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QUALITY CONTROL IN THE FURNITURE INDUSTRY[1]

by

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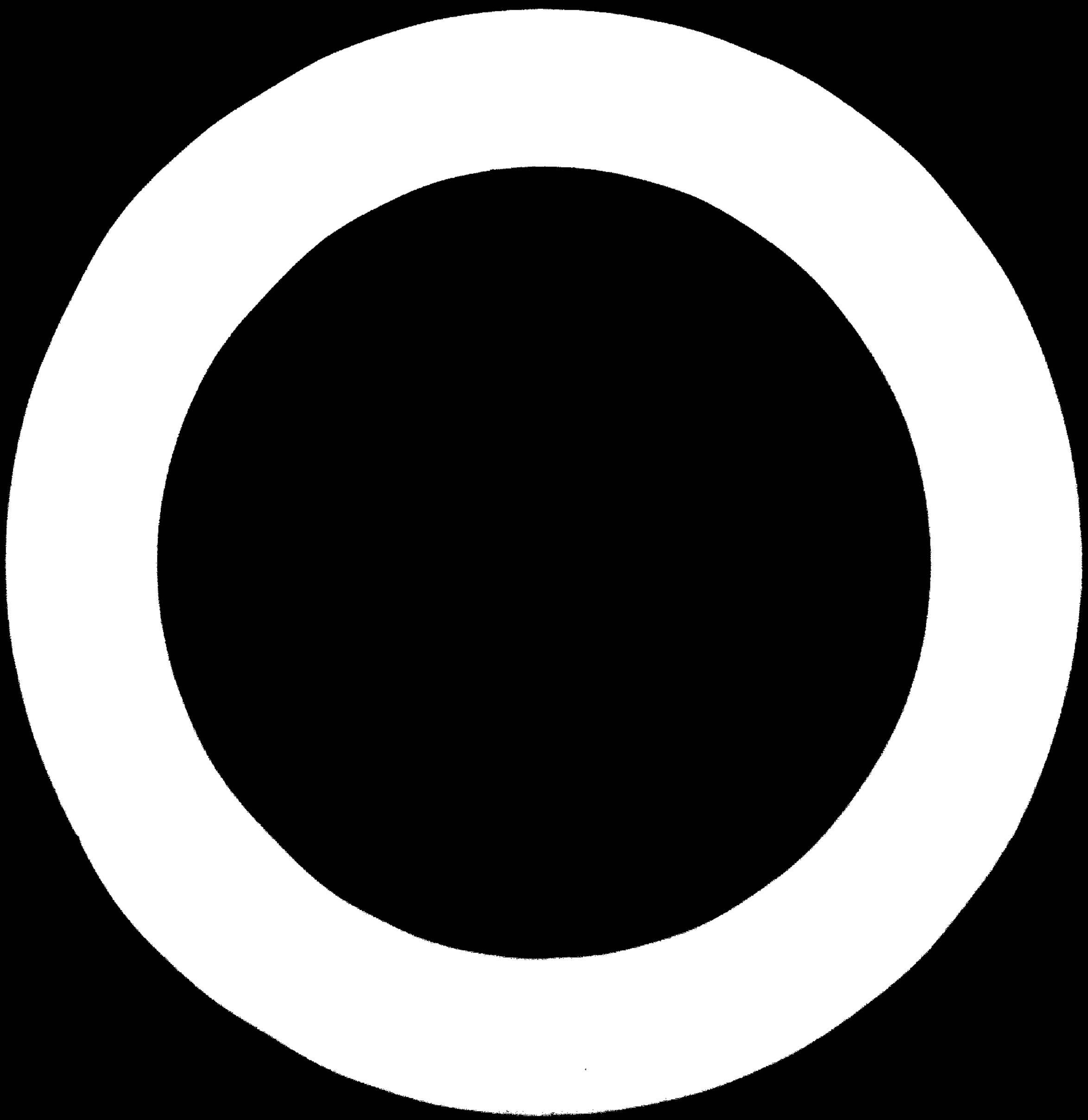


INTRODUCTION

A product's ability to compete on the market is very greatly dependent on its quality. For this reason expressions like "high quality product", "export quality" etc. are widely used in the advertising of industrial products. From the user's point of view the quality determines the usefulness or use value of a product.

Manufacture of products being absolutely similar i.e. having constant quality is impossible. Certain variations of quality are natural and cannot be avoided. The highest quality with least variations can be attained in individual production in which each part or component can be finished and fitted separately so that the desired quality standard is finally obtained.

Although, as mentioned before, certain quality variations cannot be avoided they can be kept under control. This fact is the basis of quality control in mass-production or serial manufacture. The limits within which the quality of a product, its parts or materials may vary are first defined and then these limits are maintained by applying systematic quality control. The quality may not be too low nor too high. In both cases the product's ability to compete on the market is decreased. If the quality standard of a product is set higher than normally required of products of its category the production costs will get too high to be able to market it at a competitive price.

Compared to many other branches of industry there are very many sources of quality variation in the wooden furniture industry. Typical variables are e.g. the following:

Properties and condition of lumber

Moisture content, number and size of knots and other faults, specific gravity, strength properties etc.

Properties and condition of other raw materials and semi-manufactures

Veneer, wood-based panels, plastic parts, fittings etc.

Dimensional accuracy of machined components

Thickness, width, length, joints, forms etc.

Dimensional accuracy of assembled products

External and internal measures, clearances between moving parts etc.

Quality of surface finishing

Evenness of surface, colour shade, gloss of lacquered surface etc.

Durability of finished products

The quality control includes numerous different systematically repeated measuring or other inspection actions. Despite the great number of variables the quality standard of products can be very greatly improved by the use of specially designed simple equipment. As many of these equipment can be "self-made" in the producing plant only minor capital investments are necessary.

QUALITY CONTROL OF MATERIALS

The starting point for the quality control is the inspection of materials to be processed or used. This can be done as follows:

1. When buying or ordering the material
2. When receiving the in-coming material
3. Before processing or use of the material

E.g. lumber is usually bought from outside saw-mills and should be checked already at the saw-mill's lumber yard or storage in connection of ordering the lot. The same principle applies also to veneers. Inspection of the ware upon receipt at the factory is usually necessary to make sure that the correct lot has been delivered. All semi-manufactures and other materials should be checked upon receipt. One of the most important control measures before processing is the checking of the moisture content of lumber, veneer and wood-based panels.

The usual objects of inspection for the principal materials are briefly dealt with in the following.

Lumber or solid wood

1. Kind of wood (species)
   - Sometimes difficult for tropical species
   - Test planing may be necessary
2. Quality of lumber
   - Number, size and distribution of knots
   - End splits
   - Rot and other faults
   - Colour shade and grain structure when appropriate
3. Dimensions of lumber
   - Thickness and its variations
   - Width and length of boards when appropriate
4. Average moisture content and moisture distribution within boards
   - Necessary information for seasoning (air-drying, kiln-drying)
   - Requires cutting of test samples, see chapter "Control of moisture content of solid wood"

Veneer

1. Kind of veneer (species)
2. Colour shade and grain structure
   - Checking should be carried out preferably in daylight or in light of strong incandescent lamps. Fluorescent lamps are not recommended because of their unsatisfactory spectral properties.
   - Uniform quality from batch to batch is of major importance particularly in production of element furniture
   - Checking can be carried out by comparing the veneer batch to a master sample which is stored in a dark place when not in use
   - Pyramid figure is normally allowed to some extent in parts in which the grain direction of veneer will be vertical, e.g. cabinet doors and end panels (Fig.1.).
   - Parts in which the grain direction will be horizontal require straight and narrow-striped veneer, e.g. table and cabinet tops, drawer fronts etc. (Fig.1.).

3. Thickness and its variations

- Micrometer is a suitable measuring instrument

4. Evenness of surface

- Surface shall be plane (not wavy) and smooth

5. Moisture content

- Handling of veneer necessitates at least 10 to 12% moisture content to avoid splitting. Veneer is too crisp in lower moisture content.
- Ideal moisture content at the moment of veneering with hot press is about 5% lower than moisture content of panel or solid wood
- In case veneer is too moist when glueing, surface checkings are to be expected after the panel has attained its final equilibrium moisture content

Wood-based panels

This group includes particle board, plywood, blockboard and fibreboard. The main objects of inspection are the following:

1. Surface quality

- Suitability to veneering or painting
- Carbamide or urea glue requires smooth surface which offers good contact

2. Thickness and its variations

- Standard thickness tolerance is normally about ± 0.3 mm but also rougher variations are not very uncommon
- Vernier caliper or micrometer is a suitable measuring instrument

3. Moisture content

- Moisture content at the moment of processing should be about the same as of solid wood = equilibrium moisture content in later conditions of use

Glues, lacquers and paints

Glues can be best checked by making glueing tests. The viscosity of lacquers and paints must be checked before use. This is usually done with a special standard cup e.g. Ford Cup No.4 (Fig.2.) having 100 cm^3 volume. The time in seconds the lacquer or paint needs to flow out through the bottom opening of the cup indicates the viscosity. The flowing time must meet the recommendations of the lacquer or paint manufacturer.

