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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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MATERIALS FOR SURFACE FINISHING AND APPROPRIATE EQUIPMENT*

by

G.D. Beccaria **

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** Expert in surface finishing.

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CONTENTS

TABLES

Definitions in surface coating of wooden products. The terms and definitions are collected from a seris of articles of US-Wood Magazines.

Lacquers:

The word "lacquer" was derived from the world "lac" relating to the excretion of lac insects which, on processing, is called shellac and came to be a descriptive term for thin-bodied, hard, clear, colorless finishing materials. Modern industrial usage now has limited the term lacquer almost exclusively to coating materials containing nitrocellulose, ethyl cellulose, cellulose acetate, benzyl cellulose and other film-forming chemicals incorporated with natural and synthetic resins and plasticizers in volatile solvents.

Lacquer coating:

Lacquer coatings, in general, involve those materials that form a surface film by volatilization of solvents and thinners, whereas varnish coatings involve evaporation of solvents and polymerization reactions.

Lacquer application:

The use of nitrocellulose lacquers for furniture topcoats was one of the most important factors leading to streamlined production furniture manufacture. The primary advantages exhibited by nitrocellulose lacquers were the fast drying effected by evaporation and the formation of uniform films with good physical and chemical properties. These latter properties could be adjusted for specific production requirements and the manufacture and control could be approached on an almost purely technical basis due to the nature of the ingredients.

The primary disadvantages of lacquers were the low solids content and the relatively high cost. A partial answer to the cost and solids content drawbacks has been the development of the so-called hot spray process whereby spraying visoosity is controlled by temperature and greater buld can be obtained with fewer coats than with conventional cold lacquers.

Lacquer troubles

There are numerous problems relating to lacquer topcoats that may be the result of faulty application and/or formulation. Many of these problems are not confined to lacquers. They also will develop with varnishes. The following problems or troubles are some of the most common encountered in lacquer finishing of furniture.

Blushing

When a lacquer coat turns gray or white instead of remaining clear and transparent, the film is said to blush. Blushing is caused by:

a) too rapid evaporation of solvents cooling the film below the dew point of the air, thereby affecting moisture condensation in the film;

b) incompatibility of lacquer ingredients;

c) excessive moisture or oil in the compressed air line.

Blushing can be prevented by controlling the temperature and humidity conditions in the plant, using a higher proportion of less volatile solvents in the lacquer formulation and by using adequate filters and maintaining drains on the air lines.

Bubbling

The formation of bubbles in the partially dried lacquer film is normally termed bubbling. This condition is caused by entrapping air and other gases in the film and may relate to improper spraying technique or solvent balance of the formulation.

The formulation may have an insufficient quantity of slow evaporating solvent which allows the surface to dry before the volatile solvents can escape from the film. If excessive pressure is used, air and solvent bubbles may be entrapped within the film. If the spray gun is held too far from the work, too large a proportion of the solvents may volatilize, effecting improper flow properties.

Blisters

The spraying of heavy coats of lacquer on unfilled or imporperly filled woods or the use of high drying temperatures and any other condition that will effect improper adhesion can cause the raising and separation of the film in

the form of blisters. Proper surface preparation, filling, filler drying and temperature control of the surface and lacquer will eliminate this problem.

Bridging

The application of a lacquer film over improperly fitted joints and sharp moldings may form a lacuqer bridge which will break or chip during use. Uniform moisture control of parts, proper machining tolerances and careful spraying can eliminate or minimize bridge formation.

Orange peel

When a lacquer coat lacks proper flow characteristics and does not level completely, it appears like the rough skin of an orange and is known as orange peel. It may be caused by failure to maintain the proper distance between the gun and work, excessive pressure, too rapid solvent evaporation or by use of inferior thinner.

Pinholes

The development of pin-like holes in a lacquer finish may result from improper filling or improper drying of the filler. Pinholing may be caused by the presence of water or oil in the air lines. Since both are incompatible with the lacquer, they may remain as little submerged globules which are released in rubbing. The use of adequate drains and daily bleeding of lines and tanks can often eliminate pinholes formed from oil and water globules.

Runs or sags

Application of too heavy a film frequently results in sagging or running. Proper spraying technique, which includes spraying beyond the edge of a piece, should help to eliminate this problem.

Wet spots

The presence of grease or oil spots on the wood or the lacquer may result in the formation of small ares which do not solidify properly. Proper screening of the air system and surface preparation will eliminate this problem.

Varnishes

Varnishes may be divided into three primary types. These are oleoreinous or oil varnishes, synthetic varnishes and spirit varnishes.

Spirit varnishes are solutions of gum or resin in a volatile liquid with or without the addition of modifying agents. Spirit varnishes are in reality lacquer-type coatings since they do not require oxidation or polymerization, but harden by the evaporation of their volatile solvents.

Clear oil varnishes contain drying oil, resin, driers, solvents and thinners. the drying oils may be of animal or vegetable origin and consist of mixtures of mixed triglyceryl esters of fatty acids. The drying of an oil is primarily a curing process involving hardening.

Those oils with the greatest reactive power, although they are the fastest drying and give the densest molecular structure, discolor during drying to a greater extent that the less highly conjugated oils. Therefore, in clear varnishes drying speed often must be sacrificed to reduce yellowing tendencies.

Varnish troubles

There are many problems that occur in varnish application. Most of these relate to faulty application technique or improper handling of the material.

Blistering

The formation of bubbles or blisters may be caused by the use of excessive heat during drying which allows for volatile expansion under a partially cured surface. Blistering may also result if the undercoats or the wood are inadequately dried.

Blooming

Blooming refers to the appearance of amilky or foggy surface. This condition generally relates to excessive humidity in the finishing or storage room. Condensation has been effected in the film. It may be remedied by rubbing and re-coating. Humidity control in the finishing room and/or adjustment of solvents are preventative measures.

Checking

Checking is a mild form of cracking and may be effected by the same causes. Individual pieces may be adequately touched up in many instances.

Chilling

A chilled surface caused by solidification of gums, driers or oils may give a varnish film a sandy appearance. This defect is caused when the

the varnish is stored or applied at low temperatures.

Cracking

When a varnish topcoat cracks, it may have been caused by one or several variables. The most common causes of cracking are improper drying of the wood and/or the undercoats prior to topcoat application, severe temperature changes without adequate flexibility of the finishing system, and exposure of varnish films to chemical agents which may cause embrittlement. A varnish film may crack, creating a condition similar in appearance to the skin of an alligator. This type of cracking is often termed alligatoring.

Crawling

Crawling or roping is pronounced wrinkling and generally occurs due to the same causes as running or sagging. It relates directly to the flow characteristics which might be inadequate because of formulation, improperly cleaned surfaces, high or low temperatures and excessive application. An excess of drier is often the key to improper formulation. Normal recommended control in cleaning surfaces and in application will eliminate this problem.

Flatting

If the finish coat lacks the normal desired effect and has a somewhat dull appearnace, it is described as flatting. It may be caused by dissolving inadequately dried undercoats or by excessively high temperature and humidity conditions in the plant.

Pitting

The appearance of little pock marks or pinholes on finished varnished surfaces is referred to as pitting or pinholing. This condition may be caused by inadequate drying of the undercoats and the escape of volatiles after the varnish has partially dried, by drafts in drying, or by improper atomization in spraying.

Pigments

A pigment may be defined as a coloring substance which is insoluble in the liquid in which it is suspended or dispersed. Pigments find wide usage in paints, enamels and pigmented lacquers for both metal and wood finishing;

but with the present-day trend toward greater color variation in household furnishings and with the decrease in the availability of traditional furniture woods, the role of pigments in furniture finishing is ever increasing.

Fillers

The filler is often considered "the foundation of a fine finish". Many of the principal cabinet woods have large pores and these must be properly filled in order to assure the desired final effect. Conifers and diffuse-porous woods are generally finished without the use of fillers, but occasionally these woods are filled to equalize absorption of different surface areas.

1. Composition of lacquer coating materials

Lacquer coating products are composed essentially of:

1.1. the binder

made up of one or more products, normally polymerical (resin). Essentially , the mechanical and chemical characteristics of the film obtained, depend from it.

