air temperature when painting should be above 40° F. A sizing or priming coat is not generally required except on open-textured masonry. For that, a cement-water paint containing sand should be used to fill the voids in the wall surface. On very warm days, it may be advisable to moisten the surface to be painted with water, prior to applying the paint. Resin-emulsion paint will dry in 1 to 4 hours, and may be recoated in 6 to 8 hours; the film becomes hard overnight. One gallon of the paste paint will cover approximately 200 to 450 square feet, depending upon the surface and the application. Brushes and spray guns should be washed with warm soapy water immediately after using.

Oil Paints

Oil paints intended for use on masonry are usually ready-mixed paints containing weather-resistant opaque pigments suspended in drying oils, resins, and thinners. They should be formulated so that the first coat seals the surface sufficiently to prevent spots or flashes of the second coat. Two coats are necessary for good hiding and durability.

Moisture back of the paint film will seriously impair the life of a coating of oil-base paint, therefore the application of oil paint to new masonry should be deferred until the walls have had time to dry. This may require 3 months to a year, depending upon the thickness and porosity of the wall and the weather conditions. Because of the importance of preventing water from entering the walls after painting, repairs of structural defects, such as leaks around flashing, doors, and windows, should be made before applying oil-base paint.

Dust and dirt should be washed off and efflorescence should be brushed off with a stiff fiber or wire brush. All traces of oil should be removed with steel brushes, abrasive stones, or a lye solution. However, if the surface is badly stained, it should be lightly sandblasted.

Caution.—In the use of lye (caustic soda, sodium hydroxide), avoid splashing the eyes, skin, and clothing. Rules to be followed and measures to be taken in case of accidents when using lye will be found in chapter 10, section 3.

Old coatings of organic paint or cement-base water paint in sound condition need not be removed. Whitewash or peeling, scaling, or flaking paints should be completely removed.

Oil paints should not be applied during damp or humid weather or when the temperature is below 50° F. At least 1 week of clear dry weather should precede the application of the first coat. As masonry surfaces tend to chill and collect condensed moisture, painting early in the morning and late afternoon should be avoided except in dry climates.

A minimum of 90 days' drying time should elapse before applying oil paint over a cement-water base coat or over mortar-filled joints and cracks. When it is not practicable to wait this long before painting, a calking compound rather than cement mortar should be used as a crack filler.

Rubber-Base Paints

There are two types of rubber-base paints, the rubber-solution and rubber-emulsion types.

Rubber-solution paints are available at most paint stores and usually sell for slightly more than oil-base masonry paints. They may be applied by brush or spray to dry or slightly damp walls. They are suitable for painting asbestos-cement siding and shingles. These paints are also useful for "sealing in" stains on old masonry, and as protective primers under finishing coats of resin-emulsion or oil-base paints.

The same procedure outlined for preparing the surface for oil-base paints should be followed for rubber-base paints in removing dust, dirt, loose mortar, form oil, and efflorescence on dense surfaces.

Oil paint coatings must be removed before applying rubber-solution paints because the thinners used in these paints act as solvents for the oil paints. This is not necessary when applying rubber-emulsion paints over oil paints that are in good condition since they do not contain solvents that will soften the oil paints.

Rubber-base paints may be applied to dry or damp walls. It is usually necessary to thin the paint for the first coat, using the thinner recommended by the manufacturer, as some paint thinners are incompatible with rubber-base paints. The paint dries to the touch within three hours but, at least 18 hours drying time should be allowed between coats, otherwise the succeeding coat will "lift" or soften the undercoat.

The brushing technique for rubber-base paints is the same as for applying enamels. "Back-brushing" or "working" the paint will cause it to roll and pull under the brush. As the paint tends to "set" rather quickly, it is advisable to work in shade rather than sunlight.

Brushes and spray guns should be cleaned with paint thinner immediately after they are used, because dry paint is difficult to redissolve once it has hardened.

Whitewash

Whitewashes and lime paints must be thin when applied. In fact, best results will be obtained if the application is so thin that the surface to which it is applied may easily be seen through the film while it is wet. The coating will dry opaque, but, two thin coats will give better results than one thick coat.

A large whitewash brush is best for applying the wash. One should not attempt to brush out the coating, such as in applying oil paint, but simply spread the whitewash on as evenly and quickly as possible.

The principal ingredient in whitewash is lime paste. A satisfactory paste can be made with hydrated lime, but better results are obtained by using quicklime paste that has been slaked with enough water to make it moderately stiff. The lime paste should be kept in a loosely covered container for at least several days. Eight gallons of stiff lime paste can be made by slaking 25 pounds of quicklime in 10 gallons of water, or by soaking 50 pounds of hydrated lime in 6 gallons of water. After soaking, the paste should be strained through a fine screen to remove lumps or foreign matter.

Whitewash can be made from various combinations of lime paste and other ingredients. The following two formulas are satisfactory:

Formula No. 1

Casein	5 lb
Trisodium phosphate	3 lb
Lime paste	8 gal

The casein (glue substitute) should be soaked in 2 gallons of hot water until thoroughly softened, which should be approximately 2 hours. After dissolving the trisodium phosphate in 1 gallon of water it should be added to the casein, stirring the mixture until the casein dissolves. This solution should be mixed with the lime paste and 3 gallons of water.

Formula No. 2

Common salt	12 lb
Powdered alum	6 lb
Molasses	1 qt
Lime paste	8 gal

The salt and alum should be dissolved in 4 gallons of hot water, after which the molasses may be added to the mixture. The resulting clear solution is then added to the lime paste, stirred vigorously, and thinned with water to the desired consistency. This whitewash has a yellow tinge when first applied, but the color disappears in a few days leaving a white film.

Another satisfactory whitewash can be made by diluting a moderately heavy cold lime paste (about 33 pounds of hydrated lime and 8 gallons of water) with 5 gallons of skim-milk.

The area covered by a gallon of whitewash depends upon the nature of the surface, but ordinarily a gallon will cover about 225 square feet on wood, about 180 square feet on brick, and about 270 square feet on plaster. The formulas mentioned will make from 10 to 14 gallons of whitewash. If a smaller quantity is desired, the amount of each ingredient should be reduced accordingly.

Iron and Steel Surfaces

The chief reason for applying paint to exterior metalwork, particularly iron and steel, is to control and prevent corrosion. For best results, two coats of priming paint followed by two coats of top or finishing paint are recommended on new work. For repainting, a spot coat followed by a full priming coat, and then one or two finish coats are recommended. The usual recommended spreading rate of each coat of paint is about 600 square feet per gallon. It should be stressed that the preparation of the surface, particularly steel, prior to painting is important, for unless the surface is properly cleaned so that the priming paint comes in direct contact with the metal, early failure of the paint film will probably occur.

Cleaning is the most important step in preparing metalwork for painting. It can be divided into two phases; the removal of oil and grease, and the removal of rust, dirt, scale, old paint, and moisture. All oil and grease should be removed before using mechanical methods

of cleaning. The usual method is to wipe the surface with clean cloths and mineral spirits or carbon tetrachloride. The liquid as well as the cloths should be kept clean by frequent renewals to avoid leaving a thin, greasy film on the surface. When the oil and grease have been disposed of, rust, scale, and old paint may be cleaned from the surface with wire brushes, steel wool, or motor-driven rotary brushes.

The paint should be applied in bright, warm weather to metal surfaces which are clean and dry. Painting should not be done early in the morning when the surface to be painted is damp from dew. Ample time should be allowed for each coat of paint to dry before applying the next coat.

Since the main function of a priming coat is to protect metal from corrosion, it should contain rust-inhibitive pigments. It can be applied by either brush or spray but particular care should be taken to cover the surface completely with the proper thickness of paint. Two coats of primer are recommended for new work. The second coat may be tinted to a slightly different color to make sure of adequate surface coverage. Ample time should be allowed for drying before application of succeeding coats.