CONTROL OF MOISTURE CONTENT OF SOLID WOOD

Proper moisture content of solid wood to be processed is the primary pre[illegible] for high quality products. Wood as hygroscopic material has a tendency to reach a moisture balance with the surrounding atmosphere. This condition called the equilibrium moisture content depends on the relative humidity and temperature of the surrounding air. The relative humidity is decisive the effect of temperature being minor. The graph in fig. 3 gives the average equilibrium moisture content as function of the relative humidity and temperature of air. These values apply to all species of wood with sufficient accuracy for all practical purposes.

The shrinking and swelling of wood when exposed to variations in moisture are among the most unfavorable properties of wood. In addition to change of dimensions deformations develop in cross-section of pieces because shrinkage or swelling is considerably greater in tangential (T) than radial (R) direction (to growth rings). Typical shrinkage deformations in cross-sections are shown in fig.4. Table 1. gives the average dimensional change of wood in % for certain species when exposed to 1% change of moisture content.

> E.g. assuming that the actual moisture content of wood in a furniture factory would vary ± 1% during the manufacture, the width of a part made of oak, having nominal measure of 50 mm (T-direction), would vary ± 0.16 mm.

The ideal moisture content for wood when processed is the equilibrium moisture content of the later conditions of use. From this follows that the factory climate should have corresponding relative humidity and temperature. As the time normally needed to all production stages in serial manufacture of wooden furniture is several weeks or even months the parts are likely to reach the balance during the process. This fact is a typical and well-known problem in tropical conditions with high humidity particularly when manufacturing furniture for export to countries with less humid climate. E.g. in case the moisture requirement of the target market is 10% but the equilibrium moisture content in the factory atmosphere say 16% the wood should be machined, surface finished and plastic-

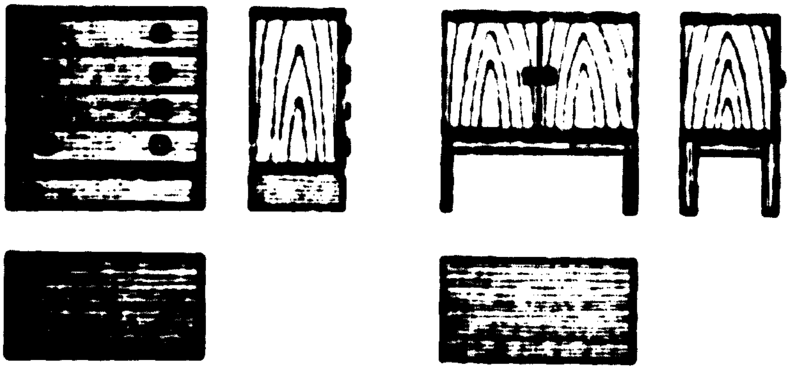
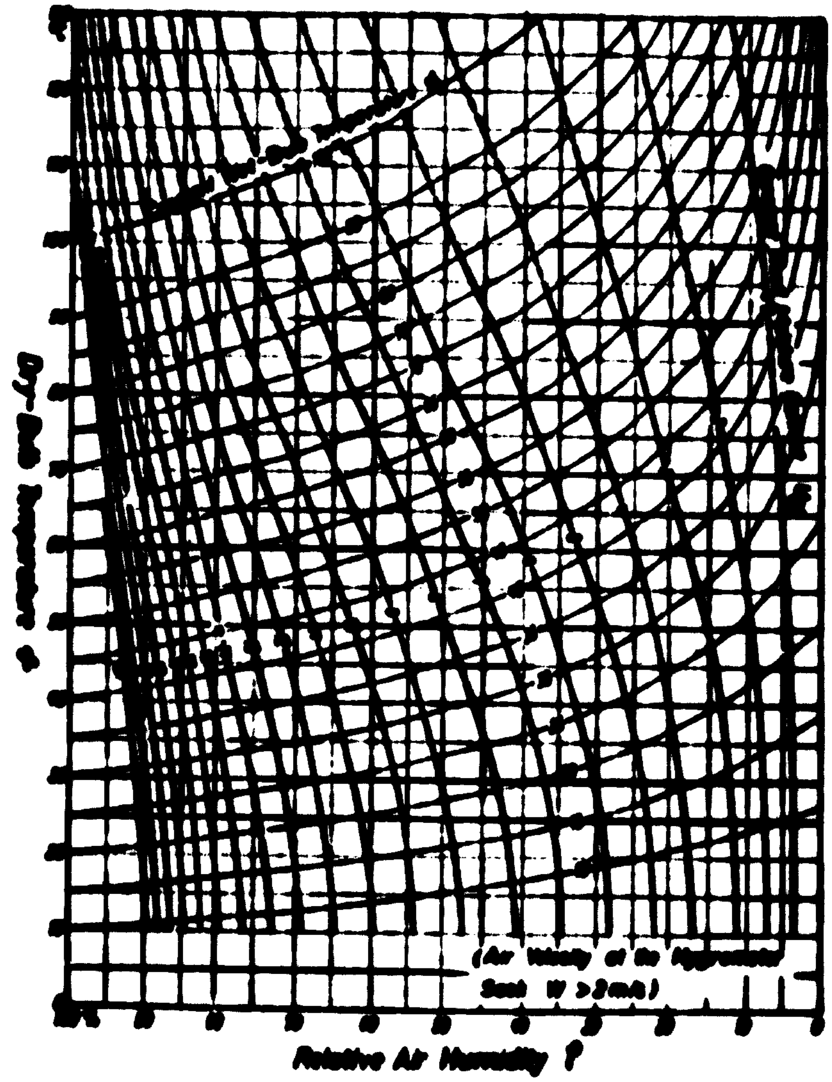


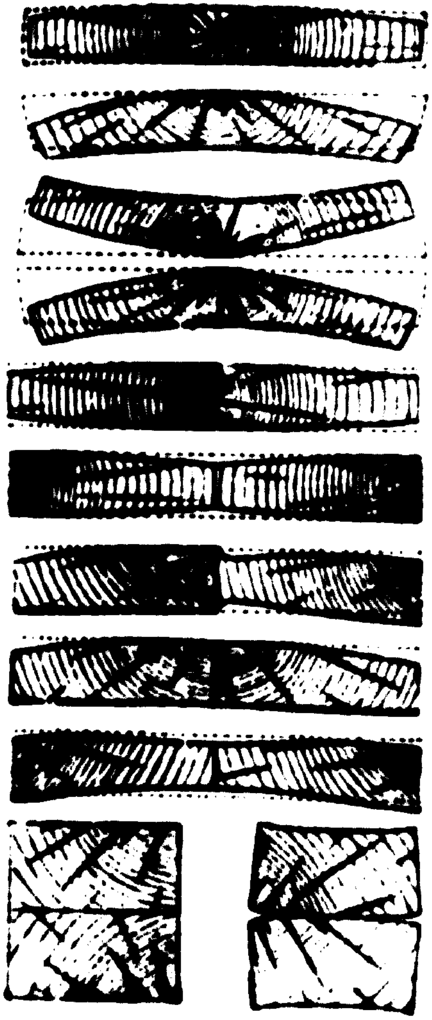
FIG.1. Veneering rules regarding grain pattern.