1.2. the solvents

from which the suitability of the varnish products depend.

1.3. the pigments (in the case of pigmented products)

which provide colour and covering power to the v.p. (varnish product). They also affect the mechanical and chemical characteristics of the films applied.

1.4. the additives

which improve, when added in small quantities, both the characteristics of applicability as well as the chemical and mechanical ones of the

of the films applied. For instance, the zinc stearate improves the possibility of sanding the bottoms, various silicones release air from the film as soon as sprayed v.p. is applied ... etc.

2. Types of lacquers

The lacquer products used in the furniture industry in Europe and particularly in Italy are substantially the following:

- polyurethan lacuqers;
- polyester lacuqers;
- direct polisy polyester lacuqers;
- urea lacquers with acid catalizer;
- nitrocellulose lacquers.

Lacquers are mostly transparent coating products, non-pigmented; paints are pigmented coating products.

2.1. Polyurethan coating products (polyurethanic c.p.) are products which normally have two components. The first component is generally constituted by solutions in organic solvents of synthetic resin, resin upon the molecules of which oxydrilic (-OH) groups are inserted.

Such resins are largely of a polyester type (alkyd, saturated polyester) and also of an acrylic, vinylic or mixed type.

The second component is constituted generally by solutions in organic solvents of various kinds of polyisocyanates. Actually, the most commonly used are: 1) the aforementioned and the homopolymers of toluenisocyanate; 2) the copolymer of toluenisocyanate and hexamethylenisocyanate; 3) the biureate of the hexamethylenisocyanate. Other types of polyisocyanates may also be used.

Polyisocyanate products are distinguished by the possession they enjoy, throughout the polymeric chain, of isocyanate groups (-NCO).

2.2. Polyester coating products

The polyester v.p. are normally constituted by solutions of polyerster which are unsaturated in styrene.

The unsaturated polyester resin are characterized by their having, within their own structure, double ties or unsaturated ties (=).

These double ties, as the result of the action of an activator or catalizer (normally organic cobalt salts and organic peroxydes are used for this purpose) open themselves by reacting with the double ties of styrene, thus provoking the formation of a polymer of a three-dimensional and reticulated structure on the support.

2.3. Polyester direct gloss coating products

The polyester coating products, referred to in the previous paragraph, when applied without particular attention, are inhibited, during the polymerization process on the support, by the oxygen of the air (the surface remains sticky and unhardened).

The addition of 0.1 - 0.2 % of low-point fusion parafin eliminates such an inconvenience, but obliges the need for somewhat more toilsome operations later (sanding and, if necessary, glossing).

The introduction of polyester resin or allylic groups into the structure allows the inconvenience to be obviated.

Such allylic groups react, in the presence of suitable activators (cobalt organic salts), with the air's oxygen, by participating together in the normal reaction of the opening of the double ties, to the formation of a three-dimensional and reticulated structure.

2.4. Urea acid catalized coating products

are produced in two components.

The first component is constituted by a solution in organic solvents of suitable urea resin and of normally alkyd resin (although suitable vinylic and acrylic resin may be used).

The reticulation comes about substantially as the result of a reaction between the methylic groups of urea resin and the oxydrilic groups of the other resin.

The reaction is provoked at room temperature by the addition of the second component, normally a solution in organic solvents of acid substances, such as phosphoric acid, acid organic phosphates and so forth.

Acid catalized urea products, of a single component type, also exist.

2.5. Nitrocellulose coating products

are constituted by solutions in nitrocellulose organic solvents.

In order to obtain good mechanical characteristics of the applied films, it is imperative that other resin be united to such solutions (e.g. the alkyd ones) and the plasticizers (such as butyl phtalate, castor oil and so forth).

The formation of the film in this case takes place by means of the simple evaporation of the solvents.

No chemical reaction of reticulation takes place.
The choice of a coating product depends on several parameters.
It is practically impossible to define and to give them an exhaustive and complete description.
Every real situation is examined in detail and to each real solution a well-balanced and tailor-made solution is corresponded.

For a better understanding of the impossibility of having solutions of a general nature, it is sufficient to consider the differences existing between countries on the costs of labour, of fashion, of the type of machinery available.

An effort has been made in the following tables and in their comment to illustrate the most important technical criteria on the basis of which one should choose the lacquer cycle.

Despite the efforts made to generalize the data available, the preceding account of facts will reflect the evident situation existing in the Italian sector.

Notwithstanding this, it is believed that the indicated data may provide the base to start a discussion on the choice of a coating cycle.

The tables are to be considered in reference to the present-day industrial practice; reference to products and systems of application under development are, therefore excluded.

TABLE Nº 1 - COATING PRODUCTS AND THE APPROPRIATE COATING EQUIPMENT

	APPLICABILITY A							
	BRUSH	SPRAY	AIRLESS	ROLL	ROLL + CURTAIN	CURTAIN 1 HEAD	CURTAIN 2 HEADS	ELECTROSTATIC SPRAY
1) polyurethane vp	YES	YES	YES	YES	YES	YES	NO	YES
2) polyester vp	YES	YES	NO	YES+	YES	NO	YES	YES
3) polyester L.D. vp	YES	YES	LIM	YES+	YES	NO	YES	YES
4) urea acid cat. vp	YES	YES	YES	YES	YES	YES	NO	YES
5) nitrocellulose vp	YES	YES	YES	YES	YES	YES	NO	YES

lim = limited

* only U.V. products

Comment on Table Nº 1:

The polyester lacquers (2) are not applicable with the airless system, with the curtain machine with one head and with the rolling machine for the extremely short pot-life (from 5 to 30 minutes at room temperature).

The same goes for the direct gloss polyester varnish (3). In this case, since it is possible to extent the pot-life (max. 1 hour) and, working with a small quantity of catalized product, it is even possible to use the airless system. For 4) and 5) the use of the 2-head curtain machine offers no particular advantage, except for highly particular cases.

TABLE Nº 2 - LIMITATIONS TO THE APPLICABILITY OF VP

1) polyurethan vp	3 - 8	YES	LIM.	LIM.	LIM.	LIM.
2) polyester vp	4 - 6+	YES	YES	NO	YES	YES
3) polyester L.D. vp	4 - 8+	YES	YES	NO	YES	YES
4) urea acid cat. vp	12-24	YES	LIM.	YES	YES	YES
5) nitrocell. vp	UNLIM.	NO	LIM.	YES	LIM.	LIM.

+ only catalized part; the accelerated part has practically unlimited pot-life the mixing of two parts brings pot-life to 5-30 min. for 2) and 5-60 min. for 3).

LIM = LIMITED
UNLIM = UNLIMITED

Comment on Table Nº 2 : The pot-lives indicated are to be understood as continuous restoration on the continuous machines (roller, curtain) of the evaporated solvent.

With regard to the need to respect the relations of catalysis and of dilution, it must be pointed out that the "NO" placed in correspondence to 5) simply signifies that the nitrocellulose varnish products do not require a catalizer (or hardener) and therefore enjoy the relative advantages and the small errors of dilution do not prejudice the application substantially.

The term room temperature is to be understood as a temperature ranging from 10º to 35ºC. By room humidity, this means an air relative humidity ranging from 30 to 80%.

TABLE Nº 3 - CONDITIONS AND SYSTEMS OF DRYING IN RELATION TO VP.

	air-drying at room temperature 10 - 15ºC	15-30ºC	30 - 35ºC.	air-tunnel drying 20º - 70ºC.	low power UV drying	high power UV drying	IR drying + forced air
1) polyurethan vp	YES	YES	YES	YES	NO	NO	YES
2) polyester vp	NO	YES	LIM.	YES	YES	YES	YES
3) polyester L.D. vp	NO	YES	YES	YES	YES	YES	YES
4) urea acid cat. vp	YES	YES	YES	YES	NO	NO	YES
5) nitrocellulose vp	YES	YES	YES	YES	NO	NO	YES

LIMIT. = LIMITED

Comment on Table Nº 3 : Those products which, by means of small additives (e.g. thinners) could be suitable for use at the indicated temperature, may be dried at temperatures between 16º and 30ºC. For higher temperatures (see Tunnel Drying, with air from 20 to 70ºC.) they should be formulated in a special manner.
Low-power UV installations signify those which use lamps when the absorbed power is lower than approximately 1 Watt per centimetre of lamp: High-power UV installations are to be understood as meaning those with lamps whose absorbed power is equal or superior to 30watt/cm of the lamp's length.