Two practical coatings for steel surfaces are red-lead and iron-oxide paints, red lead being used as a primer and iron oxide as a finishing material. Dull red and brown iron-oxide paints are economical for painting terne-plate roofs and structural metal. They are durable and are frequently referred to as roof and barn paint.

Red lead is available in three types: Type I, red-lead linseed oil paint which should be allowed to dry for a week between coats; type II, semi-quick-drying red-lead paint which is an easy brushing material suitable for general use and dries in 24 hours; and type III, red-lead paint in a varnish vehicle which dries within 8 hours and may be used for touch-up work on clean smooth steel.

Zinc-dust primers have good rust-inhibitive properties and are particularly effective for galvanized iron and sheet zinc. While the primary function of these paints is to provide adequate adherence on galvanized metal, they are also satisfactory as finish paints and may be used in one or more coats.

Quick-drying metal primers for home workshop machinery and automobiles are iron-oxide primers in which the vehicle is a thin varnish. They dry to a smooth velvety, flat eggshell finish, and give excellent foundations for decorative coats.

As finish coats on iron or steel, black and dark-colored paints are more durable than light-tinted paints. Red-lead paint should not be used as a final coat, since it does not retain its color. One of the best finish coats for metal is aluminum paint made by mixing about 2 pounds of aluminum powder or paste with 1 gallon of spar varnish.

Copper

Copper gutters and flashings, as well as copper or bronze screening, may cause yellowish-green stains on light- or white-painted houses. One way to avoid this is to paint or varnish the copper or bronze. The surface of the metal should be cleaned by washing with gasoline or turpentine, and a priming coat composed of 1½ to 2 pounds of aluminum powder to 1 gallon of aluminum mixing varnish applied, followed by the desired color coat. Weathered copper or bronze fly screening should be dusted and then given two coats of thin black enamel. Zinc dust-zinc oxide paints may also be used on copper and bronze if a gray color is acceptable. (See sec. 5 of this chapter for painting screens.)

4. INTERIOR PAINTING

Interior paints are used to obtain pleasing decorative effects, improve sanitary conditions, and insure better lighting. These paints may be divided into four types: wall primers; one-coat flats; flat, semigloss, and gloss; and water paints.

Wall primers or primer-sealers are intended to be applied directly to bare plaster, wallboard, and similar porous surfaces to provide a uniform, sealed surface for subsequent coats of paint. A typical wall primer may be made from varnish or bodied oil vehicle and hiding pigments. It is intended to penetrate only slightly into porous surfaces. The primers are best applied with a wide wall brush.

One-coat flat paints are organic-solvent-thinned paints intended to accomplish priming, sealing, and finish coating in one operation. They are often sold in thin paste form so that additional inexpensive thinner may be added and mixed before application to increase the volume of paint by one-fourth or more.

Flat, semigloss, and gloss interior paints and enamels vary in degree of gloss, hiding power, and other properties. Paints giving the best hiding power are normally paints of lowest gloss, although some modern high-gloss enamels also have good hiding power.

Water-thinned interior paints are calcimine, casein, resin-emulsion, and gloss water paints. Calcimine consists of powdered whiting and clay mixed with an animal-glue binder and a preservative. It cannot be recoated, but can be easily washed off before redecorating. It is not necessary to remove casein before recoating but, if desired, it can be softened by washing with hot solutions of trisodium phosphate. Resin-emulsion paints, which are marketed in paste form are to be thinned with water, and when properly made and applied, adhere well to plaster and provide a good decorative medium. They need not be removed before redecorating, provided the film is in sound condition. This is also true of gloss water paints.

Plaster

New dry plaster in good condition, which is to be finished with a paint other than water paint, should be given a coat of primer-sealer, and allowed to dry thoroughly before being inspected for uniformity of appearance. Variations in gloss and color differences in the case of tinted primers, indicate whether or not the whole surface has been completely sealed. If not, a second coat of primer-sealer should be applied. If only a few "suction spots" are apparent, a second coat over these areas may be sufficient.

A flat, semigloss, or high-gloss finish may be applied to the primed surface. For a flat finish, two coats of flat wall paint should follow the priming coat. For a semigloss finish, one coat of flat wall paint and one coat of semigloss paint should be applied to the primed surface. For a high-gloss finish, one coat of semigloss paint and one coat of high-gloss enamel should be used over the priming coat.

Before applying water paints of the calcimine type to new plastered walls they should be sized, using either a glue-water size or, if the plaster is dry, a thin varnish or primer-sealer. Cold water paints of the casein type may be applied either directly to a plastered surface, or the surface may be first given a coat of primer-sealer to equalize uneven suction effects. The same is true of resin-emulsion paints, with the recommendations of the manufacturer of the product being given preference in case of doubt. Since resin-emulsion paints usually contain some oil in the binder, they should ordinarily be applied only to plaster which has dried thoroughly.

Texture wall paints may also be used on plaster surfaces. The advantages of this type of paint are that one coat economically produces a textured decoration and relieves the monotony of smooth flat paint. It also covers cracks or patches in the plaster more completely than ordinary wall paint. The disadvantages of texture wall paint are that they collect dust and are difficult to restore to a smooth finish. These materials are available as water- or oil-base paints, are thicker than ordinary wall paints, and may be applied to wallboard as well as plaster to produce textured effects such as random, Spanish, mission, and multicolored.

Composition Wallboard

Composition wallboard usually presents no particular painting difficulties if the ordinary precautions are observed, such as making certain that the surface is dry and free from grease and oil. The painting procedure for wallboard is the same as for plaster; it requires a priming and sealing coat followed by whatever finish coats are desired, or may be given one-coat flat or resin-emulsion type paint.

Wallpaper

Water-thinned paint may be applied to wallpaper that is well bonded to the wall and does not contain dyes which may bleed into the paint. One thickness of wallpaper is preferable for paint application. Directions for use are usually printed on the label of the paint container. Paints other than those of the water-thinned type may also be applied to wallpaper by following the directions given for painting plaster. However, wallpaper coated with such a paint is difficult to remove without injury to the plaster.

Wood Walls and Trim

New interior walls and wood trim should be smoothed with sandpaper and dusted before painting or varnishing. To preserve the grain of the wood, the surface may be rubbed with linseed oil, varnished or shellacked, and waxed. If an opaque finish is desired, semigloss paint thinned with 1 pint of turpentine per gallon of paint or the primer-sealer previously described for walls may be used as a priming coat on wood. One or two coats of semigloss paint should then be applied over the thoroughly dry prime coat, or if a full-gloss finish is desired, the last coat should be a high-gloss enamel.

New Wood Floors

All wood floors should be given some kind of finish. The correct surfacing of a floor will protect the fiber of the wood, improve the appearance, and make it easier to clean. To be satisfactory, the finish must insure economy of maintenance, so that resanding and complete refinishing will not be necessary within a reasonable time. Unless a home owner has the proper equipment and has had some refinishing experience, he will probably find it more satisfactory and economical to have his floors sanded and polished by experienced workmen than to attempt to do the work himself.

In applying finish to a floor, it is important to follow instructions on labels of products being used. These instructions usually explain when a floor needs refinishing and how it should be maintained. They may also describe: how to prepare a floor for finishing, how finish should be applied, number of coats needed, drying time for each, and how to obtain a stained effect.

New wood floors or those from which the original surface has been removed are usually finished by one of two general methods: the first consists of treatment with filler, sealer, and floor wax; the second, with filler, sealer, and shellac or varnish. The advantage of the first method is that worn spots can be rewaxed without refinishing the whole floor;

the second produces a bright, clean luster when first applied, but cannot be refinished at points of wear without "doing over" the entire floor.

The following tools and materials are needed: Electric or hand machines for sanding or scraping, waxing, and polishing; No. 00, 0, 1, 2, and 2½ grade sandpaper; steel wool pads; paste wood filler, sealer, and wax or shellac or varnish, depending upon the finish.

Electric floor-finishing machines may be rented by the day for a nominal charge and are much more satisfactory than hand scrapers or polishers, especially for initial finishing. An electric waxer and polisher will work the wax well into the wood and smoother floors will result. Afterward, the floor can easily be maintained either with paste waxes that need buffing or with water-emulsion waxes that are self-polishing.