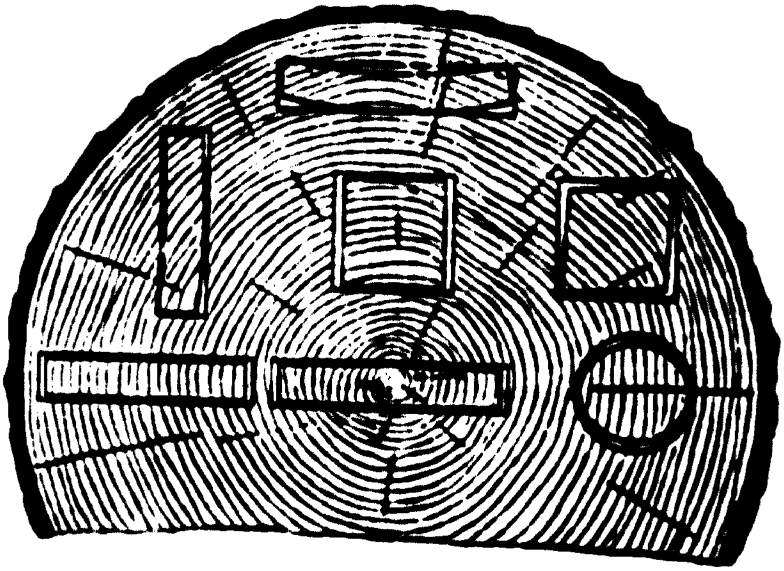
FIG.2. Viscosity measurement with Ford Cup.



Moisture content equilibrium of timber (according to R. Keylwerth and data from the U.S. Products Laboratory, Madison [illegible])
Example: With a dry-bulb temperature θ = [illegible]° C and a relative air humidity φ = [illegible] respectively a wet bulb temperature θ_f = [illegible]° C the wood equilibrium moisture content is u_{gl} = [illegible]

FIG.3. Graph for determination of equilibrium moisture content of wood as function of relative humidity and temperature of air.





—Characteristic shrinkage and distortion of flats, squares, and rounds as affected by the direction of the annual rings. Tangential shrinkage is about twice as great as radial.

FIG. 4. Shrinkage deformations in cross-sections

TABLE 1.

Shrinkage q (%) in tangential and radial direction with a decrease of wood moisture content by 1% for different wood species

Wood species	q_{tan}	q_{rad}	Wood species	q_{tan}	q_{rad}
Parana Pine	[illegible]	0.19	[illegible]	[illegible]	[illegible]
Fir	[illegible]	0.19	Limba	[illegible]	0.17
Hemlock	[illegible]	0.19	Lime	[illegible]	[illegible]
Pine	[illegible]	0.19	[illegible]	[illegible]	0.17
[illegible]	[illegible]	[illegible]	Mahogany	[illegible]	[illegible]
[illegible]	[illegible]	0.11	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.11	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	0.11	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Horse chestnut	[illegible]	[illegible]
[illegible] mahogany	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

wrapped air-tightly very fast after kiln-drying. An ideal but in practice very expensive solution to this problem would be to provide the entire factory space with airconditioning. The relative humidity of air in material stores and factory shops is best controlled with a hygrometer giving readings direct in %. The meter should be centrally located and fixed e.g. on a pillar.

Control of moisture content of wood should be done in the following stages:

1. Whenever possible when buying and ordering a lot of lumber from a saw-mill
2. When receiving the lot to the furniture factory
3. Before kiln-drying; lumber is usually then air-dried
4. During the kiln-drying process to check that the drying is progressing according to the schedule suitable to species and thickness in question
5. After kiln-drying to check the end moisture content
6. During the following machining and other manufacturing stages
7. For finished products before packaging

Moisture content determination

The moisture content of wood is determined usually either by the oven-dry method or electrical moisture meters. The oven-dry method as a rule is the most exact method, but it is slow and requires samples cut from material. Due to its accuracy this method is, however, used as standard method for moisture determination in kiln-drying. The samples should be cut from boards according to fig.5.

The sample is weighed and then placed in a laboratory oven heated to $103^{\circ}C \pm 2^{\circ}C$ and kept there until constant weight is reached. This indicates that all water has been removed from wood. The loss in weight gives the amount of moisture which was in the sample when cut. The moisture content is calculated from the simple formula:

$$\text{Moisture content} = \frac{\text{Initial or wet weight} - \text{Dry weight}}{\text{Dry weight}} \times 100\ \%$$

For weighing ordinary samples, balances having a capacity of about 200 g and a sensitivity to 0.1 g are useful.

Electrical moisture meters

The electrical moisture meters are less accurate but facilitate rapid moisture content determination for control purposes and are quite satisfactory in this regard. If meters are maintained and used carefully, and if the necessary corrections for species and temperature are applied, an accuracy of ± 1% may be expected in the range from 7 to 25% moisture content. Resistance-type meters (Fig.6.) using needle or blade electrodes about 10 mm long give an average moisture content of a board of 25 mm thick. For thicker material the moisture distribution should always be determined by driving two nail-electrodes to different depths, or the value obtained for nails driven to one-fifth the thickness should be regarded as representative for the average moisture content of wood.

The electrical moisture meters can also be used for moisture control of particle board and fibre board providing necessary corrections are applied. The correction tables needed are usually enclosed in the meter package. Testing of veneer requires plate type electrodes.

Moisture control in kiln-drying

The operation of a drying kiln is controlled by the relative humidity of air in the kiln compartment. The measuring of the relative humidity is done either with simple wet-and dry-bulb hygrometers (Fig.7.) or electrical instruments. The most advanced prefabricated kilns are completely automated and operate according to programmed schedules.

CONTROL OF MANUFACTURING ACCURACY UNDER PROCESSING

The accuracy of the working heads of woodworking machines is, at the most, ± 0.05 mm when the bearings are in good condition. Studies made in furniture and joinery industries have shown, however, that the actual maximum accuracy with which parts and their details can be machined is, at the most, ± 0.1 to ± 0.3 mm taking into account the changes in dimensions resulting from variations in moisture content during the manufacturing process. The accuracy with which small details like joints can be machined is usually higher than the accuracy of larger

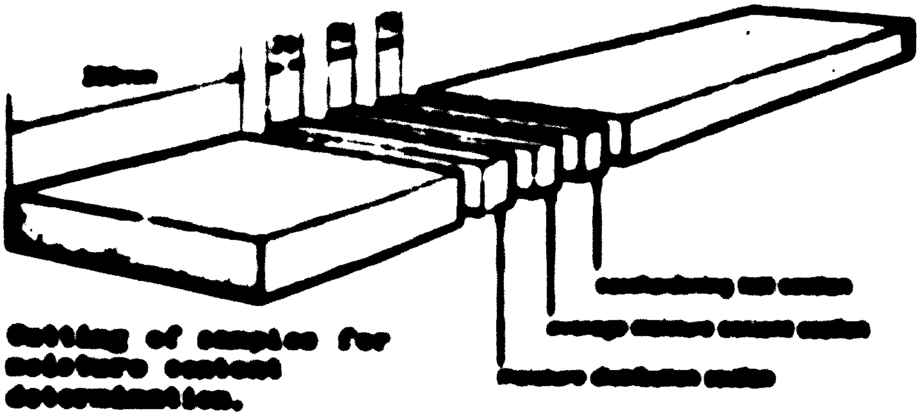


FIG.3. Cutting of samples for moisture content determination.

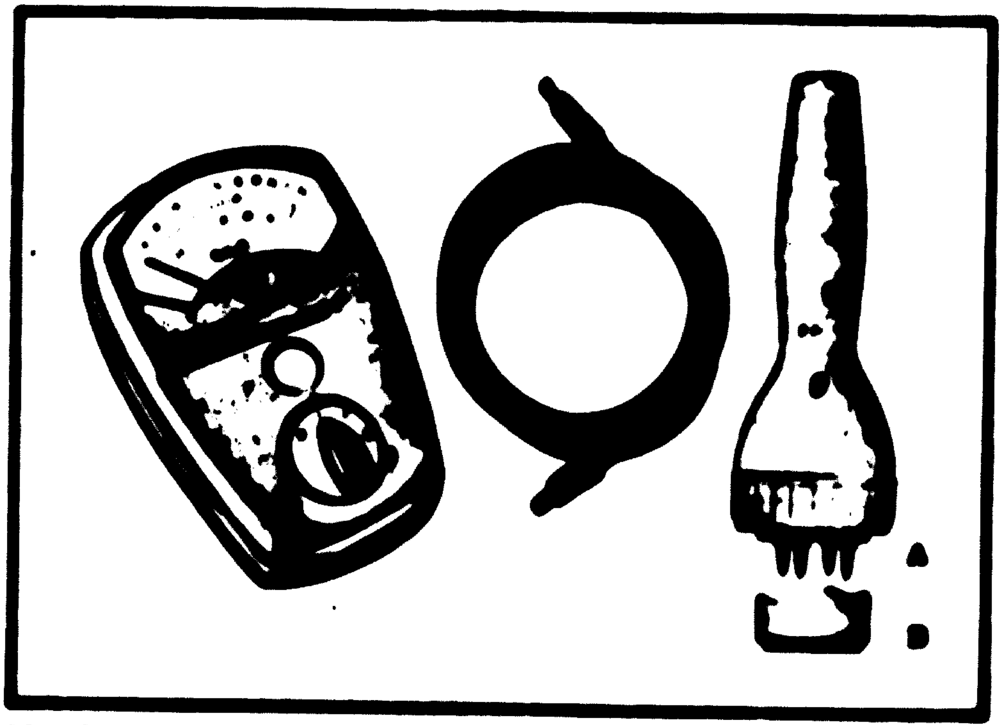


FIG.4. Electrical resistance-type moisture meter.