For IR systems, saving particular exceptions, lamps or other sources both of short, medium and long wavelength, may be used.

In the case of UV and IR drying, it is <u>always</u> necessary to have a good ventilation, with preferably pre-heated air.

TABLE Nº 4 - TIMES OF MINIMUM DRYING TO OBTAIN THE PILING UP WITH VP OF OPAQUE FINISHINGS

	at room temperature	with air-tunnel 20 - 70ºC.	with low-power UV	with high-power UV.	with medium-wave IR.
	hours	minutes	minutes	seconds	minutes
1) polyurethane vp	4 - 6	12 - 16	UN.	UN.	8 - 16
2) polyester vp	2 - 4	12 - 16	4 - 5	5 - 30	8 - 16
3) polyester L.D. vp	24-36	UN.	4 - 5	5 - 30	UN.
4) urea acid cat. vp	4 - 6	20 - 25	UN.	UN.	8 - 16
5) nitrocellulose vp	2 - 4	12 - 16	UN.	UN.	8 - 16

UN = UNUSED

NP = NOT POSSIBLE

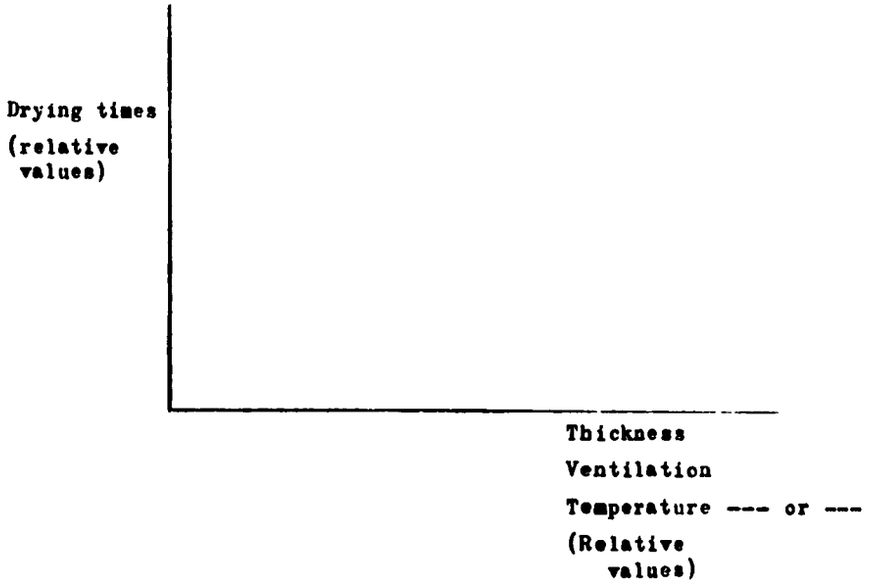
Comment on Table Nº 4 : Except for the case of drying at room temperature, one must add 1 - 2 minutes to the above times for the cooling with forced air at temperatures not exceeding 25ºC. In the case of UV dryings, it must be remembered that it is practically impossible to use pigmented products with them. Generally, the faster the drying, the more accurate should be the preparation of the product and the attention in carrying out and in following the application. Variations in the relation of catalysis and/or in the dilution, could still be tollerated, in the case of forced drying, it could cause serious inconveniences. Insofar as forced air drying is concerned, although it would still be possible to work with the indicated times, it is generally advisable to have longer time intervals (at least double those indicated) to cut down the precise critical element of the conditions of application.

TABLE Nº 5 - DRYING TIMES + HARDENING TIMES AT ROOM TEMPERATURE OF GLOSS FINISHED PRODUCTS TO OBTAIN POSSIBLE OF CARRYING OUT FURTHER WORKS

	at room temperature	tunnel forced air 20 - 70ºC.	Low-pressure UV
	hours	hours	hours
1) polyurethan vp	24	———	———
2) polyester vp	6 - 8	1 + 3	———
3) polyester L.D. vp	24 - 36	———	0.1 + 2
4) urea acid cat. vp	———	———	———
5) nitrocellulose vp	6 - 8	0.5 + 1.5	———

Comment on Table Nº 5 : The polyester coating products are the glossy types: following the indicated times, it is necessary to sand with grained paper 280-320 and then brush polish with abrasive paste and polish later on. The other glosses may be left as they are; should one wish to remove the small dots caused by atmospheric dust particles, it would be necessary to sand down with grained paper 600 and then gloss the object with a brush polish.

TABLE Nº 6 - DRYING TIMES IN RELATION TO THICKNESS, TO VENTILATION AND TO TEMPERATURE



Comment on Table Nº 6 : The diagram indicates, in a totally qualitative manner, the influence which thickness, ventilation and temperature have on the drying times. The diagram highlights the increase in thickness which, at par with ventilation and temperature, increases more than proportionately the time for drying. If the thickness increases to twice the measure, the time for drying increases by 3 to 4 times.

The increase of ventilation, at par with thickness and temperature, reduces the drying time. An increase in the speed of ventilation to twice the rate reduces the drying time by about $^1/_2$ to $^1/_3$.

The increase in temperature, at par with thickness and ventilation, reduces the time for drying.

Doubling the temperature causes the time for drying to be cut down by about 3/4 - 1/2.

In all these cases, there are limits beyond which it is not convenient to venture. The maximum quantity applicable practically by hand is indicated in Table 8.

As far as ventilation is concerned, it is advisable not to exceed 3 - 4 m/second (although in the case of the drying of products given in low quantities (30 - 40 g/m^2) one could also arrive at 10 m/second). This is to prevent the ventilation from moving the applied film and giving borth to surface defects.

The limits of the temperature are substantially given by the resistance to the temperature of the support and of the glues used. Generally, when using polyacetovinyl glues (fusible by heat) for glueing edges, the temperature of the air used for the drying should not exceed 80 - 90ºC.

TABLE Nº 7 - MECHANICAL AND CHEMICAL CHARACTERISTICS OF FILMS OF COATED FINISHING:

	adhesion	hardness	elasticity	resistance to thermal oscillations	resistance to dry heat	resistance to humid heat	resistance to chemical domestic products	resistance to alcohol	resistance to water	yellowing effect	resistance to cigarette
1) polyurethane vp	0	B/0	0	B/0	0	0	B/E	E	E	M/E	0/E
2) polyester vp	B/0	B	M/B	M	0	0	B/E	E	E	B/E	0/E
3) polyester L.D. vp	0	B	B	M/B	0	0	B/E	E	E	B/E	0/E
4) urea acid cat. vp	B/0	B/E	M/B	M/B	M/B	M	M/B	M/B	I/M	B/0	0/E
5) nitrocellulose vp	B/0	B	M/B	M/B	I/M	I/M	I/M	I/M	B	M/B	I/M

Comment : the valuation scale use is the following:

E = excellent

O = optimum

B = good

M = sufficient

I = insufficient

Although largely indicative, table Nº 7 shows that the reticulated products generally have mechanical and chemical characteristics of a far better nature than the non-reticulated systems (1,2,3,4 against 5). This tendency has a sufficiently general character.

As for the yellowing process, one must distinguish between the yellowing of pigmented products and that of transparent products. In the case of pigmented products, it is important that the yellowing be minimal due to the binding and eventually to the pigment. In the case of transparent products, the yellowing of the binder is important only if white woods and/or white painted woods are used: with the use of non-pigmented varnish products, what is more important is the protection that the same varnish product gives to the wood against the ultra-violet rays existing in the solar light. This protection is obtainable through the insertion of suitable UV absorbents in the varnish products.