To obtain a good finish, it is essential that scratches or uneven portions of a floor surface be smoothed out by scraping or sanding. The floors should be scraped or sanded lengthwise of the grain, first with No. 2 or 2½ grade sandpaper to cut off the high spots and smooth over the joints; next, with No. 1 sandpaper for the second cut; and lastly, for the final sanding, which is most important of all, with No. 0 or 00, or both, if necessary.

For both types of finish, after a floor has been sanded to a smooth, even surface and thoroughly cleaned of dust, all open-grained wood should be filled with paste wood filler colored to match the floor. As soon as the wood filler is dry and the surface has been buffed smooth again, the sealer should be applied in a very thin coat, allowed to dry, and buffed in. This will seal the pores of the wood, help to keep out dirt, and resist stains.

After floors have been filled and sealed, wax should be applied. A number of thin coats will be more satisfactory than one thick coat, because a heavy coat makes the floor slippery. Each layer of wax should be allowed to dry thoroughly and should be polished before adding the next layer. Finishing a floor in this manner will give an attractive, satin-like sheen to the wood and a finish that will not be slippery, will not mar, scratch, or flake off—one that can be touched up at worn spots or in heavy traffic lanes without completely refinishing the entire floor.

After filler and sealer have been applied, either clear or orange shellac may be brushed in, with the grain of the wood, and allowed to dry thoroughly. Should other than the natural wood color be desired, the floor can be stained before applying the shellac. The shellacked floor may also be waxed in a very thin coat, but if this is done, the wax should be the self-polishing type because buffing the other type with a machine might cause the shellac to mar, scratch, or flake off. Varnish may be applied in the same manner as shellac.

Old Wood Floors

In refinishing a wood floor, it is necessary first to remove the old finish. Varnish or paint may be taken off by machine sanding, scraping, and planing, or with the aid of a paint remover.

Commercial, nonflammable, and organic-solvent type removers have instructions on the labels which should be carefully followed. The removers are usually applied to the floor with a brush and allowed to stand for a few minutes. In brushing, care should be taken not to damage the finish on baseboards and moldings. After the remover has been allowed to stand for the required time, the varnish or paint will soften so that it can be scraped off with a putty knife or rubbed off with excelsior or steel wool. If a putty knife is used, it should be held in a vertical position, scraping toward the operator across the grain of the wood so as not to splinter the flooring. The floor can then be washed several times with clear water and when thoroughly dry, may be sanded, dusted, and refinished the same as a new floor.

Spots or Stains on Wood Floors

Wood floors that are spotted or discolored may be bleached with a solution prepared by dissolving 1 teaspoon of oxalic acid in half a pint of hot water. The solution should be applied to the floor, allowed to stand overnight, and removed by rinsing with clear water, after which the floor should be allowed to dry. When dry, the floor can be refinished by filling the cracks and holes with a commercial crack filler colored to match the wood, applying sealer, and covering with wax, shellac, or varnish.

Painted Floors

For floors that are discolored and in poor condition, it may be more practical to cover the imperfections with two or three coats of porch and deck enamel than to refinish by other methods. The enamel may be applied to a floor from which all dirt, grease, and wax have been removed to produce an attractive, abrasive-resistant finish. The enamels are obtainable in many colors and may be applied as a solid color or to give a splatter-dash effect by using several colors. The manufacturer's directions should be followed concerning the thinning and the time allowed for drying between coats. After the last coat has thoroughly dried, it should be given two coats of solvent-thinned wax and buffed. A floor finished in this manner should be cleaned with a dry mop and the wax coating renewed frequently in the traffic area.

Maintenance of Wood Floors

Waxed floors should be maintained by cleaning with a soft brush

or mop free from oil, since oil softens the wax. Volatile-solvent type floor waxes, as well as the dirt embedded therein, can be removed from wood floors by rubbing the surface first with 00 steel wool dipped in turpentine or mineral spirits and then with a soft cloth, after which the floor may be refinished with several thin coats of wax, being sure that each coat is thoroughly dried and polished before applying the next coat.

Wax coatings of the water-emulsion type may be removed by scrubbing the surface with a warm solution of soap and water (about 120° to 130° F.), using a soft bristle brush or cloth. When the floor is clean, a thin coat of water-emulsion wax may again be applied, allowed to dry thoroughly, and buffed lightly.

Varnished and shellacked floors which are unwaxed should be dusted clean with a soft brush or dry mop and then rubbed with an oiled mop or a cloth slightly moistened with floor oil or furniture polish. In general, varnished and shellacked surfaces should not be treated with water. The appearance of badly worn varnished wood may be improved by coating with self-polishing floor wax.

Painted floors may be maintained by sweeping them with a soft brush and then rubbing them with an oiled mop or cloth. Occasionally they may be washed with slightly soapy water, rinsed with a wet cloth or mop, wiped dry, and then polished with an oiled mop or cloth.

Masonry Walls and Ceilings

Interior masonry walls and ceilings above grade may, in general, be painted in much the same manner as plaster surfaces. Here again, it is necessary to allow adequate time for the masonry to dry before applying paint and, in addition, attention should be given to the preparation of the surface. When decorating a wall containing portland cement (concrete, for example), it is essential to take precautions against the attack of alkali. For this purpose, alkali-resistant primers such as rubber-base paints may be used when oil paints are to follow.

Cement-water paints are best suited for application to basement walls which are damp as a result of leakage or condensation. To apply these paints, the same procedure should be followed as is described for painting exterior masonry walls.

Dry basement walls or those above grade may be decorated with any of the four types of masonry paint described in section 3 of this chapter.

Concrete Floors

Two general types of paints for concrete floors are varnish and rubber-base paint. Each has its limitations and the finish cannot be patched without the patched area showing through. Floor and deck enamel of

the varnish type gives good service on concrete floors above grade where there is no moisture present.

Rubber-base paints, which dry to a hard semigloss finish, may be used on concrete floors below grade, providing the floor is not continually damp from seepage and condensation. Floor paints for concrete may be obtained in gray, brown, tile red, green, and black.

Paint should not be applied to a concrete basement floor until the concrete has aged for at least a year. The floor should be dry when painted, the best time for application being during the winter or early spring (assuming there is some heating apparatus in the basement), when the humidity in the basement is very low. In general, three coats of paint are required on an unpainted floor, and the first coat should be thin to secure good penetration. After the paint is dry, it should be protected with a coat of floor wax.

In repainting concrete floors, where the existing paint has been waxed and is in good condition except for some worn areas, the surface should be scrubbed with cloths saturated with turpentine or petroleum spirits and rubbed with steel wool while wet, to remove *all* wax before repainting. If this is not done, the paint will not adhere and dry satisfactorily. If the old paint is badly worn, it should be removed by treating with a solution of 2 pounds of caustic soda (household lye) to 1 gallon of hot water. This may be mopped on the surface and allowed to remain for 30 minutes, after which the floor can be washed with hot water and scraped with a wide steel scraper. Another method of application is to spread a thin layer of sawdust, which has been soaked in caustic solution, over the floor and allow it to stand overnight. The following morning, the floor can be washed with hot water and the paint scraped off. The surface should then be rinsed thoroughly with clean water.

If rubber-base paint has been used, the caustic soda treatment may not be effective and it may be necessary to use an organic solvent type of paint remover.

Caution.—In the use of caustic soda or lye, avoid splashing the eyes, skin, and clothing. Rules to be followed and measures to be taken in case of accidents when using lye will be found in chapter 10, section 3.

Interior Metal

Interior metal, such as heating grilles, radiators, and exposed water pipes, should be painted to prevent rust and to make them as inconspicuous as possible. New metal should be cleaned of grease and dirt by washing with mineral spirits and any rust should be removed by sanding, after which a metal primer should be applied. The finish coat may be either a flat wall paint or a semigloss enamel.

The paints may be applied by brush or spray, the small spray attach-

ment for vacuum cleaners being very convenient, especially for painting radiators.

