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DEVELOPMENT OF THE FURNITURE AND JOINERY INDUSTRIES AND CREATION OF A CENTRE

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YUGOSLAVIA,

Technical report:
ASSISTANCE IN INDUSTRIAL ENGINEERING

Prepared for the Government of Yugoslavia by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

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YUGOSLAVIA

Technical report: Assistance in industrial engineering

Prepared for the Government of Yugoslavia
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based of the work of Desmond P. Cody, expert in industrial engineering

United Nations Industrial Development Organization
Vienna, 1977

Explanatory notes

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

A slash between dates (e.g., 1975/1976) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960–1965) indicates the full period involved, including the beginning and end years.

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Yugoslavia is the dinar (Din). In June 1977 its value in relation to the United States dollar was $US 1 = Din 18.35.

The following abbreviations are used in this report:

BiH	Republic of Bosnia and Herzegovina
N	newton
R.O.	Radna organizacija (working organization)

ABSTRACT

As part of the parent project "Development of the furniture and joinery industries and creation of a centre" (DP/YUG/73/006) that is being carried out by the United Nations Industrial Development Organization (UNIDO) acting as executing agency for the United Nations Development Programme (UNDP) in response to a request from the Government of Yugoslavia, an expert in industrial engineering was sent on a two-month mission to assess the state of development of industrial engineering in the furniture and joinery industries of Bosnia and Herzegovina (BiH) and to elaborate a plan for its further development.

The chief objective of the mission was to identify the major shortcomings of the BiH furniture and joinery industries in respect of industrial engineering and suggest how they could be rectified. Deficiencies were identified in the following fields:

Standard of design and product policy at individual factory level

Variety in models produced

Experience of furniture designers

Design engineering, particularly in relation to structural details and efficient use of materials

Management, particularly in relation to up-to-date management techniques

Long-term planning in respect of factory building and production facilities

Internal factory organization and planning

Quality control procedures

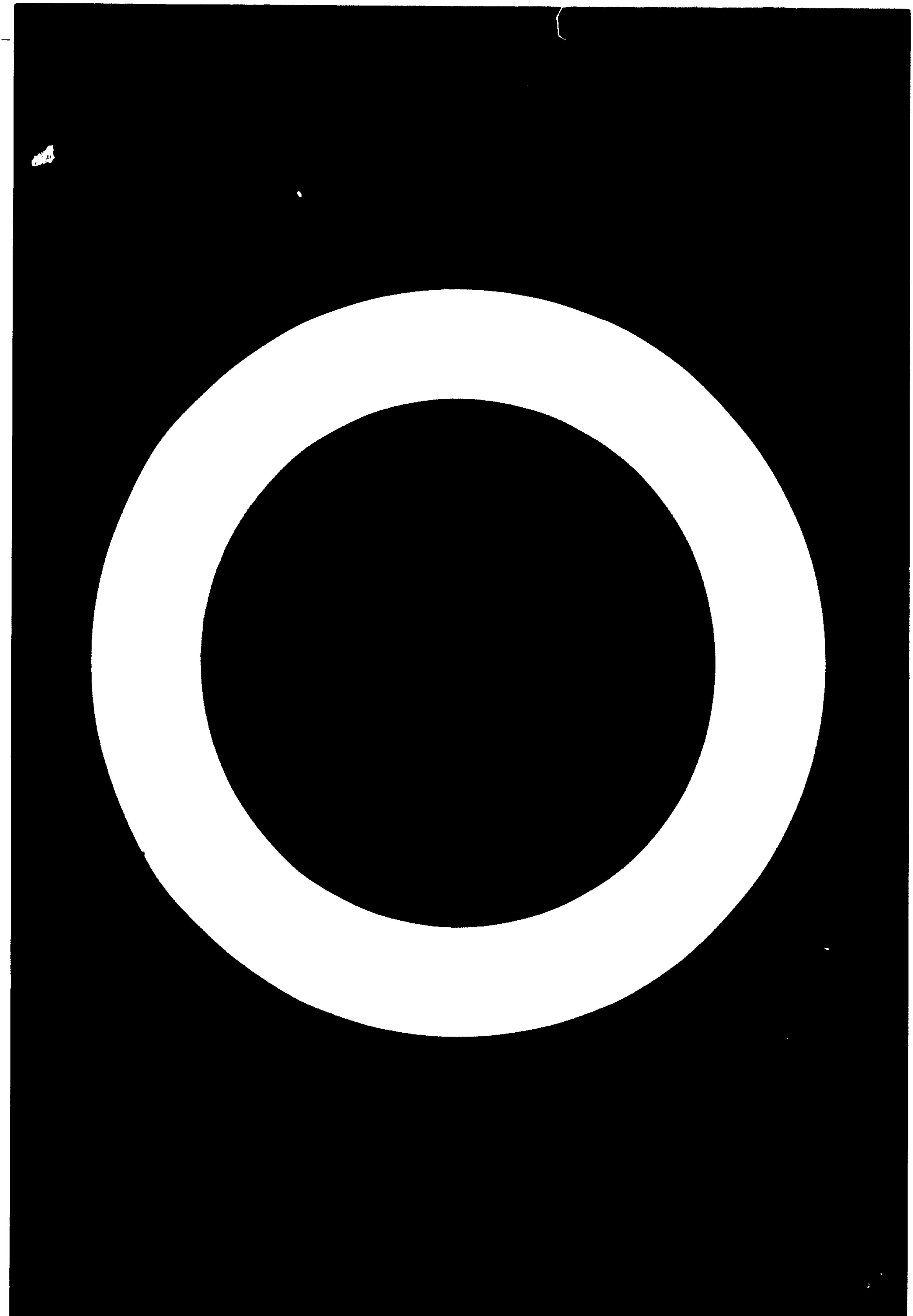
Machinery and equipment for upholstery

Marketing policy for domestic and export markets

Level of productivity

Inter-factory co-operation

Each of these aspects is analyzed in terms of the industry's needs and recommendations made as to how they may be rectified with special emphasis on the requirements of both home and export markets.



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INTRODUCTION

The furniture industry in the Republic of Bosnia and Herzegovina (BiH) is characterized by a small number of very large units which are engaged in the manufacture of corpus furniture, upholstery, bedding, dining room chairs and tables. Many of the manufacturing organizations have associated factories for saw-milling, particle board and joinery production. Most of the factories are members of the ŠIPAD organization which directs 41 factories, employs 10,538 persons and provides back-up services such as marketing and sales; design; factory organization and planning; research and development; and management and operative training.

In 1976 the ŠIPAD furniture and joinery operations had a turnover valued at Din 1,954 million of which upholstery chairs and seating accounted for 47 per cent. Roughly 30 per cent is exported, 19 per cent of which goes to countires with centrally-planned economies and the remainder, largely comprising dining-room chairs, cabinet furniture and upholstery to Western Europe, the Middle East and the United States.

The industry has developed quite rapidly, particularly over the past ten years, and the level of investment in factory buildings and production machinery and equipment compares favourably with that in any of the countries with advanced economies. The industry enjoys the advantage of being a primary producer of the basic raw materials used by the industry and has relatively abundant supplies of first quality beech, oak, spruce and fir. The plentiful local supply particularly of hardwoods influenced the establishment of many of the solid-wood processing plants, and it has become a national policy to retain these supplies at home specifically for that purpose. Thus Yugoslavia has internationally established a name as a producer of dining-room chairs, and it is the intention of the ŠIPAD organization to develop further this reputation by additional penetration of its existing export markets and by establishing new ones.

New plants for chair production are already in the course of construction or are at the planning stage. A parallel development has also taken place in respect of corpus production and most factories are very well equipped with the most up-to-date machinery for panel furniture production and solid-wood processing. Annex I gives some data on the furniture industry of BiH and the ŠIPAD organization.

The Yugoslav Government formally requested the United Nations Development Programme (UNDP) in March 1976 to provide an expert in industrial engineering to advise and assist the SIPAD organization and the furniture and joinery industry in BiH in the establishment of the principles and the practice of industrial engineering as it relates to those industries. The assignment "Industrial engineering in the furniture and joinery industries" (DP/YUG/73/006/11-03/J) began on 3 May 1977 and ended on 13 July 1977. It was part of a large-scale project "Development of furniture and joinery industries creation of a centre" for which the United Nations Industrial Development Organization (UNIDO) was the executing agency. The government agency co-ordinating the project was the Republic Association for International Scientific-technical and Cultural-educational Co-operation. The expert's job description is given in annex II.

During a preliminary discussion with Mr. Pjaca, National Project Director, and other senior engineers and executives of the SIPAD organization, it was agreed that the expert would report directly to Mr. Pjaca rather than be attached to the SIPAD Computer Centre. This was because no suitably qualified counterpart was available at the Centre. It was also agreed that the expert would spend some additional time working with the SIPAD "Standard" furniture factory where the techniques of industrial engineering would be introduced on a pilot basis in respect of certain of the manufacturing activities of that factory. His recommendations are contained in annex V. The expert would also visit a representative selection of factories, assess their product, management, and manufacturing capabilities, and report on the spot to each of the factories concerned.

Accordingly he visited nine factories which between them account for a sizeable proportion of the SIPAD output and confirmed that these factories, in one way or another, would benefit from the assistance and advice provided to "Standard". Other factors also to be taken into consideration during the assignment included design and design development, training in industrial engineering, quality control, technical management, design engineering, up-to-date upholstery planning and production, marketing and the role of such SIPAD service agencies as the Design Centre and Sumaprojekt, which is responsible for the design and planning of new factories and the re-organization and development of existing ones.

SIPAD also requested that a special one-day workshop on industrial engineering for appropriate factory and other technical personnel be organized by the expert towards the end of his assignment. This workshop was held on 6 July 1977 in Jajce, one of the main centres for furniture production and was attended by 75 participants, including factory directors, production personnel, designers and representatives of the SIPAD service agencies concerned with the organization and development of the furniture and joinery industries. The workshop dealt with topics covered in this report; its programme is given in annex III. The expert also participated in the seminars on design and computer programming and a synopsis of his lectures is contained in annex IV. The personnel directly concerned with the project at SIPAD were:

M. Pjaca, National Project Director

M. Papo, Director of Sumaprojekt

M. Baković, Director of Wood Technology Institute

Z. Praskač, Acting Director, Design Centre

T. Drakulić, Director of "Standard" furniture factory and the plant directors of the various factories participating in the project

P. Sulić, Advisor on Research and Development

K. Jirota, Director of Development Department, "Standard" furniture factory

N. Kukić, Engineer in Development Department, "Standard" furniture factory

S. Ahmedić, Designer in "Standard" furniture factory

The organizations and factories that co-operated with the expert in his field of work or participated in the project are listed in annex VI.

Annex VII gives graded performance tests for easy chairs and settees.

I. FINDINGS

General observations

The furniture industry in BiH is firmly and soundly established in accordance with the norms which apply internationally to an industry of this nature. The factories are large by any standards, employing anywhere between 500 and 1,000 persons, usually on a two-shift basis the whole year round. Until 10 years ago the industry was mainly concerned with meeting the demand within Yugoslavia. Since the pressures for supplying furniture were directed more towards production than marketing, the industry evolved a highly rationalized and extremely functional range of corpus and upholstered furniture that it has continued to produce in vast quantities to the present day. This furniture, which is produced by most factories, differs only marginally from factory to factory and is characterized mainly by the conventional wall unit which is the principal product of the corpus sector, and the studio couch, or convertible, which is the main offering of the upholstery sector. Another main product area is the dining-room chair, where undoubtedly the industry achieved some degree of individuality, and thereby made the greatest impact on foreign markets.

Factors which it is claimed have influenced the design of these models include what has been described as the extreme conservation in Yugoslav consumer tastes, and the living conditions of the people, most of whom have three- and four-room apartments in high-rise buildings.

Factories are almost exclusively production oriented and have very little contact with the consumer. Products are therefore designed with production rather than consumer considerations in mind; designers are reduced to the role of draughtsmen and are engaged mainly with construction detailing, and cannot exercise their imaginations or talents. When a factory succeeds in winning export orders, as is the case with dining-room chairs, it is because the concern has been provided with a copy of the desired model, which is carefully reproduced. In these circumstances it is difficult to escape the conclusion that this kind of market penetration is won on price only, and can thus be as easily lost whenever a rival producer offers a similar product at a lower price.

The stage has now been reached where the industry is experiencing market saturation, while at the same time, and in line with its heavy investment in buildings and equipment, it is also harvesting the fruits of this investment in form of a vastly increased output. Thus a re-appraisal of the whole industry has become necessary and with it comes the opportunity to evolve from a production-oriented industry into a marketing-production based industry where the end product reflects consumer tastes and preferences, and gives the financial return which is consistent with an investment of this nature.

Many of the shortcomings pointed out in this report are already known to the SIPAD directorate and the factories concerned. SIPAD itself is currently undergoing a period of transition, the aims of which are to make it much more efficient in every sector of its administrative, marketing and production strategy. Thus the stage is set for a realistic assessment of all these functions and in terms of product design and production this may be defined as ensuring that the best possible use of all existing resources, whether manpower or machines, is made now and in the future. Only when the management is satisfied that these resources are stretched to the utmost may further investment be justified. Even then, this should only be done after a most careful analysis of both present and future marketing opportunities. Successful application of the principles and practice of industrial engineering provides the key to the achievement of these aims.

Products and product design

The ranges of furniture produced include kitchens, living and dining-room furniture, upholstery, chairs, bedding, office furniture and occasional tables and chairs. These may be divided, from a production point of view, into three main areas of activity - firstly, the processing of solid-wood intermediate and finished components; secondly, the processing of panel products as used for corpus type furniture; and thirdly, the production of seating, i.e. of fully-upholstered suites, partly-upholstered easy chairs (show-wood), dining-room chairs and bedding.

Solid-wood furniture is largely accounted for in the production of dining-room chairs for which the excellent-quality Yugoslav beech is an ideal medium. There are roughly two designs, traditional and modern, and as has already been pointed out, particularly the traditional designs are produced on the basis of a model supplied by the customer. But even the modern models are copies in origin.

Structurally they are all extremely well made, and can only be faulted in respect of finishing and attention to detail. Naturally there are exceptions, and the expert was particularly impressed with the very high standard achieved by one factory in producing completely finished and ready-to-assemble components for a traditional type "colonial" dining-room chair which is being exported in large quantities to the United States.

The corpus or case-goods sector of the industry is dominated by the production of the wall unit, a multi-purpose storage cabinet incorporating open shelves, cupboards with doors and drawers and with provision for television cabinets and record players. It is almost always manufactured in a ready-to-assemble or knock-down (KD) condition and is delivered in a pack-flat form. This has enabled the establishment of a flowline-type production processes, calling for substantially larger production runs per component to make the process economical. This has in turn called for a high degree of rationalization with the result that consumer choice has become very limited, and design considerations have been almost eliminated. Factories are therefore competing with each other for the sale of an almost identical model, and again price rather than criteria of product appeal predominate.

In the case of upholstery, products generally reflect the traditional approach to this trade, which has been abandoned elsewhere as new materials and techniques have been introduced.

A feature of practically every piece of fully-upholstered furniture in the use of the "sprung unit" as a base for seating. In the case of the studio couch or convertible, this sprung unit is also incorporated in the back so that when it is converted into a bed, the load may be distributed evenly over the entire "bed" surface. To accommodate these units it is necessary to enclose them in a heavy wooden base-like frame which also provides storage for linen and other bed coverings. The result is a massive and unyielding structure which is almost impossible to move, once it is placed in an apartment. Similar observations apply in the case of the traditional fully-upholstered suites which consist of a settee incorporating the sprung unit and two arm chairs. Following the lines of the settee, they are bulky, rather ugly in appearance and not very comfortable.

In dealing with design in relation to the industry's products as a whole, two questions arise: (a) Do manufacturers know what good design is? (b) Is there a critical and appreciative public? At present both questions must be answered in the negative. The industry is immune to competition from abroad both in price - this is ensured by the import tariff - and in design. After many years of high protection of the domestic market, most consumers are quite unfamiliar with well-designed furniture. Furthermore, furniture is purchased so infrequently that consumers have no opportunity to acquire a background of expertise and appreciation in these matters. This will lead to a falling-off in sales once immediate needs have been satisfied and could be disastrous for the industry, particulary when it is gearing itself to become more productive.

The lesson is clear. If the design of the product is not improved, the industry will face an inevitable decline and its prospects of penetrating foreign markets will diminish. In relation to furniture design, considerations are quite specific. Based primarily and initially on a careful and accurate marketing analysis, design must take account of the production facilities of the firm; the skills of labour; an understanding of the characteristics of the materials used; and the form and colours of the article, its tactile beauty, fitness for purpose, and decoration and acceptability to the consuming public. The danger of preoccupation with "imported" design, which invariably was meant for a different combination of manufacturing facilities must be emphasized.

The remedy for this state of affairs lies largely with the industry itself. The view expressed by many factories that they are simply producing what the public wants, cannot be accepted. Many Yugoslavs have rarely seen well-designed, modern Yugoslav furniture; and when the public's choice lies between one poor design and another equally poor one, its decision cannot be regarded as meaningful. An industry with a captive market, free of all foreign competition, has a duty to the public to offer the best product it can.

