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SURFACE FINISHING[1/]

by

Kaarlo Ilonen*

* School for Small-scale Industry and Teacher Training, Lahti, Finland.

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THE IMPORTANCE OF SURFACE FINISHING

Protection

Before use, most objects made of wood must be protected with a finish because the porosity and considerable softness of wood makes it easy for impurities to stick to it. Cleaning a dirty wooden surface is laborious. The purpose of surface finishing is also to protect the wood against wear, micro-rganisms and insects.

Esthetic viewpoints

When necessary, surface finishing can be used to change the natural shade of wood; to give colour, to make light wood darker and even dark wood lighter. Using different materials and methods of surface finishing, various degrees of gloss can be obtained: glossy, semi-glossy, semi-mat, mat.

Commercial viewpoints

The choice of proper method of surface finishing makes the wood more attractive and at the same time offers more appeal to the buyer.

RAW MATERIALS USED IN FINISHING WOODEN SURFACES

PUTTIES

Putties can be made of various filling and binding materials, such as the following which are suitable for finishing surfaces to be lacquered or painted.

PUTTY MADE FROM WOOD POWDER

Method of production

- Wood dust is scraped off or sanded from the end of a piece of wood, that obtained this way is finer than that obtained from any other

direction. It is mixed with either glue or lacquer to form a dough-like material.

- It is recommended to use the same specie of wood as the surface to be repaired;

- The binding material used can be nitro cellulose or alkyd carbamide (also known as alkyd-cerea formal-dehyde) lacquer, both of which have a fairly short setting time, but other lacquers can also be used;

- Almost any type of glue can be used.

Properties and use:

- It is usual for putty to shrink as it dries. As a result a hole tends to develop and it may crack. Therefore, the putty should be left slightly above the surface;

- If the putty is too soft and thin, residues of the binding material may remain around the filling in the wood after levelling off and sanding;

- Colour adhesion is not very good and, therefore, the areas repaired show easily;

- Adhesion can be somewhat improved by sanding in connexion with the coating;

- This method is generally used in secondary objects only.

SHELLAC PUTTY

Method of production

Shellac particles are heated to form a thin cylinder (a stick could be used as a core). In the actual filling, heated lacquer is dropped into the hole and pressed in immediately, using a moistened scraping plate, so that the filling goes into the hole and dries immediately.

Properties and use:

- The putty does not shrink or crack;
- It offers good adhesion to wood;
- Preparation for use can be done in a short time;
- It does not stain the wood, but due to its dark colour it can be distinguished on light woods;
- Spirit-based stain dissolves the filling;
- Ordinary water-based stain does not adhere;
- It is used to fill in holes in dark wood species and in filling dark knots in light woods.

WOOD FILLERS

The filling powder can be fine wood dust, chalk, gypsum, clay, talkcum, etc. The binding agents are oil or alkyd varnish. Wood fillers are generally factory-manufactured and they are available in shades of various wood species, such as light and dark oak, mahogany, etc. Untinted and black fillers are also available. It is also possible to tint the filler with pigment mixed with turpentine.

This type of filler is used when a laoquered or polished surface with full pores is desired in wooden objects with large pros and the filler can reduce the number of coatings and speed up the work.

STAINS

WATER-BASED STAIN

The most common water-based stain is water-soluble anilin colour. It is available in shades of some wood species, either as granules or powder.

Method of production

The colour pigments are dissolved in water of 60° to 80°C which is either distilled or rain water. A usual concentration of this so-called basic solution is 50 g/l. The final shades are obtained by mixing the basic solution with water in a given ratio. For continuous use, the mixing formula of the batch to be used, should be written down on the reverse side of a stained sample so that the same shade may be produced at a later date.

Before use, some ammonia can be added to the cold stain solution to improve the penetration of the stain. The basic solution can be diluted with a spirit (in non-acid pigments), which improves the penetration and adhesion of the stain to surfaces to be re-coated.

Properties and use

- Easy to obtain the desired shade;
- Easy to apply;
- Inexpensive;
- The colour is not water-proof;
- All stains are not completely fast to light;
- Stains do not resist wear;
- Staining changes the natural configuration of the wood whereby a negative figure is formed.

SPIRIT-BASED STAIN

Method of production

Approximately 4 per cent pigment is dissolved in 96 per cent alcohol, with a similar amount of Shellak being added.

Properties and use

- Fast surface drying;
- Adheres to surface which is to be re-stained;
- Somewhat water-proof;
- Large surfaces difficult to coat, due to the fast drying of the stain;
- Usually not stable to light;
- The stain gives a negative configuration;
- Expensive

FACTORY-MADE STAINS WITH ORGANIC SOLVENT

This is the newest available stain, in which the pigment (anilin colour) is dissolved in an organic solvent (ethyl-glycol). Concentrated solutions are diluted with organic thinners until they reach the desired colour intensity.

Properties and use

- Very fast surface drying;
- Good adhesion and penetration also in surfaces to be re-stained;

- Partially water-proof;
- Treating large surfaces requires experience, due to the fast drying;
- Gives a negative configuration;
- Expensive;
- Time saving in the staining of furniture and other wooden objects.

SPIRIT-BASED LACQUER

- Ingredients:
  Shellac (excreta of an insect indigenous to India living in certain trees) and 96 per cent alcohol plus a small amount of other ingredients.
- Thinner:
  96 per cent alcohol (generally not necessary)
- Application methods:
  Spraying or may be applied with a brush.
- Health hazards:
  no special measures necessary.
- Inflammability:
- Drying time in temperate climate (20°C):
  touch-dry 10 minutes
  handling dry 1 hour
  subsequent coating 3 hours
- Glossy finish dries through evaporation;
- Satisfactorily water-proof;
- Satisfactory wear-resistant;
- Fairly good filling properties;
- Satisfactory resistant to solvents, turpentine and benzine (not alcohol);
- Suitable for surface finishing of instruments (violins, guitars);
- Restoration of old furniture where the surface has been finished with these materials.
- Suitable for surface finishing of new furniture in areas where these raw materials are available at a low cost particularly where more sophisticated finishing materials are not readily obtainable.

NITROCELLULOSE LACQUERS

- Ingredients:
  Cellulose nitrate to whioh softening ingredients and an organio solvent are added.

- Thinner:
  A mixture of organic solvents

- Application methods:
  Spraying, application with brush, curtain coating, immersion (dipping) drum lacquering.

- Viscosity:
  For spraying a viscosity of 18 to 20 seconds using a standard DIN cup size 4 at 20°C is reoommended.

- Coated area obtained:
  Depending on the method of application 7 to 12 m2/litre

- Health hazards:
  Sufficient ventilation must be arranged or breathing masks should be worn.

- Inflammability:
  Class I, flash point below 30°C

- Drying time at 20°C:

touch dry	10 minutes
handling dry	1 hour
subsequent coating	1 hour

- Major properties:
  Glossy and mat;
  Dries through evaporation;
  Due to the small amount of solid material it does not fill very well;
  Resists mild solvents, turpentine and benzine;
  Satisfactorily water-proof;
  Because of the strong solvent which it contains it dissolves the underlying coating.

- Main uses:
  For lacquering new wooden objects for interior use.
  As a primary coating when a fast-drying lacquer is required, or if catalyst

lacquer reacts harmfully with the wood or the stain contained in it.

ALKYD CARBAMIDE LACQUERS (TWO-COMPONENT LACQUERS)

- Ingredients:
  Alkyd resin (synthetic) and linseed oil.
- Thinner:
  Wood or mineral turpentine.
- Application methods:
  Spraying, application with brush, immersion, drum lacquering.
- Visoosity:
  For spraying 18 to 20 seconds DIN 4 at 20°C
  For application with brush about 24 seconds DIN 4 at 120°C
- Coated area obtained:
  Depending on the method of applioation 15 to 20 m2/litre
- Health hazards:
  When using mineral turpentine thinner, sufficient ventilation must be arranged, or breathing masks should be worn.
- Inflammability:
  Class II, flash point above 30° C
- Drying time at 20°C:

touch dry	3 hours
handling dry	8 hours
subsequent ooating	16 hours

- Main properties:
  Glossy and mat;
  Dries through evaporation and oxidation;
  Due to its large amount of solid ingredients, the laoquer has good filling properties (the amount of solid ingredients is about 45 per cent);

- resists mild solvents, such as turpentine and benzine, and can be washed with water;
- good wear-resistance.

Major uses:

- interior and exterior lacquering;
- re-lacquering of old objects (does not dissolve the underlying coating;
- suitable for use when the lacquered surface can be allowed a long drying time.

PRE-CATALYSED ALKYD CARBAMIDE LACQUERS (ONE-COMPONENT LACQUERS)

One-component catalyst lacquers contain a hardener which is already mixed in them (self-contained). The setting reaction begins after the solvent has been evaporated. One-component catalyst lacquers are usually weaker than those with two components. They are used both for prime coating and final surface coating. These types of lacquers also exist as two-component types.

When applying a priming lacquer coating on light coloured wood species, a type of lacquer leaving the surface with an unfinished look is often used (it does not wet the surface). The light colour of the wood can also be accentuated by mixing into the lacquer a small amount (1 to 2 per cent) of white paint of the same type or white pigment mixed with thinned lacquer.

GENERAL INFORMATION ABOUT OTHER TYPES OF LACQUERS

Polyester lacquers:

Originally, polyester resin was mainly used reinforced with fiber-glass in car bodies, boats, etc. Later it became an important raw material for lacquer. Polyester lacquers contain no evaporating ingredients and consequently they have good filling properties. Using mechanical polishing methods very high-quality lacquered surfaces can be obtained.

Polyester lacquers are two-component lacquers (like alkyd carbamide lacquers). A hardener is needed to start the setting reaction. So far, their use in small and medium-scale industries has been less significant than that of cellulose and two-component alkyd carbamide lacquers.

Polyurethane lacquers

Polyurethane lacquers set like alkyd carbamide lacquers and either contain a hardener or one can be added afterwards. The coating obtained in this way is resistant to chemicals and mechanical wear. They are used in kitchen and bathroom furniture, also on boats.

Factors affecting the choice of lacquers are:

- the wood material used in the object;
- requirements set to the lacuqer;
- available surface finishing materials;
- available equipment;
- method used in surface finishing;
- conditions for surface finishing;
- workers' skill and experience.

