PAINTING

AMERICAN SCHOOL of CORRESPONDENCE
CHICAGO ILLINOIS

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INSTRUCTION PAPER

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U. S. A.

PAINTING

Introductory. The first thing a man wishes to know when he contemplates painting a house, is the *cost*. This will obviously depend on the cost of labor, of materials, and the kind of materials chosen. The outside of a house is painted, either in whole or in part; the interior may be painted or varnished. Some houses have their walls partly covered with shingles; these shingles are sometimes painted, and sometimes—in fact, often—left unpainted; but what is called the *trim*—that is, the boarding about the eaves, windows, doors, the base-board, and corner-pieces—is painted. Shingles, either wall or roof, are often stained with a creosote stain consisting of a coloring matter dissolved or suspended in a liquid called *creosote*, which is applied for the purpose of preserving them; and though instances can be cited in which wall-shingles that were never stained are still doing good service although believed to be now two hundred and fifty years old, yet the use of creosote will undoubtedly prolong the life of modern, sawn shingles, as it is noxious to insect life and a powerful deterrent of natural decay. The color of unpainted new shingles is generally disliked; but after four or five years wall-shingles take on a beautiful, soft color. The question of staining shingles is a matter of taste.

Most houses are exteriorly painted with paint based on white lead or zinc. Some idea of the cost may perhaps be gained from the following considerations:

White lead is sold either ground with a little oil to a thick paste, or—less commonly—in the dry state.

A mixture of 100 pounds of paste white lead with 5 gallons of linseed oil, makes $6\frac{1}{2}$ gallons of paint, weighing 21.3 lbs. per gal.

Approximate figures are: 15 lbs. paste lead and 6.3 lbs. oil equals 1 gal. (1 gal. oil equals 7.7 lbs.); 14 lbs. dry lead and $7\frac{1}{4}$ lbs. oil equals 1 gal.

A mixture of 100 pounds of white zinc and $8\frac{1}{3}$ gal. oil, makes $10\frac{5}{8}$ gal. of paint; 12 lbs. zinc and 1 gal. oil make 1.3 gal., or 9.5 lbs. zinc and 5.7 lbs. oil make 1 gal. white zinc paint weighing 15.2 lbs. Dark-colored paints made from iron oxides, ochers, and the like, weigh 12 to 14 pounds per gallon; but exact figures cannot be given, as the raw materials differ greatly.

Here should be noted the difference between the priming coat and the succeeding ones. A *priming coat* is the first coat applied to the

clean wooden surface; it differs from the other coats in containing more oil, because the wood will soak up the oil and leave the coloring matter of the paint on the outside.

To make the paint for the priming coat, take a gallon of the paint already described and mix with it a gallon of raw linseed oil. Paint thus made is, of course, lower in price; it is also much thinner; but such is the absorbent power of the wood, that the priming paint does not cover as much surface as the succeeding coats per gallon. A gallon of this thin priming coat covers 300 to 400 sq. ft., while a gallon of second or third-coat paint, well brushed out, will cover about twice this surface; this is because the surface for all but the first coat is hard and non-absorbent. Priming coats are used for both outside and inside work, as will be described later.

The dark-colored paints are usually cheaper than those made from lead and zinc, and if made of good materials are not inferior in durability; the extraordinary claims made by the zinc and lead manufacturers are to be received with much doubt. Some of the dark-colored paints are the most durable that can be applied on wood. The chief cost of painting is, however, that of labor, which varies according to locality and other conditions, seldom being less than twice that of materials.

For light-colored paints, it is better to use raw linseed oil to which pale japan dryer may be added, as described later; for dark colors, either this or boiled oil, boiled oil being darker in color. The cost is practically the same; also the durability.

On inside work may be used either oil or enamel paint, as described later, the former being the cheaper, the latter the handsomer and slightly more durable; or the wood may be finished in its natural color, by varnishing it either with an oleo-resinous varnish or with shellac varnish. The oleo-resinous varnishes darken the wood very appreciably, while white shellac varnish keeps it more nearly in its natural color; although the latter does not prevent the natural darkening action of light, it may retard it. Shellac varnish is the more expensive finish of the two, if well applied. What is sometimes called *oil finish* generally consists in the application of a cheap varnish called *hard oil*, which is usually made of common rosin, linseed oil, and benzine. Its only merit is that it is cheap.

It would indeed be possible to apply neither paint nor varnish, but merely to saturate the wood with oil, and this would be truly an oil finish; it would, however, make the wood dark and dingy, and would readily retain dirt, and is a practice seldom followed except sometimes on floors—especially kitchen floors—and sink shelves. These are at frequent intervals oiled with a mixture of equal parts boiled oil and turpentine.

It is the purpose of this Instruction Paper to describe only good and approved methods. It will readily be understood, and will certainly be observed in practice, that these methods may be abbreviated by the omission of some details that are here specified as desirable. For instance, it is difficult to get interior finish sandpapered or rubbed between coats, even if so contracted; but this is the right practice. Two coats of varnish often have to serve in the place of four. No one, however, needs to be told these things. The methods herein described are not luxurious or extravagant; they are, on fairly good houses, truly economical; and we are not considering temporary structures.

It is not uncommon to find part of a house, as the living rooms, finished in varnish, and the kitchen and pantry painted with oil paints, which are lighter in color and more easily renewed. The sleeping rooms, on the other hand, are often finished in enamel paints, because color effects are desired to harmonize with the furnishings; and bathrooms are almost always done in enamel for sanitary considerations. The taste and inclination of the owner are to be consulted in regard to all these matters.

PAINTERS' SUPPLIES

Pigments and Vehicles. Paint is a mixture of a finely-divided solid substance with a liquid which, when spread on a solid surface with a brush or otherwise, will adhere and in a short time form—by evaporation, or more commonly by oxidation—a somewhat hard and tough film. The finely divided solid is called the *pigment;* the liquid part, the *vehicle.* The most common vehicle is *linseed oil.* This is an oil obtained by pressure (or extraction by solvents) from flaxseed. When spread out in a film and exposed to the air, linseed oil is converted into a tough, leathery, elastic substance called *linoxin,* insoluble in water and all common solvents. This change is brought about by

absorption and chemical union of the oxygen of the air, whereby the weight of the oil is increased about one-fifth or one-sixth. It is therefore a mistake to suppose that oil paint gets dry as whitewash does, by the evaporation of the liquid. Instead of that, it gets heavier. There are some other vegetable oils which have this property in some degree, but none which are used for paints to any considerable extent; some are used a little for artists' colors.