There is certainly no shortage of good designers within SIPAD organization or in the factories themselves. It is simply that the designers employed by the industry do not, for one reason or another, enjoy the freedom of expression essential to good design; in very many cases they are employed mainly as technician draughtsmen. Thus qualified designers have little incentive to work for the furniture industry and most find employment elsewhere. The Republic itself can play a more positive role in fostering good design. As the largest single customer of the industry both as regards the needs of its own institutions and other publicly-controlled organizations, it is in a position to insist on high standards of design in the furniture it buys.

Intensifioation of the produotion of show-wood or partly-upholstered arm ohairs and seating would widen the soope of design and marketing possibilities for the upholstery seotion of the industry and for the corpus furniture sector. The produotion of offioe furniture and demountable partitioning systems would have a similar effeot.

Produotion

Produotivity in the furniture industry in the developed eoonomies of the world suoh as the Federal Republio of Germany and Sweden has reaohed an upper limit of 1.5 million Din per worker per annum. This is the standard by whioh the Yugoslav industry must measure its performanoe, sinoe it wishes to oompete suooessfully in those markets. This inevitably means inoreasing pressure on the manufaoturer to produoe more effioiently, and to this may be added higher demands for quality and finish from the oonsumer, and oontinually inoreasing wages and salaries.

Fortunately the industry has at its disposal a relatively plentiful supply of the basio hardwoods and softwoods required for produotion and even though it must exeroise the greatest vigilanoe in their eoonomio use, the area in whioh the industry will find the greatest opportunity for aohieving higher levels of produotivity is in the optimum use of the manufaoturing faoilities available to it. These faoilities may be summarized as the buildings, maohinery and equipment; and the skills of both management and workers.

Manufaoturing faoilities

It is sometimes forgotten that buildings, as part of the total oapital investment, have to be oosted into the produot not only in relation to their ereotion oosts but also in relation to their use and maintenanoe. They must therefore be suited to the manufaoturing aotivity planned to be oarried on in them, and yet be suffioiently flexible in their design to easily absorb any ohanges whioh may ooour in the future.

Many of the faotories visited by the expert were found to be unsatisfaotory in those respeots, a faot whioh was olearly evidenoed by the following:

(a) Badly organized prooessing and assembly lines;

(b) Exoessive oapital tied up in stooks;

(o) Buildings unsuitable for modern prooessing; maohinery and internal transport;

(d) Poor spaoe utilization and work flow;

(e) Poor quality standards;

(f) Excessive waste;

(g) Low productivity with resultant high unit costs.

This means that, at the initial planning stage of the enterprises, not all the factors concerned with growth and development were taken into account, and the factory subsequently pays the penalty for this lack of foresight. In the case of a particle-board or saw-milling plant such long-term planning is simple, but in the case of furniture and joinery plants it is quite complex because of:

(a) The multiplicity of the work processes;

(b) The unlimited number of designs and design combinations;

(c) The speed with which technological changes occur.

It is therefore relevant to the immediate needs of the industry to consider the factors which go into the planning of not only new furniture and joinery plants, but also the reorganization and future development of existing ones, so that the mistakes of the past, to which reference has already been made, may be corrected. Once the building has commenced, the future possibility for flexibility has gone, which may result in high maintenance and personnel costs, poor utilization of machine capacity and space, high manufacturing costs, and unnecessarily high working capital costs. The factors which will allow for built-in flexibility for future requirements may be summarized as follows:

(a) Results of a careful analysis of the market potential of the product;

(b) Structure and materials utilization of the product;

(c) High rates of production through optimum use of modern machinery and equipment;

(d) High levels of productivity per worker through better factory organization, and production planning and control systems.

Among the most significant changes which have occured in these industries especially during the past 20 years has been the growth in space required for manufacturing purposes. In many instances this has as much as trebled, and while production space has increased at the rate of 20 per cent, storage areas both for work-in-progress and finished goods have increased four-fold. This is because the partly- or fully-automated equipment currently in use sets much higher limits on the necessary space for storage of processed components and raw materials. This in turn, has made demands on the provision of additional space for production planning and control, internal transport, organization and administration.

With regard to building disposal and layout for the achievement of optimum production efficiency, it has been found in practice that a building module of 7.5 metres produces a good planning base. Many types of building layouts have been tried in the past, including E-, F- and H-type buildings, but have in the main proved unsuitable. Experience has shown that the U-type building with two long parallel halls connected to one another at one end is the ideal shape, making the whole production line in the factory a complete circuit.

Figure I shows the layout of a typical factory using a "U" layout and figure II shows the intermediate and final stages of growth to the full utilization of the factory site.

The production flow is only interrupted where the material is fed in and at the point of dispatch. This layout has the following advantages:

(a) Extension is possible on three sides;

(b) Each production, storage or control area, while independent, is organically expandable;

(c) Raw material supply and dispatch can be located on one side;

(d) The inner yard is a fire lane;

(e) All expensive equipment is located in one area;

(f) Lower building costs;

(g) Centrally-located main and auxiliary services.

The main building which determines the future of the building, should therefore be considered as having at least a 20-year life. Once this has been determined, department layout and work-flow are produced in block form according to a logical sequence of operations. The criteria which apply in respect of the various areas of storage and manufacturing activities are as follows.

<u>Raw material storage</u>

This should be located beside or close to the break-down mill, and have the same environmental conditions as the production areas.

Figure I. Typical furniture factory plan using a "U" layout

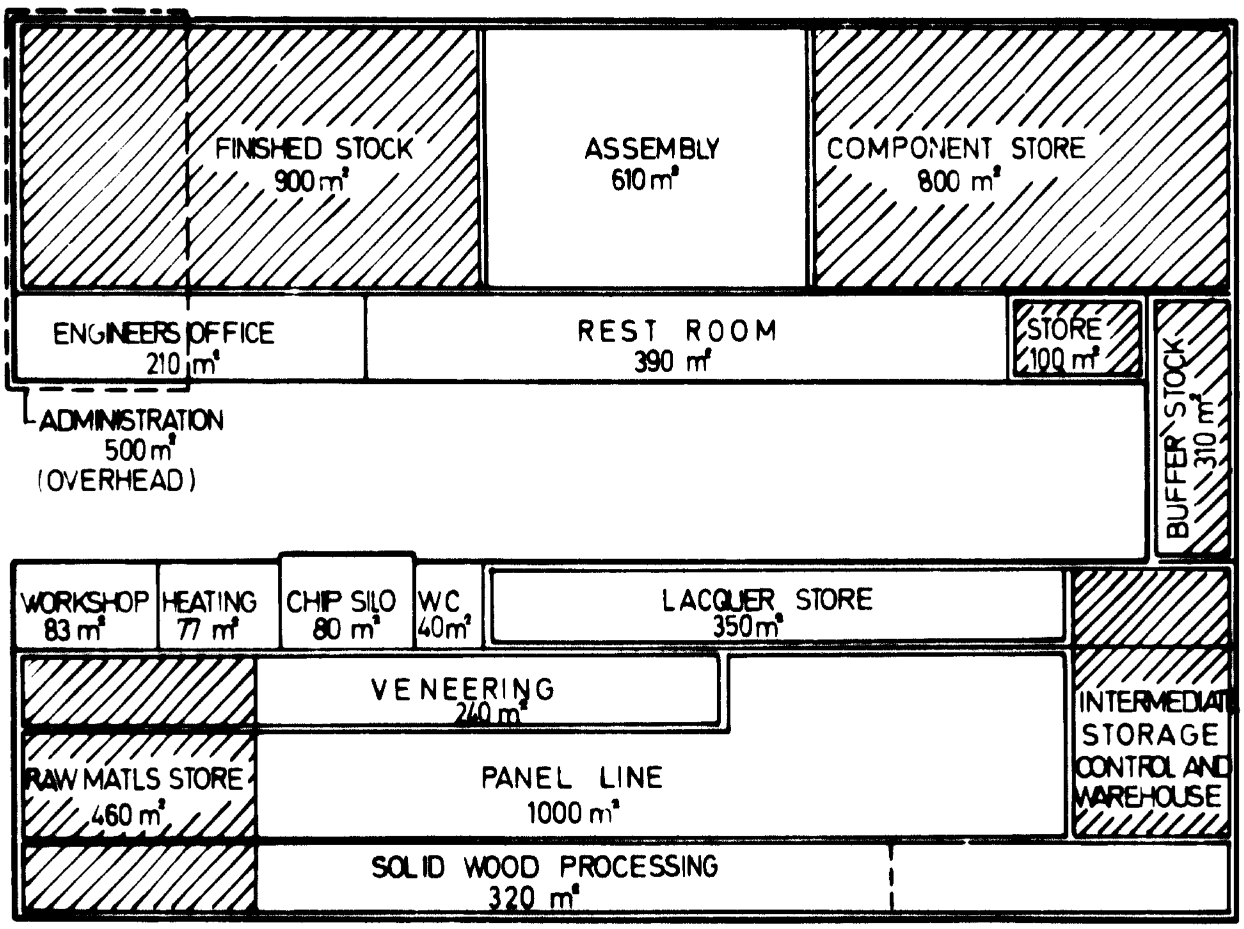
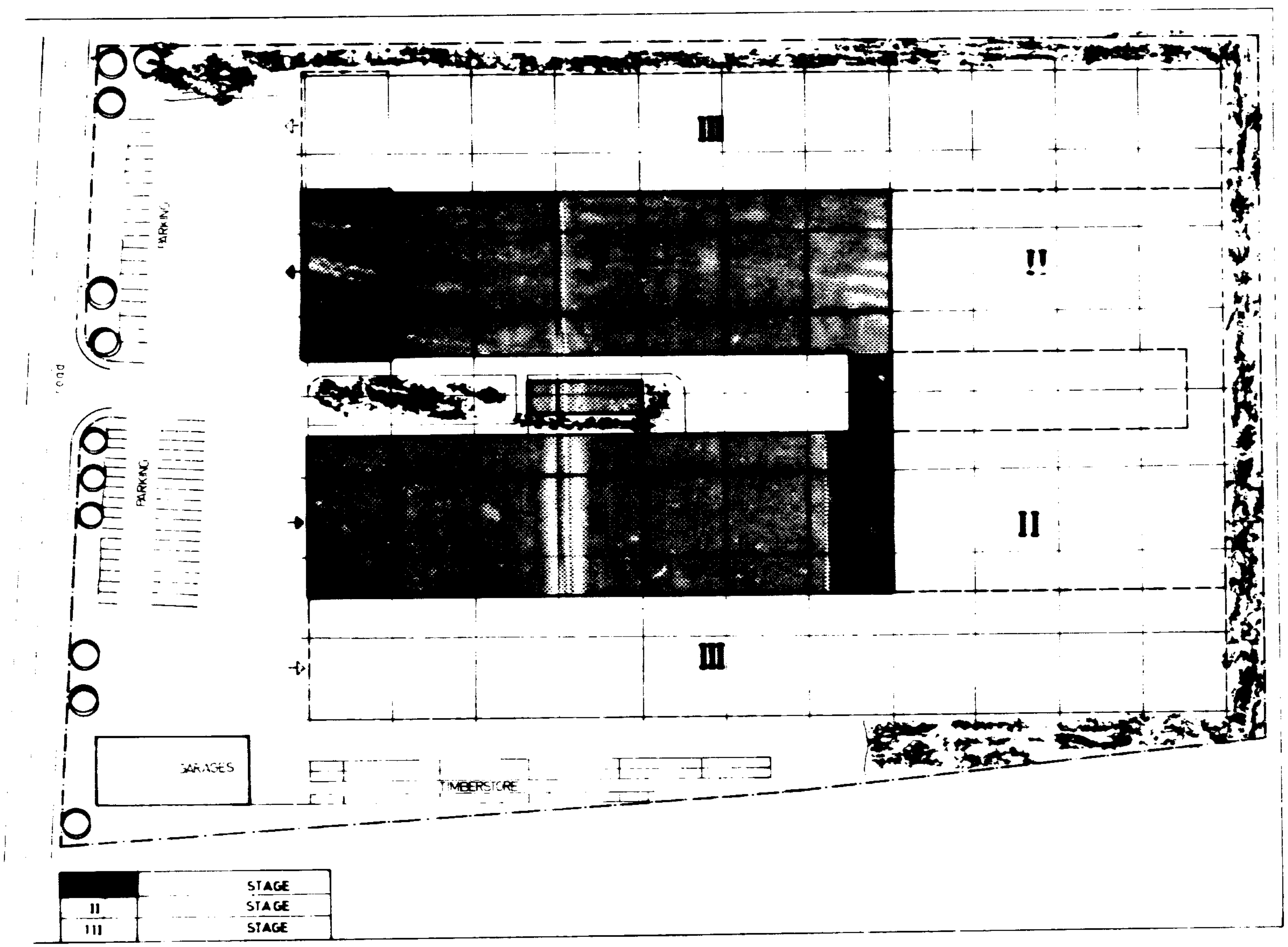


Figure II. Various stages in the development of a furniture factory



Machining areas

Since initial installation costs are high, particularly those for the foundations, these should be planned so that when expansion or re-organization is required a complete removal is not necessary. The main power and service lines should be of flexible design and located mainly at roof-truss height or under the ceiling. Compressed air lines must be on a ring system with reserve connections in each section. The electric wiring system must be carefully suited to the production areas, and the lighting system must provide general shadow-free illumination.

Intermediate storage

This area should be regarded as unwanted and should be kept as small as possible. In the case of completely knock-down (CKD) furniture it may even be eliminated. For storage long, narrow, fire-proof buildings with a minimum width of 7.5 metres should be used which should be capable of housing both rough and machined parts. Lacquer rooms should be on the outside of the building because of the fire hazard.

Assembly

The investment in this area is the smallest, but it still repays to plan according to the principles of method and work study. Work stations for various stages of assembly should be carefully organized so that the operator is enabled to work quickly and efficiently. His assembly bench, fully serviced, pneumatically and electrically, should be designed specifically to suit the assembly processes in which he is involved and he should be provided with the appropriate assembly aids, location jigs and adequate supplies of other required tools and fittings. Work delivery and disposal should also be planned so that the maximum amount of the assembler's time is engaged directly in production.

Machinery and equipment planning

The basic arrangement of the operation pattern in a machining department is as follows: rough storage, break-down (rough dimensioning), pressing, intermediate storage, sawing and cutting to shape, planing, milling, drilling, edge veneering, glueing, sanding, parts storage, lacquering, finishing, final assembly, packing and despatch.

The planning should be based on the installation of the best up-to-date equipment of maximum dimensions, even though this may initially mean that, due to oost or work load faotors, existing old equipment will have to be used initially. Identioal operations should be carried out in the same work area. The following prinoiples apply in this oonneotion to the maohining department:

(a) The rough stores (veneer, panels or solid wood) must be looated parallel with eaoh other;

(b) The press area must oontain all presses inoluding hot, oold and moulding presses;

(c) All produotion lines must be planned so as to give a minimum distanoe between individual maohines of twioe the length of the longest workpieoe;

(d) For maohines whioh are not linked, partioular attention should be given to the provision of a suitable working area around the maohine, and waiting areas for oomponents awaiting prooessing or transport to the next work station.