THE CHOICE OF SURFACE FINISHING

The choice of surface finishing depends on:

- use of the object to be surface finished;
- material used in the object to be surface finished;
- equipment available for surface finishing;
- available surface finishing materials;
- conditions under which surface finishing operations will be performed;
- conditions under which the object will be used;
- workers' skill.

PRELIMINARY TREATMENT OF SURFACE

Removal of residual glue

In assembling the objects care should be taken to avoid glue

spreading out of joints. If this does happen it should be immediately removed (a moist piece of cloth is suitable for removing most glues). In factories dried glue drops are usually removed mechanically with a chisel or a special scraper without damaging the surface. Glue stains and drops show from under the lacquered surface and they should be avoided.

Intermediate sanding

The wavy cutter head marks caused by machining must not appear in visible places and the edges and corners must have sufficient roundings. Final sanding is done with fine sanding paper in the direction of the grain so that the surface is completely smooth.

Repair

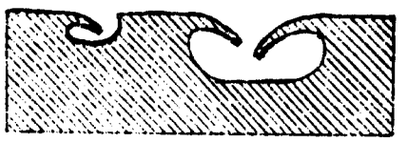
Any possible sinking of the surface is brought up with moistening. Holes in solid wood are plugged or filled either with wood putty (lacquer and wood dust), dissolved shell as lacquer, or some other method. Tears in the corners and edges of veneered surfaces are plugged with veneer plugs (taking care to have the grain directions of the plug and surface veneer in the same direction). The choice of plugging veneer and the plugging itself must be done with care. The plugs are worked and sanded flush with the surface and the dust is removed.

Moistening:

Moistening is used to bring up the pore edges of wood sunk in sanding. Addition of 2 to 3 om3/litre of a chromium salt to the moistening water makes the wood brittle and easier to sand. These are shown in Figure 1.

Unmoistened wood

The magnified pores have collapsed from their original round shape. The broken upper edge of the pores has sunk in.

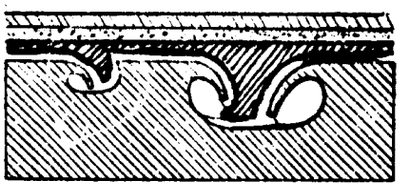


Wood with prime coating and filling

In prime coating with brush, spray gun or some other method the pore edges sink even further preventing the lacquer from entering the pores completely. If wood filler is used - as in the figure - even that cannot fill the pore bottoms.

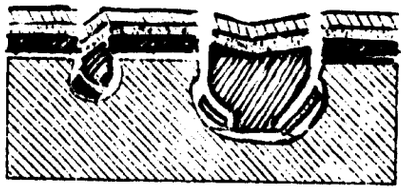
Lacquered wood

Actual surface lacquers fill the surface, leaving the pores hollow.



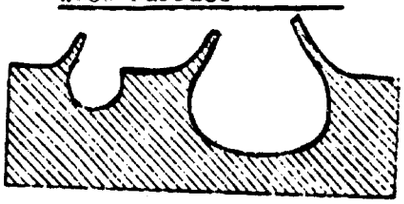
Cracked wood

Because the wood later 'lives', the pores tend to return to their original round shape tensions develop in the lacquer film, and this can result in longitudinal cracks.



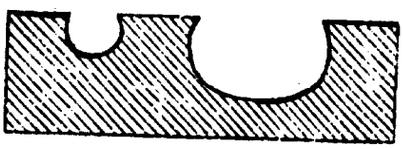
Lacquering moistened wood surface

The wood surface has been moistened with water at 60 to 70°C using a sponge. The wood surface swells fast and the pores return to their original shape. The pores open and the surface becomes rough.



Sanded wood

Moistened wood surface has been sanded and the pores have opened. A rotating sanding wheel has been used with semi-hard base and 220 sanding paper. The sanding dust has been carefully removed from the pores in the longitudinal direction.



Lacquered wood

In lacquering, the pores fill up to the bottom and the lacquering becomes durable.

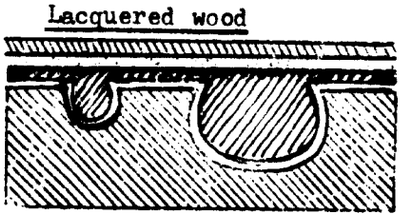


Figure 1: Effect of moistening hardwood surface before lacquering.

Final sanding

Final sanding is done with sharp and fine sanding paper in the direction of the grain but not until the surface is oompletely dry.

Staining with anilin colours

A basic solution of standard concentration is made for each required colour which is then diluted in a pre-determined proportion. This way the exact shades can be reproduced in the future.

Addition of about 10 per cent of ammonium hydroxide to the stain makes the liquid enter the wood better. The stain is applied on the surface in large quantity with a brush or sponge. The whole surface or the object is evened at the same time. Smaller objects can also be immersed in the stain.

If the wood is resinous or greasy, water-soluble stains do not adhere sufficiently well. Removal of resin and grease is necessary. Surfaces treated with water colours are sensitive to water before lacquering. Moist hands, water and stain drippings can leave marks which are difficult to repair. Therefore the objects must be dried in a sheltered place.

Lacquering Techniques

Requirements to the lacquering environment:

- dust free;
- good ventilation;
- good lighting;
- suitable work tables;
- well aranged drying and storage of objects to be lacquered

Equipment:

The lacquering brush should have a sufficiently strong edge (thickness 10 mm to 15 mm) and it should have a wide base and become narrower towards the points (see Fig. 2). Bristle is a better material than hair because it becomes thinner towards the point and thus gives the edge the correct shape and resilienoy. The most common bristles used are white swine bristle and black Shanghai brush.

The container for lacquer can be, for example, a scoop, or a pot with handle, the capacity being 0.5 to 1. The brushes and pots for cellulose lacquer stay in good condition when stored in a tin can which can be closed tightly with a lid and contains thinner, either on the bottom or in a separate container therein. The brush bristles stay straight when hung through a hole bored through the handle and supported on a thick metal wire (see Fig. 3). The equipment also comprises a scraping plate for levelling the lacquered surface and a dusting brush and a piece of chamois, or something similar, to remove the dust (see Fig. 4 and 5)

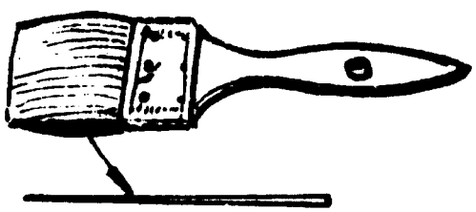


Figure 2 Lacquering brush

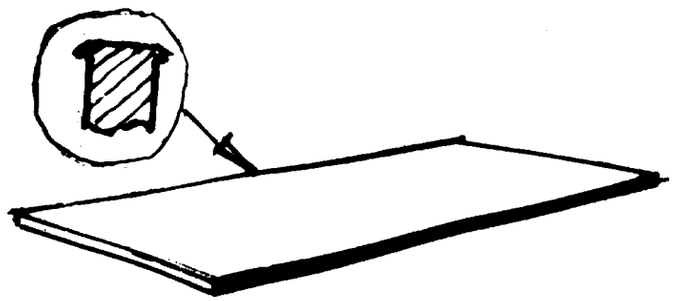


Figure 3 Scraping plate

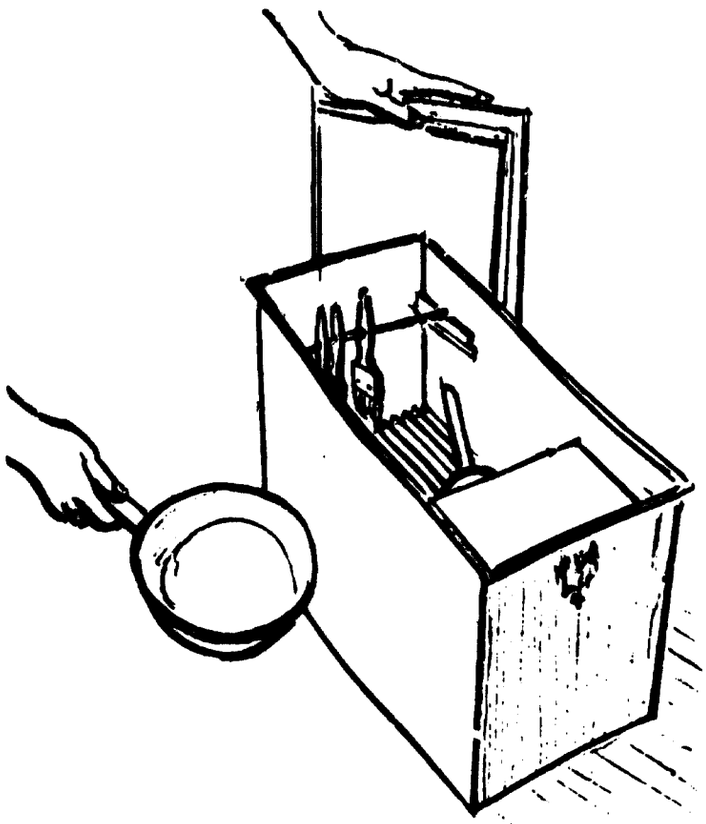


Figure 4 Container for brush storage

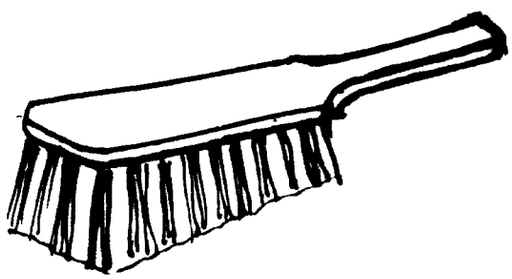


Figure 5 Dusting brush

Lacquering instructions:

Cellulose and catalyst lacquers can be best applied with a spray gun, but a brush can also be employed. Since these lacquers dry fast their application, particularly on large surfaces, requires experience and skill in lacquering and therefore the following instructions are applicable-

- the surfaces to be lacquered are preferably set horizontally so that light is reflected from the lacquered surface (see Fig. 6);
- lacquer application must begin from the edge furthest from the worker;
- lacquer is applied from the centre towards the ends;
- lacquer, immediately after application, is levelled with strokes across the whole surface, beginning exactly from one edge making the stroke lighter when getting closer to the other edge;
- the brush must be held at an angle of about 60° towards the surface and near the brushing (see Fig. 6);
- the stroke speed and pressure of the brush must be suitable;
- the lacquer which has flowed on the edge must be immediately wiped off before the underlying lacquer coating becomes soft;
- with each stroke the surface must be observed against the light;
- it is advisable to coat horizontal surfaces with a thick layer of lacquer to make the surface level off;
- in vertical surfaces the brush strokes must be from the bottom to the top;
- the lacquering sequence of an object must be planned so that the whole object can be lacquered at the same time whenever possible;
- the surfaces must be allowed to dry sufficiently before they can be turned on to own base, an exception being a case in which a special spiked lacquering and drying base can be used (see Fig. 7);
- between the coatings the surface is either sanded lightly or scraped to remove lacquer points;
- cellulose lacquer dissolves the underlying layer of lacquer but catalyst lacquer does not.