Linseed oil should stand at least a month or two before using. It should then be perfectly free from sediment or cloudiness; if it is not so, this is a sign that the oil has not been properly aged, and such oil is not fit for making paints. In this natural state, it is called *raw oil;* and the price of linseed oil as commonly quoted refers to raw oil. *Boiled oil* is this raw oil which has been heated, usually to 450° or 500° F., with the addition of a small amount of oxide of lead or oxide of manganese, or a mixture of the two (occasionally some other lead or manganese compounds are used). Boiled oil is darker (browner) in color than raw oil, but differs from it chiefly in that it dries five to ten times as rapidly. A thin film of raw oil on a glass or metal surface will dry at ordinary temperatures in five or six days, so as to feel no longer greasy; but boiled oil will do the same in a day or half a day. Oil dries best in warm, dry weather and out of doors.

The pigment is mixed with the oil by stirring the two together. This is usually done by power, in a vessel called a *paint mixer.* The mixture should then be run through a *paint mill;* some paint mills are of steel, but the best have a pair of mill-stones, between which the paint is ground and most thoroughly mixed. Paints mixed in this manner are much better than those which are mixed only by stirring.

Besides oil and pigment, paint sometimes contains a volatile *thinner,* the most important thinners being *turpentine* and *benzine.* Turpentine is a well-known essential oil, volatile, boiling at about 320° F., but evaporating at ordinary temperatures when exposed to the air. Benzine is a mineral oil, lighter than kerosene and heavier than gasoline; the kind used in paint and varnish is called "62-degree benzine," its specific gravity being 62° on the Baumé scale for liquids lighter than water. Linseed oil weighs 7.7 lbs. per gallon; turpentine, 7.2 lbs.; and 62° benzine, 6.1 lbs. But linseed oil is sold by the oil makers and dealers on the basis of 7.5 lbs. per gallon.

A dryer, in some form, is an essential ingredient of oil paint. A *dryer* is a compound of lead or manganese (generally both), soluble in oil, and is usually sold, under the name of *paint dryer* or *paint japan*, as a solution of such material in a mixture of oil, turpentine, and benzine. It is usually of such strength that an addition of from 5 to 10 per cent of it to a raw-oil paint will make it dry in from six to twelve hours sufficiently to be carefully handled. Paints are not dry enough to use, until they have stood four times as long as this; and they continue to harden for months. The strongest drying japans are dark in color; but such are more injurious to the durability of the paint than those which are paler, especially if the latter do not contain rosin. The buyer should always ask for a guarantee that the dryer is free from rosin, if great durability in the paint is needed. Not more than 10 per cent of any dryer or japan should ever be used in any paint. Slowly drying paints are more durable than quick ones.

In house painting, the white pigments are the most important, because they are the base of all light-colored paints. The most important white pigment is *white lead*. This is sold either as a dry powder, or (more commonly) as paste white lead, which is made of 90 lbs. dry white lead and 10 lbs. linseed oil. This can be thinned with boiled oil to make a white paint. White lead is a very heavy pigment; and with a given quantity of oil, more of it can be mixed than of any other pigment, except red lead. It has great opacity, or covering power. It is discolored by gases containing sulphur, becoming brown or black; and unless exposed to fairly strong light, it becomes yellowish even in pure air. It is better if it has been mixed with the oil for some time—a year or more.

White zinc is a somewhat purer white than white lead; not so opaque. Three coats of lead are reckoned equal to five coats of zinc. It becomes harder than lead, but is somewhat liable to peel off; while lead, after exposure to the air for a long time, becomes dry and powdery on its surface, and *chalks*.

A mixture of two parts of lead and one of zinc is much liked. *Zinc-lead*, however, is the name of an entirely different pigment, made by furnacing ores containing about equal parts of lead and zinc, in which the lead is present as a sulphate. This pigment is free from the liability to turn brown if exposed to sulphur gases; it is said to be not quite so pure a white as the preceding. It is a comparatively new

pigment, but is coming rapidly into use, being somewhat cheaper than the others. *Lithopone* is another white pigment of considerable merit.

Adulterants. All these pigments may be *adulterated* with barytes, or with *terra alba* (sulphate of lime), sometimes with whiting (carbonate of lime). These adulterants are powdered minerals. Barytes is a good pigment, so far as protective action goes; and terra alba is thought by some good authorities to be unobjectionable; but whiting is injurious. All of them are transparent in oil, and lessen the opacity or whitening power of the paint.

From these white paints, *colored paints* are made by adding *tinting colors*, of which the yellow is chiefly *chrome yellow*, or chromate of lead; the blue may be either *ultramarine* or *prussian blue*; and the green is *chrome green*, a mixture of chrome yellow and prussian blue. The reds are (in house paints) made from *coal-tar colors*, and most of them are now fairly fast to light. Some dull yellow colors are made from *ochers*, which are clays tinted with iron oxides, roasted and ground. These are permanent colors.

The dark-colored paints may not contain lead or zinc at all. The deep yellows, greens, and blues are made from the colors already named as tinting colors, none of which are entirely fast to light; the dark reds and browns are chiefly *iron oxides*, which are a valuable class of paints, very permanent on wood. The blacks are either *lamp-black* or *drop-black* (bone-black) and other carbon colors; and these are often added in small quantity to secure some desired tone or shade of color.

The zinc and lead pigments have some action on oil, and in their case it is considered the best practice to apply thin coats; but the dark pigments do not act on oil, and, of these, thick coats are best for durability.

Paint and Varnish Brushes. A brush that has only a low price to recommend it will prove a poor investment. If properly cared for, brushes last a long time, and it pays to have good ones. The first sign of a good brush is uniform quality from outside to center. Inferior brushes have inferior bristles in the middle, and some poor brushes are actually hollow. For ordinary oil painting, the bristles on a large new brush should be five or six inches long, uniformly flexible, and as stiff as can be found; they will be flexible enough anyway, but all should be alike.

Paint brushes are *round*, *flat*, or *oval*. A favorite brush for ordinary outside work is what is called a *pound brush*, a large, round brush with stiff bristles six inches long. Such a brush should be *bridled* when it is new—a "bridle" being a piece of cord wound around the bristles to shorten their effective length; as the bristles become worn off, the bridle may be removed. A $2\frac{1}{2}$-inch oval brush ($2\frac{1}{2}$ inches wide) is a highly satisfactory tool to use in general painting, and is the brush recommended by the paint committee of the American Society for Testing Materials. It is worth noting that this committee, made up equally of expert paint manufacturers and experts employed by the large consumers, unanimously agreed that no larger brush than this should be used in making paint tests.