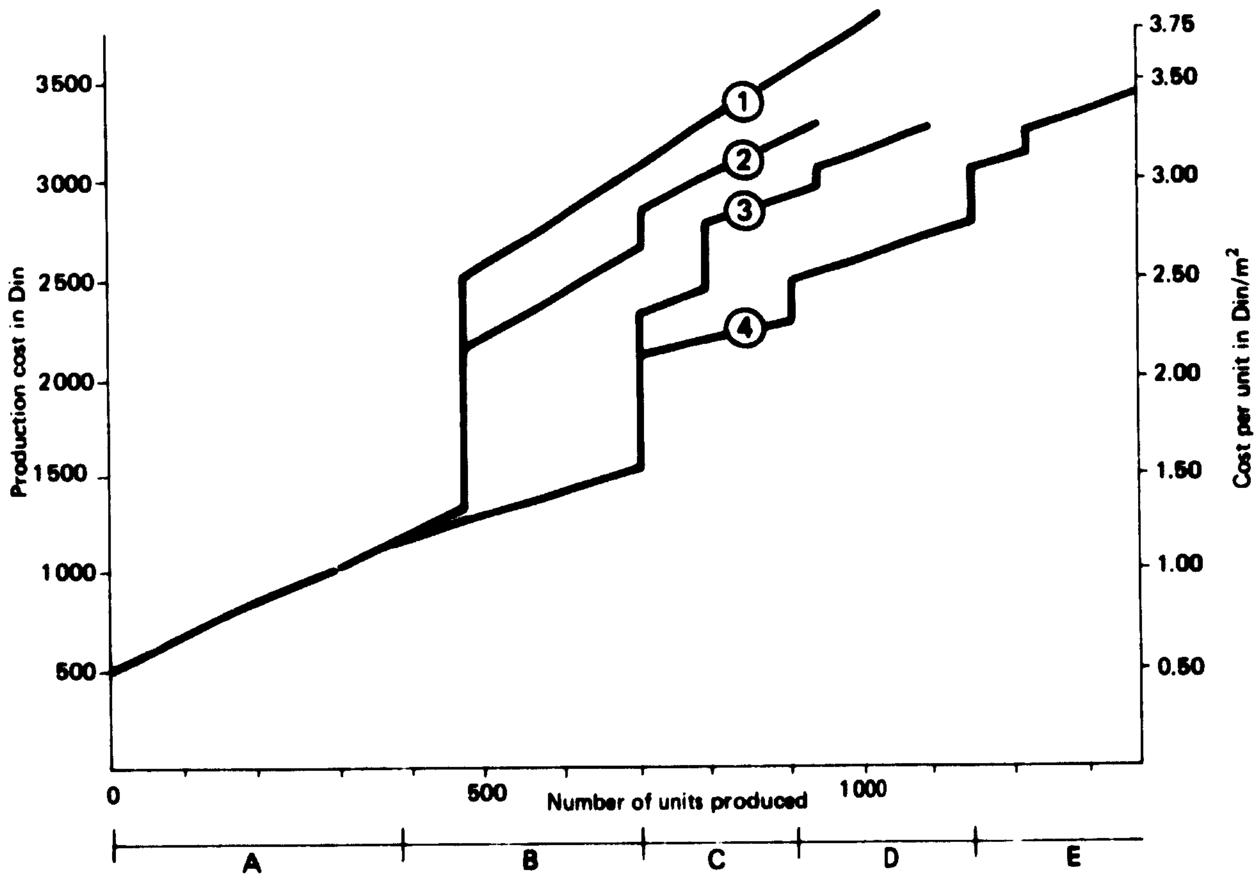
There should be adequate faoilities for transport to and from eaoh maohine without interfering with other work plaoes. The ohoioe of a partioular transport system will be influenoed by the size and shape of the oomponents being prooessed. In general, however, it may be said that for oorpus produotion roller oonveyors are the most suitable and for solid-wood prooessing live and dead pallets or bins in oonjunotion with hand-lift and fork-lift trolleys and truoks. Whatever system is used, it should be standardized throughout the faotory. Longitudinal and transverse passages should split up the entire produotion line into areas whioh oan be easily oontrolled.

<u>Seleotion of maohinery and equipment</u>

There is a vast variety of wood-prooessing maohinery available to a faotory and the diffioulty often is to make the right choice not only for speoifio operations, but also in respeot of the interrelationship between a series of prooesses and the maohines whioh oarry them out. Figure III shows produotion output with related oosts for the automated produotion of dimensioned and edge-veneered panels, and illustrates the operating relationships between individual maohines in a produotion line.

The prime reason for an analysis of this nature is to ensure that oongestion does not oooùr. Long transit times are mainly oaused by the need to adopt different treatments, eaoh of whioh brings about an element of downtime. The result is the formation of "waiting queues". The resolution of this problem will ensure optimum maohine utilization. With flow-line type produotion, the

Figure III. Comparative performance data for various processing arrangements



Key:

(1) Two conventional double-end tenoners and two veneer edge-glueing machines

(2) Linkage of two units without automated handling

(3) Complete linkage with automated handling

(4) Partial linkage with automated handling

A. One double-end tenoner and one veneer edge-glueing machine (two operators)

B. + Automated handling

C. Two double-end tenoners and one veneer edge-glueing machine (two operators)

D. + Automated handling (three operators)

E. Two double-end tenoners and two veneer edge-glueing machines + automated handling (four operators) trend has been towards a combination of processes, combining wherever possible, and consequently building up long transfer times. There are two disadvantages arising from this approach:

(a) The machine with the lowest capacity in the line determines the capacity for the whole production sequence; since, the machines with the highest rates of production are not fully used;

(b) There is a very high incidence of interruptions, and their effect on the line is one of multiplication, giving a high compounded loss in time. Thus, when a set of six linked machines fail, the interruption, which for one machine is only 2 per cent, becomes in the combined units 12 per cent.

Wherever possible, therefore, machine production lines should be planned so that they can be linked in single groups. In an analysis of the manufacture of four workpieces, it was calculated that 24 work processes were necessary, but by machine grouping this was reduced to seven processes with consequent benefits to productivity.

Upholstery production

Most factories visited by the expert have upholstery- and mattress-production facilities and in some cases these represent as much as 50 per cent of the total production. Generally these sectors have been organized almost completely informally with very little attention being paid to work-flow or job analysis. Consequently, a great deal of time and space is wasted by operatives working haphazardly. Even without considering the provision of new and up-to-date upholstering equipment, most factories could benefit from a detailed analysis of their production from which would evolve a more logical work-flow, good storage and transport arrangements, the grouping of operatives or jobs by common elements, easier production and quality control, and methods simplified by a more uniform engineering approach.

The sequence of operations concerned with upholstering may be summarized as follows:

(a) Fabric receipt and inspection;
(b) Fabric storage, handling and transport;
(c) Preparation of cutting patterns;
(d) Laying-up of fabrics;
(e) Marking and cutting of fabrics;
(f) Sewing and quilting;
(g) Button covering and buttoning;

(h) Mattress tufting;

(i) Foam cutting, jointing and profiling;

(j) Cushion filling and closing;

(k) Springing-up and padding;

(l) Upholstery and bedding assembly;

(m) Final fitting, e.g. movements, castors, glides;

(n) Packaging and despatch.

In each of these activities up-to-date machinery and equipment is now available so that the traditional approach to upholstery and bedding production, with its dependance on manual skills, no longer pertains. Indeed, well-organized factories now resemble those in the clothing industry where the emphasis is on clean lines and expert tailoring. It should also be remembered that in upholstery production by far the highest percentage of cost is in raw materials usage. Some factories informed the expert that these costs exceeded 80 per cent, and this was clearly evident from an examination of the products referred to. In appearance, they lack elegance and consumer appeal and would therefore need to be re-designed as well as re-engineered. Not the least effect of this approach would be an immediate and substantial improvement in productivity.

Factory organization

The programming of the work-flow through a factory so that the maximum added value is achieved in the minimum time, is a complex and never-ending task. This is attributable to the ever-changing marketing situation, since the customer is continually looking for more flexibility, variation and change. The production engineer has, as we have seen, to cope with a considerable number of variables, to which may be added considerations of quality, quantity and often substantial variations in raw materials. For example, in upholstery many differences in dimensions, shading, pattern and texture may be found in the same roll of covering materials; or there may be considerable variations in the same flitch of veneers leading to matching problems, and so on.

This means that the way in which work is planned, co-ordinated, controlled and monitored through the factory has probably the most direct influence on its potential for profitability. It must be remembered that the operative's function is to produce, that is to add to the value in everything he does without taking from the profit, while the engineer's function is to ensure that through his planning and supervision, the operative is always in the position to do so.

A production system must therefore be evolved to which everyone and everything works so that there is at no stage dependance on individual skills and judgements.

This is the task of production planning and control which is therefore concerned with every activity carried on in the plant from product design to the final delivery of the finished product. It must ensure that:

(a) Supplies of raw materials are always adequate to the needs of the production programme, that they are inspected on entry to the factory and properly stored;

(b) All machines are properly maintained and set up without interfering with the production programme;

(c) The production programme itself is properly balanced in terms of work-flow, so that congestion never occurs at particular work stations;

(d) The transport system in use is suited to the needs of the programme as a whole and to individual component batches;

(e) There is a suitable quality control system in operation with clearly defined specifications for materials, processing and finishing;

(f) A proper inspection system is in operation at various stages of the production cycle;

(g) The reduction of waste is continually under review and rejects are kept to a minimum;

(h) Adequate arrangements are made for waste disposal, particularly in the rough dimension mill and at the bandsaws;

(i) Components are kept continuously on the move from one work station to the next;

(j) All production aids such as jigs, formers, measuring gauges, and guide profiles are accurately made from hard-wearing materials, and carefully stored when not in use.

Good production planning and control is most effectively exercised through the right kind of documentation which will incorporate in it all the information required to ensure successful production of each component. Most of the factories visited by the expert did have some kind of documentation, but only in one case did it include all the information normally associated with series production. This information sheet, usually known as a route card because it accompanies each batch through its total production cycle to final storage before assembly, should include the following: design or model number; component name and number; blank size of component; the number of such components being produced in this series; the date and time of commencement of production; the sequence of operations to be followed; the specific process to be carried out and the machine and jig or former to be used in conjunction with that machine; the time taken for each machine setting-up procedure and for each process; the number of persons involved in each process; and the wage rate per worker. There should also be provision for any specific instructions related to a particular process and for incorporation of an analysis of the costing aspects as soon as the cycle has been completed. It is also necessary to include, usually on the reverse side of the route card, a fully-dimensioned scaled sketch of the component showing the exact location, for example, of various fittings, or dowel holes, or indicating any process which must be carried out on the component. When all processes have been completed, this card is returned to the production control centre which is thus informed that the cycle is complete.

In the case of the factories within the SIPAD organization, the production planning and control documentation should be common to all. It is an essential means of inter-factory rationalization and has the added advantage of providing a sound basis for comparative performance assessment in relation to productivity and other aspects of manufacturing activity. The design of such a system should therefore receive immediate priority in any further technical assistance provided by UNIDO, which is concerned with industrial engineering.

The more rationalized a production programme is, particularly in relation to standard sizes and component interchangeability, the easier it is to plan its efficient route through a factory. This, however, is only possible to a certain degree, and corpus furniture production offers more scope in this respect than solid-wood processing, where there is a greater variety of models, a greater number of processes per component. All of these factors must therefore be taken into consideration in establishing economic batch sizes, and in addition considerations of different machine capacity and storage availability. This can only be achieved if each individual factory will carefully analyze past results in respect of individual components as well as ensure that all factors referred to are taken into consideration.

Productivity

Productivity, or output per worker per annum in fully developed countries ranges from a lower limit of 275,000 Din to an upper limit of 1.5 million Din. The level of productivity is itself related to a number of factors not all of which are strictly comparable from one country to another. Nevertheless, there is a sufficient basis for comparison in such as in the furniture and joinery industries raw materials, equipment and skills are roughly similar throughout the world. It is therefore towards achieving this upper limit that the industry must aim, and it will at the same time be the gauge by which progress towards this target is measured.

Before considering the means by which increased productivity is achieved, it is important to acknowledge that in the case of Yugoslavia, the ratio between those directly engaged in production and those who are not is roughly 1 to 1. Individual factories are obliged to employ many full-time security guards around the clock. Despite the high investment in up-to-date machinery and equipment, manual handling is still excessive. Whatever the reason, this is far in excess of the ratio obtained in many countries, including for example the United Kingdom, most other West European countries and the United States, where it is between 6 to 1 and 4 to 1. Although this fact has an important bearing on the relevancy of such comparisons, they are justified in most other aspects, and because this well above-average employment of non-productive staff is offset to some extent by such compensating factors as lower wage rates, a longer working week and local availability of basic raw materials.

It has already been pointed out how important considerations of marketing and design policy are. Efficient production also requires adequate manufacturing facilities in terms of buildings, machinery and equipment and the skills of the management and workers. A major contribution towards an increase in productivity will be the improvement of these facilities wherever it is necessary, and the expert has drawn the attention of the management to such shortcomings on the occasion of his visits to individual factories. Most of his comments referred to the unsuitability of factory buildings, poor machinery and equipment layout, inadequate internal transport systems, insufficient management control, and weaknesses in production planning. In almost all cases the additional effort required to overcome these difficulties is concerned less with further capital investment than with greater attention to such details. There is a lack of overall tightness of control, and this is particularly the case in those factories where buildings are generally unsuitable and the layout poor; as a consequence, supervision would be expected to be more effective because of these drawbacks. Such control will best manifest itself in careful production preparation, ease of work-flow, the absence of unnecessary activities and a low reject rate.

Management

The quality of management must be judged by the tasks with which it is concerned in facing the competition of world markets. In the case of the plant director, he must "like change, be good at recognizing opportunities, be willing to take moderate risk and have plenty of drive. He needs a very good knowledge of business trends in the market and the relevant technology. He must be a generalist. He needs to know the key points in financing a business, business planning, finance, marketing, production and personnel without having the time to be expert in any one field. He can and must react quickly and has little time for anything he perceives as irrelevant".[1/]

Those responsible for planning and directing production have a much more precise role to play, and their training and experience must be directly relevant to the needs of the industry. That this is not the case is evident from their lack of awareness of, or incapacity to deal with many of the problems already referred to. There is no magic formula by which an engineer can be automatically inspired to deal effectively with the complexities of production in management. Rather it is, at the training stage, a learning process, and the knowledge must be imparted only by those who themselves are fully qualified and experienced in the industry, and continue to remain abreast of its technological development.

The expert understands that engineers are trained at the Mechanical Faculty of Sarajevo University. There they undergo a 4½ years course leading to the degree of Engineer for Wood Processing. They subsequently take up employment in a primary or secondary wood-processing factory. Since secondary wood processing is of relatively recent origin, it would not be surprising if the faculty tended to concentrate more fully in its training programmes on primary processing, because most lecturers would have gained their experience in this field.

Considering the syllabi followed, the way in which many otherwise excellent engineers deal with specific production-engineering problems, and discussions on the subject which the expert held with individual engineers, it is hard to escape the conclusion that much more could be done at the training stage to ensure greater relevance particularly in respect of the joinery, corpus and solid-wood furniture industries, and the upholstery industry.

[1/] Bolton Report on Industry, United Kingdom.

The grade of wood industry technician, a level of management which bridges the gap between that of the engineer and the operative, does not exist, and therefore no training is provided for it. Normally this individual receives a thorough apprenticeship training, works some time as a journeyman craftsman, and then returns to a technical college to receive further training in the scientific and engineering aspects of his craft. He is subsequently involved in the technology of production planning, an activity for which he is best suited by virtue of his background and training. At present the university-trained engineer is expected to fulfill this role, for which he is neither trained nor suited. Meanwhile the work in which he should be engaged e.g. industrial engineering, work planning, work study, engineering economy, suffers by default.

The nature of the training required for both categories should therefore have appropriate emphasis placed on the following:

(a) Furniture plant layout and design. Problems in industrial plant design as applied to furniture and joinery manufacturing, building structures, equipment location, space utilization, power utilization, light, heat, ventilation and safety, materials handling, maintenance;

(b) Wood-working equipment. Study of production wood-working equipment for cutting, shaping, sanding, veneering and assembly operations; capabilities and limitations of machines, theory and practice of cutting and sanding wood; low-cost mechanization, pneumatics, electrics and hydraulics;

(c) Wood processes. Processes of drying, gluing and finishing wood; reconstituting wood as fibreboard, hardboard and particle board;

(d) Engineering economy. Study of criteria and techniques for management decisions in relation to economy of design, selection, and operation; effects of depreciation policies and machine replacement;

(e) Furniture design and construction. Detailed drawings and bills of materials from samples and designers' sketches. In construction, emphasis is placed upon good performance under varying atmospheric moisture conditions, adequate strength and rigidity, and low cost;

(f) Furniture manufacturing and processing. Study of production methods in the furniture industry, including production procedures from the timber yard, through all operations, packaging and despatch;

(g) Manufacturing controls. Development of principles, procedures and documentation for control of materials, manpower and costs with special attention to production and inventory control, equipment utilization, work study, wage classification and cost reduction programmes;

(h) Quality control. Economic balance between cost of quality and value of quality. Statistical theory and analyses as applied to sampling, control charts, tolerance determination, acceptance procedures and control of production.

(i) Upholstery production.

(i) Upholstery equipment and technology: Equipment for fabric inspection, laying up, marking and cutting, sewing, buttoning and quilting, foam cutting, jointing and profiling, cushion filling and closing, springing up, assembling, packaging; capabilities and limitations of machines; theory and practice of cutting and sewing; low-cost mechanization, pneumatics, electrics and hydraulics;

(ii) Upholstery processes: Processes for cutting fabrics, matching, sewing, springing, finishing, reconstituting foam and other filling materials;

(iii) Raw materials technology: Basic raw materials, including textiles, natural and imitation leathers and polyvinyl chlorides;
Cushioning materials, including latex and polyurethane foams;
Resilient webbing and other seating support materials;
Quilting and buttoning materials;
Needles and threads for various sewing techniques;
Spring materials;
Stapling, nailing and fixing.

Students graduating from the university require further post-graduate training in a variety of factories before taking up permanent employment in one of them. Since SIPAD incorporates a very large number of factories, this could be easily arranged, and the expert recommends that this should be done not only for newly graduated engineers, but also for others who are already working. They should also visit factories abroad, attend courses in specialized subjects related to their industry, participate in study-tours and UNIDO fellowships and be provided with technical and trade literature published in Yugoslavia and abroad.