Exposed air ducts of galvanized metal should be given a primer coat of zinc dust-zinc oxide paint before the finish coat is applied.

Brass light fixtures and andirons may be polished and kept bright by coating with metal lacquers. The lacquers, held in cans under pressure, may be sprayed directly from the container. Unattractive light fixtures may be painted with ceiling or wall paint to harmonize with the surrounding surfaces.

5. MISCELLANEOUS SURFACES

Awnings and Deck Chairs

Faded or discolored awnings where the canvas is in good condition may be freshened by coating with awning paints which are available at most paint and hardware stores in a variety of nonfading colors. These materials are easily applied with a brush, are nonpenetrating, and dry to a smooth flat flexible finish. They may also be used to renew the color of old canvas on deck chairs, lawn umbrellas, or glider cushions.

Porch Decks

Exposed canvas porch decks are difficult to maintain, but may be painted with porch and deck enamel or aluminum paint. The coating should be renewed annually if the deck is to remain leakproof. Porch and deck enamel produces a glossy finish; and aluminum paint a silvery metallic finish.

Doors

In painting a door, the type of wood, the severity of exposure, the finish and color desired, and the type of paint should all be taken into consideration.. When applying each coat of paint, finish the panels first, the center rail next, then the top and bottom rails, next the vertical stiles, and finally the edges. If the surface is kept smooth by rubbing with sandpaper between each coat, the door should present a smooth velvetlike appearance when finished.

Windows

Before painting a window sash, be sure to scrape off all the old putty and coat the wood recesses with linseed oil before applying the new putty. A shield cut from a piece of tin will speed the work of painting by protecting the glass from "run overs" while still permitting enough paint to flow on to the muntins or sash bars to give a good seal

between the wood and glass. The muntins or sash bars should be painted first, then the stiles and rails of the sash, next the window frames and trim and, finally, the sill and apron below.

Screens

Door and window screens will last longer and look better if kept well painted. For this, special screen paints are best, but they should be thinned to avoid clogging the mesh. A coat of thinned white paint applied to the screen wire makes the interior of the house less visible from the outside.

The necessary tools and materials are a screen paint applicator and bristle brush; special screen paint, spar varnish, or enamel in desired color and small amount of boiled linseed oil or turpentine for thinning.

A cheap grade of screen wire will probably require painting every year, while galvanized wire may show signs of rust only after long usage and may then require only a light coat of paint. Copper or bronze screen wire will not deteriorate if not painted, but the corrosion products resulting from weathering makes it advisable to either paint or varnish copper or bronze screens to avoid staining the trim and outside walls of a house. If it is desirable to retain the original copper or bronze color of the screens, a high-grade spar varnish should be applied in two coats to both sides of the screen cloth. Inasmuch as this will not last as long as the enamel, they will need to be coated with spar varnish each season. If a dark color is not objectionable, a coat of thin black enamel should last several seasons.

Paint may be applied evenly and economically to screens with a special screen applicator. Most paint dealers carry these applicators but, if not available, they are not difficult to make. A block of wood 1 by 3 by 8 inches may be covered with thick felt or carpet attached to the face side of the block with the nap outward. A cleat of wood for a handle should be nailed along the center of the opposite side of the block. The carpet may be fastened by glue or tacks, but if tacks or brads are used, the heads should be well embedded so that they will not catch on the wire mesh while the paint is being applied.

The screen should be placed on a level surface like a table top, and cleaned of all dust, soot, and loose rust with a bristle brush. If more thorough cleaning is necessary, the screen may be washed with soap and warm water applied with a brush, after which it may be rinsed with clear water, and dried with a cloth. After the screen has been cleaned on both sides and dried thoroughly, paint may be applied by brushing the face of the applicator with a moderate amount of paint and spreading the paint over the screen with the applicator. In this way, the screen may be painted quite rapidly and easily with a thin even coating without clogging the mesh.

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The frames should not require painting oftener than once in every 3 to 5 years. If the screens are cleaned and painted once a year as described, their life will be prolonged and they will present a neat appearance.

Swimming Pools

Vitreous tile is the preferred coating for swimming pool wall and floor surfaces, but there are three general types of paint which may be used as decorative finishes: Cement-water paints, enamel paints with water-resisting varnish vehicle, and waterproof enamel paints. These paints are available in appropriate light blue and light green colors.

The advantages of cement-water paints are their ease of application and low cost; their disadvantages are their tendency to absorb body oils and grease and to accumulate algae under conditions where it exists. One season is the maximum period that wall and floor surfaces of a much-used pool coated with cement-water paints can be kept in good condition without repainting.

Enamel paints must be applied only to clean dry surfaces and no water should be put into the pool for several days after the application of each coat. Enamel paints give a smooth attractive surface that may last for a season, but may develop blisters and peel during that time.

Waterproof enamel paints will probably give the least trouble since they dry to a smooth hard glossy finish and are chemically resistant to moisture and water-purifying agents.

Wood Furniture

Finishes for wood furniture may be grouped into two classes: opaque and transparent.

Opaque finishes are paints. When the old finish is dirty the surface can be cleaned and roughened with No. 1 sandpaper, wiped clean with a cloth moistened with turpentine, and repainted with the desired kind of paint. If the coating is cracked or flaking off, the best plan is to remove the old finish.

The old finish may be removed by the use of either organic-solvent or alkali type remover. The organic-solvent type remover is preferable since the alkali type remover may raise the grain of the wood and, unless well washed out, may injure the new coats of either paint or varnish.

One coat of priming paint is needed, followed by an eggshell flat finish. For a glossy enamel finish, an enamel should be applied over the flat coat.

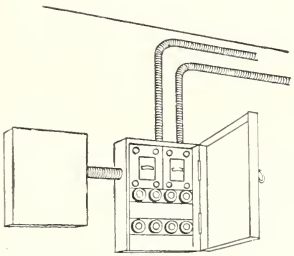
Transparent finishes include varnishes, lacquers, oils, and wax.

Varnishes of the polishing, rubbing, or cabinet type are satisfactory for refinishing furniture. They dry to a high-gloss finish and should not dull or obscure the grain of the wood. Dull, matt, or velvety sheen finishes may be obtained by rubbing to varying degrees the dried varnish film with a paste of pumice or rottenstone in either oil or water. Varnishes which dry to a lusterless or dull finish may be procured in paint stores.

Linseed oil mixed with turpentine and drier may also be used quite satisfactorily for refinishing work, the pores of the wood being filled with successive applications of the mixture. The excess coating of oil should be wiped off at the end of approximately 1 hour, and several days' drying time allowed between applications. Such a finish may then be waxed to produce a soft velvety sheen.

To make cracks and holes in furniture inconspicuous, use stick shellac which resembles sealing wax in appearance and is sold in a variety of colors at the larger paint stores.

The whitish and misty cast that sometimes appears on varnished furniture may be removed by wiping with a mixture of 1 tablespoonful of cider vinegar in a quart of water, rubbed on with a soft cloth in the direction of the grain of the wood and wiped dry. White marks made by hot dishes may sometimes be removed by applying turpentine, allowing it to remain a few minutes, then wiping it dry. Another method for removing white marks is to rub the mark lightly with linseed oil and powdered rottenstone.



12. ELECTRICITY

1. CAUTION

Electricity is one of the most conveniently applied forms of energy for household uses. In addition to its great convenience and adaptability for various purposes, it has the advantage of safety when properly handled. There are, however, possible serious hazards to both life and property if electric wiring and devices are incorrectly installed or utilized.

Electric wiring and appliances are intended for specific functions and should be used only for those purposes for which they are intended. Electrical devices, particularly heating appliances, should be moved only by means of the insulated handles provided. Current-carrying parts of wiring devices for appliances such as sockets or receptacles should never be touched before cutting off the current at the main switch.