The use of brushes five inches wide is common for outside work; but while such brushes may be had of the best quality, they are heavy and laborious to use, and the workman who uses such a brush will not brush the paint sufficiently to get the best result. If a flat brush is used, it should not exceed $3\frac{1}{2}$ inches in width; and three inches is better. A good $2\frac{1}{2}$-inch oval varnish brush is a most excellent brush for all large work in either paint or varnish. The painter should also have a good $1\frac{1}{2}$-inch oval brush for smaller work, and a number of round or oval brushes, called *sash tools*, of different smaller sizes, for more delicate work, such as sash and frame painting. Stiff-bristle brushes, which have been worn off short, are suitable for such work as rubbing-in filling. For varnishing large surfaces, flat bristle brushes $2\frac{1}{2}$ inches wide are good; also similar ones 2 inches, $1\frac{1}{2}$ inches, and 1 inch wide are useful. All flat brushes should have chiseled edges. For flowing varnish, it is necessary to have thick, flat, camel's-hair brushes, running up to $3\frac{1}{2}$ inches in width, although most house varnishing may be done with brushes not over $2\frac{1}{2}$ inches wide.

Besides paint brushes, the workman will need some ordinary *scrubbing brushes* and one or two painter's *dusting brushes*, to have the surface properly cleaned.

Steel-wire brushes, with stiff steel wire instead of bristles, shaped like scrubbing brushes, are used for cleaning off old paint and for cleaning structural metal work. These are of various sizes; and the steel wires are of different lengths and sizes, hence differing in stiffness. They may be had at hardware stores.

Care of Brushes Hair and bristle brushes must be kept clean

and soft; this can be done by care and faithfulness. They should not be allowed to become dry with paint or varnish in them. To prevent this, wash them out in oil or turpentine as soon as you are through using them; or they may be left in the paint or varnish for a few days. They may be kept over night by wrapping them very closely in paper if they have been used in a slow-drying material; in this way they may be carried from one place to another. Brushes should not be left to dry with even clean oil or turpentine in them; if they are to be put away, they should be well washed first with soap and water, then with clean water, then hung up until thoroughly dry.

In use, brushes are best kept in what is called a *brush safe*. A deep wooden pail, with nails driven in its sides at different distances from the bottom, and with a close cover, makes a good receptacle for brushes. The brushes have holes in their handles, or loops of cord tied to them, and are hung on these nails; their bristles dip into some turpentine or oil in the bottom of the pail; they are so hung that they do not dip into the liquid above where the bristles project from the binding. If brushes are left standing on the bristles on the bottom of a vessel, they soon become one-sided and distorted in shape. Tin brush-safes may be bought of any large dealer in brushes.

A brush which has dried with paint or varnish in it, may be recovered by soaking it in a non-alkaline varnish-remover. This will in time soften it so that it may be used again, but it is not improved by such treatment. Brushes used in shellac should be washed out with alcohol instead of turpentine or benzine. No brush is good unless it is clean.

Fillers. Fillers are of two kinds—*paste* and *liquid*. Paste fillers are something like a very thick paint, and are composed of some solid powdered substance, usually silica or powdered quartz, mixed with a quick-drying varnish thinned with turpentine or benzine. This is applied to the dry surface of the wood with a stiff, short-bristle brush, or is put on with a clean, white cotton cloth, and well rubbed into the pores of the wood. After half an hour or so, the surface of the wood is wiped off with a wad of excelsior or a clean cloth or a piece of felt. A liquid filler is a quick-drying varnish; and most of the liquid fillers on the market are cheap rosin varnishes loaded with dryers, and should never be used. Paste fillers are the best in almost all cases.

HOUSE PAINTING

Inside Work. All window and door frames, whether they are to be finished with paint or varnish, should receive a good coat of paint made with some cheap pigment, such as iron oxide, and boiled oil, applied to the back of the frame, before they are brought from the shop to the house; this prevents the absorption of moisture and hinders decay. If they are to be painted, they should receive a priming coat in the shop, if possible; if not, it should be applied as soon as practicable. The priming coat is composed of white lead and boiled oil or raw oil, with five to ten per cent of dryer; and should be almost all oil, with very little pigment. Turpentine is not a good thing in a priming coat, because the object is to fill the pores of the wood, and turpentine evaporates. As soon as this is dry to the touch, all holes are to be filled with putty. The best putty for this purpose is white lead putty, made by mixing a little raw oil with dry white lead, or by adding dry lead to paste lead until it is of the right consistency. This kind of putty hardens quickly as compared with common putty, and is the best for this purpose. A steel putty-knife should not be used on interior woodwork, as it is almost certain to scratch it; a hardwood stick, suitably shaped, should be used. All cracks, joints, and nail-holes should be carefully filled. All knots and sappy places should be varnished with shellac varnish; this prevents the pitch and moisture from attacking the paint. The shellac should be applied where it is needed, before the priming coat. The priming coat should be given time to get quite dry; at least a day—two days, if possible; and a week is better yet. Then it is ready for the second coat. This should contain a considerable amount of turpentine. If no turpentine is used, the surface is likely to be glossy, and the next coat of paint will not adhere well; but by replacing part of the oil with turpentine, we get what painters call a *flat coat*—that is, one which is not glossy; if this is made from paste lead or any paste paint, it can be produced by thinning the paste with a mixture of oil and turpentine in equal proportions; some painters prefer one-third oil and two-thirds turpentine. This is for inside work only. This coat should be allowed to dry thoroughly; if it takes ten hours for the paint to be dry enough to handle, then at least four times ten hours *additional* should elapse before the next coat is applied; this is a good general rule; and as much more time as possible should be allowed. If the finish

is to be ordinary oil paint, the next coat may be paint, thinned with about half as much turpentine as before, or with no turpentine at all. In the latter case, when the coat is thoroughly dry, it must be carefully examined, and, if glossy, it should be rubbed with something to take off the gloss; curled hair is often used, or a light rubbing with pumice and water. Then the final coat, which has no turpentine in it, may be applied.

But if the finish is to be with an enamel paint, the second coat, when quite dry, should be very lightly sandpapered with fine sandpaper, and the third coat should be of like composition to the second, treated the same way; then the enamel paint is applied. For a really first-class job, when this is quite dry, it should be rubbed down with curled hair or pumice and water, and another coat of enamel put on. This may be left with the natural gloss if desired; or it may be rubbed with pumice and water to a flat (dull) surface.