A: Needle electrodes
B: Plate electrodes

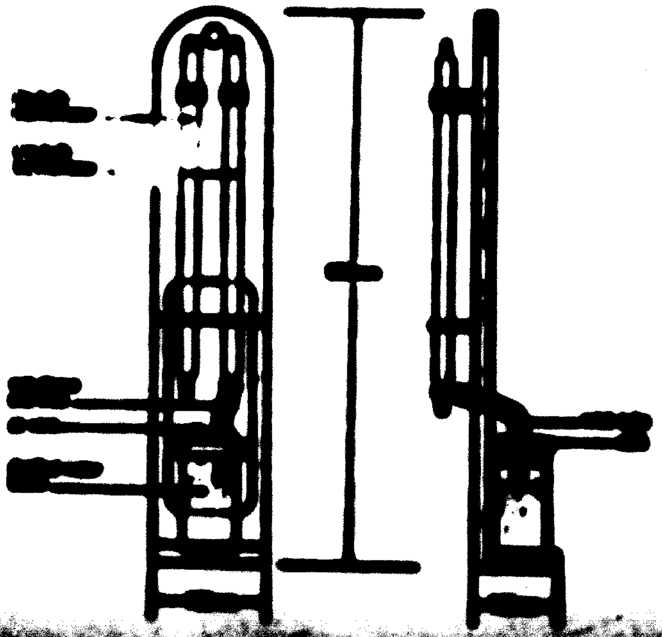


FIG.5. Wet- and dry-bulb hygrometer.

dimensions. E.g. a 10 mm diameter dowel hole can be normally bored with accuracy of about ± 0.15 mm but a 1000 mm long table rail is difficult to trim-saw with a better accuracy than ± 0.3 mm. These figures mean accuracy in continuous work, that is the extreme limits within which the actual measure will vary. The accuracy of rectangularity of panels is of particular importance in production of element furniture like bookcases, office furniture and kitchen equipment. At times the rectangularity varies as much as ± 1 mm in panels less than 0.5 m wide when a double-end tenoning machine is used for trim-sawing.

One of the prerequisites of being able to fix realistic quality demands for manufacturing accuracy is the knowledge on the precision of different machines and equipment. It is apparent that the actual precision of woodworking machines is lower than generally believed but, on the other hand, the practical accuracy attained is in many cases far lower than could be possible. This is usually due to improper use of machines, bad condition of machines or tools or wrong type of tools.

Advantages of high accuracy

The main advantages of a high (highest realistic) and controlled accuracy in manufacturing are the following:

1. Parts of products belonging to different series are interchangeable
2. A sliding fit between parts is possible without manual fitting in assembly
3. Joints are easy to assemble and have good strength
4. Manufacture in large series is possible
5. Number of faulty parts or products decreases
6. Higher quality means easier marketing
7. Less reclamations from customers'side
8. Profitability becomes better

Measures in order to achieve high accuracy

1. The machines are regularly serviced according to their working instructions
2. Proper type of tools are used
3. Only well-maintained tools are used

4. [illegible] by using high-quality special measuring instruments like micrometer dials etc. and set-up gauges. Set-up made is best checked by test feeds and using nominal measure gauges.

5. Dimensioned working drawings are used throughout. The numerical values indicate the nominal dimension to be achieved

6. Only high-quality measuring instruments are used. These include steel tape rulers, Vernier calipers, angle gauges etc. (Fig.8.).

7. The unavoidable measure variations are concealed by structural means by taking them into consideration already in the design stage of product (Fig.9.).

8. Nominal measure gauges and templates are used to control the dimensions during machining (Fig.10.).

9. Jigs are used in machining and assembly whenever possible (Fig.11.).

10. The machining and assembly shops are adequately illuminated

11. The accuracy is continuously controlled by spot tests

As mentioned before, the use of dimensioned working drawings in which the numerical values indicate the nominal dimension to be achieved is the prerequisite for attaining high accuracy in serial production. This information on dimensions is needed for the following operations:

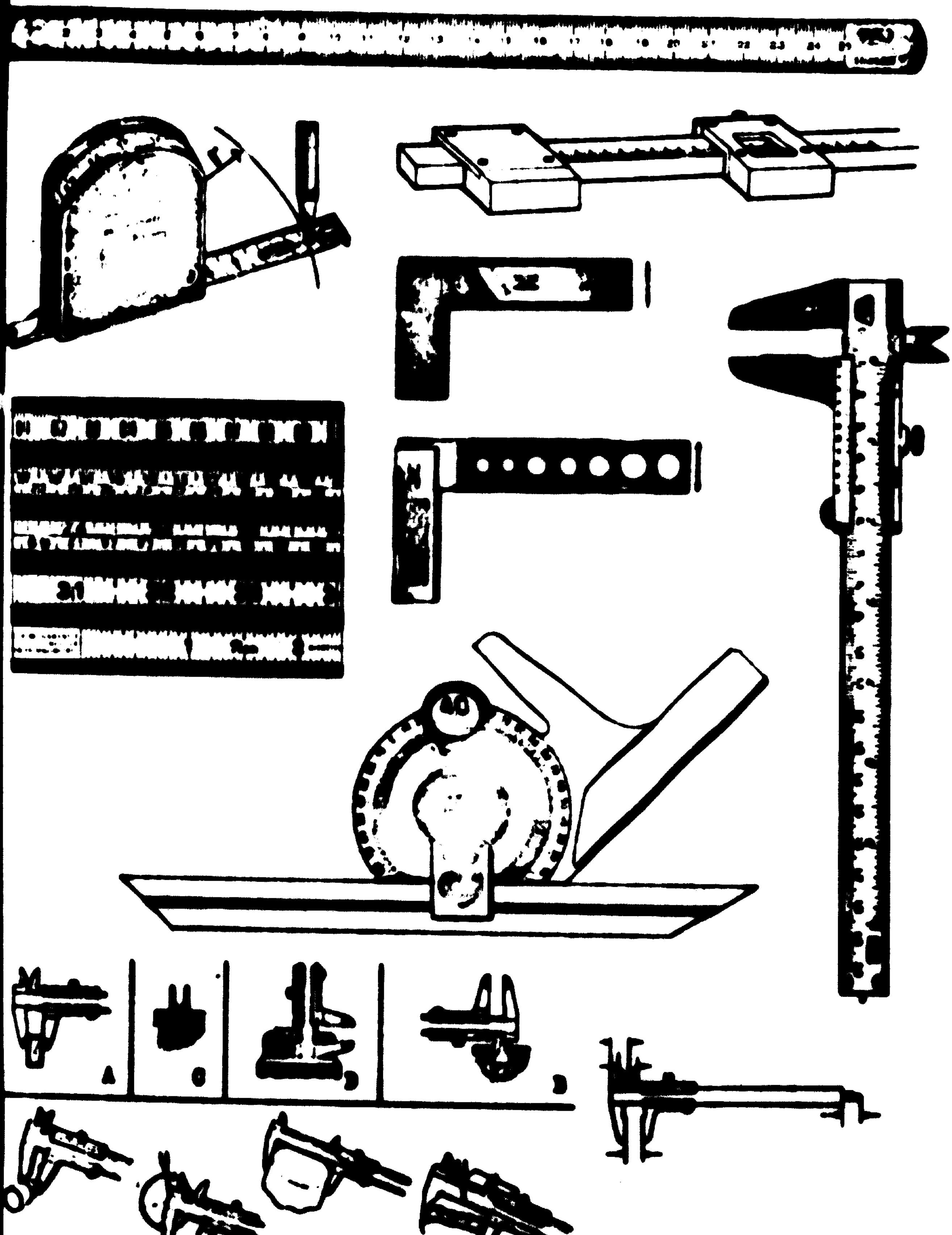
1. Set-up of machines and equipment
2. Design and construction of jigs for machining and assembly
3. Control of measures in machining and assembly

Ordinary measuring instruments

At least the following types of measuring instruments are necessary for the tasks mentioned above:

1. Tape rulers with mm-scale
2. Rigid straight rulers with mm-scale
3. Vernier calipers, reading by steps of 1/10 or 1/20 mm
4. Fixed angle gauges for 90°
5. Adjustable angle gauges

Only high-quality steel instruments should be used. Particular attention must be paid to proper handling and storage of all measuring instruments. Rulers with worn-out scales, Vernier calipers with worn-out and rounded measuring surfaces etc. damaged instruments must be rejected. The most important ordinary measuring instruments are shown in Fig.8.