TABLE Nº 8 - CHARACTERISTICS OF PRIME COAT PRODUCTS

	elasticity	resistance to thermic oscillations	adhesion on wood	inhibition by rosewood	hand sanding	machine sanding	over-spraying
1) polyurethan vp	0	B/0	0/E	NO	B/0	0/E	0/E
2) polyester vp	M/B	M/B	B/0	YES+	I	B/0	0/E
3) polyester L.D. vp	B	B	B/0	YES+	M/B	B/0	0/E
4) urea acid cat. vp	M/B	M/B	M/B	NO	B	B	B/0
5) nitrocellulose vp	M/B	M/B	B/0	NO	0/E	0/E	M/B

+ may be applied on rosewood prior to application of a polyurethane sealer.

Comment on Table Nº 8 :

The prime products are those which are in direct contact with the wood; they are applied, according to the filling requested and the type of wood used, with one or more passes or hands. Their purpose is to give the finishing coating a support which is the nearest possible to perfection, to obtain aesthetically and technically excellent results.

In particular, there are two characteristics which clients seek mostly for use as prime base: the sandability and the resistance to over-spray. A good sanding down enables a work to be done rapidly and to obtain a perfect and defectless surface. A good resistance to overspraying prevents the prime coating from removing itself and therefore losing its qualities of flatness obtained by sanding.

As far as the inhibition of the polyester products by the rosewood type of woods is concerned, we should draw the attention to the need of always to carry out practical tests of on the wood to be used and to sample out the wood itself. There is too great a variety between one lot of wood and another to be able to affirm at an early stage that one or two hands of polyurethane sealer paint would suffice.

TABLE Nº 9 - MAXIMUM QUANTITY OF VP APPLICABLE WITH ONE HAND
(QUANTITY IN G/M^2)

	product ready at application	dry product
1) polyurethane vp	140 - 180	60
2) polyester vp	320 - 380	340
3) polyester L.D. vp	200 - 250	180
4) urea acid cat. vp	120 - 140	50
5) nitrocellulose vp	120 - 140	45

Comment on Table Nº 9

The data indicate the reasons for the polyesters' success in Italy. In fact, by using them it is easy to obtain a perfectly filled pore with a few hands, starting from a support and one prepared by a gauging machine. Moreover, the filled pore obtained with, for instance, only polyurethane products is entirely better from an aesthetic point of view, leaving as it does the wood's natural characteristics very much in evidence.

TABLE Nº 10 - QUANTITY OF DRY (G/M^2) OF V.P. NECESSARY TO OBTAIN :

	CLOSED PORE	OPENED PORE
VERY POROUS WOOD (e.g. rosewood mahogany)	270	100
50% POROUS WOOD (e.g. LOCALLY GROWN OAK)	200	70
LITTLE POUROUS WOOD (e.g. ANIEGRE)	140	40

Comment on Table Nº 10

The contemporary use of tables 9 and 10 should enable one to determine, at least approximately, the quantity of v.p. and the number of hands necessary to obtain a given filling.

3. Request for Finishing Operations

The attached form Finishing Operations applied and the Questionnaire on page 26 should enable one to formulate a request for a suitable coating cycle to suit one's needs.

Some introductory explanations might perhaps be useful:

- for external use, one is to understand the outdoor wooden components. The problems of coating wood to be exposed outside are among the most serious and delicate. For better results, one should follow the instructions provided by the lacquer material producer who should be a first-class one;

- for internal use, one is to understand the indoor wooden components (door and so forth), the coating cycles of which are altogether similar to those of furniture;

- for panels to be coated, this signifies the panels inside the appartements made of veneered plywood, veneered fibre panels and so forth. In Italy and Europe, panels to be coated for outside use are little used; ouside matchboarding is more favoured;

- for prev. panels, one is to understand these as meaning the pre-coated panels which furniture-makers purchase from specialized firms. Normally they are used to make furniture rear panels and drawers' bottom panels.

- mus. instruments stand for musical instruments.

The production of wooden musical instruments in Italy is particularly concentrated in the Marche.

The products and the cycles used for coating musical instruments are substantially similar to those used for coating furniture.

- The problem of modular case-good furniture is that of the constancy of the finishes both regarding the colour as well as the artificial ageing.

In such a case it is necessary, however, to guarantee not only the uniformity of the production from series to series, but to make sure that the artificial ageing does not alter the colour and aesthetic aspect of the furniture to the extent that it could prevent the most recent parts

from being attached to those coated earlier on.

3.1. Dimensions of the manufactured product

This item is specially important for panel lining and pre-coating panels. In fact, panels of a few millimeters (3-5 mm) thick are often used and several metres wide and long (2 x 3; 2 x 5 m): it is necessary in such cases to provide v.p. with excessive elasticity because during normal operations of coating and use, the panels have a tendency to bend and cause considerable demands on the films of the v.p. applied over them.

3.2. Substrate used

There is a preferential cycle of coating for every type of substrate: for instance, in the use of the plywood and laminated plastic covered panels or even those of the same type but of a honeycomb shape, there are normally local variations in the thickness of such panels which prevent the use of roller-coaters. Or the chipboards, or the thin particle boards, these require, generally, a gauging process prior to coating.

3.3. Type of surfaces to be coated

The coating cycle will vary also in view of the type of surface to be coated.

As an example: In the case of a rough chipboard, it would be necessary to apply a first hand of preparation to the panel so that the porosity would be blocked and one could then have a perfect surface for later hands of coating.

The second part of the form may serve as an indication of the cycle already used and the improvements desired or, simply, to indicate the machines available.

3.4. Conclusion

The preparation of the coating cycle can be extremely simple and extremely difficult; it depends entirely on the interaction and on the exchange of information between the furniture-maker, the lacquer producer and the manufacturer of machines.

It is necessary that all three parties interested would communicate with another and exchange the aims and means necessary to attain them, to seek together a reasonable agreement regarding the type of lacquer, the products and the machines to be used, the production costs of the coated products.

Neglecting this fundamental precaution could lead, in many cases, to a failed selection of coating lines and, precisely, to the impossibility of putting the lines into action, shortly after having them installed, through lack of suitable machines and vice versa.

We shall conclude by affirming that, in Italy, the development of furniture-coating material has been, within its own sector, unique in the world; commencing from the simple basis of craftsmanship which was dominated by the manual application of products and by air-drying, it developed over the span of 20 - 30 years into highly automated systems without any prejudice to the quality factor which has always stood at very high level.

All this experience is at your disposal to solve your problems which might range from the simplest to the most complex.

FINISHING OPERATIONS APPLIED

CYCLE USED OPERATION	PRODUCT	g/m² dry	Visc. CF 4	application dilution %	with	°C.	Ventil.	Time	Machine
Sanding									
Colouring									
Drying									
Stacking									
Sanding									
Colouring									
Drying									
Stacking									
Printing									
Drying									
Printing									
Drying									
Stacking									
1st. ink									
Drying									
2nd. ink									
Drying									
3rd. ink									
Drying									
Stacking									
Priming									
Drying									
Cooling									
Stacking									
Sanding									
Priming									
Drying									
Cooling									
Stacking									
Sanding									
Stacking									
Colouring									
Drying									
Stacking									
Assembling									
Finishing									
Drying									
Stacking									
Assembling									
Packing									

NOTE _____

SIGNATURE

QUESTIONNAIRE

Report given by Mr. _____ data _____

Client _____ Address _____

PRODUCTS TO BE COATED

0 Wardrobes	0 Ext. casings	0 Radio TV furniture	0 Tables
0 Bedrooms	0 Int. casings	0 Panels to be coated	0 Turnings
0 Chests	0 Entrances	0 Precoated panels	0 _____
0 Frames	0 Marbles	0 Halls, living-rms.	0 _____
0 Kitchens	0 Chairs	0 Mus. instruments	0 _____

The products are 0 modular type 0 Office 0 _____
0 individual type 0 Standard 0 _____

PARTS OF MANUFACTURES TO VARNISH

0 Internals 0 Edges
0 Externals 0 Rears

TYPES OF COATING MATERIAL

0 Pigmented
0 Transparent

DIMENSIONS OF PRODUCTS

Thickness _____ Width _____
Length _____ Depth _____
Height _____

SUBSTRATE USED

0 Plywood 0 Honeycomb core /lam/plast.
0 Chipboard 0 Hardwood (Solid)
0 Plywd/lam.plast. 0 Fibre
0 Blockboard

TYPE OF SURFACE TO BE COATED

0 Rough 0 Assembled
0 Fibre 0 Verneered
0 Paper 0 Coated

FILLING

0 Open pore 0 semi-open pore
0 Closed pore 0 semi-closed pore

Supplying firm _____

Gloss

0 Strongly opaque 0 Semi-bright
0 Opaque 0 Semi-sparkling
0 Semi-opaque 0 Sparkling
0 Calendered
As our product _____

PARTICULAR NEEDS

The cycle must respond to some chapter 0 Yes 0 No

In case of affirmative attach copy of chapter

GRAIN PRINTING

0 Embassing 0 Transparent
0 Printing 0 Covering
0 Semi-covering

NOTES

_____

_____

_____

4. Lacquer Coating Equipment

4.1. Introduction

The choice of equipment necessary for lacquer coating is not simple; it does not, in fact, depend solely on the strictly technical aspects of the problem but on countless factors amongst which are, for instance:

- the available capital for investment;
- the expertise of available labour;
- the quality and quantity of production which is aimed at;
- the available area for the plants to be installed;
- the type of support or supports from which a departure would be effected.