Standard specifications and quality control

Organizations responsible for the preparation of national standards and the maintenance of quality control for furniture are operating as effectively as possible, given the prevailing situation with regard to current raw materials utilization and product design. It is obviously not their function to introduce new designs, but to subject existing products to the performance standards laid down. Should the industry introduce new materials and techniques, there is no reason why they would not adapt existing standards to suit such changes. They should also be prepared to adopt existing quality control and test procedures currently used in other countries.

In any event, furniture being produced for export must conform to the standards of the country to which it is being exported. In the case of dining-room chairs, the major kind of seating so far sold outside Yugoslavia, there have been few, if any, problems regarding standards.

These national standards organizations could, however, assist the industry in considerably shortening the time it takes, often extending well over a year, for a new design on the drawing-board to reach the consumer. Such a reduction in time is in the producer's and consumer's interest. A long product development cycle can mean that by the time the product becomes a standard item, it will have lost its sales impact.

The best solution, and one that has found favour in other countries, is for the larger factories to install their own test equipment. This equipment is relatively cheap and can be operated under the same conditions and to the same standards as those existing in the national organizations. In this way not only would the whole process of product development be speeded up, but also more effective quality control procedures could be adopted.

There is no shortage of trained personnel in the factories capable of carrying out the testing and other quality control procedures effectively. They would probably require no more than a short, intensive training course to become familiar with all the requirements.

It is also recommended that these institutes maintain close relations with other similar institutes abroad, particularly the Furniture Industry Research Association in Stevenage, United Kingdom, and the Centre Technique du Bois in Paris. Both organizations have carried out a great deal of detailed research into furniture design and production, the results of which have proved beneficial to the industry throughout the world.

It is also the responsibility of standards and quality control organizations to keep the furniture industry informed of changes that may have been made in national standards specifications in other countries, so that the factories exporting to those countries may incorporate the changes into their products.

Annex VI contains a description of graded performance tests for seating, easy chairs and settees, that should be used in conjunction with the standards for corpus and other solid-wood furniture, which are already available from the Yugoslav Bureau of Standards.

Research and development

Within the organisation of SIPAD research and development is the responsibility of the Research and Development Sector. It is still very much at its initial stage and the intention is to provide a comprehensive technical advisory service to the factories which will be concerned with research into existing raw materials utilization, product engineering and the technology of glueing, finishing and upholstery.

It therefore would be expected to play a key role in the reorganization and development of the industry and to do this effectively it should be staffed by experienced technologists preferably drawn from the industry. No doubt it will collaborate fully with the reconstituted Wood Technology Institute, but to be really effective it should become part of the latter so that it may benefit from the proximity of other disciplines such as design, industrial engineering and training, which presumably will be operating under the same roof.

Industrial engineering within the SIPAD organization appears to be largely the responsiblity of "Sumaprojekt" which provides consultancy services in respect of design and planning of new factories and the reorganization and development of existing ones. The expert understands that most of this organization's time is taken up with the former activity, and while undoubtedly this is important, it is perhaps even more so that existing factories should receive active and continued attention. Very often the factories are themselves unaware of the need for reappraisal, because they are fully occupied with the immediate problems of production, but, as has been emphasized throughout this report, they have many weaknesses which need to be dealt with immediately.

"Sumaprojekt" should therefore have a special department to deal solely with this situation. It should be staffed with the most experienced engineers who fully understand every aspect of factory organization and management as well as the technology of production. These engineers must realize that initially they have a "selling" job on their hands, that is, they must sell themselves as well as their ideas to management and thus win the confidence of the latter in executing meaningful change. They must also work very closely with the staff of the Design Centre because the two disciplines are so closely interwoven technically and are also interdependant commercially.

It must be said that the Design Centre has so far not made any kind of worthwhile impact on the various factories. This is regrettable, particularly when it is realized how desperately and urgently they need design. But just as in any other kind of business, the factories have to be convinced of this. Up to the present this has not been the case.

Just like factory reorganization, the idea of design involvement must be "sold" to the management, which means that the product has to prove its worth

Thus the Centre cannot expect to "have its loaf and eat it" or in other words, expect the factory to pay them in advance for a design, which in the first place they would not have produced without being reasonably sure of its potential success. To do otherwise is to completely misconstrue the whole purpose of design in relation to the commercial aspect of the furniture market both from the points of view of the market and as a revenue earner for the Centre. The factories will be the first to appreciate the sharing of the risk element in new product design and will draw encouragment from the Centre's willingness to do so.

It must also be emphasized that "selling" design does not mean producing a drawing in isolation from a factory and then presenting it to the factory for subsequent development. An important characteristic of various stages of design procedure and management, as described in annex IV, is the total involvement of the designer from start to finish, and that he will not be concerned with one product only, but with a whole range of interrelated products and their promotion, e.g. exhibition and fair participation, catalogue and brochure design and house-styling. The Design Centre should concentrate initially on one or two factories, or for example, work with one working organization (R.O.) such as "Majevica" in the development of an interrelated design programme for its nine factories which would enable it to fully exploit its production potential. Eventually the Design Centre should become an information centre for design from which the activities of all SIPAD designers would be co-ordinated and where a permanent exhibition of their designs would be on view to the public.

Inter-factory co-operation

The possiblility of co-operation between factories in the same line of business is always an attractive consideration, at least in theory. Its implementation, however, can provide many pitfalls particularly if the factories are competing with each other in the same sector of the market. In the case of the SIPAD organization, they are already committed to at least horizontal integration, and while much has yet to be done before full implementation is achieved, the prospects are potentially very rewarding. The most important aspect of this co-operation is the total commitment of management, particularly at factory level, to its success and it will require at times a degree of unselfishness and a preparedness to make sacrifices from which only the organization as a whole may benefit.

It will not be easy, therefore, to achieve this integration whioh has been made more difficult, as we have seen, by the fierce competition existing between factories making similar products. But it is preoisely in order to avoid self-destructive competition that the whole idea of co-operation should be avidly pursued. For example, there is little sense in two SIPAD factories produoing bedding or upholstery individually, when by combining their resouroes in one faotory, not only would they avoid oompetition, but they would also produoe more efficiently and profitably.

The expert experienced many similar oiroumstances where such oo-operation would be to everyones benefit, and he reoommends that the following fields of operation be investigated in this respeot:

(a) Planning. Exchange of experienoe, oo-ordination of planning, joint purchasing of elements, joint total purchase;

(b) Produot design. Design oo-ordination, product rationalization, joint marketing, joint promotion;

(c) Production. Division of production range, joint production, inter-firm comparison, product development, research and development, production documentation, standard specifications and quality control;

(d) Raw materials. Combined produotion, combined purohasing, standard specifications;

(e) Administration. Commeroial prooedures, finanoial oontrol prooedures, data prooessing, dooumentation;

(f) Training. Common training programmes for management and operatives, oommon training prooedures for management and operatives, joint seminars and workshops. joint study tours, joint attendanoe at trade fairs.

This list is by no means exhaustive and it will be found in practioe that one form of oo-operation almost always leads to another. The oo-operation itself must be oarefully planned and oo-ordinated, and this will be the funotion of the SIPAD Kombinat (oo-ordinating unit). In order to do it effeotively it should appoint a full-time oo-ordinating offioer who will advise and assist in the implementation of this work. He should be an experienoed engineer who is familiar with all aspects of factory management and one who is capable of assessing the potential for co-operation in terms of the corporate strategy. He should also act as a liaison officer and honest broker between the individual factories and the SIPAD Kombinat, as well as at inter-factory level.

Future UNIDO assistance

In the field of industrial engineering, the expert recommends that further assistance should be provided along the lines of that carried out in the current assignment, with particular emphasis on the implementation of the recommendations contained in this report. The sheer size of the industry, and its physical location over a wide area made total contact impossible. All the factories which participated in the programme were found to have many problems in common, most of which could only be highlighted rather than solved in a period of two months. Should a future assignment be for a similar period, this would be best spent by concentrating on assisting one working organization on a pilot basis so that the experience gained in this way might be more satisfactorily shared with other working organizations later.

There should also be closer collaboration with "Šumaprojekt", and at least one engineer from that organization should accompany the expert in his field work. If possible, the expert should also be given the opportunity of spending some time with the consultation section of Institut za Drvo, in Zagreb which is now working with at least one factory within the ŠIPAD organization, and intends in the future to work with others.

Young engineers would benefit from attending short intensive post-graduate courses in industrial engineering at either Rosenheim or Detmold colleges of technology in the Federal Republic of Germany, and these could be made available through UNIDO fellowships. Successful participation would, however, depend on fluency in either the German or English languages and potential candidates should in the meantime reach an acceptable level of proficiency in one or the other language.

The expert also recommends the holding of two study tours, one for personnel in the joinery industry and the other for those engaged in furniture production, to factories and other relevant institutions in the United Kingdom. The purpose of these study tours would be to see at first hand the developments of these industries and to relate it to the specific needs of BiH. Accordingly, all factories and institutions to be visited would compare in size and scope with those of the developing needs of BiH.

The following outline programmes for the study tours should be followed as closely as possible, and final details should be subject to careful planning and liason prior to the commencement of the tours:

1.	Titles	A. Joinery study tour B. Furniture study tour
2.	For whom	Engineers and teohnioians who are engaged at management or supervisory level in the produotion of furniture or joinery
3.	Period	From Sunday departure Zagreb or Belgrade to the following Saturday return to either plaoe for eaoh tour. Tour A to be immediately followed by tour B
4.	Number of partioipants per tour	10
5.	Travel	**External, scheduled airlines** **Internal,** publio **transport**
6.	Looation	Greater London area
7.	Aooommodation	Appropriate London hotel
8.	Tour dates	Two weeks in late Autumn

9. Tour programmes

Tour A - joinery

Visits to faotories produoing the following: flush doors; standard windows; off-standard joinery; timber-framed housing; laminated struotures.

Visits to the Timber Researoh and Development Assooiation (TRADA); the Princes Risborough Laboratory (Building Research Establishment); the Furniture and Timber Training Board (FTTB); a technical college for the timber and joinery trades; manufacturers of wood-preservation and timber-drying equipment and of wood-processing machinery and equipment.

Study tour review and preparation of tour report.

Tour B - furniture

Visits to faotories produoing the following: oorpus furniture; ohairs and frames for upholstery; upholstery; bedding; furniture inoorporating wood bending and lamination.

Visits to the Furniture Industry Researoh Assooiation (FIRA); oolleges for the training of furniture design and produotion management personnel; **Furniture and Timber Training Board (FTTB); design oentre and furniture exhibitions; manufacturers of wood-prooessing machinery and equipment.**

Study tour review and preparation of tour report.

10.	Interpreter	A full-time interpreter should be provided for eaoh study tour.
11.	Tour leader	This should be a UNIDO expert who is oapable of planning, organizing and leading eaoh group

II. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The industry for the most part is well equipped with up-to-date machinery and equipment. Many factory buildings are unsatisfactory because they were badly planned originally, and little provision was made for orderly expansion. Not enough attention has been paid to plant layout and optimum use of all available space, internal transport, and cheap and simple methods of reducing handling costs. Cramped working conditions were to be found in many of the factories visited, particularly in the solid-wood and upholstery sectors. This was in sharp contrast to the orderliness generally prevailing in the corpus sectors of the factories.

2. Production techniques require to be improved particularly in factory planning, production planning, control documentation, work study, design of production aids, work flow, design of individual work stations, materials inspection and storage, and packaging.

3. The levels of skill practised in each of the departments are generally good. With improved management systems and better overall planning and supervision, productivity could be increased considerably.

4. Training for engineers and designers does not appear to be in line with up-to-date developments in the industry.

5. The industry has plentiful supplies of basic raw materials, but some are not always the most suitable for specific requirements.

6. The industry's deficiencies are most apparent in design, the meaning and function of which do not appear to be fully understood. If this aspect is not improved, the industry cannot hope to expand exports.

7. Within the ŠIPAD organization, the commercial sector (ŠIPAD Comerc), the Design Centre and the Research and Development sector could play a more positive role in improving design standards and developing more up-to-date materials and structural details.

8. The future of the BiH furniture industry, especially for exports, does not appear to lie in the use of mass-production methods, but rather in the production of well-designed distinctive products of above average quality.

9. SIPAD has immediate plans for further expansion of its manufacturing activities. These should not be proceeded with until full utilization has been made of existing production resources.

10. Further investment is required, particularly in the upholstery sector of the industry.

11. Individual factories must see themselves as competing with those producing other consumer durables such as television sets radios, record players, electrical equipment, rather than among themselves.

12. National standards for product specification, materials utilization and quality control are not as universally applied as they should be.

13. Most of the factories are large enough and have a sufficient number of trained personnel to have their own product testing facilities.

14. Closer liaison between the national agencies responsible for quality control and standards and the factories would reduce considerably the time taken to introduce new models to the market.

15. The training of engineers in wood processing is not sufficiently broad in scope to be completely relevant to the current needs of the furniture and joinery industries.

16. There is no provision for the training of furniture and joinery technicians in the industry. This is a category of management which is urgently needed.

Recommendations

Design

1. Design standards throughout the industry should be raised.

2. Each factory or group of factories should have its own design programme distinguishable from, but complementary to, design programmes of other groups within SIPAD.

3. Agreements by individual factories to produce "imported" models, or to manufacture under licence, should be regarded only as an interim solution to the problem of design.

4. Public institutions should insist on high standards of design in the furniture they buy or the purchase of which they finance.

5. The Design Centre, in executing designs for industry, should involve itself more closely with individual factories. Design fees should be on a royalty basis. There should be a permanent exhibition of new designs at the Centre.

6. The Design Centre should investigate the needs of the home market, particularly in respect of furniture which is suitable for present living conditions in apartments in high-rise buildings, and design new ranges of furniture accordingly.

7. Additional product areas should include demountable partitioning systems, show-wood easy chairs and seating, and bathroom furniture.

Product Development

8. Since there must always be very close collaboration between the drawing office and the prototype workshop, the two should be located in adjoining areas in the factory.

9. Prototyping facilities should in general be improved, and prototyping should not be done in the factory proper.

10. Prototyping should also include the design and production of all processing aids such as master parts, formers, jigs, measuring devices and fixtures. These items should be made from materials which have particularly good wearing properties.

Raw materials

11. At least one of the particle-board plants within the SIPAD organization should produce a board finished with a pigmented melamine coating. This is urgently required for kitchen and bathroom furniture production.

12. Home manufacturers of raw materials such as furniture fittings and foam and springing systems should improve the quality and variety of their products.

13. Considerable savings in raw materials utilization is possible by the application of the principles of design engineering and value analysis to the products manufactured.

Production and productivity

14. Greater attention should be paid to factory planning, work planning, machinery layout, job analysis, production planning and control, materials inspection, storage and handling, and internal transport.

15. Production planning and control systems and procedures should be fully documented and the documentation should be uniform in all factories.

16. The volume of batch or series production should be more carefully calculated on the basis of factory capacity, so that congestion in work flow is avoided at all times.

17. There should be stricter supervision of the work flow, particularly in confined areas and supervisors should also act as progress chasers.

18. Work should never be permitted to accumulate around individual work stations.

19. The design of work stations, particularly in the machining, upholstery and assembly departments should be improved.

20. The principles and practice of work study and low-cost mechanization should be a permanent feature of production co-ordination and supervision.

21. All products should be subjected to an assessment based on value analysis and appropriate design engineering techniques.

22. Quality control should be made more effective and the reject rate reduced substantially by establishing written quality control standards and specifications and by improving inspection systems.

23. Lighting throughout many plants should be improved and this improvement maintained. Because of the problems in variation of patterns and colour shading, veneer preparation, finishing and upholstery processes should always be carried out in artificial lighting because of its uniform intensity.

24. The "housekeeping" in most plants should be considerably improved. Exhaust systems should be dust-escape proof, floors should be kept clean, gangways clearly marked and kept clear, and waste bins provided where waste or offcuts normally accumulate.

25. In order to achieve an acceptable level of productivity, specific production targets based on capacity and known performance, should be set in advance of production and monitored daily.

Management and workers

26. Job specifications and responsibility levels should be clearly defined for all management and supervisory personnel.

27. The categories of furniture and joinery technicians should be included in the managerial structure of each factory. Reponsibilities of such technicians should include all technological aspects of their craft.

28. Before taking up a particular management appointment all personnel should undergo a period of induction and training. In the case of production engineers, this should include periods in other factories within SIPAD so that they can understand better the relationship between individual factories.

29. There should be weekly production co-ordinative meetings between production engineers in the various departments. There should also be weekly meetings between the plant directors and their engineers at which all aspects of production including raw materials, supplies and progress in achieving targets would be discussed.

30. Engineers should understand and apply such management techniques as work study, production planning, production controlling, quality control, work programming, machine loading and waste reduction.

31. Supervisors and engineers should realize that there is no substitute for direct and personnal supervision. They should therefore spend much of their time on the factory floor.

32. The level of skills should be further upgraded by the application of strict supervision and quality control.

33. The job of the operative should be to produce and that of management to ensure that he has all the facilities necessary to do so.

Training

34. In-plant training programmes should be immediately established as a matter of policy for all plants and all grades of management within SIPAD and in the other plants in BiH.

35. While the training content will take various forms, according to the subject matter and grade of management or worker, it should be uniform throughout BiH.