It is important to avoid contact with electric wires or conductors in bathrooms, kitchens, laundries, basements, garages, or other rooms where floors may be damp. The danger of receiving electrical shocks is greatest under wet conditions because of the increased conductivity of the skin. Therefore, when the hands or any part of the body are wet, do not touch electrical appliances, fixtures, or the connecting cords. Electric shock usually occurs when current flows from the live part of a device through the point of contact to a person's hands or body, with the return circuit being made either through wet feet or contact through a hand that is touching some grounded object, such as a radiator, stove, or heater. If current flow passes through or near the heart, the effects may be very serious.

2. HOME REPAIRS

Minor repairs to the electrical system and equipment of a house are the only ones which should be undertaken by the home repairman. They may include such tasks as replacing a blown-out fuse, replacing broken or frayed appliance cords, or overhauling an electric-bell system. The householder should not attempt to disturb permanent wiring or make extensions thereto, even though he may be familiar with such work. Work of this nature should be done by a licensed or experienced electrician in accordance with local regulations or the provisions of the latest edition of the National Electrical Code.

3. DISCONNECTING

The entire supply of electric current may be cut off where it enters the house system by pulling or disconnecting the main switch, which is usually located in a metal box near the meter in the basement.

Each adult member of the household should be familiar with the means for disconnecting the current. The method of operation will vary according to the type of design. In most equipment, a handle protrudes from the box or enclosure, and the circuit is disconnected by pulling the operating lever down; on circuit breakers or pull-out type switches, the method of opening is indicated on the outside of the enclosure. In case of fire or other emergency, or when a house is to be left unoccupied for long periods, the main switch should be opened.

4. FUSES

The wires in each house circuit are intended to carry a certain current load and if overloaded may become heated and cause a fire. Fuses or circuit breakers are used as a safety device to guard against this danger. When more than the rated current load is placed on the circuit wiring, the safety device operates, opening the circuit. This is called the "blowing" of a fuse or the "tripping" of a circuit breaker. In attempting to restore service, the cause of the blown fuse or tripped circuit breaker should first be determined. To do this, the appliance which was put on the line at the time the fuse blew should be disconnected. If, after all portable equipment (including lamps) has been disconnected, however, and the fuses on this particular branch again blow, an electrician should be called in and no further effort made to use this circuit until the trouble has been located and corrected.

If an electrical circuit is overloaded by connecting too many appliances to it at one time, a fuse may blow or a circuit breaker trip. A short circuit, which may also blow a fuse or trip a circuit breaker, may be caused by worn or damaged electrical insulation.

Inasmuch as fuses are intended to protect the wiring of a circuit, it is important when replacing them to use those of the proper rating. Branch circuits in residences are usually wired with No. 14 or 12 wire and are intended to be protected with fuses rated 15 or 20 amperes, respectively. The 20-ampere circuits are used in kitchen, breakfast room, pantry, dining room, and laundry appliance circuits only. The 15-ampere fuse protects the usual lighting circuits and may be distinguished from those of higher rating by its hexagonal shape, which may be a hexagonal opening, recess, or depression on the (metal) cap. Appliances which draw heavy currents should not be connected to lighting fixtures because their wires are not designed to carry heavy loads. Electric ranges and water heaters are usually installed on separate circuits where the rating of the fuses corresponds to the rating of the device. Approved fuses only should be used, and it is well to have an extra supply in or near the fuse box for an emergency.

Before replacing a fuse, the switch controlling the circuit affected or the main switch should be opened to avoid possible shock. Fuses should be replaced by those of the same rating, as fuses of higher capacity will not protect the wiring from overheating, thus defeating the safety purpose for which they were intended.

5. DAMAGED APPLIANCE CORDS

The cords by which electrical appliances are connected to a circuit often cause trouble. In most cases, this is due either to wear or to improper handling, but in some cases may be the effect of moisture, oil, or heat. A cord usually shows the first signs of wear at the point where it is most frequently handled or where bends occur. If the cord is often twisted and bent sharply, some of the small wires beneath the covering may break and perforate the insulation. If they come in contact with a conductor of the opposite polarity, a short circuit will result causing a flash or arc which may start a fire. Even if the insulation is not perforated the failure of the small constituent wire of such a conductor will ultimately result in a reduced current to the device, perhaps with a "hot spot" in the conductor. When all of the small wires in a conductor have failed, the current cannot flow through it, and the appliance will not work. Defective cords should be promptly discarded.

Proper Handling

To avoid twisting a cord, provided a screw socket adapter is used, do not screw the plug into the socket with the cord attached to the plug. If possible, separate the screw half of the plug from the cap and screw it into the socket. When this has been done, the prongs of the cap may be inserted into the plug without twisting the cord. For

convenience in attaching and to prevent the entrance of foreign objects if sockets are located close to the floor, the threaded half of the plug should be left in the socket. Most of the modern receptacles are made to accommodate the bayonet-type plug. As the name implies, this plug is equipped with two bayonet-like prongs, to be inserted into corresponding slots in the receptacle. With this type of plug, the cords are not subject to twisting as is the case with a screw plug.

When disconnecting an appliance from a plug, the cap should be grasped to avoid pulling on the cord. This will prevent strain on the wires. Some caps are obtainable with handles attached (see fig. 55). If a cord becomes badly damaged, it should be replaced. However, if the cord is sound and has merely been pulled out of the plug, it can readily be reconnected.

To replace the cord in a plug, loosen the screws inside the plug cap and remove any short pieces of wire which may remain attached to the screws (see fig. 55). Then clip the end of the cord and push it through the hole in the cap from the outer side. Next, split and remove the outside braid of the cord for about one inch from the end, which will expose the two separately covered wires within. Then, carefully remove the insulation from these wires for a distance of one-half inch. Twist the strands of each wire to keep them together and form each of

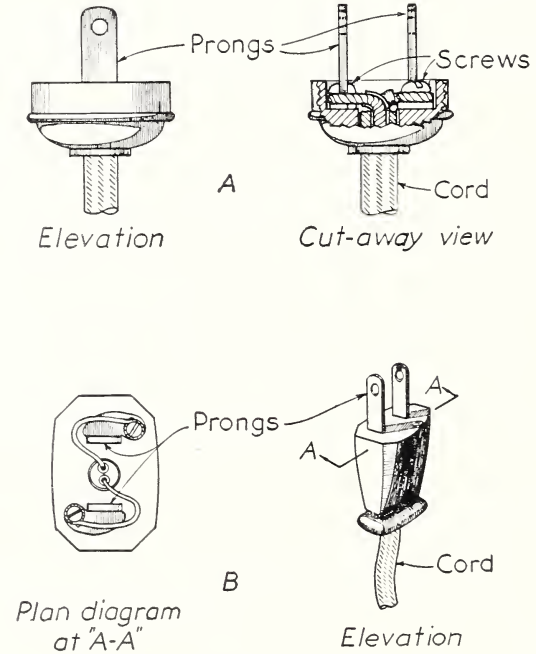


FIGURE 55.—*Electric convenience plugs.*

the conductors into a loop so that the run of the wire is clockwise when placed under the terminal screw. Each wire should then be looped around the blades of the plug, as shown in figure 55, and secured under the terminal screws. Be sure there is no opportunity for bare wires of opposite polarity to come in contact with each other.

If cord becomes badly worn, it should be replaced with cord approved by the Underwriters' Laboratories for the specific use for which it is intended. The uses of the various types of flexible cords are listed in table 31 of the National Electrical Code.

6. DOORBELLS, CHIMES, BUZZERS

Electric doorbells, chimes, or buzzers may be operated by transformers connected to the house wiring or by means of batteries. Transformers should be used only with alternating current as they will not function on direct current and if plugged into that type of system will overheat and may start a fire. The primary circuit of the transformer should be connected to the house wiring by an electrician.

There are several ways in which electric-bell systems, especially those operated by batteries, may get out of order. The usual source of trouble is a worn-out battery. Other difficulties which may occur are loose connections on the transformer, bell, or push-button terminals, a broken circuit wire, a short-circuit, or corrosion of push-button, bell, or buzzer contacts (see fig. 56).