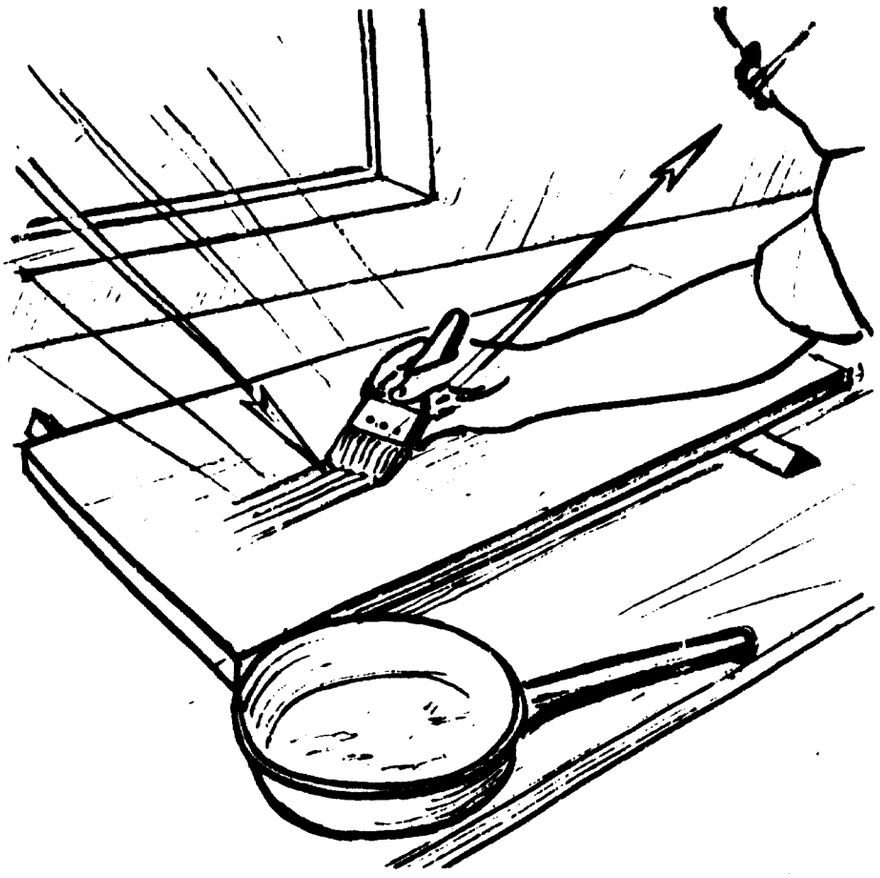


Figure 6 Reflection of light from the lacquered surface and holding the brush lacquer container.

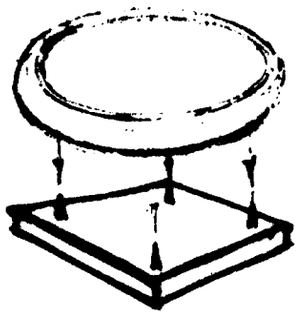


Figure 7 Spiked lacquering and drying base.

In lacquering with a brush the viscosity of the lacquer does not play an important role. In prime coating both the cellulose and the catalyst lacquers are thinned 10 to 30 per cent, depending on the temperature of the air, to ensure better adhesion. The hardener is added to the catalyst lacquer in a ratio of 1:10 of the actual amount taken into the container. The lacquer containing hardener remaining upon completion of the job must not be mixed with the rest of the lacquer. If the catalyst lacquer changes the normal shade of the wood the prime coating can be made with cellulose lacquer.

Care of equipment:

Dripping lacquer is removed from the brushes and they are then hung in a brush container. Also the lacquer containers can be put into the same larger container (see Fig. 3). Brushes and pots must be cleaned with thinner after use with catalyst lacquer. The brushes are stored with the bristles pressed tight and flat at their extremity. If the brushes are well taken care of they give the worker good service and satisfaction.

SPRAY LACQUERING

Environmental requirements for lacquering consist of a special fire resistant closet provided with fans, particularly in the case of spray lacquering (see Fig. 8 and 9). This prevents the spreading of lacquer particles and fumes to other work areas and keeps the environment clean, thus diminishing the danger of fire and health hazards. By providing a cleaner working environment higher quality items can be produced.

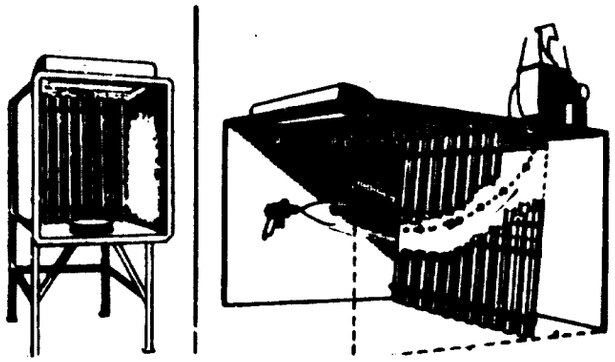


Figure 8 Spraying closets provided with dry filter.

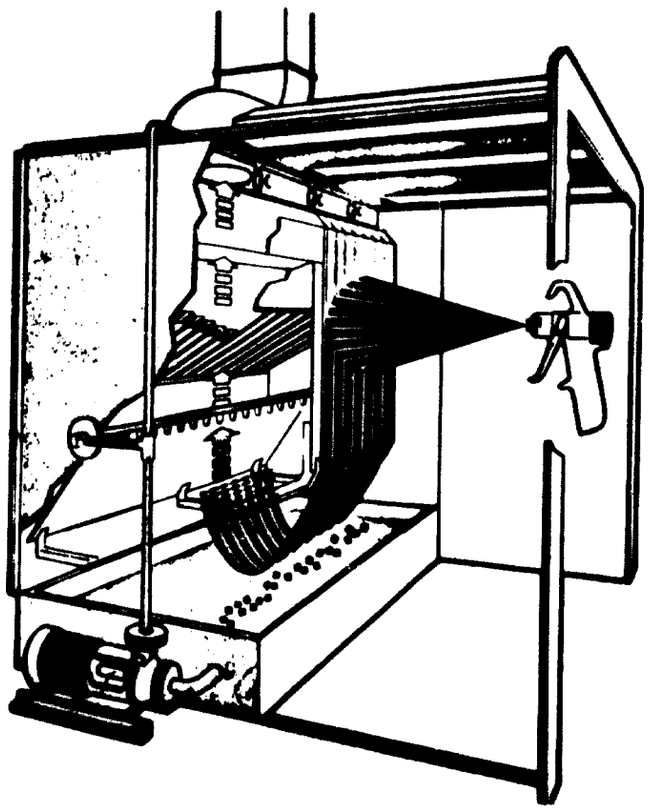


Figure 9 Spraying closet provided with water curtain.

SPRAYING EQUIPMENT

Electric spray guns: An electric spray gun (see Fig.10) is a piece of equipment supplying a high pressure spray without a compressor and all liquid materials can be sprayed. The operation is based on a high pressure pump operated by an electro-magnet. The liquid to be sprayed is sucked by the cyclic wave current due to a vacuum being created and ejects at a high pressure (100 impulses per second are obtained from 50 cycle alternating current)

Technical data-

- weight about 1 kg;
- capacity 170 to 320 grams of paint per minute;
- power 35 to 60 watts (consumption);

Application-

- suitable for small scale production, repair shops, etc;
- must not be used in areas where a danger of explosion exists.

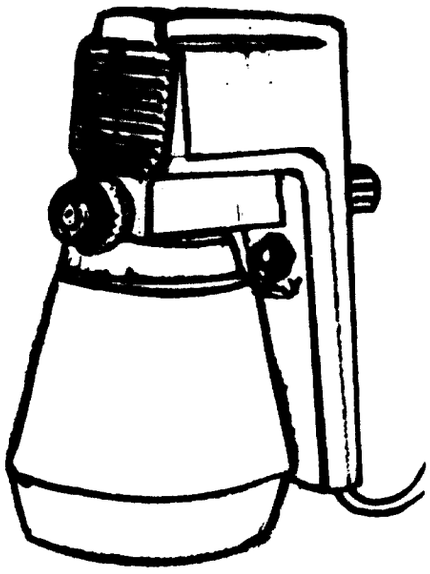


Figure 10 Electric spray gun.

Pneumatic spray guns: Compressed air is fed either directly to the spray gun or to a pressure chamber and from there through an air filter and pressure control valve to the spray gun. The suction air coming through the air cap, or the pressure created in the lacquer container, raises the lacquer to the spray head and the compressed air coming through the air cap atomises the lacquer which is ejected at the desired angle of spread.

Light pneumatic spraying devices: (See Fig. 11) The compressor used is a small film or piston compressor. The spray guns usually operate on low pressure and are either suction or pressure fed. The lacquer can be fed from a container attached to the head or from a separate container through pipes. The lacquer spray is uniform, just as in large spraying devices. This device cannot be used to spray materials requiring high pressures because of its design characteristics.

Technical data:

- weight 15 to 30 kg:
- compressor with monophase electric motor under 0.5 k.w;
- pressure in continuous operation 2 to 2.8 kg/cm^2;
- capacity 8 per minute of free air at pressure of 2 kg/cm^2.

Application:

It is suitable for small scale production, repair shops, etc., which have no separate compressor and where a spray gun with high capacity is not required.