[illegible] Ordinary measuring instruments.

Nominal measure gauges

The set-up of machines and later control of measures in machining can be very greatly facilitated by the use of specially constructed nominal measure gauges. The most usual types are the following:

1. Length and width gauges
2. Thickness gauges
3. Boring pitch gauges
4. Joint gauges
5. Profile gauges or templates

The construction principle of these gauges is shown in fig.10. The best material is steel or hard aluminium (Duraluminium). In certain cases also wood or thick plywood is usable providing, however, that the variations of the relative humidity in the factory are small. Wood or plywood should be used only for the body of gauge the actual measuring pieces being made of metal. It must be remembered that only the length (grain direction) of a solid wood piece can be regarded as constant for most practical purposes. In gauges made of metal plates like thickness gauges the corners of the measuring openings must always be bored out to make space for small splinters and other machining rests at the edges of parts to be measured.

The gauges are often constructed to perform several measuring operations. E.g. a rod-type gauge may be constructed to give both the length and width of a panel. If the gauge is made adjustable it can easily be re-adapted for later measuring purposes. The adjustable types should be constructed of steel. The thickness gauge in fig.10. is intended for measure control in thickness planing. The selection of thicknesses it includes represents by the same the standard thicknesses used in the factory. The values are based on standard raw-thicknesses of lumber. E.g. raw thickness of 25 mm gives usually finished thickness of 20 mm, 19 mm correspondingly 14 mm etc.

The correct workpiece measure is achieved when the gauge fits to the workpiece when pushing lightly. If the gauge fits without any force at all the workpiece is too small and in case strong pressing is necessary the workpiece is too big.

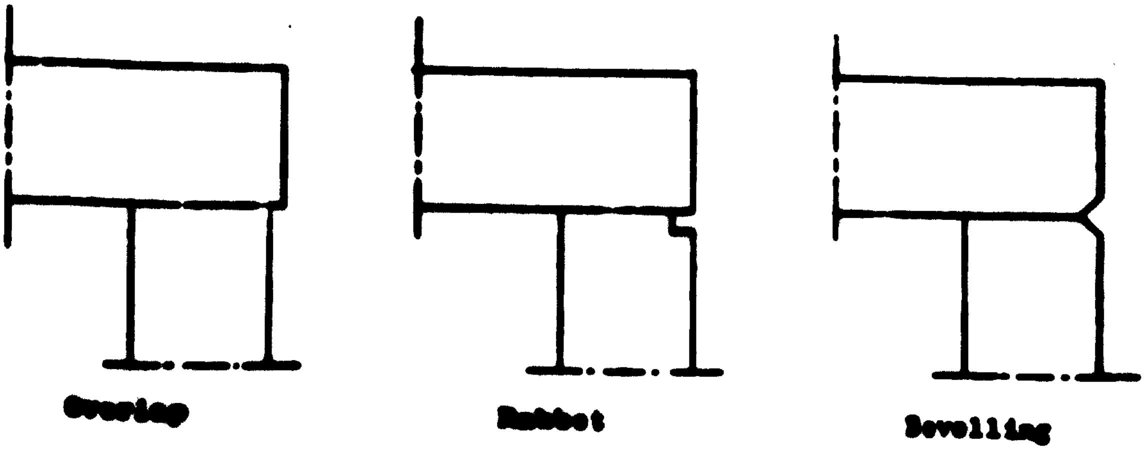
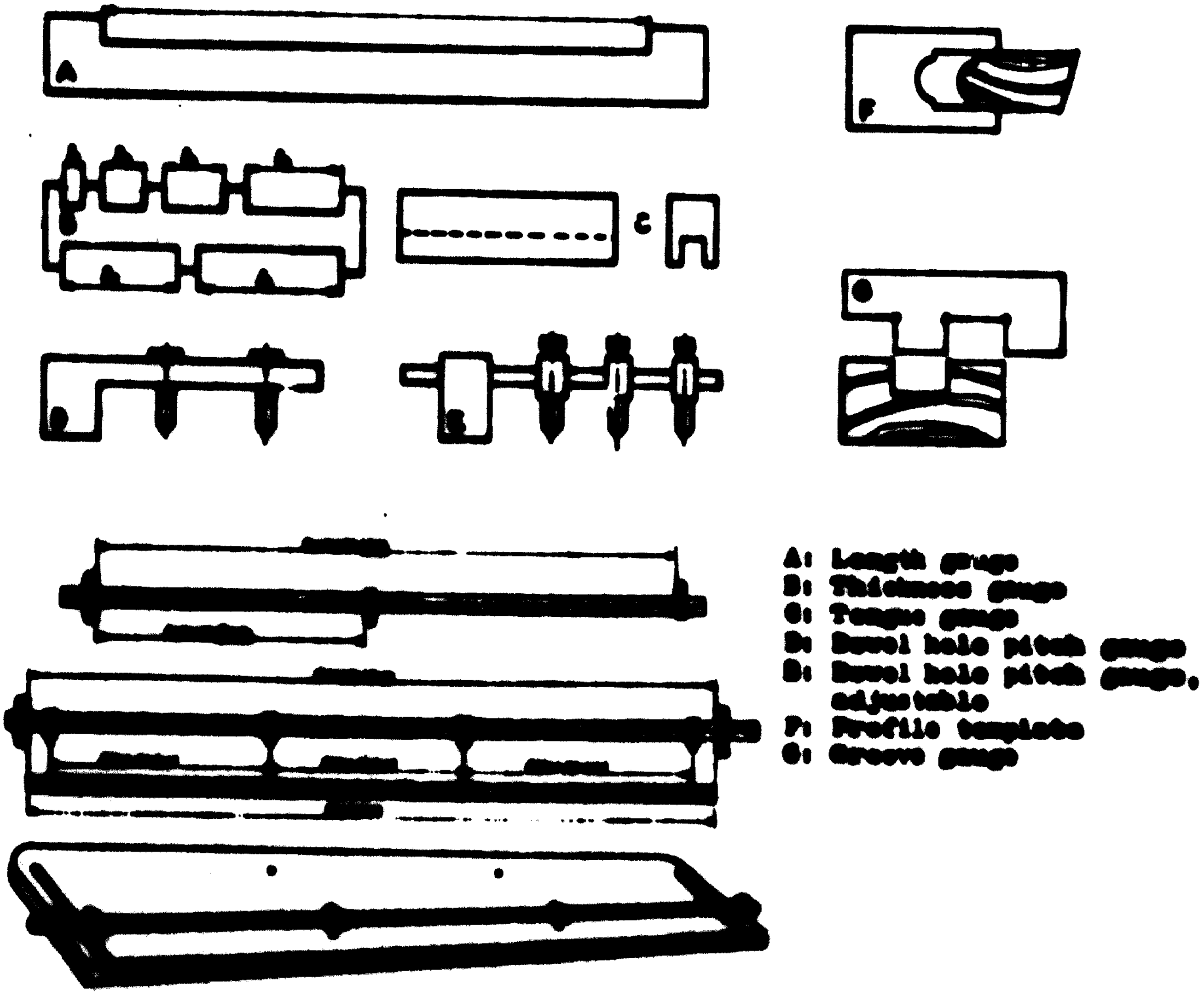


Fig.2. Structural means of concealing dimensional inaccuracies.



[illegible]

It can therefore be seen that the "tolerance feeling" is in the fingertips of the measuring person. Proper use of nominal measure gauges is very rapidly instructed to any user. The main advantages of gauges are the following:

1. Risk of misreading is non-existing
2. Machine and equipment set-up is more accurate and rapid than by using ordinary measuring instruments
3. Continuous measure control during machining by making frequent spot tests is simple, reliable and rapid
4. Measure control is accurate also in badly illuminated workshops

Tolerance gauges

The actual tolerance gauges which are standard quality control instruments in metal industries can be applied also to furniture industry with certain modifications. This necessitates, however, reliable knowledge on the practical accuracy of the woodworking machines to be used. When the possibilities of different machines is known realistic tolerances can be fixed.