In order to examine the connections in the push button, it is necessary either to unscrew it from the wall or to remove it from the outer shell, depending upon the type of button. Sometimes the contact becomes dirty or corroded from exposure to the weather, in which case the contact points should be cleaned with sandpaper. Examine the connections in the button and tighten any which appear to be loose. Do the same with the connections on the bell, transformer, or battery.

A derangement of the bell parts sometimes occurs, but not frequently. Where it does, tightening the adjusting screw or cleaning the contact may be all that is necessary. This screw is located inside the bell box and may need to be moved closer to or farther away from the spring. If the spring is too stiff, it should be bent slightly toward the coils.

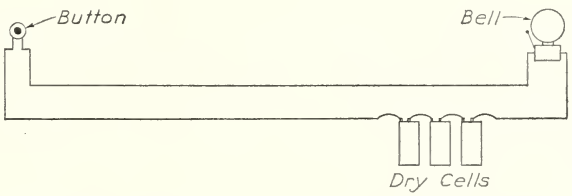


FIGURE 56.—*Electric bell system operated by dry cells.*

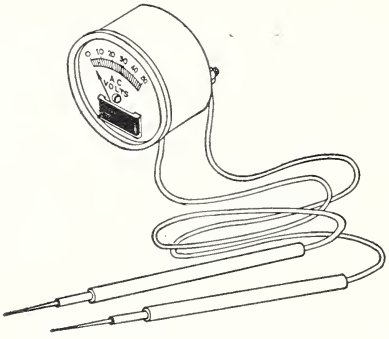


FIGURE 57.—*An alternating-current voltmeter.*

If the bell refuses to work after all of these adjustments have been made, look for a short circuit or broken wire in the system. A piece of metal carelessly placed across the lead wires or terminals, or a staple touching both lead wires where the insulation is badly worn, will produce a short circuit. Worn places on the insulation should be wrapped with friction tape.

A broken wire is sometimes difficult to locate. To find the break, examine the wire with particular care where it is exposed, especially in places where it is fastened with staples or where there is a sharp bend. If the break cannot be found in this way, tests will have to be made to locate the source of trouble. This may be done with a small test meter. An alternating-current meter, shown in figure 57, should be used where the current supply is a transformer; where a dry or storage battery is employed, a direct-current meter should be used.

13. APPENDICES

1. CLOSING THE HOUSE

A house that is to be unoccupied for an extended period, especially during cold weather, should be inspected carefully and precautions taken to guard against possible damage during the absence of the occupants. Such damage might be the result of a leaky roof, water pipes that burst, cracked plumbing fixtures, defective wiring, or other causes.

There is usually more or less haste in leaving a house that is to be closed, and it is for this reason that important safety measures are sometimes overlooked. Therefore, it is best to do some advance planning in a systematic manner.

The roof, for example, should be examined for possible leaks, and repairs should be made, if necessary. Gutters and downspouts should be cleared of leaves and rubbish to prevent overflow.

All rubbish should be gathered and burned, particularly accumulations in the basement. Piles of paper, rags, shavings, and similar discarded material sometimes cause fires by spontaneous combustion. All matches should be put in glass or metal containers, or be removed from the premises, and all oil, gasoline, and paint cans disposed of.

Most fire insurance companies require the insured to obtain a "vacancy permit" before leaving a house unoccupied for an extended period. The necessary requirements in this respect are usually outlined in the policy.

Before the occupants leave the house, the refrigerator should be disconnected, defrosted, cleaned, and the doors left open for airing.

The water should be shut off, and such other precautions taken in regard to the water system and heating system as are recommended in chapters 9 and 10.

The electrical supply should also be cut off as described in chapter 12, section 3. This should be done because fires are sometimes started by short circuits that result from crossed bare wires or other faults in the wiring system. Cutting off the supply of electricity also provides protection against damage from lightning which might pass through the house circuit.

The telephone service may be temporarily discontinued by notifying the telephone company and the charges are usually reduced during the period the telephone is out of service.

The gas company should be requested to shut off the gas supply, to guard against possible damage resulting from a leaky pipe or fixture.

All doors and windows should be closed and locked and the shades drawn. If there are blinds or shutters on the house, they should be closed and locked against intruders and as a protection for windows during heavy storms. Basement doors should be securely bolted.

It is advisable to leave a key to the house with a neighbor or at the nearest police station, so that entrance may be readily gained in case of an emergency. In some cities, where police are notified that a house is to be left vacant, an officer on his regular rounds makes an occasional inspection.

2. MINOR ITEMS

Drawers That Stick

In damp weather, drawers in dressers or cabinets may be difficult to open as a result of the paint or varnish becoming soft and sticky, warping of the wood, or overloading of the drawers.

To relieve this condition, plane the bottom edges or sides of the drawer until it slides in and out readily. Do not plane the top edges, however, as this would mar the appearance, especially when the drawer is open. Apply paraffin to the runways and to the bottom edges of the drawer after which it should slide in and out smoothly.

Making a Miter Box

The use of a miter box will be found helpful in sawing pieces of molding, weather strips, bridging strips, or small-sized lumber where diagonal cuts or true, square ends are desired. The ordinary miter

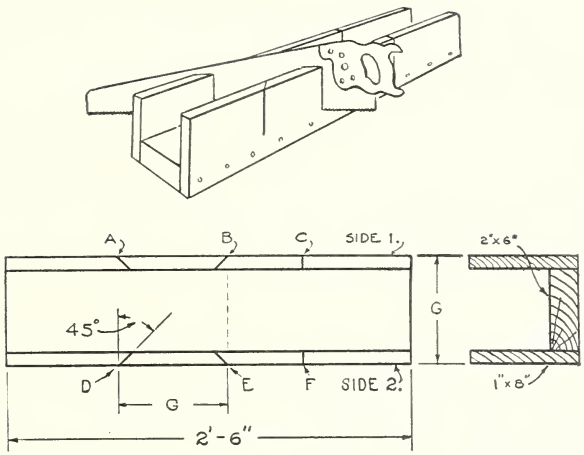


FIGURE 58.—*A home-made miter box.*

box is a three-sided or trough-shaped box, having both ends open and with slits cut through the sides to guide the saw (see fig. 58).

Many kinds of adjustable metal boxes are on the market, but for occasional use in the home, a wooden box will prove adequate and is quickly and easily made.

The most frequent angle cut is 45° and a square-end cut may also be made more accurately with the aid of a miter box. Where many cuts of a certain angle are required, it is advisable to make a special miter box for that particular angle.

The following tools and materials are needed: screw driver, saw, and steel square; three pieces of dressed lumber, consisting of one piece of 2 by 6 inch by 2½ feet long for the bottom and two pieces of 1 by 8 inch by 2½ feet long for the two sides, and about 18 2-inch wood screws.

The two side pieces should be screwed to the edges of the bottom piece to form a channel or three-sided box, being careful to have the sides flush with the bottom. To avoid splitting the side pieces, holes should be drilled for the screws. Then, as shown in figure 58, square a line between *B* and *E*, across the top of the box near the middle, marking the line on top of side pieces 1 and 2. Next, measure from point *B* along the outside edge of side 1, the distance *G* which should be the same as between the outside faces of the side pieces, and mark point *A*. From point A, draw diagonal line *AE*. This diagonal line will be on a 45° angle drawn from one outisde face to another. Each end of the diagonal line AE should then be squared down the outside face of each side, to form a perpendicular. Proceed in the same manner to lay out a second diagonal line *BD* in the opposite direction, to form an X cut with diagonal *AE*.

Before cutting through on the diagonal lines, be sure that there are two screws in each side between points *A* and *B* and *D* and *E* to securely fasten the two short sides thus formed. Saw carefully through the two sides along the diagonal and down the perpendicular lines until the top face of the bottom piece is reached.

Near one end, cut a third line *CF* across the box, at right angles to the sides and perpendicular to the bottom, to be used for cutting off square ends. Screws should be placed close to this cut also, on both sides, to make the side more rigid.