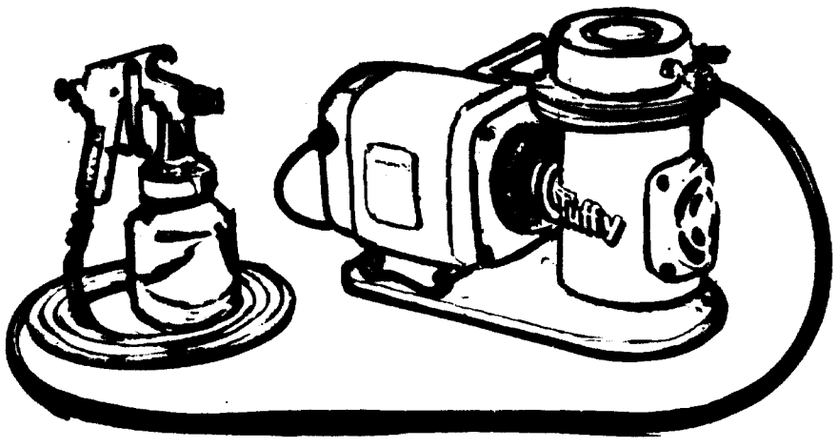


Figure 11 Light spraying equipment.

Fixed spraying device: (See Fig. 12) The capacity of the compressor must be sufficient. If there are other pieces of equipment using compressed air the air supply and the pressure obtained must be sufficient for all. Fixed spraying devices often have more complete auxiliary equipment and they also have a wider range of application than the lightweight ones. The main parts of a fixed spraying device are:

- spray gun
- compressor;
- pressure chamber:
- pressurized material container;
- air line;
- pipes for transport of material to be sprayed;
- pressure reducing valve provided with water extractor, air filter and pressure gauge.

Technical data:

- the capacity of the compressor must correspond to the consumption of air, both with respect to pressure and volume;
- the amount of air needed for one spray gun is 100 to 600 per minute, depending on the material to be sprayed, operating pressure and the spray head used;
- the weight of these spray guns varies between 300 and 1000 grams.

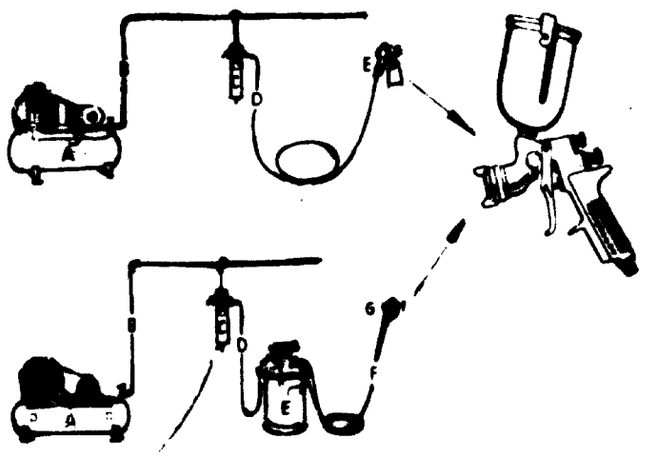


Figure 12 Fixed spraying equipment.

Instructions for spraying:

Choice of spray head - There are spray head combinations (spray head and needle valve) available for each spray gun (See Fig. 13). The choice depends on the type of spray gun, material to be sprayed and operating pressure. A rough rule to follow is-

- the thinner the material to be sprayed is and the lower the operation pressure is, the smaller the size of the spray head;
- spray head sizes suitable for lacquering have diameters of 0.4 to 0.5 mm for electric spray guns, and 1 to 1.4 mm for suction and pressure fed spray guns (See Table I);
- in suction feed and external mix gun is best for fast drying catalyst and cellulose lacquers (See Fig. 14).

TABLE 1 - Spray head data.

Materials to be sprayed	Spray model	Spray head combination	Feed	Spray head size	Air intake l/min - Pressure kg/cm^2		
Thin: water stain solvents thinner fixer etc.		74-FX	P	1,07	285–3,5	330–4,2	395–5,3
	P-MBC-510	704-FX	P	1,07	285–2,1	350–2,8	420–3,5
	P-JGA-502	705-FX	P	1,07	205–1,4	230–1,8	260–2,1
	P-AGA-502	2-FX	P	1,07	225–2,1	275–2,8	330–3,5
	P-AGB-501	203-FX	P	1,07	200–2,1	240–2,8	285–3,5
	P-AGA-517	36-FX	P	1,07	190–2,1	235–2,8	285–3,5
	P-AGB-504	56-FX	P & I	1,07	145–2,1	180–2,8	215–3,5
		56-FF	P & I	1,40	145–2,1	180–2,8	215–3,5
		110-FX [1]	P	1,07	95–2,1	120–2,8	140–3,5
	P-CM-501 P-AGA-504 P-AGA-505 P-AGA-571 P-WDA-502	37-FX	I	1,07	160–2,1	200–2,8	230–3,5
		29-F	P	1,04	140–2,1	170–2,8	205–3,5
		100-F [1]	P & I	1,04	90–2,1	100–2,8	120–3,5
	P-CMF-501	F-49-F [2]	P	1,04	85–2,1	105–2,8	125–3,5
	P-TGA-501	944-F	P	1,04	135–2,1	165–2,8	190–3,5
		90-F	I	1,04	100–2,1	125–2,8	150–3,5
	P-EGA-502	392-H	P & I	0,46	40–2,1	–	–
		126-H [1]	P & I	0,46	20–2,1	–	–
	P-CGA Kaikki mallit	84-FF	P & I	1,40	90–2,1	110–2,8	130–3,5
	QGA-501	84-F	P & I	1,04	90–2,1	110–2,8	130–3,5
Medium thick: lacquers, cellulose paints synthetic paints varnish thin glues fillers etc.		160-FF	P	1,40	540–3,5	615–4,2	695–4,9
		160-FZ	P	1,19	540–3,5	615–4,2	695–4,9
		161-FF	P	1,40	465–3,5	540–4,2	610–4,9
		161-FZ	P	1,19	465–3,5	540–4,2	610–4,9
		765-FF	P	1,40	415–3,5	545–4,9	675–6,3
	P-MBC-510	765-FX	P	1,07	415–3,5	545–4,9	675–6,3
	P-JGA-502	74-FF	P	1,40	285–3,5	330–4,2	395–5,3
	P-AGA-502	74-FX	P	1,07	285–3,5	330–4,2	395–5,3
	P-AGB-501	704-FF	P	1,40	285–2,1	350–2,8	420–3,5
	P-AGA-517	704-FX	P	1,07	285–2,1	350–2,8	420–3,5
	P-AGB-504	43-FF	I	1,40	245–2,1	295–2,8	345–3,5
		43-EX	I	1,78	245–2,1	295–2,8	345–3,5
		36-EX	I	1,78	210–2,1	255–2,8	300–3,5
		705 FF	P	1,40	205–1,4	230–1,8	260–2,1
		705-FX	P	1,07	205–1,4	230–1,8	260–2,1
		401-D [2]	P	2,18	180–2,1	220–2,8	260–3,5
		36-EX	I	1,78	190–2,1	235–2,8	285–3,5
		84-FX	P	1,07	165–2,1	205–2,8	240–3,5
		56-FF	P & I	1,40	145–2,1	180–2,8	215–3,5
		56-FX	P & I	1,07	145–2,1	180–2,8	215–3,5
		45-FF	P & I	1,78	100–2,1	125–2,8	140–3,5
		45-E	P & I	1,40	100–2,1	125–2,8	140–3,5
		110-FF [1]	P	1,40	95–2,1	120–2,8	140–3,5
		490-FF [2]	P	1,40	100–2,8	–	–
	P-AGA-520	Z-19 [2]	P	4,36	365–4,2	–	–
	P-JGA-502-A P-AGA-502 P-AGB-501	78-FF	P	1,40	505–3,5	615–4,2	670–4,9
		78-FX	P	1,07	505–3,5	615–4,2	670–4,9
		78-FZ	P	1,19	505–3,5	615–4,2	670–4,9
		770-FZ	P	1,19	480–3,5	560–4,2	635–4,9
		775-FF	P	1,40	490–3,5	565–4,2	640–4,9
		775-FZ	P	1,19	490–3,5	565–4,2	640–4,9
	P-CM-501	37-E	I	1,78	160–2,1	200–2,8	230–3,5
	P-AGA-504	37-FF	P	1,40	160–2,1	200–2,8	230–3,5
	P-AGA-505	29-F	P	1,04	140–2,1	170–2,8	205–3,5
	P-AGA-571	100-F [1]	P & I	1,04	90–2,1	100–2,8	120–3,5
	P-CMF-501	Z-47-FF [2]	P	1,40	90–2,1	115–2,8	140–3,5
	P-CM-502	Z-47-FF [2]	P	1,40	90–2,1	115–2,8	140–3,5
	P-TGA-501	944-F	P	1,04	135–2,1	165–2,8	190–3,5
		92-E	I	1,78	120–2,1	150–2,8	180–3,5
	P-EGA-502	395-E	P & I	1,78	70–2,1	–	–
		390-F	P & I	1,04	65–2,1	–	–
		124-F [1]	P & I	1,04	40–2,1	–	–
	P-CGA Kaikki mallit	84-FF	P & I	1,40	90–2,1	110–2,8	125–3,5
		Z-46-FF [2]	P	1,40	60–2,1	75–2,8	90–3,5
	QGA-501	84-F	P	1,40	90–2,1	110–2,8	125–3,5
		Z-46-F [2]	P	1,40	60–2,1	75–2,8	90–3,5

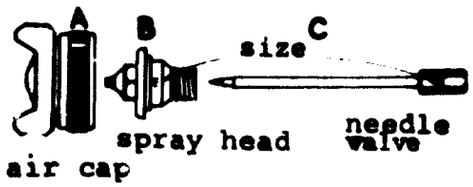


Figure 13 Spray head components.