It is sufficiently clear how difficult it would be to indicate solutions without examining the particular and concrete cases. It would suffice therefore to carry out a general review of the equipments used in the sector of industrial furniture coating and to try to provide those indications necessary for at least a start and a discussion of the question relating to the choice of installations.

It must be stressed that the choice of any plant cannot be effected if not through serious comparison and co-operation between the purchaser, the supplier of the plant and the supplier of the coating products. The more complex is the coating procedure, the more indispensable is the close co-operation between the interested parties. To proceed in a different direction would lead to disastrous results both in quality as well as in the quantity of production.

Another point worthy of consideration is that of the speed of production. It is effectively possible to have very rapid coating cycles but it must be clearly stated that, with such cycles, it is not always possible to solve all the problems. Generally speaking, the faster the coating, the more precise and accurate the preparation should be, the conditioning of the substrate and the care of which coating should be followed in its single phases: one hour's drying less for a product dried in 8 - 12 hours may be non-critical; thirty seconds less of drying in a drying cycle of 10 - 12 minutes could lead to disastrous results. Similarly, the fixing of the quantity applied at 120 - 140 g/m² instead

of at 100 - 120 g/m2 could be indifferent if the drying is carried out at room temperature for at least 8 - 12 hours. The entire matter would be different if the drying process were conducted with forced air at 25 to 50°C. in times lesser than the hour.

Having placed these indispensable premises, the equipment may then be described in two divisions: in equipment for application and in equipment for drying.

4.2. Selection of coating equipment

4.2.1 Manual coating operations

The manual methods of application of coating products survive only for works of a strictly handicraft nature (restoration and imitation of antique furniture, small restoration works) and for the maintenance of wood work out-of-door (casings, windows, sashes, etc.).

They are normally marked by a negligible cost of investment (the equipment is simple and at low cost) but by a considerable cost of labour and a very low speed of application.

The manual systems used are: the French-polish application, by extrusion and by brush.

4.2.11 French-polish application

is used only in very special cases (restoration). The means by which it is applied are constituted by a mass of cotton or woollen threads wrapped around by an external cloth of linen or cotton. In actual fact, nitrocellulose products are used for this type of application.

The application requires a notable manual skill and is carried out by tingeing, in a correct measure, the lower part of the padding in the varnish and passing it on the support, which is already treated with a suitable filler, with longitudinal movements. The first movement serves to transport the desired quantity of varnish on the support. The same may be obtained by passing the surface time and time again with the French-polish wad in figure of -8 movements.

4.2.12 Application by extrusion

is used for coating products such as billiard-cues, rods, pencils, etc., therefore with a constant and regular section.

Normally, the extrusion is made up of a tank fitted with shaped apertures, in special rubber, which allow the product to be coated while passing the infeed and outfeed opening. The products used are normally high vicous, nitrocellulose lacquers.

4.2.13 Application by brush

This is still highly used especially for coating installed wood (window frames, roll-shutters etc.). Although very simple to carry out, the application by brush does not permit a perfect application: the stretching of the products is always limited; it is easy to have a run-off from vertical surfaces. It is used, through lack of anything better, where the functional aspect of the coat (resistance to outside factors, protection against humidity and so forth) prevails over the aesthetic needs.

4.2.2 Spray coating application

The application is carried out by directing a spray gun on to the object to be coated.

The method with which the lacquer product is atomized, distinguishes the various spray-application systems. We have:

4.2.21 The standard spray lacquers, which, as a means of atomizing uses compressed filtered, de-humidified air and void of oil. The product passes the spray-nozzle intimately mixed with air whose pressure could vary from 2 6o 6 atm according to the products applied.

The consumption of air could be, for each spray-gun, of 3 ÷ 20 m3/h according to the largeness of the spray-gun used.

The types of spray-guns used are normally distinguished on the basis of the type of feed of the lacquer: a) by gravity, by means of a small material container placed above and rigidly linked to the spray-gun.

This type of spray-gun is economical, light, easily cleaned and is commonly used for small-medium duty works where products must be changed frequently.

b) by suction of the coating product from a material container placed below the spray-gun's head and rigidly connect to it. The flow of compressed air through the spray-gun forms a depression which conveys the coating material to the nozzle.

+ The good spray-guns are usually equipped with an adjuster for the quantity of air and product and with an adjusting system which regulates the abundance of jetted atomized coating material.

Any type of product, catalyzed (polyester, polyurethane, acid catalyzed) as well as non-catalyzed (synthetics, nitrocellulose), can be sprayed.

The results which may be obtained (and which could be excellent) depend largely on the good regulation of the spray-gun (a perfect atomization requires an optimal combination between pressure, the quantity of air and the quantity of product), on the use of the product according to the instructions provided by its supplier, (pressure of air, diameter of nozzle, thinner and viscosity of the product), on the correct application (distance of the spray¡gun from the object to be coated, speed and manner of application and from environmental conditions: temperature, ventilation and absence of dust).

4.2.22 Application of airless spray

In this case the vaporization of the varnish product is obtained by means of a pressure conferred to the product itself by the compressed air or directly, through a tank (under pressure spray) or indirectly, by means of a piston-pump.

In the first case, compressed air moves a pistoned pump which gives the varnish product in which it is immersed, the necessary pressure for vaporization.

With the use of such systems, one could apply greater quantities of varnish products per hand compared to the application by normal spraying.

4.2.23 Spray exhaust systems

Every system of application by spraying must be used in premises equipped with mechanical ventilation both for hygienic as well as for safety reasons (reduction of the concentrations of solvents below M.A.C. (Maximum Admissable Concentration) and elimination of the possibility of forming explosive air - solvent mixes) as well as to guarantee environmental conditions for a perfect outcome of application work (absence of dust).

Therefore, spray-booths are used and these can be:

4.2.23.1 Dry Filter system:

which go from the simple winged wall ventilation, extracting gases, vapours and smoke generated by the application to systems fitted with filters which retain the grater part of solid particles.

4.2.23.2 Curtain System:

which by using one or more water curtains and dry filters manage to absorb most of the gas, vapours and solid particles generated by the spray application. The water wash spray booths are nowadays eliminating the dry filter systems.

The problem which remains unsolved is that of the elimination of the spray-cans of varnish products, aerosol which they can neither manage to eliminate nor demolish. It is advisable, however, that operators use face masks.

4.2.24 Automatic Spray Systems

The systems of spray application with or without air are also capable of being automated. Three types of equipment are to be found on the market for linking to the continuous operated lines for lacquer coating.
They are distinguishabe in:

4.2.241 Equipment with fixed spray guns:

The pieces for varnishing or colouring, moved along a conveyor belt, are made to pass under 2-3 adjustable spray-guns so that the piece will be completely treated. The opening and closing of the spray-guns are controlled by servo mechanisms. Lying below the conveyor belt and

precisely below the spray-guns is a collection basin for the sprayed varnish which is not absorbed by the passing piece.

This system is highly popular for colouring and for the varnishing of frames and baseboards.