Painting Plastered Walls. Old plastered walls may be painted with oil or enamel paints as though they were wood, remembering that the priming coat will have almost all of its oil absorbed by the plaster. New plastered walls do not take paint well, on account of their alkaline character, which gradually disappears with exposure to the atmosphere. It is well to let a wall remain unpainted at least a year. But if it is necessary to paint a freshly plastered wall, the wall is prepared by some painters by washing it with a solution of sugar in vinegar, the sugar uniting with the lime to some extent; or—more commonly—by washing it first with a strong solution of common alum and then with a solution of soap. After this is dry, it is washed with clean water, allowed to dry, and then painted. The alum and soap form an insoluble compound which closes the pores of the plaster to some extent, and prevents the lime from acting on the paint.

Outside Work. Exterior paints are more elastic, as they need to be far more lasting, than those used on interiors, since the effect of exposure to the sun and rain destroys paint more than almost anything else does. Paint on the interior of a house will last almost indefinitely; but on the outside the best paint is not very durable. The surface, if new, should be cleaned by brushing; knots should be shellacked; after which the priming coat should be applied. This may be the same paint which is selected for the finish, only thinned with boiled oil (or raw oil and dryer), using one to one and a-third

gallons of oil to each gallon of paint. The reason why ordinary paint may not be used as a primer, is that the wood absorbs the oil, leaving the pigment as a comparatively non-adhesive powder on the surface, from which the next coat will probably peel off. The next step is to putty up all nailholes and other defects. For the second coat, many experts advise the addition of half a pint of turpentine to the gallon of paint; others make no addition to it. The third coat is applied after the second is thoroughly dry; if a week or a month can elapse between these coats, so much the better.

Repainting. If the old paint has been on a long time, it is liable to be permeated by minute cracks, which admit moisture to the surface of the wood and loosen the paint. If now we paint over this, the new paint, which shrinks in drying, tends to pull off the old paint, and of course the whole peels off in patches. If the old paint is in this state, it must be removed before the new paint is applied. This can be done by *burning off*. For this work a *painter's torch* is required, which is a lamp burning alcohol, gasoline, or kerosene, and is so constructed that a blast of flame can be directed against the surface. This melts or softens the old paint, which is then immediately scraped off with a steel scraper. The paint is not literally burned, but is softened by heat so that it can be scraped off. In some cases it is sufficient to remove as much as possible with a steel brush; this is a brush like a scrubbing brush, with steel wires instead of bristles, and, when vigorously used, will take off the loose paint.

Old paint, however, is not always in this condition. If it adheres well, it may be cleaned with an ordinary scrubbing brush and water, and when it is quite dry, the new paint may be applied. Sometimes the paint seems in good condition, only it has faded and lost its luster; in such cases a coat of boiled oil, or raw oil with dryer, is all that is needed.

It is well to paint the trim—that is, the window-casings, door-casings, corner-pieces, and the like—before painting the body of the house; then the paint can be applied to the flat surfaces more neatly than is otherwise likely to be done. Paint should be applied in thin coats, well brushed on; it is not unusual to see paint come off from re-entrant angles while it is still good on flat surfaces, because it was difficult to brush the paint properly in those places. There is a great difference in durability between a thin paint flowed on with a large,

flat brush, and one of proper consistency well brushed out with a brush of medium size. In all painting on wood, it is desirable to brush it on with the grain of the wood; and by painting only a few boards at once, we may avoid laps by painting the whole length. Rough surfaces hold paint better, and more of it, than smooth. A gallon of paint will cover, one coat (on a painted or well-primed surface), about 600 square feet, not flowed on, but well brushed out in a thin film. The priming coat will not cover more than 300 or 400 square feet to the gallon. In measuring the outside of a house for surface, make no deductions for doors and windows; if the trim is to be painted a different color, from one-sixth to one-third of the paint will be required of that color. Paint should be stirred frequently while using. A coat of dry paint is from $\frac{1}{500}$ to $\frac{1}{1,000}$ of an inch in thickness.

Roof Painting. Roof paints should contain a larger proportion of oil to pigment than other paints, and less dryer (or none at all). Many think that the addition of ten to twenty per cent of fish oil to a paint for roofs is advantageous; fish oil greatly retards drying and prevents the paint from becoming brittle. Tin roofs, if new, should be thoroughly scrubbed with soap and water, or with pieces of harsh cloth, such as burlap, well wet with benzine. They may then be painted.

Paint dries relatively fast on roofs; but as a roof paint is very slow-drying, plenty of time must be allowed between coats. A new roof should receive three coats. Metal gutters and spouts are to be treated the same way. Do not forget that new tin or galvanized iron is difficult to paint; have it very thoroughly scrubbed, even though it looks perfectly clean, and then rub the paint on well with the brush. Metal spouts will usually be painted the same color as the wall of the house.

Sometimes shingle roofs are painted with fireproof paint. This is not really fireproof, but considerably retards the spread of fire, after it has become thoroughly dry; when fresh, it does not even do that; nor does it have much effect after it has been on a year or so. It may be made by adding to a gallon of any good paint about a pound of powdered boracic acid. When strongly heated, this material fuses and forms a sort of glass, which keeps the air from the wood. It is after a time washed out by the rain.

Canvas roofs are prepared in the following manner: The canvas

(10-ounce duck is often used) is first nailed down, care being taken to draw it tight; it will show some wrinkles, but these are not to be allowed to accumulate to form a large wrinkle or fold. Then the canvas is thoroughly wet; it shrinks, and all the little wrinkles disappear. It is a common practice to paint it while it is still wet, this being an exception to all other practice; but some wait until it is dry. The writer has been accustomed to the latter method, and has not found that the canvas shows wrinkles on drying, while the results are all that can be desired. A well-painted canvas roof is very durable and satisfactory.

PAINTING STRUCTURAL METAL

Steel is a more perishable material than wood, and more difficult to paint. Without regular expenditure for maintenance, wooden bridges last longer than steel ones; there are wooden roof beams a thousand years old; and iron roofs are so short-lived that they are used only over furnaces and the like, where wooden ones would take fire. The painting of structural steel is therefore important; and it is also difficult, if we are to judge by results.