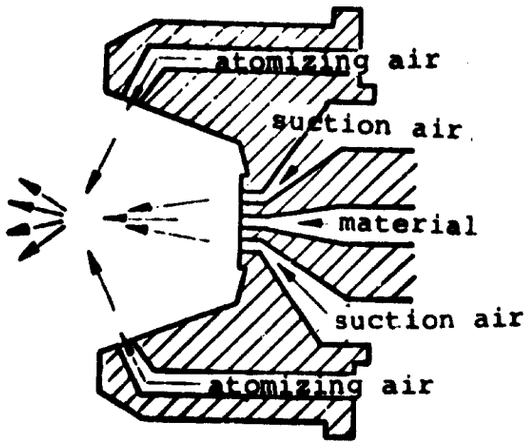


Figure14 External mix spray gun.

Determining the lacquer viscosity:

Lacquer viscosity is most important for obtaining good spraying results. It can be checked in a number of ways. The simplest method is to measure the time in seconds that it takes for the lacquer to flow from a standard viscosity cup (See Fig. 15). The viscosity is measured in seconds. The better known viscosity metres have Ford and DIN cups. The lacquer viscosities are normally given in these units. The lacquer viscosity can be diminished either by adding thinner to it or warming it. Warmer lacquer gives a stronger coating in a single spraying since it contains evaporating material. The viscosities for cellulose and catalyst lacquers are about the same - 18 to 20 seconds using Ford cup No. 4.

Figure 15 Measuring viscosity.

Pressure control:

In electric spray guns the spraying pressure cannot be controlled. In compressor operated suction and pressure fed spray guns the lacquer is atomised at a pressure of 200 to 400 kN/m^2, depending on the lacquer viscosity.

SPRAYING TECHNIQUES:

Learning and controlling the correct spraying technique and the use of equipment is most important because the work rate, quality and material used are affected. In addition to the technique the spray gun operator must also be familiar with the regulation of the spray gun and he must be able to find out possible disturbances and their causes, besides being able to remove them. Some instructions on techniques and problems connected with spraying are indicated in Figures number 16 to 31 below-

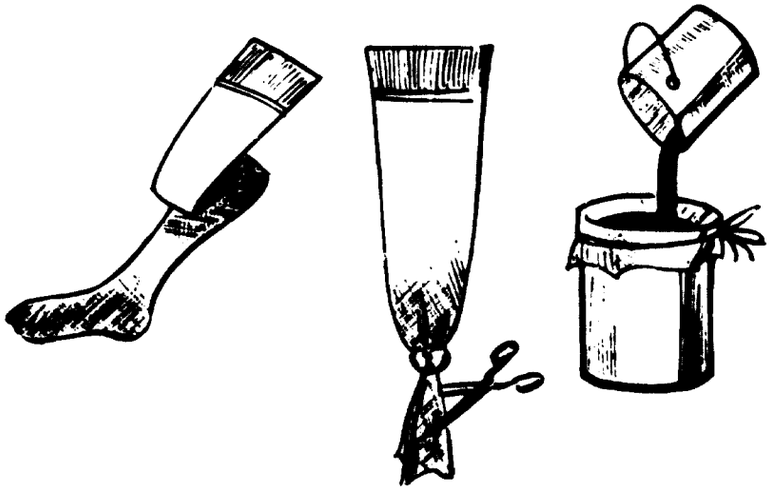


Figure 16 Use of nylon stocking for screening paint.

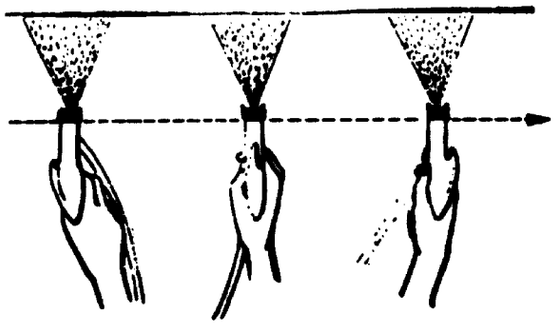


Figure 17 Correct pointing ofspray gun for level surface.

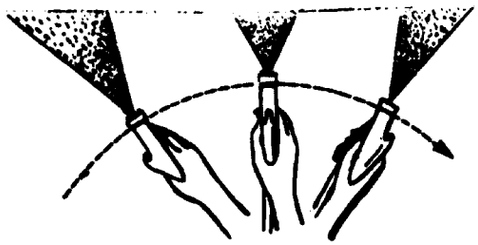


Figure 18 Wrong pointing of gun for level surface. The gun is turned so that the surface becomes uneven, in the figure at the edges and at the same time paint is atomised at the edges.

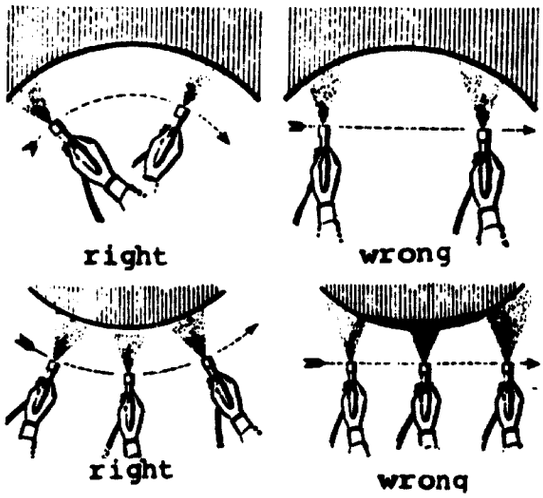


Figure 19 Spraying curved surfaces. The figures on the right show wrong pointing of the gun. On the left the pointing is correct.

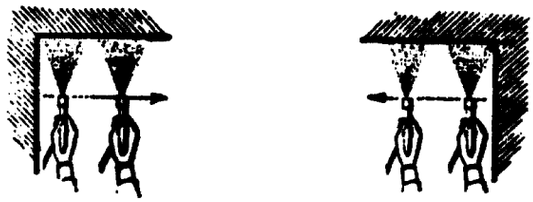


Figure 20 Correct pointing of gun at corners.

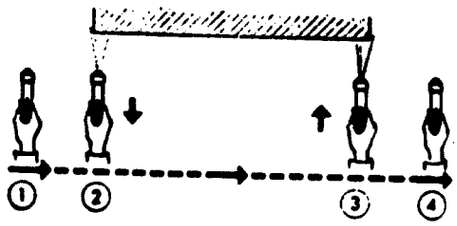


Figure 21 Spraying is started from the outside of the surface. The trigger is pressed when the gun reaches the surface and released after the gun has passed it, but the movement is continued a little on the outside of the surface.

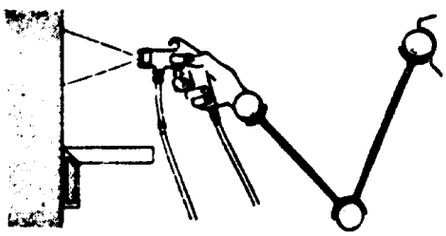


Figure 22 The paint is sprayed with long even strokes. The arm must not be held rigidly but all joints must move and in this manner the gun can be pointed straight which is essential to achieve an even surface.

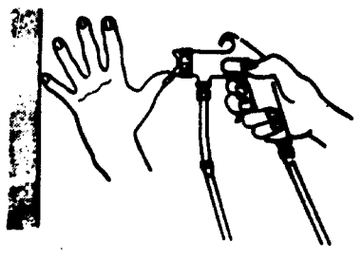


Figure 23 The gun is moved with an even speed across the surface. The distance between the surface and gun must remain constant and be between 15 and 25 cm

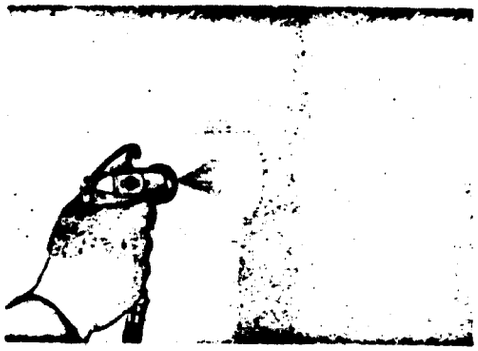


Figure 24 Do not change the direction of the movement during spraying - otherwise the surface spread valve will change at the turning point.

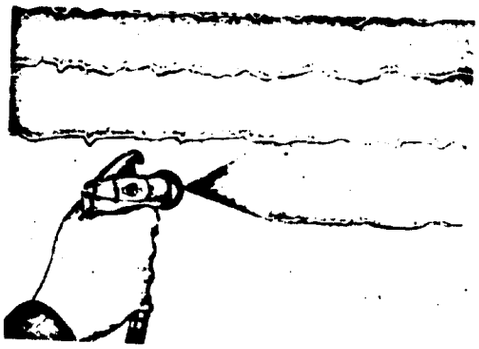


Figure 28 Do not spray too much or too thick a paint as it will settle in folds.

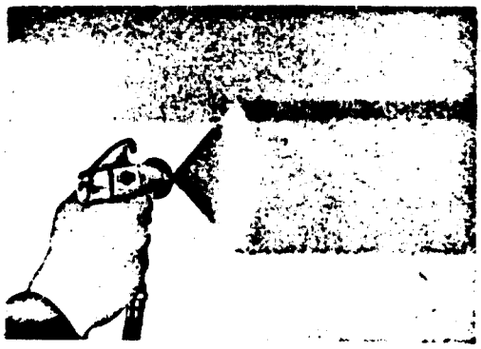


Figure 25 The sprayed coatings must not overlap too much.

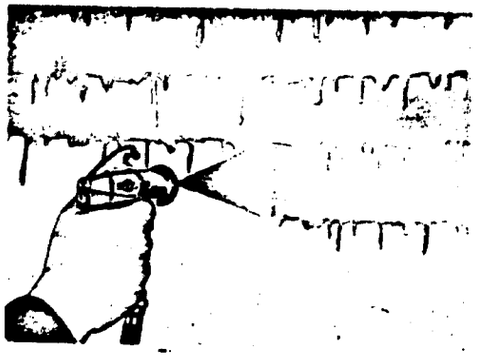


Figure 29 Do not spray too much or too thin a paint as it will run.