4.2.242 Equipment with oscillating spray guns

The pieces which are to be varnished pass along a conveyor belt right below the spray-gun. which has adjustable, alternative movement (obtained normally by means of hydraulic or mechanical gadgets) and perpendicular in respect to the movement of the piece. Also in this case, there are servo mechanisms which regulate the opening and closing of the spray-gun in relation to the movement and dimension of the piece. Again, there is always the usual collection basin at the foot of the equipment to receive the unused varnish from the passing piece.

This system is particularly used in the automatic varnishing of mirrored panels, friezes, handles, frames, etc.

4.2.243 Equipment with rotating spray guns (trunning type fixture) are substantially constituted by a vertical shaft which causes a series of arms (6 to 12) to rotate and at the extremities of which, a similar number of pistlos are attached. These spray-guns move perpendicularly to the conveyor belt, usually of a rolling shutter type, upon which the objects to be varnished pass. Suitable servo mechanisms synchronize the aperture and closure of the spray-guns in relation to the field within which the varnishing takes place.

These equipments are largely used for the colouring of wood.

4.2.25 Eleotrostatic spraying application

The vaporized particles are projected on the object to be varnished through the use of an electrostatic field of force. This enables the wasting of varnish to be cut down to a bare minimum and a good ooating of the supports.

Every electrostatic system is therefore oharacterized by the use of a high-tension generator (40 ÷ 90 KV for the portable equipments up to 150 KV for the automatic and fixed equiipments). The electrostatic systems are distinguishable in relation to the system used to varporize the varnish products:

4.2.251 Electrostatic atomization

could be used only with little conductable liquids (approximately $12^9 \Omega$ cm). They have a high-level yield but are critical as far as the cavities which eventually are visible on the piece to be varnished are concerned.

4.2.252 Combined centrifugal force electrostatic atomization.

The use of a disc or of a rotating cup on which the varnish product flows, allows an easier atomization by means of the electrostatic field of the product itself. This facilitates the use of the products which have a reduced resistance ($10^8 \Omega$ cm).

4.2.253 Electrostatic atomization with compressed air

The coating product is atomized by the use of compressed air and special spray-guns which activate the movement of turbulent and not very fast particles. In such a case, the electrostatic field succeeds in leading the particles to the piece to be coated. The coating material should have a resistance of about $10^7 \Omega$ cm.

This method is used very much for systems of manual application.

4.2.254 Electrostatic atomization without air

The atomization is obtained by the simultaneous use of pressure and the electrostatic energy. The latter leads the particles to the product to be coated. The resistance, however, drops down to the levels of approx. 10^6 cm.

For electrostatic lacquer coating, it is necessary to control the humidity, both conditioning it to suitable environment (constant temperature, fixed humidity) as well as using products which, normally dip coated, regulate the conductibility of the wood itself.

With the electrostatic systems, it is possible to apply practically every type of coating product. Normally, the electrostatic systems are adopted for the coating of spauced or round items such as furniture legs, of chairs, of radio - TV furnitures, rifle-butts, billiard-cues, etc.

4.2.3 Flood coating systems

4.2.31 Dip coating

This type of application is especially used with objects having a small section, difficult to handle (chair-legs, curtain rods, brush handles) or objects when it is essential to guarantee the penetration with preservatives or protective solvents of the wood itself (window frames). The ideal shape to obtain a positive result by dipping is cylindrical with a conical or spherical crossection.

Generally, it is sufficient that the object to be coated would not have holes or shapes as a result of which the product would not flow or run well, during and after dipping, so as not to leave surplus material causing coating runs.

In the case of coating small series, it is customary also to eliminate the coating runs by using a sponge or by upturning the coated product.

For better results, it is important to use a mechanical operated system for dipping as well as for drip wip of.

Dipping should normally be slow to enable the air, which is always present in the wood itself and in the cavities of the manufactured product, to go out completely.

The dipping speed has to be tuned to the viscosity of the coating material used; the higher the viscosity the lower the outfeed speed.

Normally the out feed speed varies from 1 to 6 ÷ 7 cm/minute. In order to have a better lacquer flow it would be preferable that all surfaces be extracted from the basin with a more acute angle possible with respect to the vertical direction.

Dipping could also be done manually by using products having a very low viscosity. However, results are average, therefore it is suitable for pre-treatment or for the application of the prime coats on every day used.

The equipment needed for dip coating includes:

- the vat which, in relation to the dimensions and shape of the pieces to be dip coated should be, preferably, narrow and deep (to avoid an excessive evaporation of the thinner and an accelerated oxydization of the wood) with a V-shaped bottom.

Besides, the vat should be fitted with an agitation system prevent, as in the case of pigmented products, an excessive sedimentation of the pigment and a filter system to eliminate the solids (e.g. sawdust conveyed by the pieces to be coated) or the coated surface.

The agitation and filtering are normally obtained by the use of a pump which recycles the content of the vat through adequate filters. Completing the requirements of the vat are an overflow wall, a drip-drainer, and a cover. The overflow wall eliminates floating material (air bubbles, sawdust, etc.); the drip-drainer returns excess lacquers dripped off the pieces; the cover is for use during non-working hours to avoid fire risks.

4.2.32 Flow-coating

is a method which is little used for coating wood. Often, it is carried out by means of a pump and a series of tubes which literally pouring the coating material to the product. A drain vat collects the unused coating material.

Obtaining a good result depends on the form and dimensions of the object to be coated, on the direction of the tubes, the flow of the product and the speed with which the pieces pass through the pouring zone.

4.2.33 Curtain coating

The introduction of a curtain coating which occurred about twenty years ago, caused a revolution in the coating furniture, facilitating the finishing of the different parts ofr the furniture before the final assembling of the parts.

Every type of product may be curtain coated. The two-head machine also allows the use of products, such as polyesters.

The only limitation given by the curtain coater is that of the shape and curve of the pieces; curved pieces, with acute angles such as rods with a round, square or rectangular section cannot be coated.

The major organ of the curtain coater is made up of a long pouring head, rectangular in shape and with a bottom which opens in the form of a V. The opening of the bottom can be adjusted with the accuracy of a minimum of 0.5 mm up to some millimetre. Flowing material forms a curtain of lacquer collected in a trough recycled to the pump's feed tank. The pump feeds the material through a filter, to the pouring head.

The objects to be coated passing along the conveyor belt and through the curtain thus receiving a batched quantity of the coating material. The quantity of the product is regulated by means of the speed of the conveyor belt (the faster the belt speed the less material is applied) by the width of the head slot (the more it is opened, the more material is applied). The pump's rate of flow can also be regulated by the use of a speed variator. It should be as low as possible to avoid foam and tuned to the head's slot opening.

The two-head machines are used for the application of polyesters. Generally, polyester containing the catalizer (peroxide) is poured by the first head whilst the polyester containing the accellerator goes into the second head. Therefore, the catalized and fast-forming polyesters are applied on the product to be coated. The normal hardening process of the coat follows.

The coated film obtained through the use of the curtain coater is far better than those obtained by other systems. In fact, they are outstanding for their spreading, uniformity of thicknesses and satin finish.

The quantity applied may vary from a minimum of 60 g/m2, normally 80/90/g/m2, to a maximum of 600/700 g/m2, per hand. The conveyor belt's speed can be altered from 20 to 150 m/minute; the pump's rate of flow from 5 to 25 litres per minute. The width of the objects to be coated should be normally less than 1200-1300 mm; it may reach 2300 ÷ 2500 mm by using specially constructed machinery.

Rise and fall adjustment permits the use of products of different thickness, normally up to 150 + 200 mm, to be coated without any difficulty.

4.2.4 Roller coating systems

4.2.41 Direct roll coating

The direct roll coater applies the coating materials with the feed direction. There are three rolls in the most roll coaters: the doctor roll, in chromed steel, smooth or engraved; by varying the position to the spreading roll, the quantity of the coating material is thereby regulated; the spreading roll which is made up of a rubber-coated steel drum spreading the material to the product to be coated; the nip-roll, a rubber-coated steel drum which guides both the piece in conformity with the spreader roll as well as the control of the pressure.