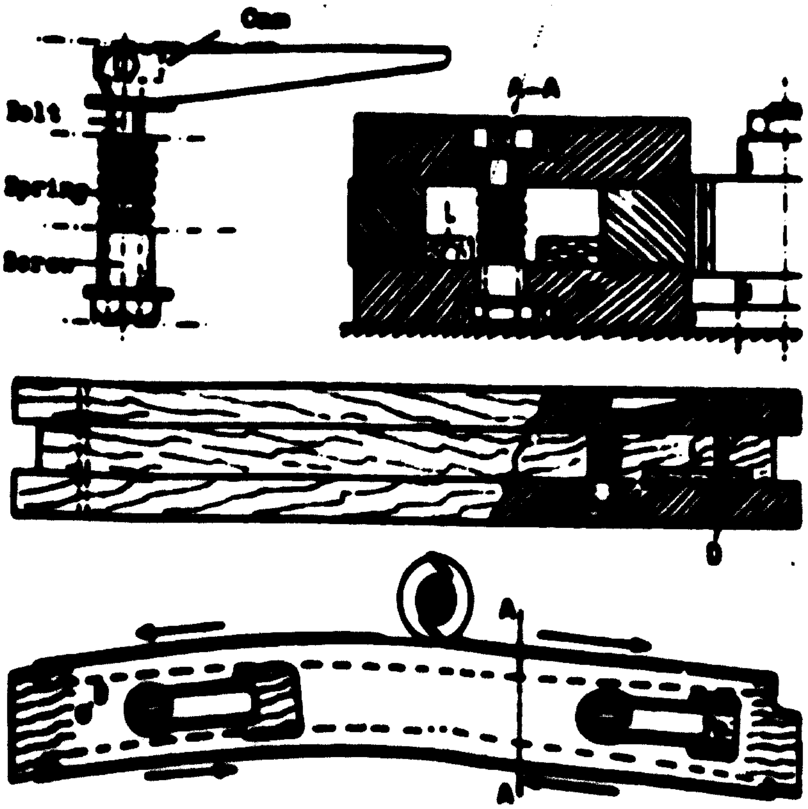
By the term tolerance is meant the range within which the actual dimension may vary around the nominal dimension. E.g. if the width of a solid wood component must be machined with a tolerance of ± 0.3 mm, the nominal measure being 62 mm, all pieces in the batch having width between 61.7 and 62.3 mm can be accepted. The tolerance range is in this case 0.6 mm. A simple tolerance gauge with minimum and maximum dimensions is shown in fig.12. The other gauge in the same figure includes additionally also the nominal measure step in the middle of the tolerance range. The middle step or nominal measure is needed e.g. for set-up of machines.

Tolerance formula for assembly

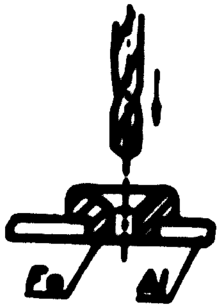
The tolerance of a construction assembled of several parts is calculated from the following formula:

$$t = \sqrt{t_1^2 + t_2^2 + \dots + t_n^2}$$

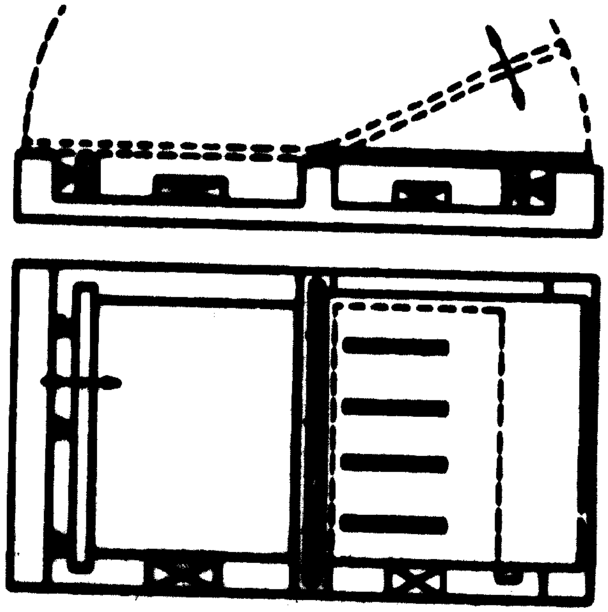
where t_1, $t_2 \dots t_n$ are the tolerances of the components.



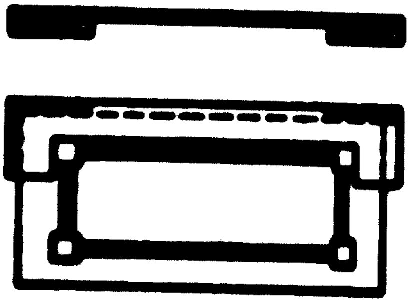
Jig for spindle-moulding of both edges of curved chair leg.



Detail of boring jig for hand-held machine.



Left and right hand stapling jig for drawer sliding strips.



Assembly jig for cabinet base

Fig.11. Machining and assembly jigs.

Example

The height tolerance of the cabinet in fig.13. is thus:

$$t = \sqrt{0.4^2 + 0.3^2 + 0.4^2 + 0.3^2}\ \text{mm}$$

$$= \sqrt{0.16 + 0.09 + 0.16 + 0.09}\ \text{mm}$$

$$= \sqrt{0.50}\ \text{mm}$$

$$= \underline{\underline{\pm\ 0.7\ \text{mm}}}$$

A tolerance system in a furniture factory, if realised as a complete programme, offers numerous advantages. The manual fitting and adaptation can be avoided in assembly because the application of tolerances throughout will control e.g. the value of clearances of drawers, doors, extension rails etc. The tolerances must be indicated in all work drawings. An example of tolerances which are directly applicable to production is given in table 2. The values are based on strength tests made in laboratory. Corresponding tables can be found from some handbooks of wood technology(e.g. Blankenstein: Holztechnisches Taschenbuch). Creating of a complete and realistic tolerance system is, however, a very demanding and complicated task. Therefore the use of tolerances is not yet very widespread in the furniture industry.

The normal practice in the use of gauges during machining is to make random spot tests by taking samples out of the batch of parts. The check-up with gauges can be carried out either by the machine operator, assembler or a special inspector.

CONTINUOUS QUALITY CONTROL BY WORKERS

The quality control in a furniture plant must be understood as a continuous activity which should cover all stages of production. Lot of unnecessary work can be avoided when faulty parts are rejected immediately in the stage the faults come out. E.g. if a large quality-lowering knot is found in a chair leg when planed, the leg should be rejected and not put through

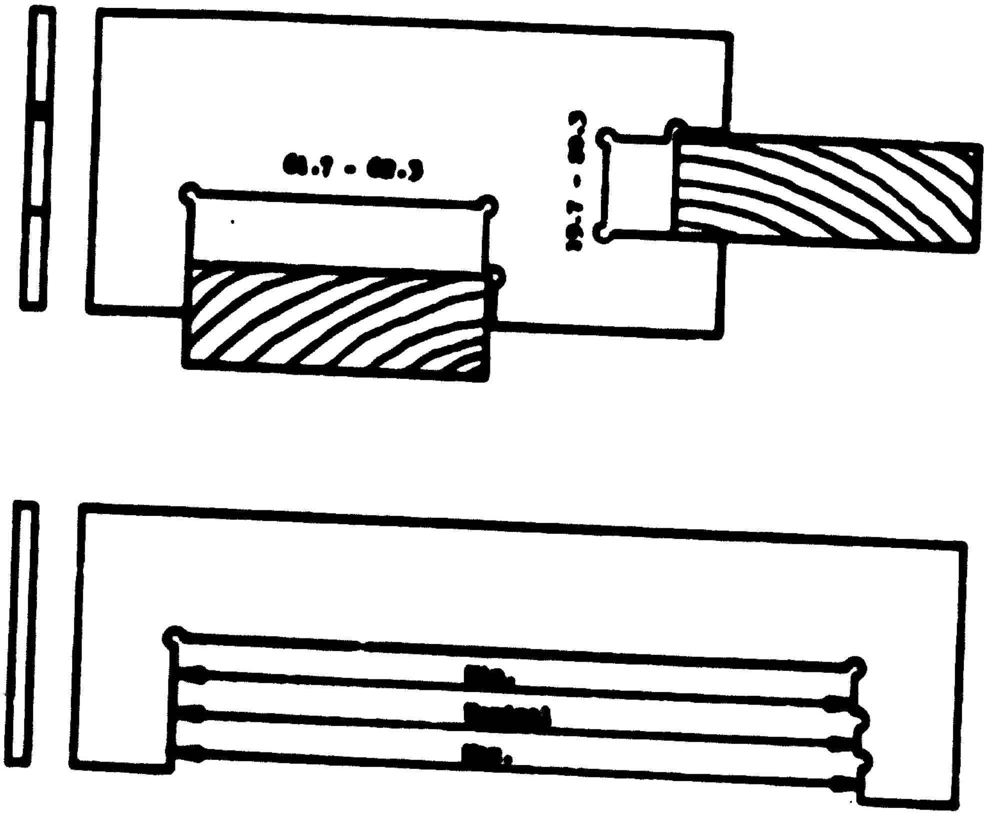


Fig.12. Tolerance gauges made of metal plate.