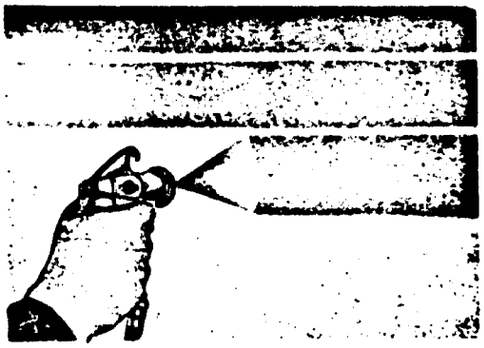


Figure 26 Unless the sprayings cover each other the surface becomes striped.

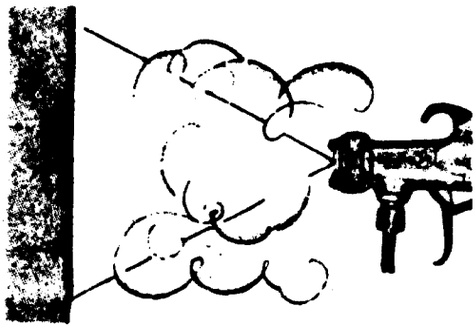


Figure 30 Watch out that the pressure is not too high otherwise the surface will the peel of an orange.

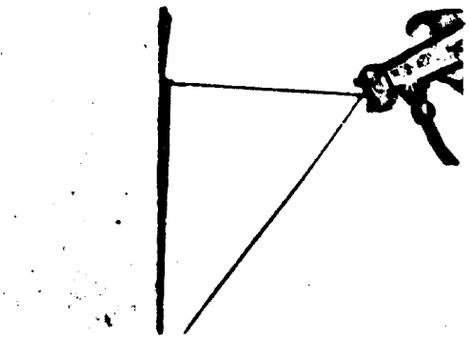


Figure 27 Do not hold the gun diagonally or the coatings of paint will have different thicknesses.

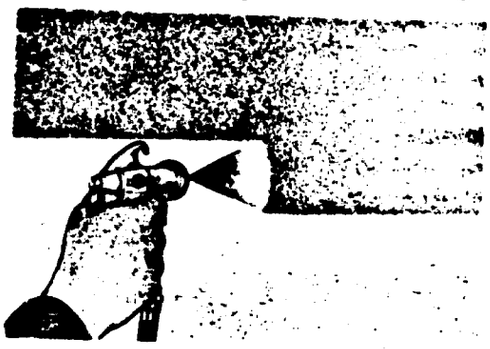


Figure 31 The distance between the surface and the gun must not be too great. The paint will dry on its way otherwise.

Possible reasons for uneven spray:

Where the colour sprayed is uneven the defect could be due to any of the following reasons-

- too little colour in the container;
- position of container too slanted (See Fig. 32);
- blocked suction pipe;
- loose or damaged suction pipe;
- loose or damaged seal;

When using a suction container also:-

- colour too thick;
- opening in the lid of container blocked;
- damaged air pipe or pipe connector;
- seal of needle valve poor or loose;
- colour tube reaches the container bottom

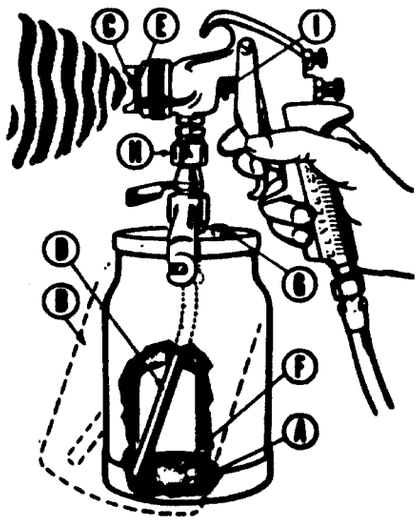


Figure 32 Possible reasons for uneven spraying.

Possible reasons for irregular spray patterns:

(a) Reasons for narrowing of the pattern at the top or bottom (See Fig. 33) can be-

- that the side openings of spray head are blocked;
- the spray head is partly blocked;
- impurities exist in the air cap or spray head;

Figure 33

(b) Reason for the pattern turning to the right or left (See Fig. 34) could be-
- blocked side opening of the air cap, right or left;
- partly blocked spray head;

Figure 34

(c) Reason for the pattern spreading in the middle (See Fig. 35) could be-
- too narrow a spray;
- too low a pressure or paint is too thick;
- too small an air cap with pressure feed;
- too large a spray head;

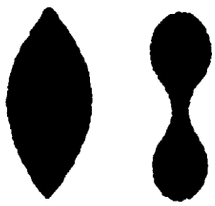


Figure 35

(d) If the pattern narrows in the middle the reason can be wrong pressure. Make the spray narrower or add pressure. Regulating the latter increases the amount of colour but the spray movements must be speeded up.

Locating the faults of points (a) and (b): Find out if the spray heads are blocked. Turn the air nozzle half a revolution and spray. If the pattern has turned the same amount the fault is in the air cap. If the fault is however in the spray head careful cleaning is necessary.

Locating the faults of points (c) and (d): If the pressure of atomizing air or pressure of colour has been wrongly regulated the pressure must be regulated again and also the width of the fan or the spray. This is done until the right pattern is found. The rightpattern is according to Figure 36.

Figure 36

Possible reasons for air or paint leak:

The reasons for a leak through the air cap can be:-
- impurities in the sealing surfaces or the air valve; (a)
- sealing cone of needle or its chuck worn or damaged; (b)
- a weak spring; (c)
- poor greasing; (d)
- bent needle; (e)
- too tight a seal; (f)
- damaged or poor seal; (g)
- refer to items on Figure 37

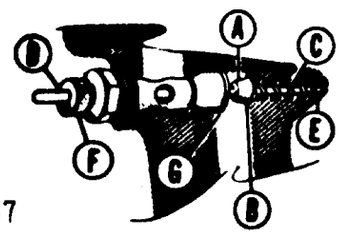


Figure 37

If the paint leak comes through the tightening nut of the needle valve seal, the reason might be–

- damage or worn needle valve or spray head; (a)
- impurities in spray head; (b)
- too tight a seal for needle valve; (c)
- a weak spring; (d)
- colour needle and spray head not of the same size; (e)
- refer to items in figure 38 below

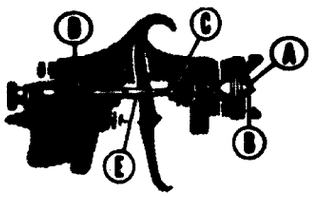


Figure 38

Greasing the spray gun:

The following parts are greased regularly–

- seal of the needle valve; (a)
- seal of the air valve; (b)
- tightening bolt of trigger; (c)
- springs of the needle; (d)
- see Figure 39 below

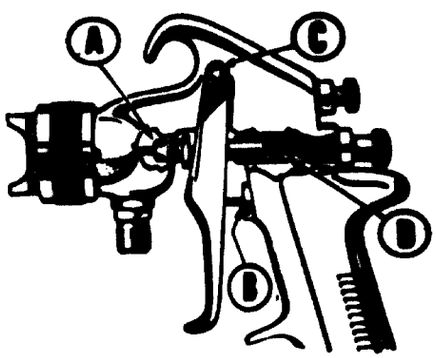


Figure 39 Greasing the spray gun.

Suitability of cellulose and catalyst lacquers to spraying and production:

As fast drying lacquers they are particularly suitable since the time between coatings at normal room temperature is relatively short. Due to the fast film formation the lacquer levels off well. Catalyst lacquer gives a more durable surface than cellulose does, both with respect to mechanical wear, resistence to chemical substances and other stresses.

In some species the catalyst lacquer may cause changes of colour. In such cases the prime coating should be made with cellulose lacquer. The surfaces must be dry and clean from dust and other impurities.

Accident Prevention for spraying:

Fine lacquer spray is highly dangerous being very inflammable and must be dispersed with proper ventilation. The following points should be observed:

- do not smoke when lacquering;
- do not paint near open flames or other sources of heat, including spark emitting equipment, electric motors, or others in the vicinity of the spraying area;
- the area should be explosion proof with sufficient ventilation when lacquering indoors. Ventilation of a well designed spraying booth is shown in Fig. 40;
- protective masks of the type shown in Fig. 41 should be worn when lacquering indoors.

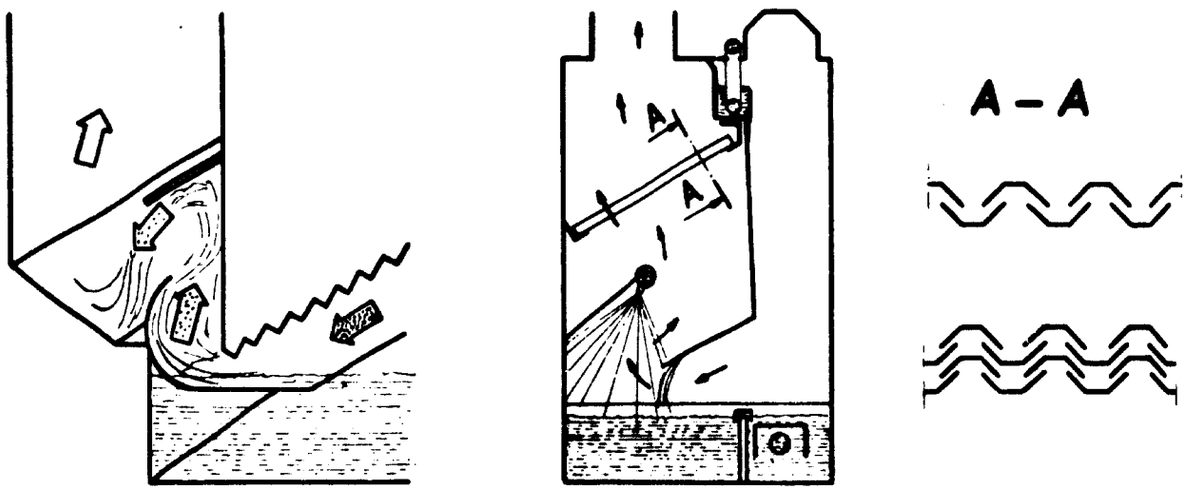


Figure 40 Suitably ventilated spraying booth.

Figure 41 Protective masks for wear when spraying.

Cleaning the spray gun:

To obtain good lacquer suction and spray formation it is important to keep the spray head openings clean (see Fig. 42). They are cleaned with a sharp piece of wooden stick. Metal wire can damage the orifice of the opening.