In the first place comes the preparation of the surface. When we paint wood, we have the surface clean and dry; and then we soak it with oil, so as to have the paint bound to it in the most intimate manner. Iron and steel, on the other hand, always come to us dirty, and covered with oxide; and as the surface is not porous, the paint does not penetrate it, but has to stick on the outside the best way it can. If we paint over the dirt and scale, and that ever comes off, the paint comes off with it; if the metal is actively rusting, and we paint over the rust, the corrosion is perhaps made slower, but it does not stop.

Air and moisture cause rust; if we can keep them away, the metal will last; but, unfortunately, all paint is very slightly porous, and if exposed to the weather it in time deteriorates. The most essential thing in painting metal is to *get the paint on the metal*, not on an intermediate coating.

There are only two ways to clean steel perfectly. One is by pickling it in dilute acid (usually 10 to 20 per cent sulphuric acid), followed by washing to remove the acid; and the other is by the use of the sand-blast. Neither of these processes is available to the ordinary painter, who must do the next best thing. This is to remove absolutely all dirt and all loose scale and oxide. First clean off the dirt, if any,

with brushes, as it would be cleaned off any other surface. Then, with scrapers and steel-wire brushes, clean off all the scale which will come off. If there is any new rust (not mill scale), it must be well scraped out and cleaned off. This is indispensable. When this is done, immediately paint it, before it begins rusting again.

One of the most popular materials for a first coat is red lead in oil. This must be mixed on the spot, shortly before it is used, because it will harden into a cake in the pail or can if allowed to stand very long. From 30 to 33 pounds of dry red lead is to be mixed with each gallon of oil—not less than 28 in any case. This is immediately painted on the metal; if it is put on in too thick a coat, it will run and be uneven. Some use raw oil, others boiled oil; it does not make much difference which is used. The paint dries rapidly; and as soon as it seems hard, a second coat of the paint can be applied. Red lead is different from all other paints in this, that it will finish hardening just as well away from the air. This is because it does not dry by oxidation, as other paints do, but by the lead combining chemically with the oil, just as water combines with Portland cement. In the opinion of the writer, red lead should have one or two coats of some good paint, other than red lead, over it. But red lead is not the only first coating which may be used. Any good paint may be used—a good graphite paint, or other carbon paint, or some of the varnish-like coatings containing linseed oil and asphaltum which are made for the purpose. It is important, in using any of these, to let plenty of time for drying elapse between coats. Not less than two coats is permissible, and three are desirable.

Projecting angles, edges, and bolt and rivet heads are the places which first show rust through the paint. This is partly because the brush draws the paint thin at such places. To overcome this, it is now becoming common practice to go over the work after the first coat, and paint all edges for about an inch from the edge or angle, and all bolt and rivet heads, with an extra or striping coat; then, when the second coat goes on over the whole, there is the equivalent of two full coats everywhere.

Painting on iron, as on wood, should be done in dry weather, when it is not very cold—at any rate not below 50° F. Full, heavy coats should be used, and well brushed on. Care must be taken to get the paint into all cracks and corners.

VARNISH

A varnish is a liquid made to be applied to a surface in a thin film, which, on exposure to the air, hardens into a protective coating that is usually glossy and almost transparent. There are two principal classes—*spirit* and *oleo-resinous varnishes.*

Spirit varnishes, of which *shellac** is the most important, are made by dissolving a resin (or sometimes some other substance) in a volatile solvent, such as alcohol. They dry by evaporation, the solvent going off and leaving the resin spread out in a thin film, the liquid or vehicle having really served as a mechanical means of spreading the resin over the surface. Shellac is a resin which comes on the market in large, thin flakes. It may be dissolved in denatured (or any other) alcohol in the following manner:

Put the alcohol in an earthenware jar, and weigh out five pounds of gum shellac for each gallon of alcohol. Just before leaving at night, carefully and gently drop the shellac, little by little, into the jar of alcohol, then put on the cover and leave it until morning. Do not on any account stir it. In the morning the flakes of shellac will be soaked and swollen; but if you had stirred them in, the night before, they would have stuck together in lumps. Now, during the day, stir the mass with a wooden stick once every hour or so; do not put any metal in it, especially iron; one iron nail will spoil the color of a whole barrel of shellac. By the next morning—perhaps before—the shellac will be ready for use. It does not make a clear solution, because the gum shellac contains some wax, which does not dissolve, and so the varnish is milky or cloudy; it is, however, ready for use. As the alcohol is volatile, the jar should be kept covered; and after it is made, the varnish should be put in glass bottles or clean tin cans.

There are many grades of shellac gum, the best being known by the letters D C; but there are others nearly as good. The common shellac is brownish yellow, and is called *orange shellac;* this is the natural shellac color. White shellac is made from this by bleaching with chlorine; but it is not of so good quality as the unbleached; it has, of course, the advantage of being much paler in color. White shellac gum will, on long standing, sometimes become insoluble. Shellac

*NOTE.—By some painters, the term "varnish" is never used to include shellac. There is, however, no valid, objective reason for thus limiting the use of the term.

varnish may be thinned with alcohol, and often this is necessary. Shellac is too often adulterated with common rosin, which greatly lessens its value. This is easily detected by a chemical test.

Damar is a white resin which is soluble in spirits of turpentine—five or six pounds of resin to a gallon of turpentine. It is the most nearly colorless varnish we have, but never becomes very hard. It is used to a considerable extent as a vehicle for white lead and zinc, to make a very white enamel paint. It is not durable if exposed to the weather.

More important than spirit varnishes are the oleo-resinous varnishes, which consist of certain resins dissolved in linseed oil, the mixture being thinned with turpentine or benzine. In making these, the resin is put in a copper kettle and heated until it is thoroughly melted; then some hot oil is added to it, and the mixture cooked until the whole is thoroughly combined. The kettle is then taken from the fire, and when partly cool, the turpentine is stirred in. The resin makes the film hard and lustrous, and the oil makes it tough. Thus the larger the proportion of resin, the harder and more brilliant will be the film; the larger the proportion of oil, the tougher, more elastic, and more durable it will be, and the slower it will dry. Most of the color of varnish comes from the resin; the paler this is, the paler will be the varnish. The pale gums are higher in price than the dark ones, but are no better in any respect except color. Dark varnishes may be just as good (except in color) as pale ones—in fact may be better, for the dark resins are often harder and better than the pale ones of the same sort. The hard and quick-drying varnishes are suitable for furniture; the medium, for interior house-varnishes; the slow and elastic, for exposure to the weather.