The hardness and the type of rubber used to coat the drums of the roll coater are of extreme importance. Normally, the hardness (measured by Shore A hardometer) should vary according to the type of coating material applied: it ranges from a Shore 30 hardness for colouring materials to Shore 60 for primer polyester materials for UV (ultra-violet) drying. The higher the viscosity of the material, the harder the rubber cover. The type of rubber should be adjusted to the coating material. Indeed, elastomers of a neoprene type may be used since they are resistant to all thinners used in coating wooden products, but the high cost of such rolls, and the rapid wear and tear discouraged the use at an industrial level. The problem may be solved by asking the lacquer producer to indicate the thinners existing in the product used and informing the machine or rubber producer.

From 60/80/g/m2 could be applied with the rollcoater and this amount is in relation to the viscosity of the product, to the pressure exerted by the doctor roll on to the spreader roll, and to the speed of the product to be coated (the higher the speed the greater the quantity applied).

The problems of roll-coating are connected with the grade of the substrate flatness, for which reason, as an example, if the panels to be coated are not perfectly gauged, there could be areas in which there would be an excessive quantity applied and others where there is none at all. For the same reason, there could be some difficulty in applying materials on plywood and laminated plastic panelled products. It is also difficult to obtain a good flow of the materials applied, especially if work is carried out with a high viscosity and with flash periods of less than 2-3 minutes. Because of these difficulties, the roll coater is more substantially used for the application of prime coats and of colours.

4.2.42 Reverse roll coating

The coating machine is similar to the direct roll coater; it is fitted with an extra two rolls, the wiping roll and its counter-roll. The purpose of the wiping roll which turns against feed direction of the panel and is welted by a suitable thinner, is that of smoothing and wiping perfectly the applied material.

The reverse roll coater or reverse roll filler have gained some success in the application of drying polyesters with ultra-violet rays on very absorbing rough surfaces (e.g. panels of rough particles) in order to prepare the base coat for the following application of prime coats and finishes, eventually preceded by the application of a painted base showing the wood's grain.

The quantity of the material to be applied with a coating machine varies from 10 to 200 g/m2. The maximum quantity of UV-drying products is from 100 to 120 g/m2: larger quantities prevent a perfect drying in depth with a subsequent lack of adherence to the substrate.

The working width is generally 1300 mm and the maximum thickness of the products to be coated is of 200 mm.

The feed speed can vary from 2 to 20 m/minute. Generally, the length of the work pieces cannot be less than 200/300 mm.

4.2.5 Gravity tumble polishing

is a perfectly suited system of application of lacquers on objects which are either very small or in large quantities.

The equipment consists is a cylindrical (or rarely octagonal) drum which is made to rotate horizontally at a number of revolutions varying from 20 to 50 per minute. Holes are situated in the drum's body and cover to enable the solvent to evaporate. The operation is carried out by loading a quantity of workpieces to be coated to fill 50 to 80 per cent of the drum's total volume, together with a certain amount of coating material. The necessary amount is calculated after several tests have been carried out. The drum then rotates about 30 to 60 minutes and then the work pieces are removed in a dry state. The viscosity of the materials used (usually nitrocellulose products) is about 60 + 70 on Ford Cup (CF) 4 mm at 20°C. The quantity of coating material is about 600 - 150 g/m2 of surface to be coated.

4.2.6 Centrifugal polishing

A metal network basket contains the pieces to be varnished (the process is, similar to the preceding one, for very small pieces) and is dipped in a coating product, usually nitrocellulose, with low viscosity and extracted mechanically.

The basket is then inserted in a centrifuge which removes the cess lacquer by high speed rotation and simultaneous drying the coating material.

4.2.7 Grain printing

The machine for grain printing is similar of the type of an offset machine.

A steel drum on which the grain is reproduced by photographic process, rotates in a basin to pick up ink. A scraping knife removes the excess ink leaving the correct amount on the drums' etched grooves.

Another steel rubber-coated drum removes the ink from the etched grooves and transfers it to the panel beneath which is conveyed a series of small rolls.

The grain printing on wood is done on two types of substrates:

a) on a low-cost substrate such as particled boards or chipboard. In such a case, one or two coatings of polyester filler are applied on to the panels by means of a filling machine. The filler is cured by means of UV rays. After sanding, the base is set with one or two coatings of prime material and, after drying, the printing of wood grain follows normally with a double printing device. (Two printing devices are used in order to provide by film thicknesses and intensity of grains a good shading in the sense of depth).

Later, the cycles continue with an ordinary lacquer coating process.

b) on a substrate veneered with a low-cost specie. The only difference which exists with regards to the preceding cycle is the use of complete or semi-transparent printing (generally one pass): this is done to leave a certain transparency of the so-called "natural" aspect of the veneering surface. The results obtained with this procedure are excellent.

The rpinting machine is, however, a machine which demands permanent maintenance by a specialized crew for correct operation and for good results. This explains why the printing process is more and more replaced by other developments.

4.2.8 Equipment for drying of lacquer coats

4.2.81 Open-air-drying

The coating material could be dried by simply exposing them to the air.

The equipment includes an appropriate covered area and a system of air-conditioning for drying. A ventilation plant is necessary for both hygienic reasons as well as for safety. The rate of air flow should be such as to be maintained everywhere below the M.C.A. (Maximum Concentration Admissable) limit and that of the solvents' explosive potential.

We stress the importance of the uniformity of the ventilation for drying purposes; the differences of air-speed at different spots causing different drying speeds generating blooming or blushing effects.

The problem of film uniformity, the necessary work flow adequate to M.C.A. values, the sufficient space and appropriate work conditions will eliminate this type of drying which will be applied for individual production but not for batch production.

4.2.82 Hot air drying

This drying process is mostly applied and because of its simplicity. In fact, any type of coating material may be dried with appropriate equipment.

4.2.821 Merry go round trolley system

This equipment has been developed to speed drying of lacquer coats. The rock trolleys which carry the coated products are moved by an endless chain linked by a power and free system passing the drying zone where most of the solvents evaporate in the two-fold reaction of heating and ventilation.

Operation times for this drying process are:

	Satin finish material/hours
polyurethane vp	2 - 3
polyester vp	0.5 - 1
urea acid cat. vp	2 - 3
nitrocellulose vp	0.5 - 1.5

The merry go round drying tunnel is suitable for any type of manufactured items: panels, frames, assembled furniture, chairs, One charge covers up to 1500/2000 m2 per day.

4.2.822 Convey or system

The tunnel-type drier with roller or belt conveyors has different drying zones. Normally, this type of drying system is divided into three sections: the flash off zone, the drying zone and the cooling zone.

The temperature and the airspeed in all three sections vary in relation to the coating material. Generally, the temperature varies in conformity with the feed speed of the panels to be coated from 20° to 50/70°C.

The drying capacity varies between 2000 and 3000 m2 per day in relation to the shape and dimension of the pieces to be coated.

The conveyor type driers are preferably used for drying panel products.

4.2.823 Multi-deck systems

Multi-deck drying tunnels are similar to those mentioned above under item 4.2.822. The conveyor belts are arranged in multidecks (up to 10) which are usually loaded by tipple loader. The efficiency is not like that of the merry go round system. However, difficulties have arisen with this type of drier because of uniformity of the ventilation and therefore in the temperatures from deck to deck.

These driers have a capacity of 2000 m2 per day of panel like products like doors, etc. The greatest advantage of this type of drier is its relatively small dimension.

4.2.824 Vertical merry go round system

These driers are equipped with trays which are linked to a vertical merry go round system. The completely automatic loading and unloading is maintained by synchronized conveyor belts which are regulated by servo controls to the movement of the trays. The latter has a dimension of about 3 ÷ 5 m x 1.3 ÷ 1.5 m and are made to pass in sequence the flash off zone, drying zones (1 - 2 or more zones), and cooling zone. The number of trays in a furnace can vary from 40 - 50 to 100-140 in relation to the drying teims and of the production requested.

The daily drying output of one similar furnace is around 2000-2200 m2.

The drying time, with satin finish, could be:

	hours
polyurethane vp	0.5 - 1
polyester vp	0.3 - 0.8
urea acid cat. vp	0.5 - 1
nitrocellulose vp	0.3 - 0.5

The vertical tower drier is considered suitable for drying of panel like parts and of squared stock viz: frames, rods for curtains, etc.