If the work is temporarily interrupted, the drying lacquer in the spray head can be prevented by wrapping a cloth moistened with thinner around it and then covering it with a plastic foil. The spray head can also be immersed in thinner. When the work has been finished the spray gun must be cleaned with care. In suction feed spray guns the container is removed, the spray head blocked with a piece of cloth and the trigger released. Pressure makes the paint go back to the container. After this has been done thinner is sprayed into the container. Finally the spray heads are removed, rinsed in thinner and dried and the outside of the spray gun wiped clean.

Cleaning a pressure feed spray gun is similar but pressure flow to the compression chamber must be prevented and the pressure must be removed from the container before opening the lid.

Important points to remember are-

- the spray gun must not be immersed completely in thinner;
- lye and alkaline fluids must not be used in cleaning as they damage metal parts;
- joints, threads and seals must be oiled or greased after cleaning.

Refer to Figures 43 - 44 - 45 below-

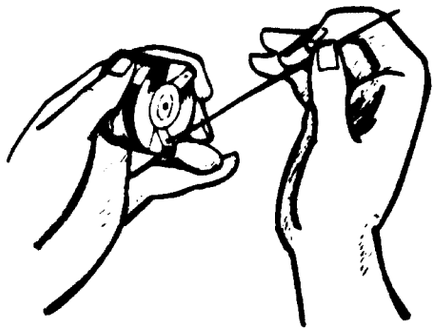


Figure 42 - Cleaning side openings.

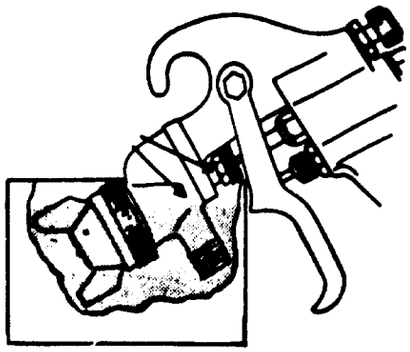


Figure 43 - Upper limit of thinner must not rise above the seal.

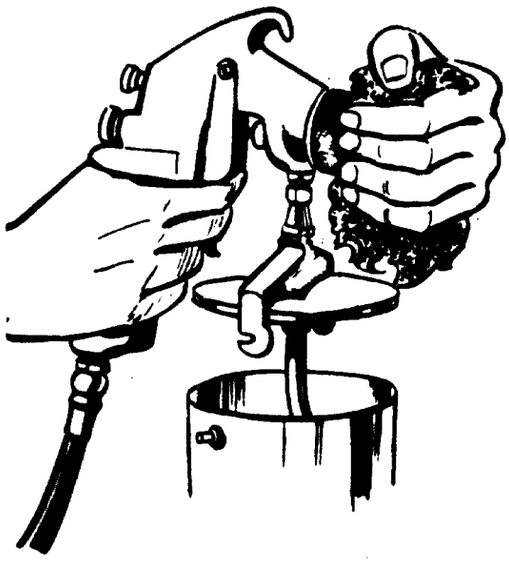


Figure 44 - Cleaning spray gun with suction feed container.

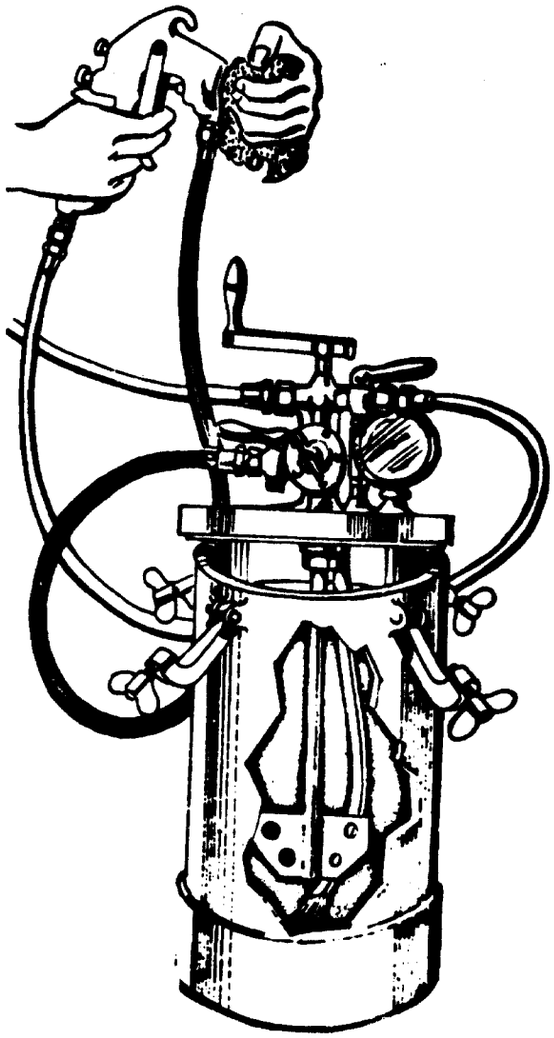


Figure 45 - Cleaning the pressure system.

IMMERSION LACQUERING:

If only immersion is used in lacquering good final results in surface finishing require special equipment which ensures an adjustable rate of lift of the item being immersed from the lacquer of 2.5 to 10 cm/minute. Lacquer viscosity and temperature must be carefully controlled. Simple protective lacquering with thin lacquer can be applied manually so that the objects are immersed one by one, or several at one time. Small objects can be immersed in lacquer in a large sieve made of metal wire. Objects moistened one by one are hung and those immersed in a sieve (see Fig. 46) are turned over on a wire mesh to dry. Satisfactory results can be obtained by combining the use of a brush with immersion lacquering and arranging the hanging and drying in a proper way. Objects should be shaped so that the lacquer drips off when hung and the drying can occur when placed on wire mesh or hung from an appropriate support, such as sticks, pins, tool handles, parts of toys, pegs, beads, etc. Cellulose lacquer is suitable for this application since it does not set in the pot but due to fast evaporation of the thinner it sets and dries quickly.

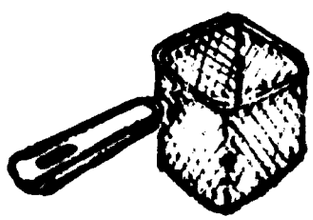


Figure 46 - Large wire sieve.

TUMBLE LACQUERING:

In lacquering small items, such as beads, buttons and ends of small tools, tumble lacquering can be used. The drum in which they are tumbled is round or octagonal and it spins and can be tilted to an angle of 45° (see Fig. 47) below-

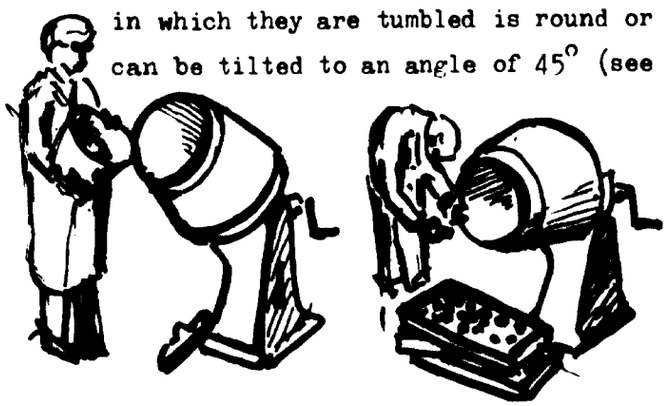


Figure 47 - Drum for tumble lacquering.

There are two different way of lacquering-

(a) - about two thirds of the drum is filled and a measured amount of lacquer is added (e.g. 1/150 of the volume of the items) and tumbling is continued until all items are coated with lacquer and then they are turned over on a wire mesh to dry;

(b) - while the objects are moving in a spinning tumble, lacquer is sprayed until all objects are coated with lacquer, and then they are turned over to dry on a wire mesh.

A suitable spray gun for this operation is an electric gun, which sprays less material than suction or pressure feed guns due to its counter pressure. Cellulose lacquer is also more suitable for this type of lacquering, since lacquer which has dried in the drum can be removed with thinner.

DRYING TECHNIQUES

The drying process of cellulose lacquer is based on the evaporation of the thinner material. In catalyst lacquer drying takes place through a chemical reaction. The drying time for cellulose and catalyst lacquers are approximately the same. They are (for an ambient temperature of 20^{0}c):-

- touch dry after about 10 minutes
- handling dry after about 1 hour
- package dry after about 24 hours

At higher temperatures the drying is more rapid.

The drying of cellulose lacquer coatings depends on the thickness of application, or spraying, and the thickness of the whole film, since cellulose lacquer partly dissolves the coatings under it.

Drying stands:

In small and medium scale production, articles are usually dried at room temperature in well ventilated rooms. The objects to be dried can be positioned on shelves or racks along walls in the immediate vicinity of the application area. (see Fig. 48). In spraying, mobile stands are to be recommended where spraying and drying areas are separate. In this manner the objects can be transferred and dried in the same stand. The stand model depends on the need. Often the needs change and therefore the stands used should be so constructed that they are versatile (usable for as wide a range of objects as possible). The stands can be made from wood or metal. For flat surfaced objects they

are usually of the type shown in Figure 49 (for small items) or Figure 50 (for larger panels). Shelves of the types shown in Figure 51 are sometimes used on the horizontal supports. Another less common type is shown in Figure 52. Objects that are turned or dipped are often dried on stands similar to the one shown in Figure 53.

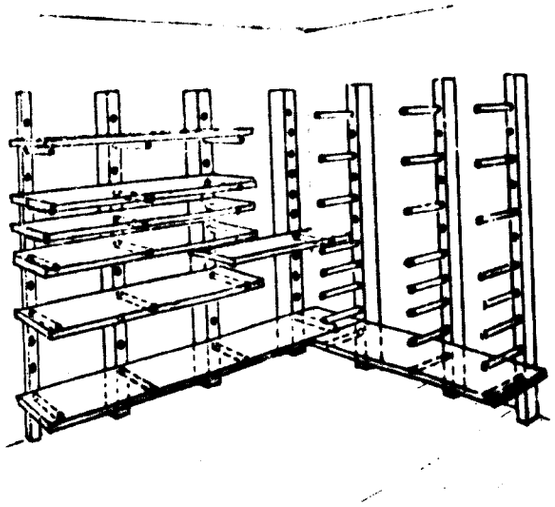


Figure 48 - Drying and storage stands.