Loose Screws

Screws used to fasten hinges on doors and other movable fittings sometimes work loose. If the screw holes are not too much worn, it is easy to tighten them with a screw driver; if worn so that the threads do not hold, larger screws will need to be used or the holes filled. In some cases, however, because of the size of holes in metal fittings or the thickness of wood, it is not practicable to use larger screws, in which case the holes must be filled. Screw holes may be filled with wood plugs, plastic wood, or steel wool.

The wood plug should be tapered to fit the hole and covered with glue. The hole should then be filled with glue and the plug driven as tightly as possible into the hole removing all excess glue with a damp cloth. After the glue has set, the plug is cut off flush with the wood and drilled to receive the screw.

If plastic wood is used to fill the hole, it should be allowed to set, after which the hole should be drilled to a diameter slightly less than the outside diameter of the threads of the screw to be inserted. The screw can then be driven to a tight fit.

A small amount of fine steel wool inserted in the screw hole will also make the screw fit tight.

Cracks in Stationary Laundry Tubs

Leaks caused by cracks in laundry tubs and other tanks made of concrete, slate, or stone, may be mended by cutting a groove along the crack, one-half inch or deeper, with a slender cold chisel. After wetting, the crack should be filled with a mixture of 1 part portland cement, 2 parts fine sand, and enough water for a workable mix; packing it in with a flat-ended tool. The tub should then be filled with water and let stand for 2 days or more, allowing time for the patch to thoroughly cure and to form a good bond.

The crack may also be sealed by packing it with soft cotton cord that has been well covered with white-lead paste.

3. LIST OF TOOLS AND SUPPLIES

The tools listed below are those recommended for the jobs described in this handbook.

General Tools

The most frequently needed tools to enable the householder to perform the usual tasks in the upkeep of a house are:

Claw hammer.
Two screw drivers (one large, one small)
Wire-cutting pliers.
Monkey wrench.
Hand saw (crosscut).
Two wood chisels (¼- and ⅞-inch).
Small flat paint brush.
Jackknife.
Putty knife.
Hacksaw.
Cold chisel.
Folding rule.
Hatchet.
Gimlet.
Smoothing plane.
6-foot stepladder.
Oilcan.
Steel square.
Nail set (1/16-inch).
Mason's trowel.
Force cup (plumber's friend).
Three-cornered file.
Stilson wrench.
Carpenter's pencil.
Metal shears.
Brace and bits.
Soldering iron.
Glass cutter.
Drawknife.
Galvanized water bucket.
Small washtub.
Funnel.
Flashlight.
Oilstone.

Special Tools

Tools which are very useful, but which are not required so often as those in the preceding list, include the following:

Ripsaw.
Jackplane.
Miter box.
Vise.
Plasterer's trowel.
Steel crowbar.
Pinch bar.
12-foot straight ladder.
3-inch flat paint brush.
Gasoline blowtorch.
Coil spring-steel pipe-cleaning auger.
Seat-dressing tool for valve seats.
Force pump.
Suction pump.
Carpenter's level.
Hand drill, ¼-inch.
Drills, twist, assorted.

The following power tools are available to the home craftsman for making home repairs:

Band saw.
Circular saw.
Drill press.
Grinder.
Jigsaw.
Lathe.
Planer.
Sander.

Supplies

The following supplies will be found useful in many cases and may be kept on hand to meet emergencies:

Sandpaper.
Sponge.
Seat washers.
Candles.
Assorted nails.
Assorted screws.
Friction tape.
Liquid glue.
Rubber tape.
Electric fuses.
Nuts and bolts.
Wire (copper and iron).
Soft solder.
Rubber tubing (small).
Lubricating oil.

Materials, as well as tools, required for specific jobs are mentioned throughout the text of this handbook.

4. CHECK LIST

A systematic check of the house and its equipment should be made at regular intervals in order that defects may be noted and measures taken to correct them. In making this survey, the following check list of items for possible repairs and improvements may be helpful.

Foundation Walls

1. Masonry walls for cracks or broken portions that may require filling.
2. Mortar joints to see if pointing is needed.
3. Walls for leaks that may require dampproofing.
4. Eaves or tops of walls for leakage and to see if repairs or coping are needed.
5. Masonry walls for efflorescence or scum that may need removal.
6. Stucco walls for cracks, discoloration, or damaged portions that may need pointing, cleaning, or replacing.
7. Frame siding for loose or decayed boards or open joints that may need repair or replacement.
8. Painted surfaces to see if blistering, cracking, or peeling has occurred and if repainting is needed.
9. Wall surfaces to see if they need replacement or re-covering.
10. Grading around foundation for proper drainage.

Windows and Doors

1. Window caps to see if new flashing or repairing of existing joints is required.
2. Holes or cracks around window frames to see if calking or repair is needed.
3. Windows for broken glass panes that may need replacement.
4. Putty around panes to see if reputtying is necessary.
5. Screens to see if repair or repainting is needed.
6. Storm doors and windows to see whether they need repair or repainting and if additional ones should be provided.

7. Blinds and shutters, to see if repairs are needed.

8. Awnings to see if repairs or replacements are necessary.

9. Balconies and railings to see whether they need repairs or painting.

10. Windows to determine whether additional ones should be installed.

Roof, Flashing, Gutters, and Downspouts

1. Shingle slate, or tile roofing to see whether repair or replacement of broken, loose, or missing units are necessary.

2. Metal or roll roofing for cracks, open joints, or worn coatings that might need repair or the application of waterproofing materials or paint.

3. Flashing for rust or defects and to determine whether repair, replacement, or repainting is necessary.

4. Gutters or conductor pipes for leaks and to see whether they need repainting or replacement.

5. Skylights for leaks or defects that might require glazing, flashing, repairing, or repainting.

6. Trapdoors, scuttles, or other roof openings, for leaks that might need flashing, repair, or repainting.

7. Chimney for defects and to see whether pointing or replacement of brick is necessary.

8. Need for chimney cap or chimney pots.

9. Chimney draft to see whether it is effective or may require lengthening of the chimney or installation of metal hoods.

10. Lightning arrestors.

11. Downspouts to see whether splash blocks need to be provided at outlet end or whether downspouts should be connected to a drain line.

Porches and Steps

1. Column bases for possible decay and need for repair or renewal.

2. Balusters to see that none are broken, loose, or missing.

3. Railings and posts to see that none are broken, loose, need repair or strengthening.

4. Floor boards to see that none are decayed, broken, or loose and need repair.

5. Floor supports for decay and to see whether they need replacement or strengthening.

6. Steps to see that none are broken, loose, or worn and need repair.

7. Advisability of installing latticework to screen spaces under the porch.
8. Advisability of enclosing porches with glass or screening.
9. Floors to see whether they need refinishing or repair.
10. Masonry for open joints or cracks that might need pointing.
11. Floor tile for loose tile or other masonry material for damage that might need repair.

Garage

1. Advisability of installing insulating material.
2. Roof for cracks, open joints, or worn coatings that may need repair.
3. Doors, for adjustment.
4. Windows, for replacement of broken panes.
5. Advisability of laying concrete floors.
6. Advisability of installing heating equipment.
7. Inside and outside surfaces to see if painting is necessary.

Grounds

1. Walks and driveways; to see whether they need repair, replacement, or whether additional ones are necessary.
2. Fences, trellises, and latticework that might require repairing or painting.

Basement

1. Foundation walls for large cracks or broken places that might require filling.
2. Walls for smaller cracks or mortar joints that might require pointing.
3. Walls and ceiling to see if they need brightening with new and lighter paint coatings.
4. Walls and floors for leaks that might require waterproofing or provisions for drainage.
5. Wood sills and walls for joints between them which might require calking.
6. Floor joists at the sills for spaces or holes around pipes that might need firestopping.
7. Floor joists for sagging and warping that might require additional support or bridging.
8. Basement floor for cracks or disintegrated places that might need repair or resurfacing.
9. Need for additional partitions to provide space for special purposes.