36. SIPAD should appoint a full-time training engineer to plan and implement the various training programmes.

37. The training of engineers at the Faculty of Mechanical Engineering in Sarajevo should include a greater degree of relevance of its syllabi to the needs of the furniture and joinery industries.

38. Engineers should spend some time in other plants in BiH before working permanently in one of them.

39. Special courses for the training of furniture and joinery technicians should be organized at the Technology Institute Sarajevo.

40. In the training of production workers particular emphasis should be placed on the achievement of skill and craftsmenship. A section of each plant should be set apart for this purpose.

41. Training should also include the following: the organisation of study tours at home and abroad; attendance at trade fairs for processing equipment, raw materials and end-products; participation in UNIDO workshops and seminars; fellowship for special categories attendance at full-time and part-time trade and management courses.

42. Personnel should be encouraged to study at least one foreign language. German or English would be the most appropriate in order to acquire the technologies used by the furniture plants in the markets they wish to enter.

Standard specifications and quality control

43. National standard specifications for furniture of all types should be

adopted as a matter of policy, and should be fully excercised by each individual plant.

44. Each factory should have and use a copy of Minimalni uslovi kvaliteta namestaja, the Yugoslav handbook on quality control and furniture testing.

45. As part of their quality control systems each plant should have some performance testing equipment, particularly for dining-room chairs, which would be operated in collaboration with the Yugoslav Bureau of Standards. This should help considerably to speed up product development to the stage when it will be ready for the market.

46. Management should ensure that quality control is everyone's responsibility, and that such standards apply in all circumstances.

47. Quality control specifications and procedures should be uniform throughout the SIPAD organisation.

Research and development

48. The Research and Development Sector of SIPAD Kombinat should be located in the Wood Technology Institute and should work very closely with the other departments there, particularly in relation to raw materials replacement and utilisation, product development and the technologies of glueing, finishing and upholstering.

49. It should, as a matter of urgency, examine the possibilities for the production of melamine-faced particle board for kitchen furniture production.

50. It should also assess the suitability of such materials as furniture hardware and fittings, upholstery fabrics and cushioning and upholstery springing systems.

51. It should provide a comprehensive technical information and advisory service to industry concerned with every aspect of production technology. This should be in the form of a well-produced and well-illustrated technical bulletin.

52. The staff of the Research and Development Sector should also work closely with the factories and should visit them frequently.

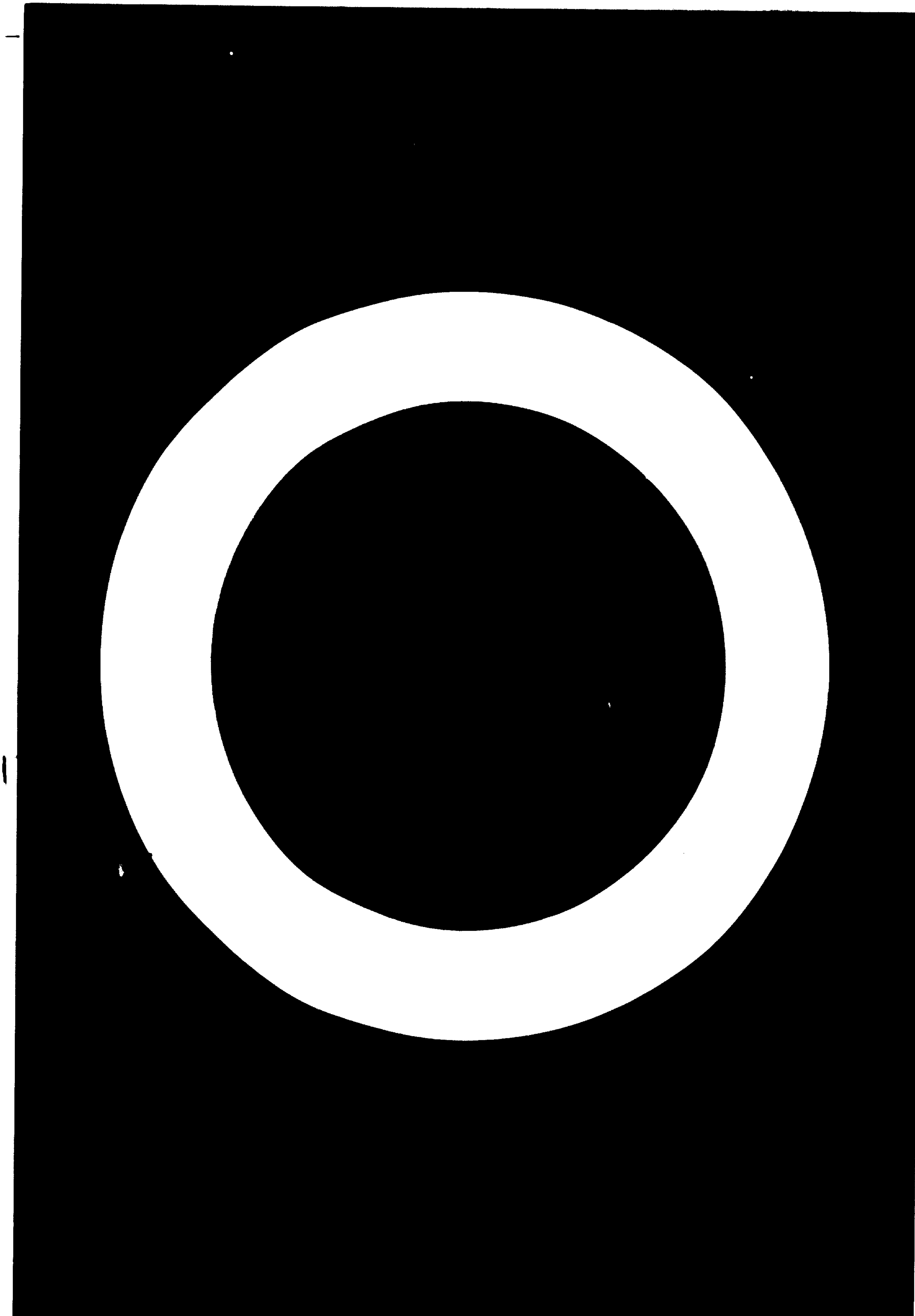
53. Sumaprojekt, in providing a service of industrial engineering and factory planning, should place greater emphasis on the re-organisation and development of existing factories. This assistance is urgently needed.

Inter-factory co-operation

54. Co-operation should begin at working organisation level and should be concerned, at the beginning, with those areas of activity where it can be most easily implemented. This should include product design and marketing for export, promotional activities, participation in trade fairs, representation abroad, and shipping.

55. Later it should develop into other areas of activity including design and product rationalisation, production rationalisation, quality control, research and development and training.

56. There should be a joint committee appointed to plan, promote and implement inter-factory co-operation and there should be a representative of each plant on this committee. The committee should be advised and assisted by at least one full-time senior engineer who will be responsible for planning, implementing and co-ordinating this work.



Annex I

DATA ON THE FURNITURE INDUSTRY IN BiH

	ŠIPAD	BiH
Total factories (number)	41	49
Furniture	25	31
Joinery	16	18
Service organizations		
Wood Technology Institute		
Forestry Institute		
Design Centre		
Šumaprojekt		
Computer Centre		
Total employment (number of persons)	10.538	
Corpus and upholstery production	4,573	
Solid-wood production	2,811	approx. 4,000
Joinery production	3,154	approx. 3,500
Value of production (million Dinars)		
1970	416	a/
1976	1,954	a/
1980 (estimate)	4,150	a/
Type of production in 1976 (%)		
Corpus	28	
Solid wood	24	
Upholstery	23	
Joinery	25	
Productivity in 1976 (Dinars/person)		
Furniture average	208,000	
Corpus and upholstery production	458,000	
Solid wood production	166,000	
Joinery production	156,500	
Exports (%)		
To centrally planned economies	19	
Market economies	81	

a/ ŠIPAD's contribution to total production in BiH is approximately 77 per cent.

Annex II

JOB DESCRIPTION

DP/YUG/73/006/11-03/J (31.7.A)

Post title:	Consultant in industrial engineering.
Duration:	Two months.
Date required:	As soon as possible.
Duty station:	Sarajevo, with travel in the Republic of Bosnia and Herzegovina.
Purpose of project:	To assist in the development of the furniture and joinery industries of BiH, and the creation of a Centre.
Duties:	The expert will be attached to SIPAD central control organization and will be responsible to the National Project Director. He will, in collaboration with the appropriate SIPAD technical personnel, assess the state of development of industrial engineering in the Republic's furniture and joinery industries and advise the management of these plants on the development of modern production technology, design practice and process and quality control. Specifically the expert will also be expected to:

1. Survey the present level of industrial engineering in a representative sample of the Republic's furniture and joinery plants;
2. Advise on its further development with specific reference to product design; factory planning; organisation of production; productivity; standard specifications and quality control; research and development; industrial training;
3. Asses the consulting facilities offered by Sumaprojekt, the SIPAD planning and consulting agency and elaborate plans for its further development in terms of the immediate and long-term needs of these industries.

The expert will also be expected to prepare a technical report, setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.

Qualifications:	Industrial engineer with high level experience in consulting to a large range of industries. Experience in furniture and joinery industries desirable.
Language:	English; French acceptable.

Background information:

The furniture and joinery industries in BiH contribute about 8 per cent to the Republic's gross national product, and represent over 4 per cent of its exports. An ambitious five-year development plan is being implemented to double the production of furniture to attain Din 2,000 million and increase the work force from 6,000 to 9,000 persons. This plan calls for an investment of Din 800 million. Joinery production will increase from Din 200 million to Din 650 million and the work force will treble to attain 4,500 persons. Investment of Din 950 million are foreseen for joinery plants. ŠIPAD, a co-operative integrated forest industry organization, consisting of 126 factories and employing 55,000 persons, accounts for 65 per cent of saw-milling and 85 per cent of the final products of the wood industries of BiH. The Government of BiH and the SIPAD organization have decided to create a "Centre for the Development of the Furniture and Joinery Industry" to cater for the 38 existing furniture and joinery plants within the organization, and have requested UNDP/UNIDO assistance in the development of this industrial sector and the establishment of this Centre. It is to have the following departments: technology; quality control and documentation; design, marketing and engineering; and organisation services.

The SIPAD Computer Centre is to be incorporated in the above Centre once it has been established. It has presently a staff of about 30 persons, all engaged in computer services. Industrial engineering is to be incorporated in the Computer Centre in order to create an integrated function in engineering and organisation services and computerisation of the furniture and joinery industry.

Annex III

WORKSHOP IN INDUSTRIAL ENGINEERING

Programme

Title:	Industrial engineering in furniture and joinery.	
Location:	Hotel "Jajce", Pliva Lake, Jajce.	
Date and timetable:	6 July 1977	
	08.00 - 10.00	Introduction by M. Pjaca, National Project Director and lecture by D.P. Cody, industrial engineer and UNIDO consultant.
	10.00 - 10.30	Coffee
	10.30 - 12.30	Lecture (continued)
	12.30 - 14.00	Lunch
	14.00 - 15.00	Lecture (continued)
	15.00 - 16.00	Panel discussion

Topics: Products and production potential

Part 1: Organization of production
Productivity
Management

Part 2: Product specialization and quality control
Research and development
Industrial training
Marketing
Inter-factory co-operation

Annex IV

SYNOPSIS OF LECTURES GIVEN BY THE EXPERT
AT THE DESIGN AND COMPUTER SEMINARS

Co-ordination of design, production and marketing, or design management a/

The question of design is so fundamental to the furniture industry that it would be difficult to exaggerate its importance. Yet much of the industry throughout the world still lacks any understanding of the place and function of design in relation to its products. In many cases, design, where it is given any attention, is thought of exclusively in visual terms, as something to be added to or subtracted from the final appearance of the product in order to distinguish it.

It is necessary therefore to define what is meant by design in relation to furniture. Design must take account of the production facilities of the plant, the skills of its work force, an understanding of the nature and characteristics of the materials used, the form and colour of the article, its tactile beauty, its fitness for the purpose, its decoration and its acceptability to the consuming public.

Design will therefore play as important a role in the function of management as any other managment technique. It must, however, be preceded by what is known as the product policy of the firm, that is, the range of products for which the firm was originally established. This may be the manufacture of kitchen furniture or office furniture or a particular kind of upholstery, and within that general category, a specific design range will have been evolved which gives the firm a particular identity on the market.

It is the function of management to ensure that all these considerations are given due prominence when a new or continuing design programme is being evolved. This is most effectively excercised through the establishment of a design management team which comprises the major elements of design contribution. It would include the designer, the marketing executive and the production executive. The plant manager will often find himself acting

a/ Lecture given at the Seminar on Design held at the SIPAD Design Centre in Sarajevo on 16 May 1977.

as chairman of this team, ensuring that the sometimes conflicting views and ideas of the other team members are eventually reconciled.

It is always difficult to predict how successful any particular design is going to be, but experience has shown that this approach has the best chance of success. Competition in the furniture industry is particularly keen, and it would be no exaggeration to say that in Europe, at any rate, there is probably an over-abundance of furniture factories. The consuming public is therefore faced with an enormous variety of merchandise from which it can choose, and it follows that the chances of success of any particular design are thereby lessened.

To this may be added the problem of lack of production versatility, particularly in the more recently established furniture plants. A fully automated panel-producing plant may give high productivity, but the furniture produced from it will always have a basic box-like structure and will only achieve a degree of individuality by the addition of special finishes and fittings. This further emphasizes the need for highly-trained and imaginative designers whose success in producing a saleable design can only be measured in terms of their ability to overcome these difficult obstacles.

Design as a tool of management must be costed into the product just like any other production or marketing process. While every effort will therefore be made to allow the designer freedom of expression in executing his designs, his activity must be carefully monitored so that realistic results are achieved within a reasonable time. This is only the first stage, because the design must now be prototyped, and finally put into production on a trial-batch basis. It is expected that during these stages some amendments will need to be made to the original drawing, but those should be minimal, because an experienced designer, who is fully acquainted with production techniques, will have anticipated most problems of this nature at the drawing-board stage. Naturally this control of the design function will lead to considerable cost savings which may be further added to by applying the techniques of value analysis and design engineering, particularly in relation to materials usage.

When a furniture plant contemplates the commissioning of designs by a designer who is not a member of the plant's permanent design staff, the same principles concerning design management should apply. It is essential, however, to ensure that the designer in this instance is properly briefed by the management, so that misunderstandings at a later time may be avoided. The designer must familiarize himself with every aspect of the plant's product policy, production facilities, pricing structure and market sector, and then he must be presented with a brief which shall ensure that he brings together all these elements in a product which can be made efficiently and sold profitably.

Considerations of standard specifications and quality control are other integral parts of any design programme. Performance testing, as part of the initial marketing strategy, will further ensure the success potential of any product. To these may be added the principles and practical application of ergonomics and anthropometrics culminating in a range of products in which attention to detail is always clearly evident.

Computers and production management b/

Electronic computers first became commercially available only 24 years ago. Now computer usage has grown to the extent that over $850 million are spent annually in computer departments in the United Kingdom alone and applications range from space flight to choosing a marriage partner.

This may give a false impression of computers and it is necessary to remind ourselves that they are merely machines for automatically sorting, storing, combining arithmetically and printing information.

A computer is impressive in the way it handles information only because it works very quickly and consistently and because it can be programmed to proceed automatically through a long and complicated sequences of operattions.

A computer can be compared with an automatic factory machine. Sorting, storing and processing information is like cutting, planing and processing timber. A machine, like a linked double-end tenoner, combines several operations in precisely the same way that a computer does. In both cases advantage is taken of the opportunity to delegate the control of frequent and repetitive operations.

In fairness to computers it should however be emphasised that the flexibility of a computer in controlling different sequences of operations far exceeds that of any other machine.

Before discussing the role that computers can play in assisting production management it is necessary to examine the procedures involved in

b/ Lecture given at the ŠIPAD Computer Centre in Sarajevo on 9 June 1977.

planning and controlling production and identify the information processing requirements. For simplicity, a single-stage manufacturing process will be considered, in which timber and other materials are purchased and converted into products in a mill. Stocks are held both of materials and products, so as to allow economy in batch purchasing and batch production and to enable rapid delivery to customers.

The organizational structure is made up of several interrelated management control loops, each loop being the responsibility of a different department. The purchasing manager will be responsible for maintaining a stock of materials, the production manager for maintaining a stock of products, and the sales manager for maintaining a demand for the products. In each of the control loops there are three main elements:

(a) Recording, in which performance of the factory is measured;

(b) Planning, in which the performance is compared with the targets and new plans developed;

(c) Instructing, in which the execution of the plans is begun.

Figure IV shows the three control loops corresponding to materials management, production management and sales management. The loops are shown without any links between them and are apparently operating completely independently. Though this is a potentially dangerous situation, there are many factories operating in this way. In many cases the only interdepartmental communications are informal, except in times of troubles, such as shortages, when they become highly formal and often over-heated.