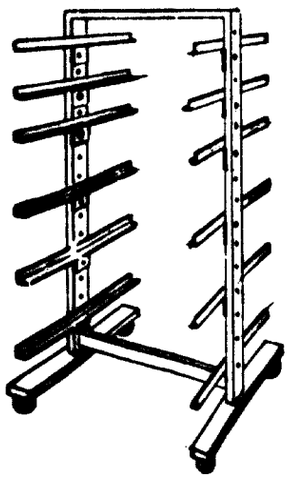


Figure 49 - Mobile transfer and drying stands.

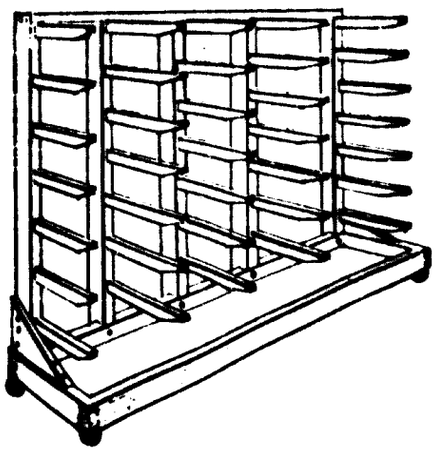


Figure 50 - Mobile drying shelf.

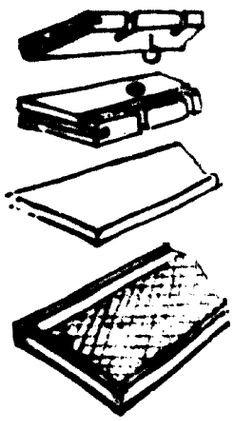


Figure 51 - Shelf suggestions.

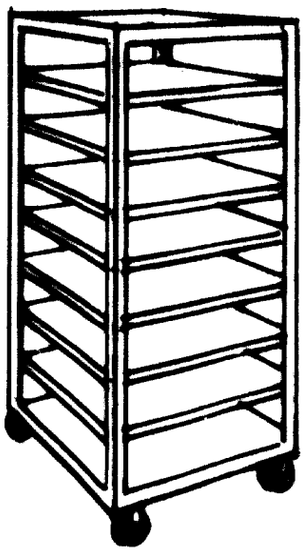


Figure 52 - Drying stand.

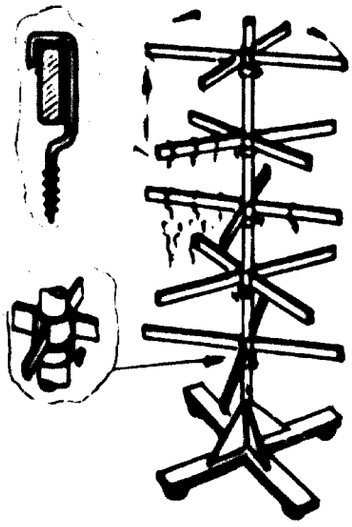


Figure 53 - Drying stand.

POST TREATMENT PROCESSES

If a mat lacquer surface is required it can be obtained by either using mat lacquer or rendering a glossy lacquer surface mat. Dry matting is obtained by rubbing the surface with thin steel wool (no.000) and a pad in the direction of the grain or strewing pumice powder on the surface and then rubbing it with a brush also in the direction of the grain. Instead of a brush, fine steel wool wrapped around a sanding pad can be used. When using the wet method, the pumice powder is mixed with turpentine, oil or vaseline, and the sanding performed with a soft cloth with sanding support in the direction of the grain. After sanding, the surface must be cleaned with lacquer, petrol or another solvent which removes the grease but does not dissolve the lacquer.

In wood with rough grains mat lacquer gives a more attractive surface, since even the bottoms of the pores become mat. In matting with steel wool or pumice powder they remain glossy.

Post treatment of lacquered surfaces with wax produces an attractive silk-like surface. The wax is applied on the surface and rubbed firmly in the direction of the grain with a piece of woollen cloth. The durability is not as good as that of lacquered surfaces. If the surface must be lacquered later, the wax must first be removed carefully, otherwise the lacquer will not dry.

REPAIRING LACQUERED SURFACES

Flow:

The lacquered surface is allowed to dry completely, after which it is levelled with a well-sharpened scraping plate or wet-sanding paper using a sanding pad. If the final coating of lacquer, or a coating leaving the pores open, develops, flows should be particularly avoided, since the levelled points may remain visible.

Holes resulting from sanding:

If excessive sanding results in the removal of the veneered surface it must be repaired with lacquer before the next coating, either by using a spray gun, brush or finger. If the surface of the wood has been stained before lacquering, the damaged part must be re-stained. Stain dissoluble in ammonium or alcohol is more suitable than ordinary water soluble stain. Colour adhesion

can be improved with light sanding.

Old lacquered items:

Before surface finishing, grease and other surface impurities must be removed with an appropriate cleaning substance, such as soap - or crystal soda solution, spirit, etc., which does not dissolve the lacquer. The surface is then sanded in the direction of the grain. If the colour has worn off on the edges or corners, they are repaired as described above. For surfaces with cellulose lacquer, the first two coatings should be made with almost pure thinner. Thus the small cracks in the old lacquered surface can be levelled out. After each coating the surface is sanded or scraped lightly. When using catalyst lacquer, the lacquer used in the first coatings need not be applied thinner than normal, since the thinner does not dissolve the underlying coating.

Removing old lacquer:

An old coating of cellulose lacquer can be removed mechanically, using a scraping plate, other types of scrapers or sanding paper. To facilitate the work, the lacquer can first be softened with a lacquer remover. Also thinner can be used applying it on a piece of cloth or a sheet of paper spread on the surface. To prevent evaporation it can be covered with a plastic foil. The cloth and the plastic foil are then rolled away when the softened lacquer is being scraped off.

The surface is sanded before lacquering. If special lacquer removers are used, the surfaces must be cleaned according to instructions (usually with a white spirit) otherwise the lacquer may not dry and the adhesion of a new coating can be rather poor. In surfaces with colour and decorative carvings or moulded shapes the lacquer can be removed using a lacquer remover and scraper which does not damage the colour and the surface of the wood. A scraper made of hardwood, plastic or bone can be used. Also a dull scraping plate is suitable. Catalyst lacquers are removed mechanically. Before lacquering, the surfaces are sanded and worn or damaged stained points are repaired.

ACKNOWLEDGEMENT

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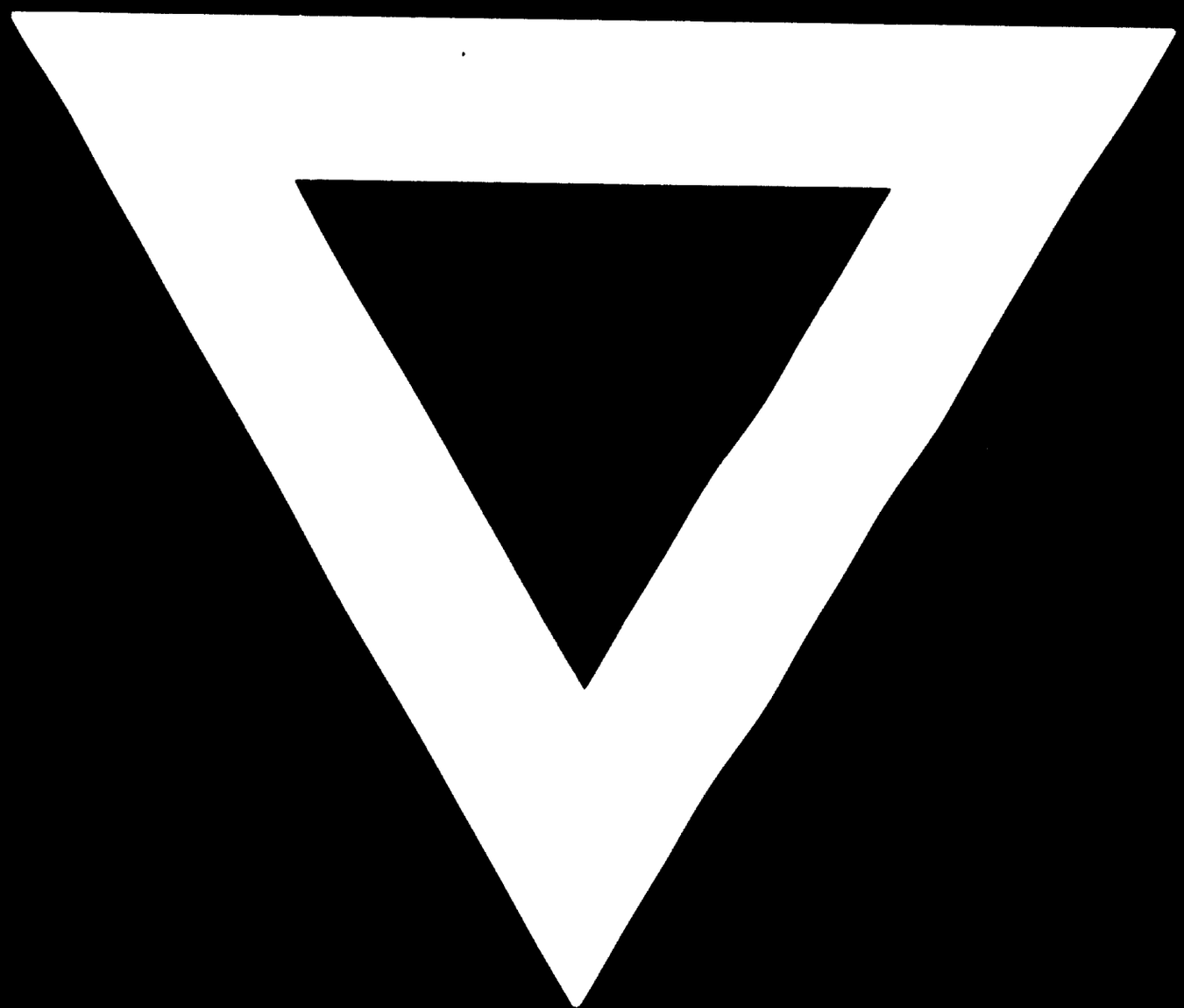

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