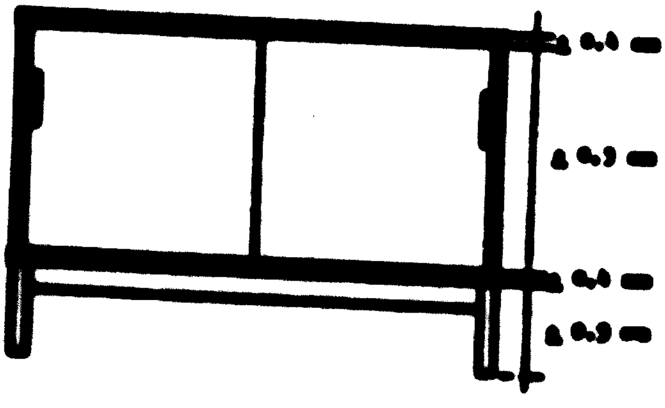


Fig.13. Tolerances of cabinet components.

the following stages of operation. A not very uncommon mistake is to bring faulty parts through all machining stages even to assembly. The use of a faulty part in assembly results in rejecting or expensive repairing of the whole product in which all other parts may be of proper quality.

Visual piece by piece control by workers

The visual piece by piece control is in first place on the responsibility of the workers like machine operators. The foremen and supervisors should therefore emphasize the importance of visual quality control when instructing their subordinates. The control is easier to put in action if the aim and reasons are well explained so that the workers understand what is in question.

QUALITY CONTROL IN ASSEMBLY

The assembly of furniture is usually devided into two sub-stages, parts assembly and final assembly. The parts assembly takes care of the assembly of drawers, frames, bases, stapling of sliding stripe on drawer unit sides etc. whereas the final assembly puts together the actual body of tables, chairs, beds, cabinets etc. The parts assembled in the parts assembly are fitted into the bodies in this stage. The quality control actions should consequently be divided into two parts.

Principal objects of control

The principal objects of control are the following:

1. Main dimensions
2. Overlaps etc. minor measures
3. Rectangularity
4. Other angles
5. Parallel run of parts (free of warp)
6. Clearances and function of moving parts
7. General check-up

Assembly jigs

Jigs should be used in assembly whenever possible to facilitate the attaining of high accuracy. The guiding surfaces of jigs should correspond the primary measures of the product. By the concept "primary measure" is meant a measure which is decisive e.g. to the proper function of a product or its part. For instance, the sliding strip supports a drawer at the upper edge of the side groove. Therefore the stapling jig must be constructed to give the guidance to this edge. The distance of the strip ends from the front edge of the side panel is a primary measure as well because the end stops the drawer. The thicker lines in fig.14. illustrate the edges to be controlled by a stapling jig.

Control of accuracy in assembly

The accuracy of assembly is best controlled with specially constructed nominal measure or tolerance gauges if a tolerance system is used in the plant. The rectangularity is of major importance for element-type panel furniture and should be checked by using diagonal measure gauges (Fig.15.). The parallel run of parts can be checked with gauges or in some cases by the naked eye.

QUALITY CONTROL IN SURFACE FINISHING & FINAL CHECK-UP

The surface finishing has traditionally been a stage following the assembly. The tendency of today is, however, to lacquer or paint the parts and carry out the assembly as the last production stage. This necessitates usually special constructions with knock-down fittings. The quality control actions of the finished surfaces are principally the same in both cases. The effect of the finished surface is, anyway, of major importance as regards the product's ability to compete on the market because the outer appearance of a piece of furniture is often decisively dependent on its finish.

The check-up is usually done by the naked eye without any instruments.

Principal objects of control

The principal objects of control are the following:

1. Evenness of surface
2. Gloss of surface

TABLE 2. Lower and upper limits of mortise and tenon dimensions. Nominal dimension of joint is 8 mm.

Hardness of wood	Boring or mortise (mm)	Dowel or tenon (mm)
Soft (pine, spruce)	+ 0.05 - 0.0	+ 0.3 + 0.2
Semi-hard (birch, beech)	+ 0.05 - 0.0	+ 0.2 + 0.1
Hard (oak, teak)	+ 0.05 - 0.0	+ 0.1 + 0.0
Very hard (rosewood, wenge)	+ 0.05 - 0.0	+ 0.0 - 0.1

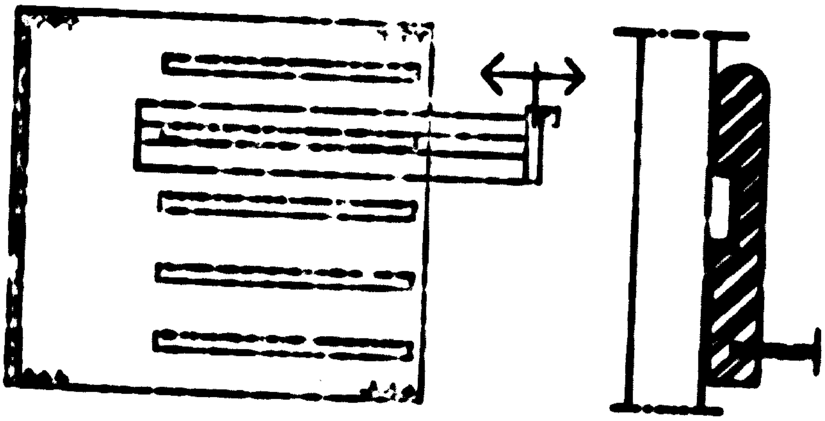


FIG.14. Side panel of drawer unit with sliding strips. Thick lines indicate edges which are guided by assembly jig.

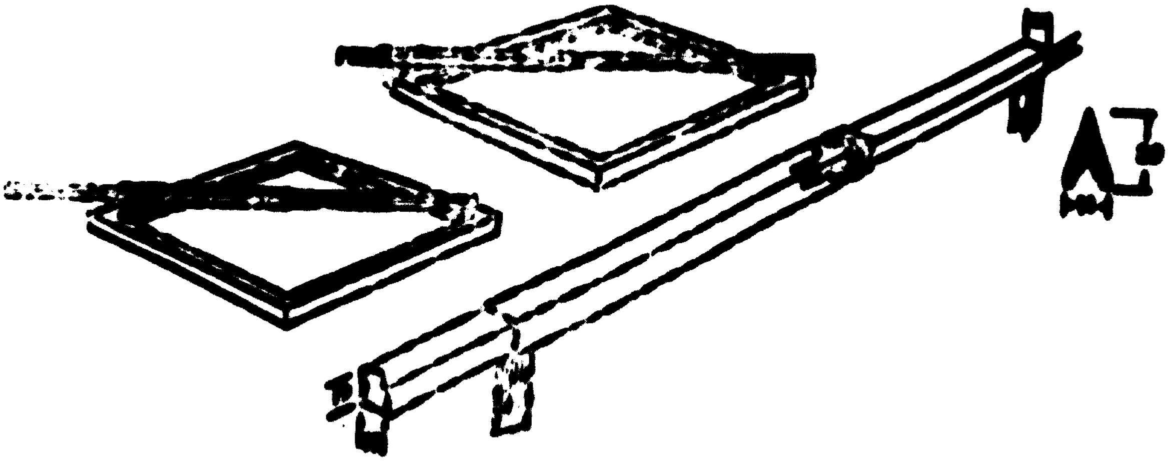


FIG.15. Diagonal measure gauges used for check-up of rectangularity.