10. Unfinished walls and ceilings to determine desirability of finishing them.
11. Floors for painting or installation of asphalt tile.
12. Storage facilities such as shelves, closets, cupboards, and bins.
13. Advisability of constructing basement garage.

Heating and Ventilating

1. Smoke pipes or flues to see whether cleaning is necessary.
2. Boiler coils or baffles to see whether they require cleaning.
3. Grates to see if they are warped or broken and need replacement.
4. Fire box to see if cracked, and whether repairs are necessary.
5. Boilers for cracks or leaks that might need repair or new parts.
6. Chimney masonry for cracks that might require pointing.
7. Woodwork adjoining pipes and heating system to see that fire protection is adequate.
8. Coating on boilers to see whether patching or recovering is needed.
9. Heating pipes to see whether repairs to covering are needed.
10. Advisability of installing automatic stokers, ash conveyors, or similar labor-saving devices.
11. Radiator valves for leaks that might require repacking.
12. Radiators to see that they are painted properly to increase efficiency.
13. Need for installation of additional radiators.
14. Need for radiator covers and radiator tops.
15. Thermostatic heat-control system to see that it is operating properly.
16. Air conditioning and need for humidifiers.
17. Advisability of building new or additional fireplace.
18. Advisability of installing an ash dump for fireplace.
19. Need for installation of room-heating device in existing fireplace.
20. Fireplace screens, andirons, and similar equipment to see whether repair or replacement is needed.
21. Gas or electric log to see that it is operating properly.
22. Fireplace hearth, fireback, and dampers, for possible repair.
23. Mantel or fireplace front for possible remodeling.
24. Ventilating devices in kitchen and need for additional ones.
25. Walls and ceiling for installation of insulating material.

Plumbing

1. Drains to see that they are open.
2. Faucets for leaks that might require new washers, tightening, or new parts.
3. Flush valves in water closets to see whether they need repair or replacement.

4. Covering for water pipes and advisability of taking other precautions to prevent freezing.

5. Water-pipe fittings to see whether additional shut-off cocks or valves are needed.

6. Water-heating equipment to see that it operates properly.

7. Piping for possible repair or replacement.

8. Fixtures for repair or replacement.

9. Advisability of installing additional bathrooms, lavatories, and toilets.

10. Advisability of providing toilet and shower in basement.

Lighting and Power

1. Wiring to see whether rewiring is needed.

2. Exposed wires to see that insulation is not worn or damaged.

3. Appliance cords to see whether they need to be replaced.

4. Electrical outlets to see whether additional convenience outlets, such as floor and base plugs, are needed.

5. Supply of fuse plugs for fuse box.

6. Chimes, buzzers, and doorbells to see whether repairs or additional installations are needed.

7. Advisability of installing transformers for bells to replace batteries.

Doors and Windows

1. Doors and windows to see whether they need refitting, adjustment, or repair.

2. Doors for advisability of replacing wood panels with glass.

3. Locks, chains, or bolts, to see whether they are defective and need repair or replacement.

4. Supply of extra keys for various locks.

5. Window cords and pulleys to see if they are broken or defective and need replacement.

6. Window latches or other window-fastening devices to see if they are broken or need replacement.

7. Window sash and doors to see if cracks around them need weather-stripping.

Walls and Ceilings

1. Plaster for cracks or holes that may require patching or replastering.

2. Advisability of installing more partitions, either temporary or permanent, to provide additional rooms or closets.

3. Partitions for removal to afford additional space.
4. Doorways for width and to see if plastered arches or similar larger openings should replace them.
5. Walls and ceilings for refinishing or redecorating and need for painting, papering, or installation of wall tile.

Floors

1. Floors to see that they do not creak and whether they need renailing, additional supports, or joists stiffened by bridging.
2. Need for refinishing.
3. Advisability of laying new flooring over old.
4. Floor coverings to see if they need repair or replacement.
5. Baseboard and molding for shrinking and settling, to see if adjustment or replacement is needed.
6. Tile for repair or replacement.

Stairs and Stairways

1. Stairs to see that they do not creak or need strengthening.
2. Treads on stairs to see if replacements are needed.
3. Rubber or composition treads for slipperiness.
4. Basement stairs to see whether additional supports or repairs are needed.
5. Railing on basement stairs to see that it is structurally sound.
6. Advisability of changing closed stairways to open ones by the removal of wall on one side.
7. Posts and railings for stiffness and need of replacement.
8. Method of access to attic and advisability of providing disappearing stairs.

Attic

1. Walls, floor, or underside of roof to see whether insulation is needed.
2. Ventilation and need for installation of louvers or additional windows.
3. Mortar joints in chimney to see whether they require repointing.
4. Chimney and side walls for cracks between them that may need filling.
5. Studs at floor line for firestopping.
6. Possibilities for changing attic space into finished room or rooms.
7. Need for additional partitions.
8. Flooring for stability and smoothness as well as need for refinishing.

Miscellaneous

1. Lining of existing closets and need for additional closets.
2. Need for additional shelves, bookcases, and cupboards.
3. Advisability of providing clothes chute, telephone cabinet, or other built-in conveniences.

5. SELECTED REFERENCES

Following is a selected list of publications of the National Bureau of Standards relating to home building and maintenance, which may be of interest to the home owner. The publications may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., at the prices indicated.

Recommended Minimum Requirements for Plumbing, BH13 (75¢).
Metallic Roofing for Low-Cost House Construction, BMS49 (20¢).
Moisture Condensation in Building Walls, BMS63 (15¢).
Solar Heating of Various Surfaces, BMS64 (10¢).
Asphalt-Prepared Roll Roofings and Shingles, BMS70 (20¢).
Indentation Characteristics of Floor Coverings, BMS73 (10¢).
Performance Tests of Floor Coverings for Use in Low-Cost Housing, BMS80 (15¢).
Field Inspectors' Check List for Building Constructions, BMS81 (20¢).
Water Permeability of Walls Built of Masonry Units, BMS82 (25¢).
Fire-Resistance Classifications of Building Construction, BMS92 (30¢).
Tests of Cement-Water Paints and Other Waterproofings for Unit-Masonry Walls, BMS95 (25¢).
Painting Steel, BMS102 (10¢).
Measurements of Heat Losses from Slab Floors, BMS103 (15¢).
Paint Manual, With Particular Reference to Federal Specifications BMS105 ($1.00).
Temperature Distribution in a Test Bungalow with Various Heating Devices, BMS108 (10¢).
Strength of Houses: The Application of Engineering Principles to Structural Design, BMS109 ($1.50).
Paints for Exterior Masonry Walls, BMS110 (15¢).
Performance of Radiant and Jacketed Space Heaters in a Test Bungalow, BMS114 (25¢).
Wall Plaster: Its Ingredients, Preparation, and Properties, C151 (20¢).
Thermal Insulation of Buildings, C376 (5¢).
Cautions Regarding Gas-Appliance Attachments, C404 (5¢).
Washing, Cleaning and Polishing Materials, C424 (20¢).
Safety for the Household, C463 (75¢).
Safety Rules for the Installation and Maintenance of Electric Utilization Equipment, H33 (20¢).

The above and other publications of this Bureau, as well as those of other Federal Government agencies on matters pertaining to the home, are listed in Price List 72, Publications of Interest to Suburbanites and Home Builders, which may be obtained free upon request from the Superintendent of Documents.

In addition to the suggestions contained in this publication, various sources of information concerning the care and repair of the house are available to the home repairman.

The dealer from whom purchases are made may often be consulted regarding correct amounts and grades of materials required for a specific job. In addition to his personal knowledge, he may be able to furnish printed instructions covering the use of the products which he handles. These instructions are prepared by the manufacturers of the materials and are usually comprehensive and useful.

In addition to the assistance rendered by the material dealers and manufacturers, many national trade associations retain staffs of experts, experienced in the correct methods for using the products they represent. The results of their studies are usually published and distributed by those associations, many of the publications being in the form of booklets concerning subjects of particular interest to the home owner. These booklets usually contain illustrations, plans, specifications, or detailed instructions relating to the selection and use of building materials and equipment.

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