Varnishing. The wood should be dry. For this reason it is better, if necessary to clean it, to avoid washing as much as possible, using sandpaper instead, which will also make it smooth. Of course the carpenter is supposed to do this, but the painter must not neglect it on that account. When in proper condition, it first receives, if it is an *open-grain* wood, a coat of paste filler. The open-grained woods in most common use are oak, chestnut, and ash. The woods classed as *close-grain* woods are white pine, maple, birch, yellow pine, whitewood, cherry, and sycamore. These latter do not need filling. If filler is used, it should be well rubbed in with a short, stiff brush; and

when it has set, say in fifteen to thirty minutes, it is rubbed off with a handful of excelsior, rubbing across the grain, and rubbing hard, so as to force the filler well into the pores of the wood. Then it should stand 24 to 48 hours.

When purchased, a paste filler is too thick to be used with a brush, and must be thinned with turpentine or benzine; at the same time it may be stained to any desired color with an oil or varnish stain. These stains can be purchased of any desired color. If a close-grained wood is under treatment, the first thing is to apply a stain if it is desired to stain the wood; but it is common practice to finish in the natural color. Stains usually require a good deal of thinning before using; the amount of thinning will determine the depth of color. Water stains are seldom used, as they tend to raise the grain of the wood.

In cleaning off the filler, be careful to clean out corners and mouldings, using for this purpose, properly shaped hardwood sticks; do not use any steel tool.

Where rooms are to be finished in the natural color of the wood, it is nevertheless a common practice to stain the window-sashes; a cherry or light mahogany stain is often used. Fillers are sometimes used on close-grain woods; but this is not advisable, as they tend to prevent the varnish from getting a good hold on the wood.

Next comes the varnishing. Window-sills, jambs, inside blinds, and other surfaces exposed to the direct rays of the sun, are to be treated as exterior woodwork, and are not varnished with the ordinary interior varnish used on the rest of the work. The floors also are left out of account for the present. The rest of the woodwork receives its first coat of varnish; apply it, as much as possible, with the grain of the wood, brushing it out well in a thin coat. The varnish ought to dry dust free (*i.e.*, so that dust will not stick to it) over night; but at least five days should elapse between coats. When dry, it should be rubbed with curled hair or excelsior enough to remove the gloss, so that the next coat of varnish will adhere properly; a better result will be had if it is lightly sandpapered with 00 paper. The second coat is treated like the first. The third is not sandpapered, but rubbed with curled hair; the fourth or finishing coat may be left with the natural gloss, or, if preferred, it may be rubbed with fine pumice and water to a smooth, dull surface. For this purpose the varnish dealers sell felt, about an inch thick, which is well wet in clean water; a little dry pumice powder is

put on it; and the rubbing is done with this. The varnish must be quite hard and dry before this is attempted. Varnishing, if properly done, is slow work; that is, much time must be allowed for each coat to dry thoroughly.

The varnish which is used on interior woodwork should not dry too quickly; it should dry enough over night so that dust will not stick to it, and in twenty-four hours should be hard enough to handle freely; but if a chair, for example, were varnished with it, it would not be entirely safe to sit on it for a week. It should, however, finally become perfectly free from tack, which it will not do if it is a rosin varnish. At present prices (and it is not probable that they will ever be lower) varnishes for interior woodwork are sold, according to color and quality, at prices ranging from $2.50 to $4.00 a gallon. It is in the highest degree inadmissible to use a cheap varnish for undercoats; the outer coats will crack if this is done. A good varnish that dries too quickly, such as what is called a *rubbing varnish,* or one intended for furniture, has not the durability needed for this work. It is economy to use a good varnish. The writer has in mind a house which was properly varnished eighteen years ago and has been constantly occupied by a large family, yet the varnish is still in fair condition; if it were lightly sandpapered and one new coat applied, it would be like new—as good as it is possible for a surface to be. Cheap rosin varnishes never look well, even when new, never keep clean, and deteriorate rapidly.

Shellac. Interiors are sometimes finished with shellac. This varnish is not used on exterior work, but it is a good varnish for interiors. All varnishes containing oil darken the color of wood; but white shellac is comparatively free from this objection; at any rate it does it less than anything else. Orange shellac is a dark varnish, and even white shellac darkens with age to an appreciable degree. Orange shellac is more durable than white, and should be used wherever admissible, rather than white; but it is usually necessary to use white shellac for this service. If shellac is made up as heavy as has been described—five pounds to a gallon of alcohol, and this is the standard—it should be thinned considerably with alcohol before using on interior woodwork. It must be applied in thin coats, and given plenty of time to dry. It is very deceptive about this; it appears to be dry and hard in an hour, and it is hard enough to handle freely; but if we apply coat after coat, even six hours apart, we shall find that the wood is

finally covered with a waxy mess which will be the source of nothing but trouble. The first coat sinks rapidly into the wood; a second coat may be applied six hours later; but after that, allow two days at least between coats. Shellac makes a very thin coat; so it is necessary to apply a large number of coats, at least twice as many as of oleo-resinous varnishes, to get a sufficient thickness of coating. Because of this labor, shellac is an expensive finish; but it is handsome and durable. The treatment of it, as regards rubbing, etc., is the same as has been described for other varnish.

Varnish makers usually advise that shellac should never be used as a priming coat for other varnish; this is probably because they wish to sell more of their own goods, for shellac is really an excellent first coat, except for exterior work, where it should not be used. Of course, wood should be filled before shellacking, the same as for other varnish. Varnish does not, however, wear well over a heavily shellacked surface. Shellac makes a good floor varnish, discoloring the wood very little, and wearing fairly well. After the floor has been well varnished with it, very thin coats, applied rather frequently—say every one to four months, according to use—will keep the floor in fine condition; and after applying one of these thin coats (of thinned shellac), it will be dry enough to use in an hour. This can be applied with a very wide, flat brush, and a man can go over the floor of an ordinary room in a few minutes. Shellac brushes should be washed out with alcohol immediately after using.

Exterior Varnishing. Varnishes dry much more rapidly out of doors than within, so that it is practicable to use more elastic and durable materials. The conditions, in fact, are so severe that the best are not good enough. In the first place, do not use any filler on exterior work; it will probably crumble and come out. Do not use shellac; as an undercoat exposed to the hot sun, it will soften and blister. Use only the best *spar varnish*, such as is made for varnishing the spars of yachts; fill the wood with it; sandpaper lightly between coats, just enough so that each succeeding coat will take hold well; finish with a coat well flowed on; and leave it with its natural gloss, which is more lasting than a rubbed surface. This is the treatment for hand-rails, outside doors, inside blinds, window-sills and jambs, and everything exposed to the direct sun. Hand-rails and outside doors should be refinished every year; varnish will

not last on an outside door more than one-twentieth as long as it will on an inside door. Never use interior varnish for outside work.