3. Colour shade and its evenness in lacquered products
4. Visible glue penetrations and [illegible] upper surface film
5. Quality of edges and corners (through-sanding of veneer becomes visible sometimes only after lacquering)
6. Quality of surfaces close to joints

Final check-up

The final check-up is always done for products being completely finished and ready for packaging. This last control stage includes a general check-up of the product. All functions of the product are also checked: working of doors, drawers, table top extension mechanisms etc. If faults are found the product is transported to repairing point. An accepted product is provided with manufacturer's stamp or self-adhesive sticker and is packaged.

TESTING OF FINISHED PRODUCTS

This task requires particular testing equipment with which a product can be loaded or stressed or in some other way tested e.g. testing the chemical resistance of the surface finishing. The number of products to be tested is naturally limited to few spot tests within a batch of products.

Furniture testing standards

Special testing standards have been developed in some countries. Three examples of testing arrangements according to Swedish Furniture Standards are shown in fig.16.

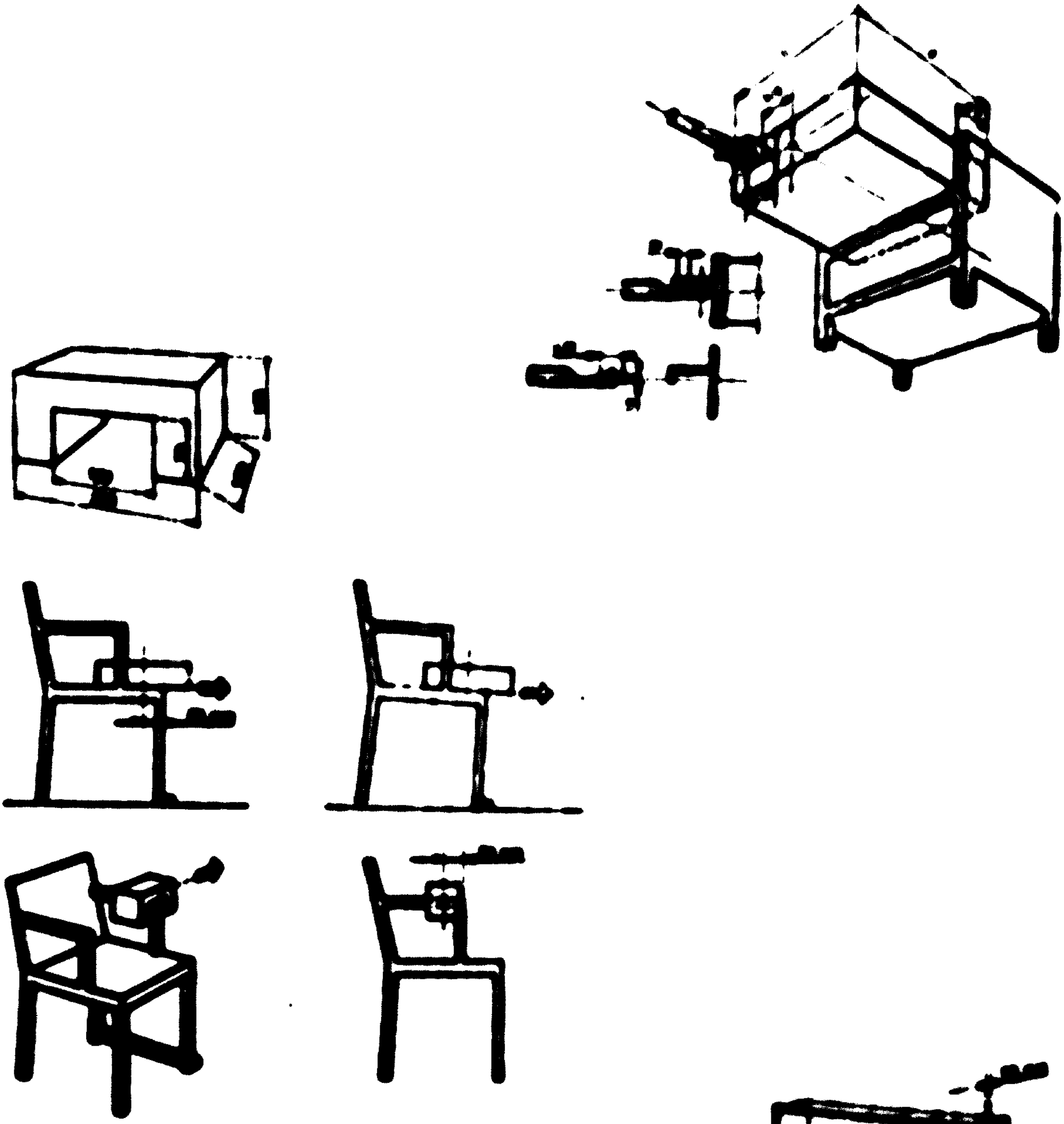


Fig.14. Examples of testing arrangements according to Swedish Furniture Standards.

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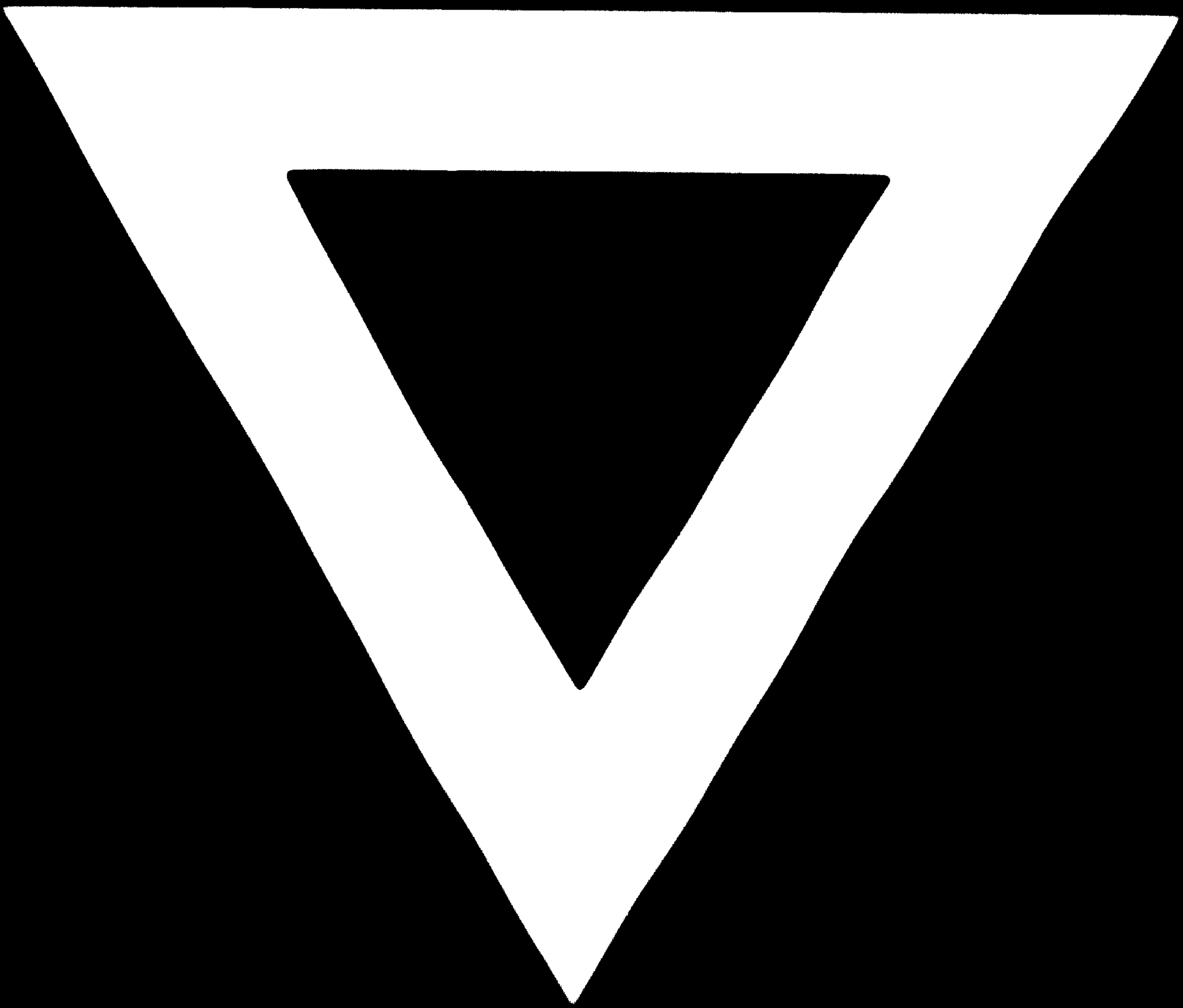

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