In the absence of any communication between departments, the management of materials and production can only be based upon replenishing stocks. This method of control, in which materials are purchased to replace those withdrawn by production, and products are manufactured so as to replace sales, give rise to two potential dangers: firstly the items drawn from stock may not reflect the true demand if there is any possibility of substitution of materials or products; secondly changes in demand for a product take some time to reach the production manager and a considerable time before reaching the materials manager.

The solution to these problems is to ensure that sales orders are analysed and information fed immediately to the production and materials manager. This additional information channel is shown in Figure V.

Figure IV. Control loops in production management

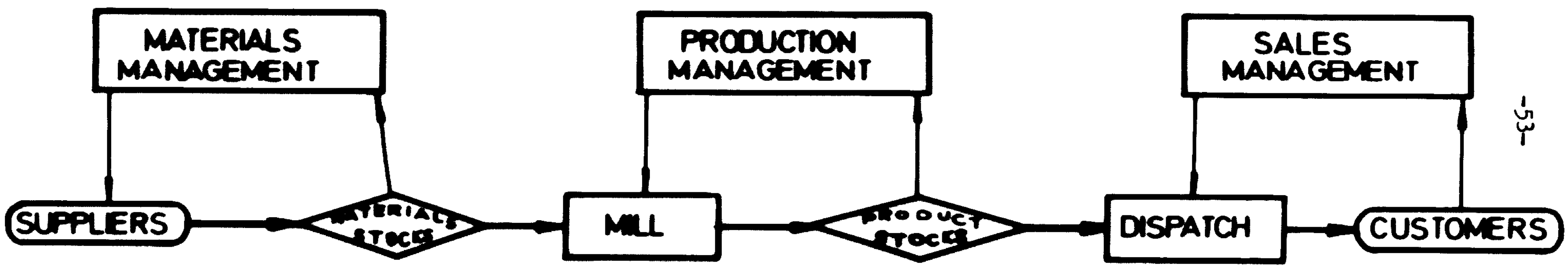
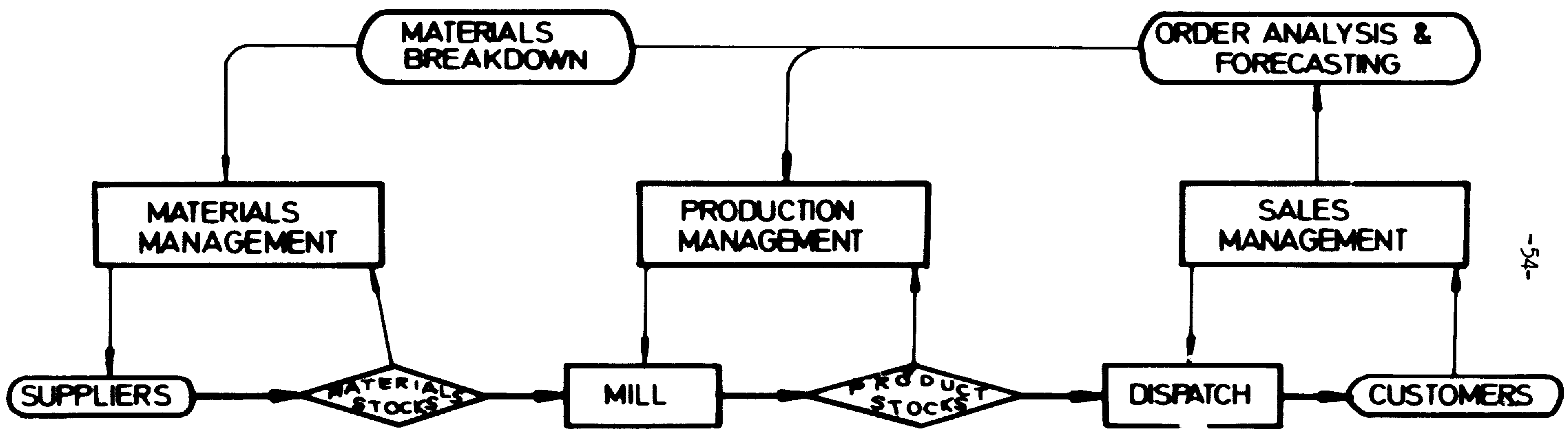


Figure V. Co-ordination of management control loops



Each of the control loops operates in essentially the same manner. In the case of production management the steps involved are as follows:

Demand analysis

Production plans are based upon an analysis of the present and expected future balances of product stock. The records used in this analysis are: the current product stocks, the planned addition to stock from production, the stocks allocated to existing orders and the expected future demands arising from orders which have been forecast. This information is combined to estimate when further production will be required.

These records must be kept up to date by adjusting them whenever a production batch or series is completed, when a new series is programmed for production, when further sales orders are received or when a new forecast is produced.

Requirement analysis

Having found when further production batches will be required, these must be broken down into demands for materials, machine time and labour. These requirements will depend upon the batch sizes, which can be chosen at this stage, to be the "Economic Batch Sizes".

To perform the "transition" (or explosion) of product batches into materials, machines and labour, reference must be made to product specification records.

Comparison of resource requirement with availability

The possibility of producing these batches of products, by the required time, can now be checked. Records showing the free balance of material stocks can be consulted to check for shortages and records showing the free balance of machine time and labour can be checked for under- or overloading.

Production planning

If shortages do occur, or if machine and men are badly loaded, adjustments must be made by changing batch sizes, arranging overtime or shift work, subcontracting etc.

Production programming

Having finally decided which batches will be made and in what quantities, some attempt may be made to sequence the batches and the production operations involved, so that the work will flow smoothly. In some cases it is impractical to plan this programme in advance; instead the entire production plan for each planning period is released as a single factory order and it is left to the production supervisor to decide which work to do next in the light of the circumstances at the particular time.

Production instructing

The material requisitions, route cards and job cards may now be issued, either as a batch or, if the work is formally programmed, individually.

Production monitoring

As the programmed operations are completed the instruction documents are returned, perhaps with notes added to them explaining any departures from the instructions. In some factories the return of one document may be used to control the release of the next. In all factories the returned documents will be used to note the completion of the activity or process instructed and to update the relevant records. It will be noticed that the flow of information in this production control loop very much resembles the flow of materials, but in a reverse direction. It will also be noted that there are several references to files containing records. The production management system depends heavily on good information files and records in these files must be kept up to date by a good work recording system.

Computer aided production management

All too frequently there are no "master files" in a factory. Instead records are dispersed throughout the factory, and in some cases do not exist except in a supervisor's personal notebook, or even in his head. It is impossible to apply successfully computers to production control without collecting all relevant sources or files of information and introducing formal systems to maintain these files. The discipline obtained in this way is one of the two main sources of improvement when using a computer. The other improvement results from speeding up the flow of information. In most factories a very significant part of the production lead time is the time taken in processing the information necessary to plan and instruct the production.

The files of information required in a production control system are:

(a) Product stock records: showing for each product the current free balance, the quantities expected from production already programmed, the quantities allocated to existing orders and the demands for each of several future planning periods;

(b) Product specification records: showing for each product the materials required and the production sequence;

(c) Production planning records: showing for each work centre the free and allocated capacities in each of several planning periods;

(d) Materials stock records: showing for each material the current free balance, the deliveries expected from suppliers for each of several future planning periods, the quantities allocated to production and the expected future demand arising from forecast orders. If production is pre-planned, a further file or record similar to the production-planning file, but showing much greater detail, will also be required.

It should be emphasized that the computer has not been assumed to take over complete control of production. The computer analyses the situation and presents management with the necessary information, and when fed with a plan of action, it translates this into instructions, and monitors the execution of the instructions. The planning decisions are and must be left to management.

Will the benefits of using a computer justify the costs?

The computer-aided production-control system already described could in principle be operated in an in-factory computer or a bureau computer. In either case the costs will not be just those of buying or hiring a computer or computer time. Systems must be redesigned and staff trained in their use; programs must be specified and tested; and information must be collected to generate computer files.

It is difficult if not impossible to say which application should be considered first and to quantify the costs and benefits of such applications without making reference to a particular sector of the wood industry, and even to a particular factory. Many factors must be taken into account and a full study of the particular circumstances should be carried out before a decision is made. In considering the process of arriving at this decision it is useful to return to the comparison of a computer processing information and a machine processing timber.

Supposing that a factory is examining the case for introducing a new machine which will combine several existing operations into one single operation, the first consideration will probably be whether or not the volume of work in the factory will provide a reasonable load for the new machine. If the utilization would be poor there may be the possibility of contracting this paricular work to another company which specializes in work using the new machine (e.g. a company owning a Zuckerman automat). An associated consideration will be the machine setting-up costs. To operate the new machine economically it may be necessary to operate with larger batch sizes, which may increase work-in-progress and lengthen the production lead times. Another consideration will be the extent to which the methods of the new machine are expected to improve the quality of the product and reduce the losses due to faulty processing. A consideration of extreme importance will be the costs of implementing the new production method. Product designs may have to be modified and machine settings worked out. The transition period, during which the new methods are tested and unexpected problems found and solved, can be made less painful by careful planning but will unevitably involve additional costs. A further consideration is the way in which the new machine will fit in with other developments in the total production system and perhaps open up possibilities for new developments such as more automatic flow lines.

These same considerations apply to decisions regarding implementation of computer systems. The information-processing work-load must be examined to assess whether an in-factory computer would be reasonably well used or whether a bureau service should be saught. The data volumes for individual runs must be examined to compare the economics of batching data over long periods against the disadvantage of processed information being less up to date. The value of processed information being more accurate and complete must be assessed. The costs of designing the system, writing programmes and implementing the new methods must be estimated. Finally, the future development of the total information system must be considered to ensure that the first step must not hinder progress.

In deciding whether to make use of a computer, which application to select first and how these should be tackled, all of the considerations referred to must be taken into account.

Annex V

REPORT ON ŠIPAD "STANDARD" FURNITURE FACTORY, SARAJEVO

Introduction

This factory was established about 20 years ago, employs 800 persons on a two-shift basis and manufactures corpus furniture, upholstery (mainly fully-upholstered suites) and bedding. It is sited on the outskirts of Sarajevo.

The expert was requested by the Director of the factory, T. Drakulić, to advise and assist the factory engineers in solving the problems of poor internal transport and unsatisfactory work flow. He was assigned two engineers, K. Jirota, Director of the Development Department, and N. Kukić, Engineer in the Development Department. Later, S. Ahmedić, Furniture Designer, joined the team.

It was agreed that the work would be carried out during the full period of the assignment, and that the expert would make a series of visits - about two per week - during which each aspect of the work would be examined, and the procedures arrived at for reorganization and replanning. The engineers would subsequently complete the drawings and relevant specifications, which would then be ready for the next visit of the expert.

Factory assessment

A preliminary survey of every aspect of the manufacturing activities of the factory was made and this indicated that, in addition to the shortcomings originally discussed, the following areas also needed attention:

(a) Product policy design and rationalization;

(b) Unsuitable buildings for production;

(c) Organization of processing and assembly sections;

(d) Space utilization and work flow;

(e) Quality control;

(f) Excessive waste;

(g) Unsatisfactory internal organization.

It was not expected that all of these could be dealt with satisfactorily during the time available, but at least a start could be made, and the engineers concerned would continue to deal with the remainder after the departure of the expert. During his assignment, however, all efforts would be concentrated on the replanning of the following:

(a) Panel production and solid wood processing;
(b) Upholstery production;
(c) Work flow and internal transport.

During the course of this work it was intended that many other problems, particularly those concerning product design, design engineering, value analysis and quality control would be dealt with at the same time. It was further agreed that the findings and recommendations of the team would be submitted to the management committee of the factory at an all-day workshop, which was convened in the factory on 7 July, the day before the departure of the expert.

Recommendations

Corpus production

Figure VI (in the pocket) shows the existing layout of the factory and the location of the various departments which are connected by a centrally-located corridor. This corridor was intended for ease of communication and internal transport. Between each factory "bay" there is an open area which, apart from providing light to the adjoining buildings, is wasted space. The resulting lack of usable space has required that processes, normally carried out in one area, have to be split up, and carried out in seperate but adjoining areas, which adversely effects efficiency and productivity. It is quite clear that this situation cannot be remidied except by carrying out major structural alterations, and the objective therefore would be to endeavour to make the best use of the existing space. The areas most affected were solid-wood processing and veneer pressing, veneer preparation, panel dimensioning, edge veneering, sanding and jointing.

As has been emphasized elsewhere in this report, the absence of the provision for orderly development at the planning stage can cause numerous and often serious problems later, and in this respect the "Standard" factory is no exception. In the long run, the only real solution would be to rebuild much of the factory and in the short term, to attempt, at minimum cost, to re-plan each area taking into account, and possibly amending, product and production requirements.

The over all impressions in these areas are ones of congestion and the absence of strict control of work flow. The congestion is caused by an excessive build-up of work-in-progress which, taken in conjunction with the limited space available for machines, work and storage areas, and clearways for the free flow of materials, indicates that all the facilities available are not adequate to production requirements. The absence of strict control manifests itself in undue delays at particular work stations, high reject levels, and the build-up of waste materials throughout the departments concerned.

Figure VII (in the pocket) shows the proposed layout of the machining and storage area. This appears to offer the best interim solution because it can be done at minimum cost and without unduly affecting production. Preliminary estimates indicate an increase in throughput in the order of 20 per cent, which, if taken in conjunction with a more rationalized approach to product design, could eventually be substantially higher.

The major recommendations concerned with this part of the reorganization are as follows:

1. The relocation of the panel-sizing machine in the area currently used for storage of particle board. Only dimensioned stock would be delivered to the machining area, and this would be stored on "dead" roller conveyors in the area vacated by the panel sizer. The primary storage of the particle board sheets should be replanned for easy access, thereby eliminating double handling at the point of entry. The additional roller conveyorization will allow for seperate storage of differently dimensioned stock.

2. The removal of machines currently not in use and the relocation of others to a more appropriate area. This will allow for the establishment of clearways throughout the factory, as illustrated, and the use of a suitable fork-lift truck around every work station.

3. The provision of additional access to the cross-cut saws for the delivery of solid wood with sufficient internal storage for at least one day's use.

4. The provision of additional storage after pressing which will optimize the use of the veneer press, and subsequent conditioning of panels before further processing.

5. The consequent removal of veneered panels from the interconnecting main corridor linking the veneer preparation, pressing and panel finishing areas. This will immediately improve the flow of materials in both directions and reduce substantially collision and damage hazards.

6. The full linking of the panel dimensioning, edge-banding and multiple-boring line and the provision of a clearway and additional roller conveyorization in the same area.

7. The readjustment and layout of the machines in the veneer preparation section.

8. The provision of specially designated parking areas for finished panels awaiting lacquering. Each line of roller conveyor is to be used for storage of one specifically dimensioned panel batch.

9. The relaying of the floors, particularly in the clearways, so that pallet-trucks and fork-lifts may move easily.

10. The redesigning of pallets and stillages to suit the various components. For example, long, flat, castorized bogies for veneer and panel transport, and specially-constructed mobile bins for small solid-wood components.

Figure VIII is a flow chart of the machining area.

Upholstery production

Figure IX shows the existing layout of the upholstery halls, one of which, upholstery assembly, is located on the ground floor and the other two, spring-making and cutting and sewing are located side by side on the first floor.

Again management must recognize that there should be a more rationalized approach to production not only in respect of product design and technology, but also with regard to its involvement in certain types of component production which are not strictly justified by both, space and availibility of equipment. There is also the need to have processes which are interdependant to be carried on as close as physically possible to each other. Product design must, as well, reflect in its make-up the considerable advances which have taken place in recent years in upholstering technology.

Figure X shows the proposed relayout of the upholstery department and the following major recommendations are made:

1. The factory should discontinue the manufacture of mattresses, since it is not realistic to produce them in such limited quantities.