4.2.825 Infra-red drying

The drying process by means of infra-red could be carried out by using various sources; substantially, there are three types of sources, characterized by a maximum amount of radiation in three different zones: shortwave, varying from 0.8 to 2m; medium wave varying from 2 to 3.5 m, and long wave varying from 3.5 to 12 m.

There have been discussions about the use of one type of source or the other. Indeed it is possible to maintain a good drying process with all types of IR. For safety reasons, the short/medium-wave radiators are mostly applied.

In Italy, infra-red drying did not show any advantages but are in use for pre-heating of panels or in cases in which a short and rapid drying is required (colour-drying).

The equipment is generally formed by a conveyor belt upon which an infra-red ray drier is installed.

It should be pointed out that infra-red ray drying should be well ventilated because the infra-red rays provide heat only required for the evaporation of the solvents. The varpours have to be removed by an exhaust system.

Insufficient ventilation causes vapour clouds preventing evaporation of further solvent from the coated film. In such a case the drying process delays and the superficial effect of the film could turn out to be imperfect.

4.2.826 Ultra-violet drying

Ultra-violet systems are actually and preferably used to apply the prime coats with the decelerator or roll coats on abosorbent substrates such as particle boards, fibre boards or for coating of the interiors surfaces starting with a prime coat of UV material, generally applied by roll coaters and finishing the work with traditional material.

UV-systems lost their importance in coated film drying because of lack of flexibility insofar as the applicable products are concerned; it is impossible and at least more difficult to dry pigmented lacquer finishes.

Ventilation is also important with UV plants both for avoiding explosive mixtures of air and styrol as well as in certain cases to enable the parafin of the polyesters to come to the surface.

UV drying systems are available in different versions:

4.2.8261 Systems with low-pressure light.

These have been widely used for drying of UV polyester materials applied with a coating film of 250 + 280 g/m2. Drying times vary from 3-5 minutes.

UV plants are usually equipped with conveyor belts and overhead UV lamps. They are in shape of common fluroescent lights.

It is important that the distance between the light and the coated surface to be dried does not exceed 5/8 cm and that the distance between the lamps does not exceed 5 cm so that sufficient readiation is guaranteed for rapid curing.

The first drying tunnels applied, cause cracks in the coated film. These cracks usually occurred along the panel edges. This defect has been avoided through the use of lights larger than the conveyor belt to guarantee a homogeneous radiation over the entire surface. Such a tunnel could have 12 to 20 lights per meter.

4.2.8262 Systems with high pressure light.

These plants, considerably compact, have been used especially for drying of UV decelerators applied by roller coaters. The application of other types is faced with the problem of the formation of small bubbles due to oeverheating of the radiated surface.

The drying times are very short and can vary from 10 to 30 seconds. A typical tunnel contains a dozen lights with a capacity of 25 KW.

In order to obtain a uniform and sufficiently intensive radiation, the lamps have to be placed at distances of about 7 - 12 cm on top of the work piece and the distance between the lights should not exceed 25 cm.

The tunnels are generally fitted with a well operating ventilation which is particularly necessary for safety reasons. Normally, there are three areas in these plants: flash off zone, a radiation and a cooling zone with heavy duty ventilation.

4.2.8263 Systems with low-power and high pressure light.

When drying UV polyester materials, best results were maintained for gelling and pre-hardening under low pressure and final hardening under high pressure lights.

Such plants turned out to be less cumbersome than the plants of only low pressure; the total drying time decreased to about 2 minutes.

4.2.8264 Systems with high power light.

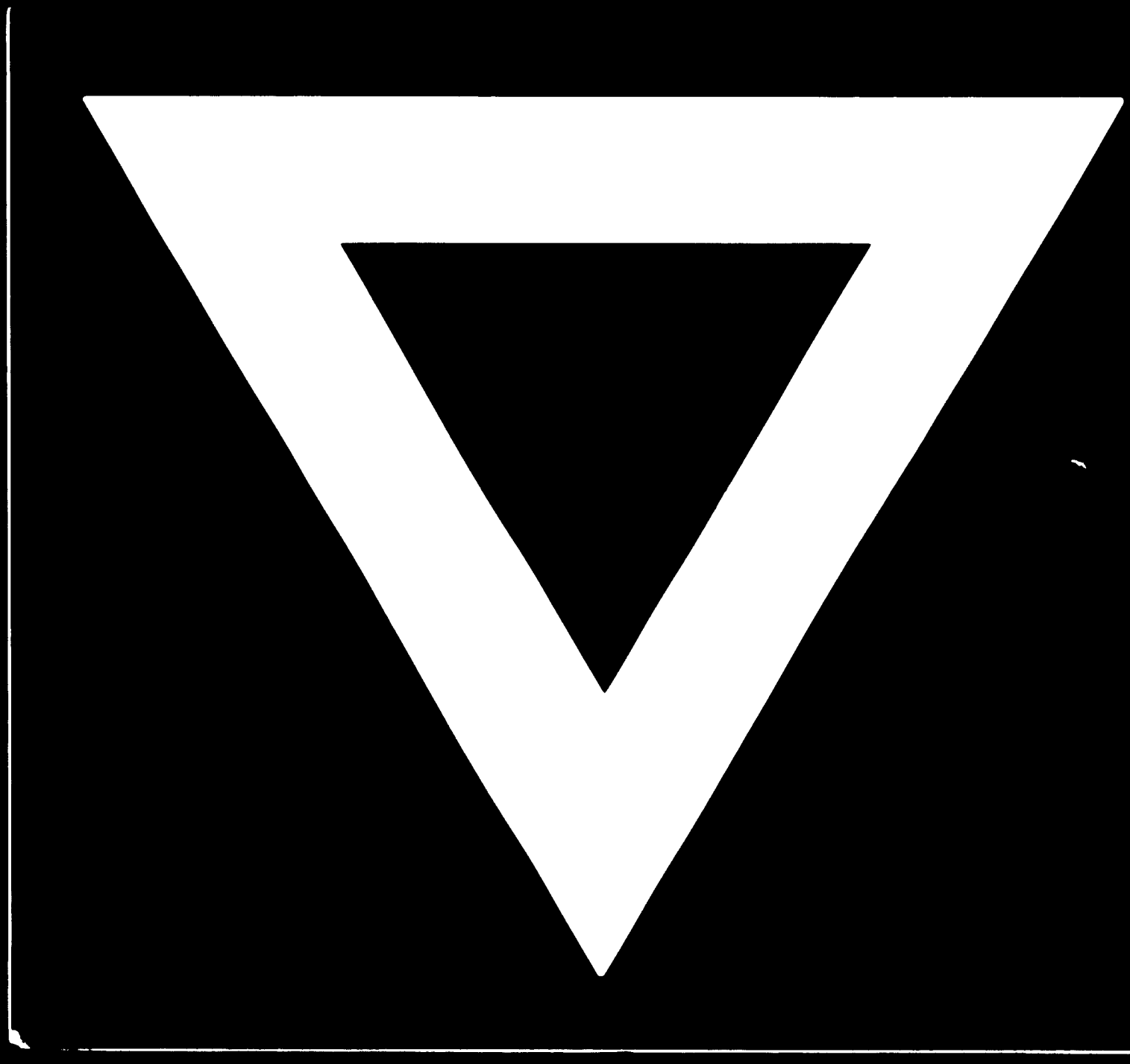
The high power lights are latest developments in this field. The lights have a capacity of about 80/100 watt/cm, compared with apprximate 30/40 watt/cm of the high pressure lights.

This fact permits further reduction of the curing times which become a few seconds (from 3 to 10 seconds). Besides this advantage, thanks to the particular construction of the lights of its feed system and the genius development to reduce the maximum temperature of the radiated surface panels it turned out best results.

This fact has permitted the use of the high-power plants not only for the uses described earlier for the high pressure lights but to extend the use for drying prime and finishing products with good results.

An efficient plant is equipped with 2 to 3 lights in relation to the speed of the conveyor in relation to the type of material to be dried. The feed speed is calculated at an average of 3/4 m/minute and per light. The plants with high power supply generally do not need a cooling zone.

G-664



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