ENAMEL PAINTS

Varnishes are all more or less brownish yellow or yellowish brown. Therefore a coat of varnish applied over a paint obscures and changes its color to some extent. To overcome this as much as possible, the varnish, instead of oil, is mixed with the pigment, as a vehicle. In this way the pigment comes to the surface and displays its color. These paints, if made with good varnish, are durable; the method of application has already been described. If necessary to thin them, do it with spar varnish instead of oil; a good interior varnish may be used, but it injures the flowing quality of the paint somewhat.

White lead and zinc are sometimes mixed with damar varnish. This makes the whitest enamel paint, but it never gets very hard, never has much luster, and is not very durable. It is very white, is easily applied, and dries quickly.

A NEW VARNISH FINISH

A method of finishing open-grained interior woodwork, which has been practiced for a few years, consists in first staining the wood with a water-stain—dyeing it, usually—and then, when it is dry, filling the pores of the wood with a paste filler which has been colored by the addition of a pigment. For example, the wood may receive a stain of any dark color, and the wood-filler be mixed with white lead. This shows the open or porous part of the grain in white on a dark background. By using artistic combinations of color in the stain and filler, very beautiful effects can be produced, and this finish has been used in some of the most handsome and costly public and private buildings. Thus, if a room is to be decorated in green, the woodwork can be made to harmonize with the prevailing color. An oil stain must not be used on the wood, as it will not work well with the filler. The colored filler is applied and rubbed off in the same way that any paste filler is used, and then the varnish is applied over it in the usual way.

FLOOR FINISHING

The primary trouble with floors is that people walk on them. If they did not, there would be no trouble at all. Four coats of varnish,

or even paint, having an aggregate thickness of less than one one-hundredth of an inch, will not last indefinitely under the wear of nail-shod heels.

Probably the simplest treatment for floors is painting them. The paint should contain a large proportion of a hard oleo-resinous varnish; an ordinary oil paint is not hard enough. If an oil paint is used, it must be heavily charged with dryer, for a floor paint should dry in twelve hours. Good quick-drying floor paints are in the market.

Floors of choice wood, however, are not usually painted; they may be either varnished or waxed. If they are of oak or other open-grained wood, they must be filled with a paste filler; otherwise the varnish is applied directly to the wood. Floor varnish is quicker in drying, and harder than interior finishing varnish, but should not be so hard as to be brittle; rubbing varnish is too hard. If the floor is to be stained, this is done with an oil stain before varnishing; if it is a floor which has previously been varnished, so that the stain will not penetrate the wood, the stain may be mixed with the varnish, although the effect is not then so good.

Floor wax is not made of beeswax, but of a harder vegetable wax, and is sold by all paint dealers. The floor should receive one coat of shellac; then the floor wax may be rubbed on with a stiff brush, and when it is dry, which will be in a few hours, it may be polished by rubbing with a clean cloth or with a heavy, weighted floor brush made for the purpose. It should receive another coat every week until four or six coats have been applied; after this a little of the floor wax, thinned if necessary with turpentine, should be applied often enough to keep the floor looking well. Alkalies dissolve the wax, and in cleaning the floor only a little soap should be used in the water with which the floor is washed. A wax finish kept polished with a polishing brush, is the handsomest surface than can be obtained for a floor; but it is so slippery that it is somewhat dangerous. It does not discolor the wood. Interior trim (but not hand-rails) is sometimes wax-finished. This finish requires a good deal of care, as it is likely to catch dust; otherwise it is handsome and durable.

Old floors which require cleaning and revarnishing should have the old varnish or paint removed by a good *varnish-remover*, one of the modern sort, free from alkali. This is painted over the surface, and,

after a short time, removed with a scraper. The last of the varnish-remover is taken out with a rag wet with turpentine or benzine, care being taken that there is no fire of any sort in the room or any neighboring room. This will not only take off the old varnish, but the old filler also; and the floor must be treated like a new floor. Any stains on the floor may be treated with a hot solution of oxalic acid, one part to ten of water; when the stains disappear, wash well with clear water; let the floor dry a day; sandpaper; and it is ready for varnishing again. This treatment—removal of old paint or varnish by a liquid varnish-remover—is applicable to all varnished or painted work. The outside of a house could have the old paint taken off in this way, but *burning off* is cheaper and quicker. These varnish-removers are mixtures of benzole, acetone, alcohol, and other liquids, and the best of them are patented.

ALUMINUM AND BRONZE PAINTS

Radiators and pipes are often painted with aluminum or bronze paints. These consist of metallic powders, in fine flakes, mixed with some varnish—usually with a pyroxylin varnish, which is a thin solution of a variety of gun-cotton in a suitable solvent, generally acetate of amyl. If one of these paints—which smell somewhat like bananas—becomes thickened in the can by evaporation, it can usually be thinned with acetate of amyl, if some of the special thinner cannot be had; brushes can be washed out in the same. A good aluminum paint is durable, even exposed to the weather. One coat is usually enough, two certainly so.

GLAZING

House painters are usually expected to understand the art of setting window-glass; it is not difficult to learn. Glass is classified as *sheet* or *cylinder glass* and *plate glass*. Sheet glass is made, at the glass works, by blowing a quantity of glass, first, into a hollow globe; then, by more blowing and manipulation, this is stretched out into a hollow cylinder perhaps a foot in diameter and five feet long; this cylinder (whence the name "cylinder glass") is cut open, and, after reheating, is flattened out into a sheet, whence the name "sheet glass;" after annealing, it is cut up into convenient sizes. It is made of two

thicknesses—*single thick*, which is about one-sixteenth of an inch; and *double thick*, one-eighth of an inch; but it does not run perfectly uniform. All sheet glass contains streaks, bubbles, and specks of dirt, and is more or less irregular or wavy in its surface; and in respect to this it is graded as first, second, and third quality; in American glass these grades are usually marked "AA," "A," and "B;" and anything poorer than "B" is called *stock sheets*. Foreign glass is not thus marked, each maker having his own arbitrary marks. Single-thick glass is used for sizes not greater than about 28 by 34 inches; double-thick, up to 40 by 60. For larger sizes, plate glass only is used; but of course either plate or double-thick can be used for small sizes, if desired.