Figure VIII. Flow chart of machining area at Standard, Sarajevo

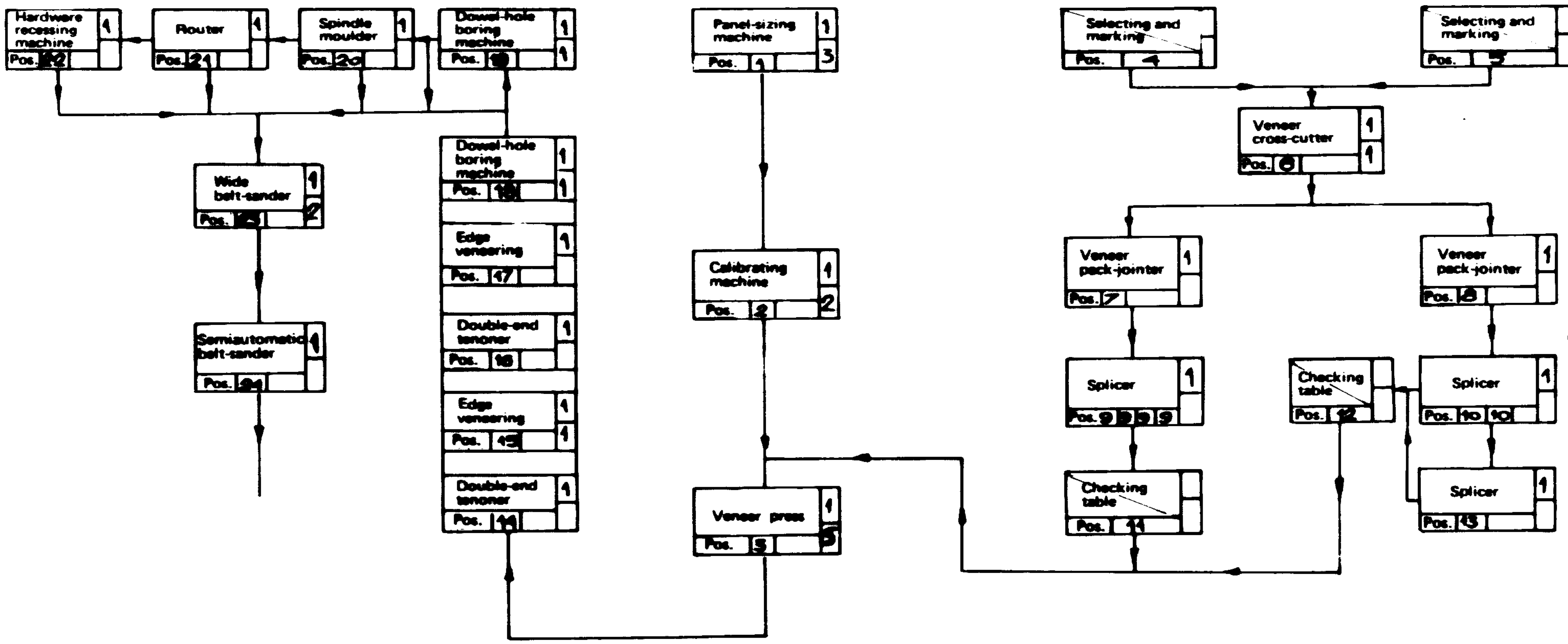
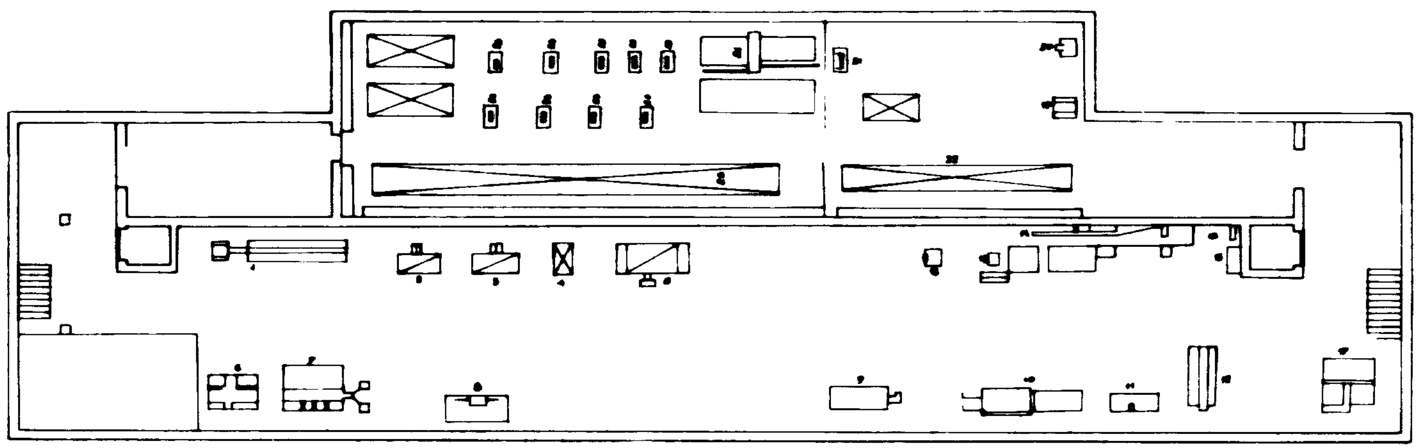
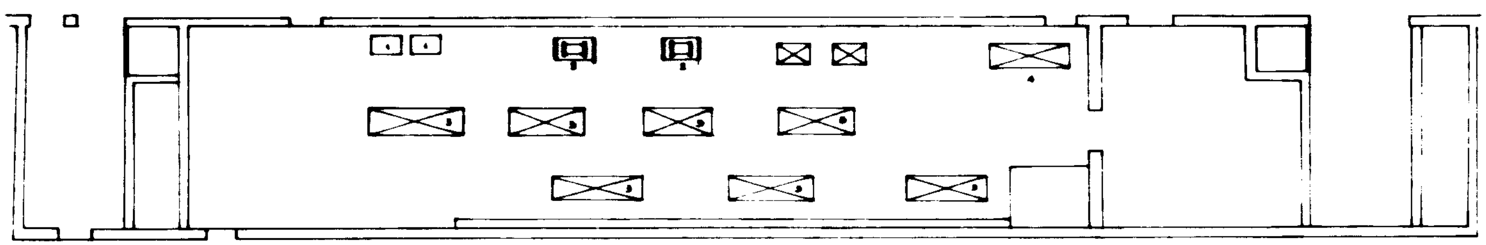


Figure IX. Existing layout of upholstery hall at Standard, Sarajevo



First floor

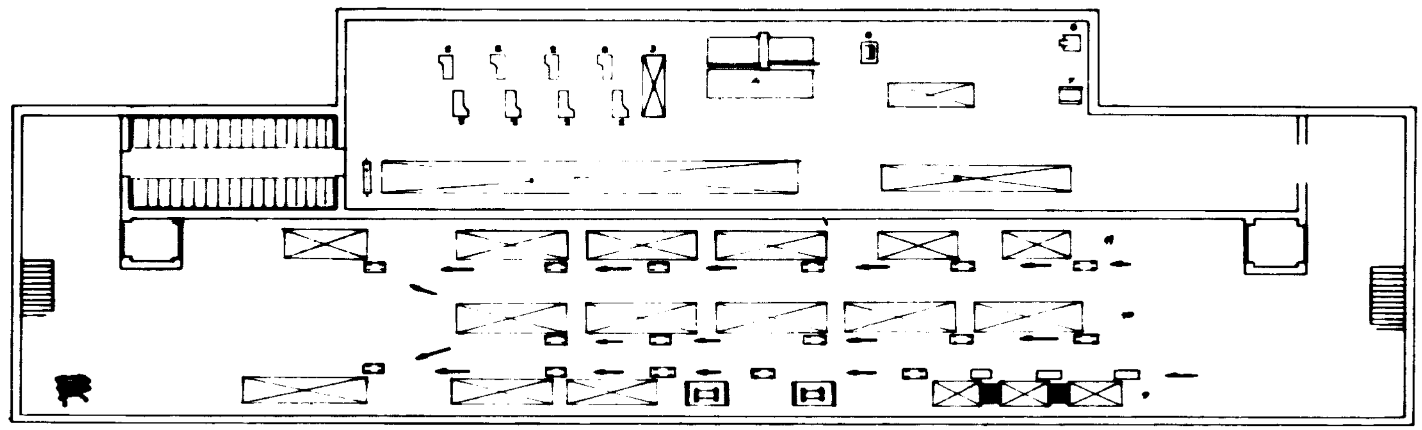
1. Spring-making machine
2. Stapler
3. Webbing machine
4. Work bench
5. Decorating machine
6. Spring-making machine
7. Core-making machine
8. Stapling machine
9. Decorating machine
10. Mattress press
11. Tape edger
12. Button-sewing machine
13. Band-joining machine
14. Band-coiling machine
15. Band-cutting machine
16. Band-cutting machine
17. Cutting machine for foam
18. Staple-making machine
19. Button-setting machine
20. Cushion-covering machine
21. Buttoning machine
22. Tables
23. Sewing machine
24. Mammoth machine
25. Cutting table.



Ground floor

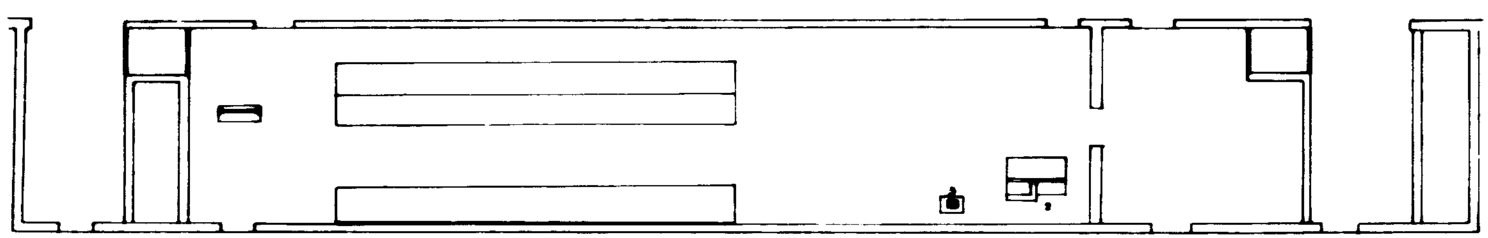
1. Tables for frames
2. Press
3. Work tables for production of settees and armchairs
4. Assembly

Figure X. Proposed layout of upholstery hall at Standard, Sarajevo



First floor

1. Cutting table
2. Sewing machines
3. Checking table
4. Mammoth machine
5. Buttoning machine
6. Cushion-covering machine
7. Button-setting machine
8. Tables
9. Assembly line: Settees (seats and back rests)
10. Assembly line: Supports
11. Assembly line: Armchairs



Ground floor

1. Machine for inspection of fabrics
2. Cutting machine for foam
3. Shredding machine for foam

2. As a consequence, the factory would discontinue the production of springs and spring units, and should buy its requirements for upholstery.

3. The factory should make greater use of resilient webbing and serpentine springing as less expensive and adequate substitutes for the traditional spring unit currently used.

4. The space occupied by spring production will be used for upholstery production, and laid out in accordance with figure X.

5. The area on the ground floor currently used for upholstery production should be used for inspection and storage of fabrics; storage, cutting, jointing and profiling of foam, foam storage and storage of finished goods.

6. Delivery of frames and components to the second floor and delivery of finished items to the ground floor should be by means of existing elevators. These should be properly serviced and be manned all the time.

7. Intermediate storage for inspected fabrics, and arrangements for marking, cutting and sewing of fabrics should be improved by greater attention to the planning and design of these work areas.

8. The assembly area should have three upholstery lines for studio couches, settees and armchairs.

9. The factory should discard the existing upholstery benches and replace them with work holders and work presses which are more suited to modern upholstery production.

Figure XI is a flow chart of the upholstery section.

Product rationalization

Drawings A to I of figure XII illustrate changes which are recommended in the redesigning of basic elements of a wall-unit system. The criteria applied include the principles of design engineering and value analysis, without affecting the visual appearance of the product. For example, 16-mm particle board would be used for all components normally made from 19-mm board; overall dimensions would be based on a common module which would allow for interchangeability of components such as carcase ends, shelving, door and drawer fronts; common drawer-elements tops and bottoms would be used. Some dimensional details have also been altered allowing for ease of construction and fitting.

Table 1 gives comparative data showing materials savings resulting from such changes.

Figure XI. Flow chart of upholstery section at Standard, Sarajevo

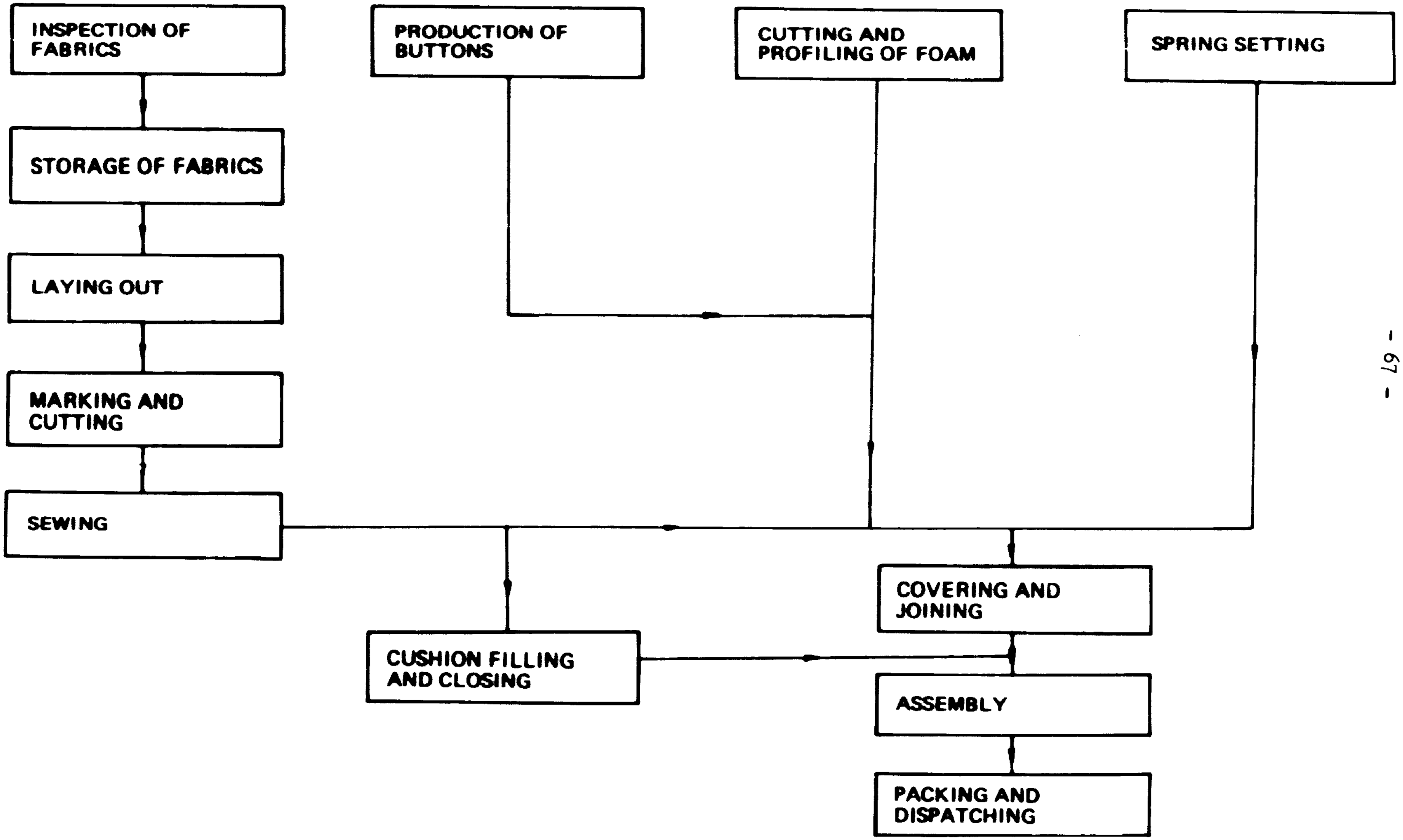
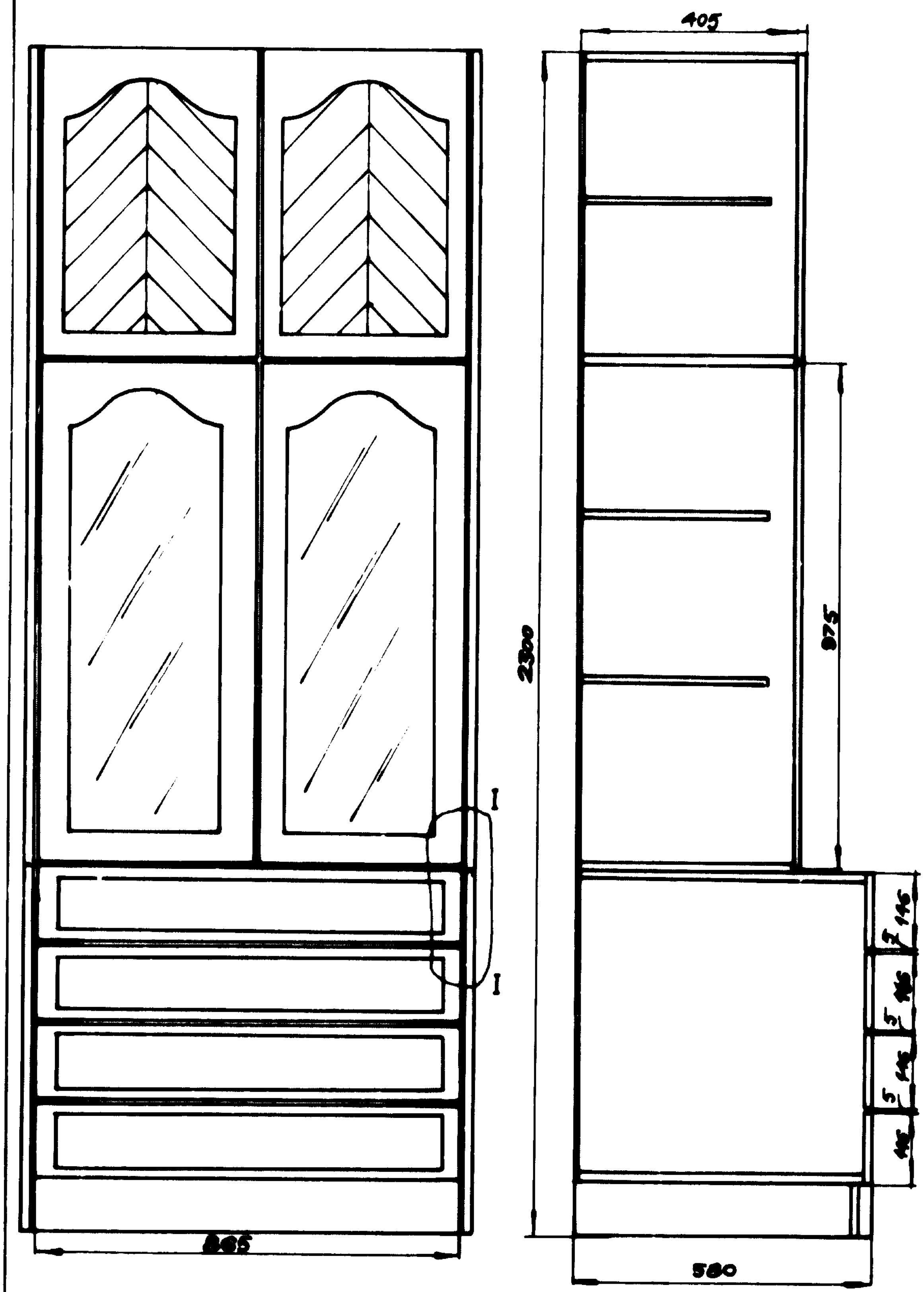