Plate glass is cast in plates; the liquid glass is poured out on an iron table, about 15 feet wide and 25 feet long, and smoothed down to a uniform thickness of half or five-eighths of an inch by passing a roller over it, like rolling pie-crust; after this it is ground down with sand, emery, and polishing powder to a quarter or five-sixteenths of an inch in thickness. It is therefore much more costly than sheet glass, but is also more perfect.

Crystal is a very thin plate glass, about one-eighth of an inch thick, and is used where ordinary plate is too heavy, as in movable sash. It is the finest of all window glass. There are two grades of plate glass, known as *glazing* (for windows) and *silvering* (for mirrors), the latter being the best. In the first place, the sash is prepared for the glass. It must receive a priming coat; if it is to be painted, it is primed with white lead and boiled linseed oil, the mixture having very little or no turpentine added; if it is to be varnished, it is primed with boiled oil alone. If it is not primed, the putty will not stick; the wood will draw the oil out of the putty and leave it crumbly. Next, the glass is fitted to the sash. It is cut either with a glass-cutter's diamond or with a wheel cutter, the latter being a little sharp-edged steel wheel set in a handle. If well made, the wheels may be bought separate and are replaceable. The wheel cutters are generally used on sheet glass; but plate glass is cut only with a diamond, which makes a deeper cut. The wheels are kept wet with kerosene; the workman has a little bottle or cup of kerosene on the bench, and dips the wheel in it.

The glass being cut to the right size, a layer of putty is spread, with the putty-knife, along the recess in the sash where the glass is to

rest. This is called *bedding* the glass, and should always be done. It is not uncommonly omitted with pine sash; but it absolutely must be done with all hardwood sash, metal or metal-lined sash, and for all plate and crystal glass; and it ought to be done in all cases. Then the glass is gently pressed into place, after which it is fastened with *glaziers' points*, which are triangular bits of metal. No. 2 points are used on single-thick, and No. 1, which are larger, are used on double-thick glass; they are put in 9 to 12 inches apart. They are driven, not with a hammer, but with the thin side of a two-inch chisel, the flat side of which lies on the glass, the edge of the chisel away from the surface so as to avoid scratching it. The chisel is also useful for adjusting the position of the pane; if it is smaller than the sash, it is so placed that when the sash is in its natural upright position the pane of glass will rest with its lower edge bearing on the wood. The points are commonly of zinc, which bends easily; and when the pane is properly placed, if there is on one side a space between it and the wood, the chisel is held over this crack, and with its edge an indentation or crimp is made in the little triangular zinc point which has already been driven; this crimp prevents the glass from sliding back against the wood. This is the reason zinc is used for the points; it will bend. Steel points are sometimes used for plate glass, because of their greater strength, the glass being heavy. To drive through the sheet metal of metal-covered sash, steel slugs are used; these are about $\frac{1}{20}$ inch thick, about $\frac{7}{8}$ inch long, and $\frac{7}{16}$ inch wide at the wide end, triangular, and sharp-pointed.

There is a machine for driving points, but it is not much used except on small glass set in soft-wood sash.

The glass being properly secured by points, it is ready for puttying. To do this, the professionals set the sash up in a nearly vertical position on an easel; the glass is puttied on the right-hand side and across the bottom; then the sash is turned the other edge up, and the operation is repeated. This finishes the work.

The most important things about glazing are to use a sufficient number of points and to use good putty. Ordinary (pure) putty is made of whiting, which is pulverized chalk, mixed with enough linseed oil to give it the consistence of stiff dough. The workman can make it from these materials with his hands; everyone can make his own putty. As a matter of fact, however, the putty of commerce is made by ma-

chinery; and also, as a matter of fact, it is in general abominably adulterated. It would seem as though whiting and linseed oil were materials cheap enough; and in reality putty can be sold for about three cents a pound, or sixty dollars a ton; and a dollar's worth will putty all the glass in an ordinary house. Pure putty, however, is almost impossible to get. Marble dust is substituted for whiting, and a mixture of rosin and mineral oils for the oil, and the cost reduced about half. It is the use of this miserable stuff which causes nine-tenths of the troubles with windows. If the glazier cannot be sure of his putty otherwise, he should make it himself.

The best putty for glazing is a mixture of pure whiting putty with one-tenth white lead putty. This makes it set a little more quickly, and it becomes harder. Pure white lead putty gets too hard; it is too difficult to remove it in case of breakage of glass.

If the glass has not been bedded in putty, it is customary to go around the indoors side of the glass, and crowd some putty into the crack between it and the sash. This is called *backing* the glass. Large plates of plate glass are not puttied, but are held in place with strips of moulding nailed on the sash, in which case the crack between the glass and the moulding is backed with putty.

EXAMINATION PAPER

PAINTING

Read carefully: Place your name and full address at the head of the paper. Any cheap, light paper like the sample previously sent you may be used. Do not crowd your work, but arrange it neatly and legibly. *Do not copy the answers from the Instruction paper; use your own words, so that we may be sure that you understand the subject.*

1. What is the difference between raw and boiled oil? When is one preferable to the other?

2. What would you consider a good brush outfit for painting and varnishing the interior woodwork and exterior finish of a modern frame dwelling?

3. How would you make your own putty if you could not buy a satisfactory grade?

4. Describe the principal ingredients used as *pigments*. As *vehicles*.

5. What are *thinners? Dryers? Fillers?*

6. How are painters' brushes kept in good condition?

7. How are paints adulterated?

8. Describe the process of mixing the successive coats of paint for ordinary interior (not floor) and exterior woodwork.

9. Describe the process of preparing the woodwork and applying the successive coats of paint in ordinary interior (not floor) and exterior work.

10. What points require particular attention in the repainting of an old job?

11. Describe the process of painting a plastered wall.

12. Describe the material and methods of work in roof painting.

13. What is enamel paint? How would you do a job of enameling the woodwork, say, in a bathroom?

14. Describe in detail the process of painting structural metal.

15. How are varnishes classified?

16. Describe the method of preparing and applying shellac varnish.

17. Describe in detail the method of preparation and appli-

cation of varnish (not shellac) in the case (*a*) of interior woodwork (not floors); (*b*) of exterior woodwork.

18. What method in your opinion, gives the best finish to a floor (*a*) of pine; (*b*) of ash? Describe the process in detail.

19. Distinguish the different kinds of glass used in windows and doors.

20. In window glazing, describe in detail the method of preparing the sash and inserting the glass. Is large plate glass put in in the same way as ordinary window glass?

After completing the work, add and sign the following statement:

I hereby certify that the above work is entirely my own.

(Signed)