Figure XII. Details of product redesign and rationalization



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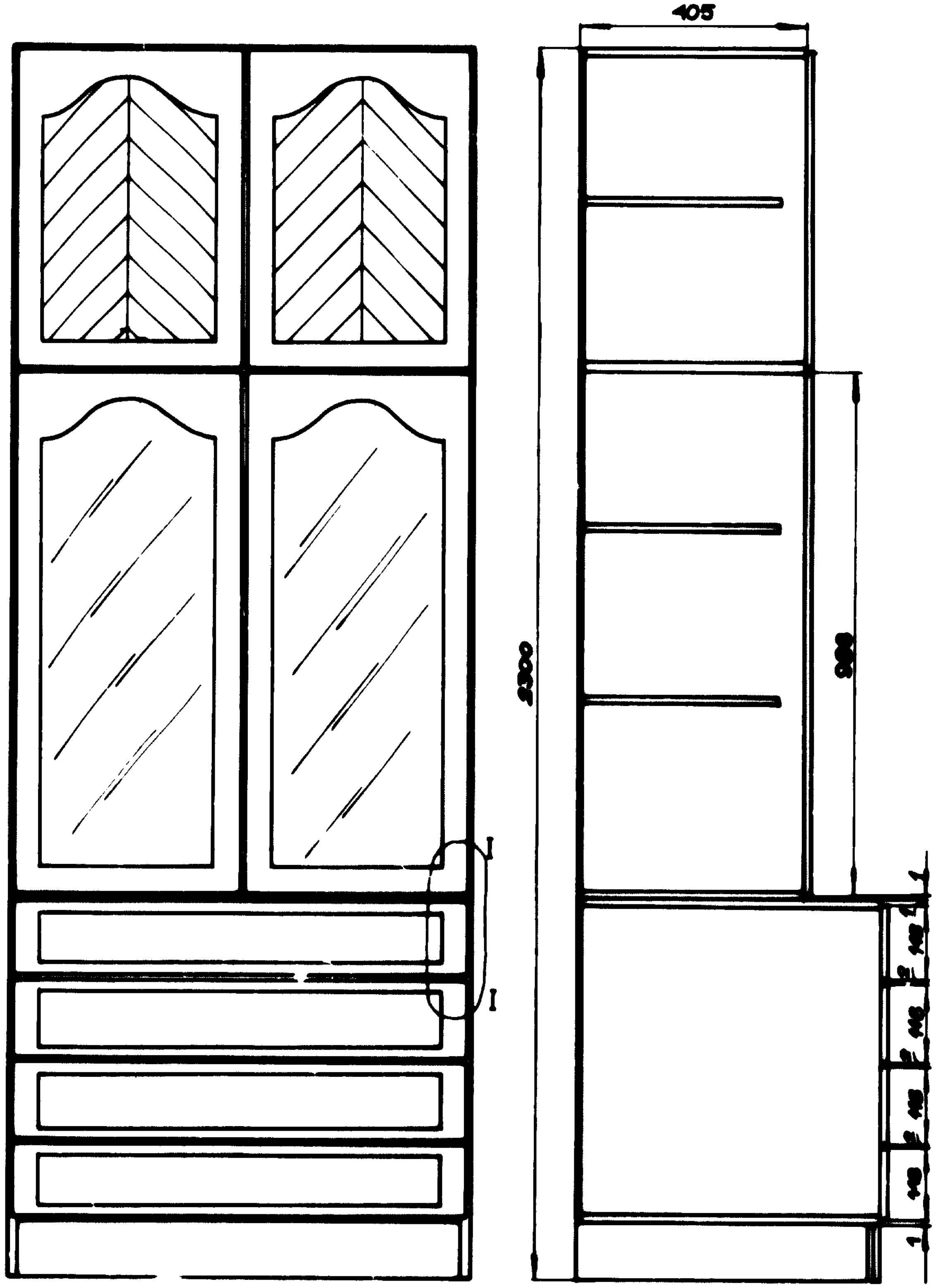

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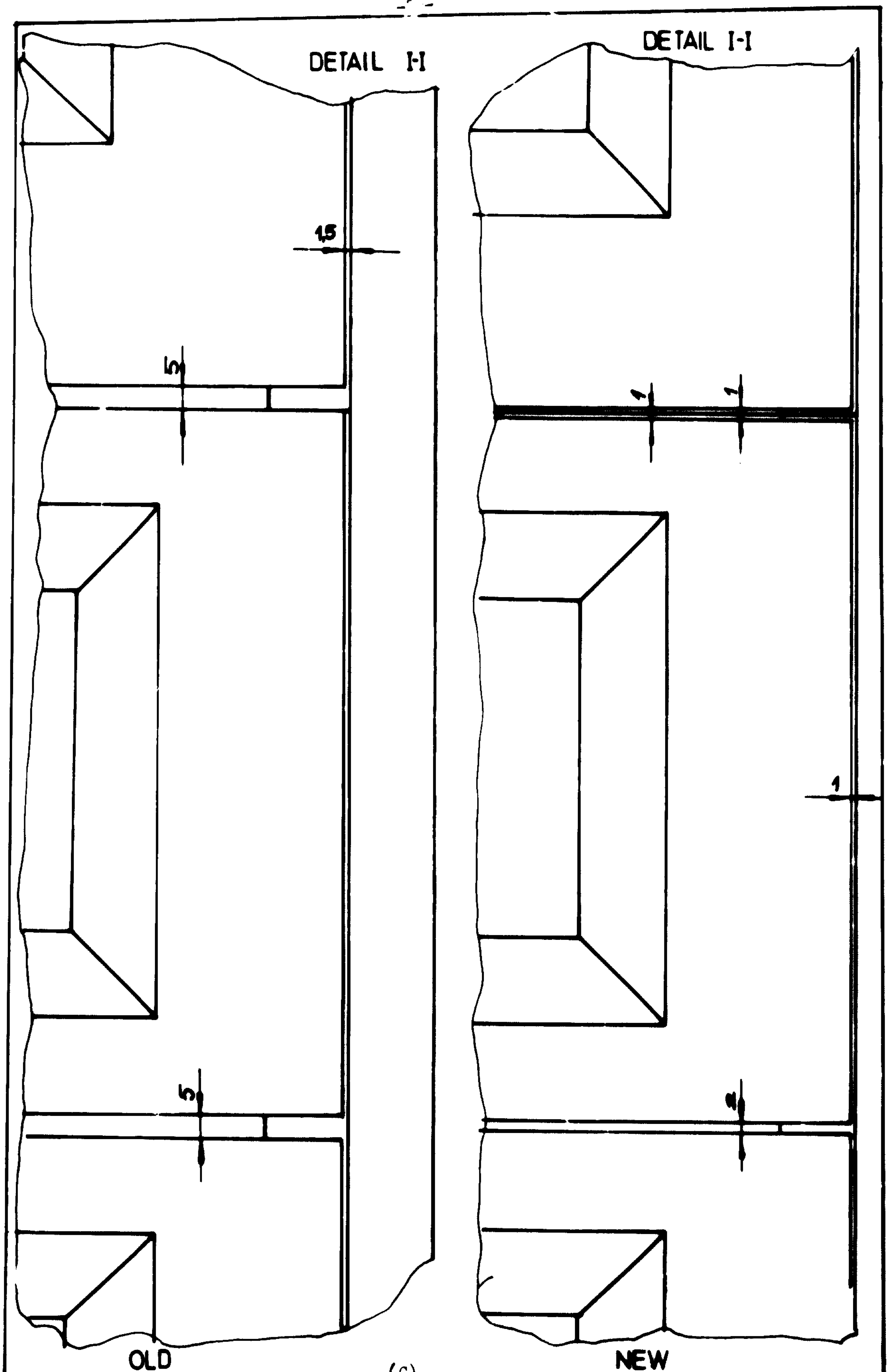

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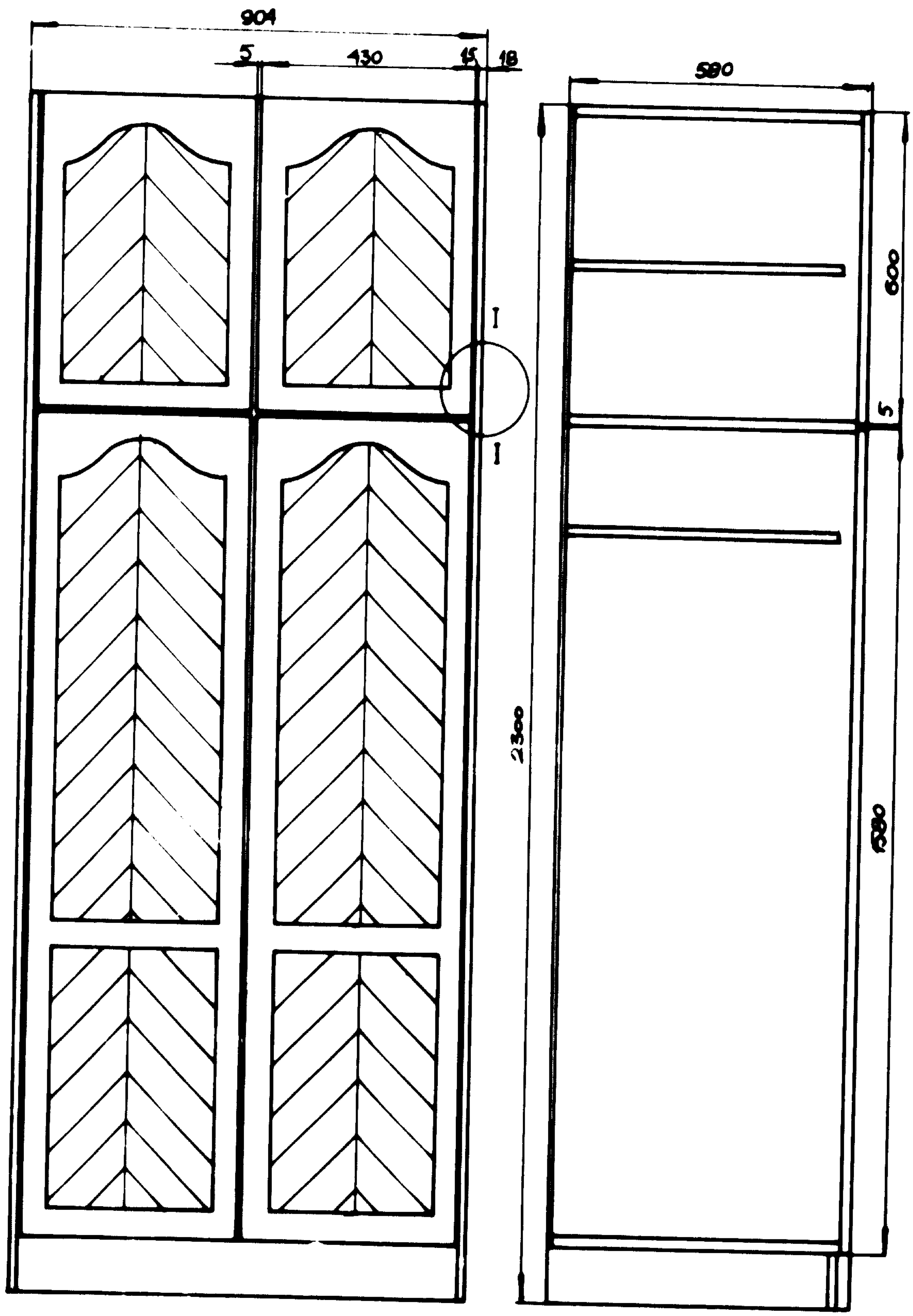

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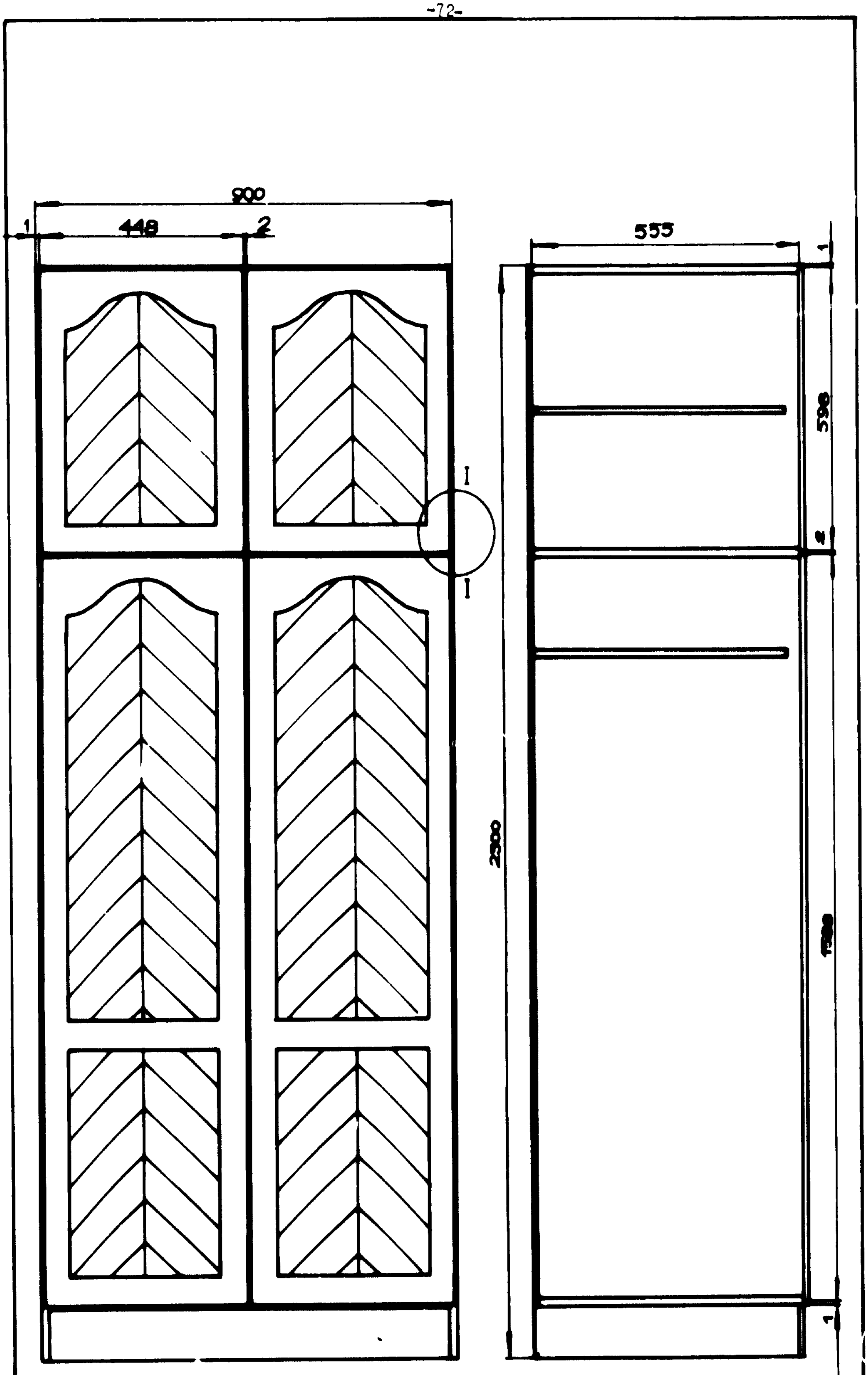

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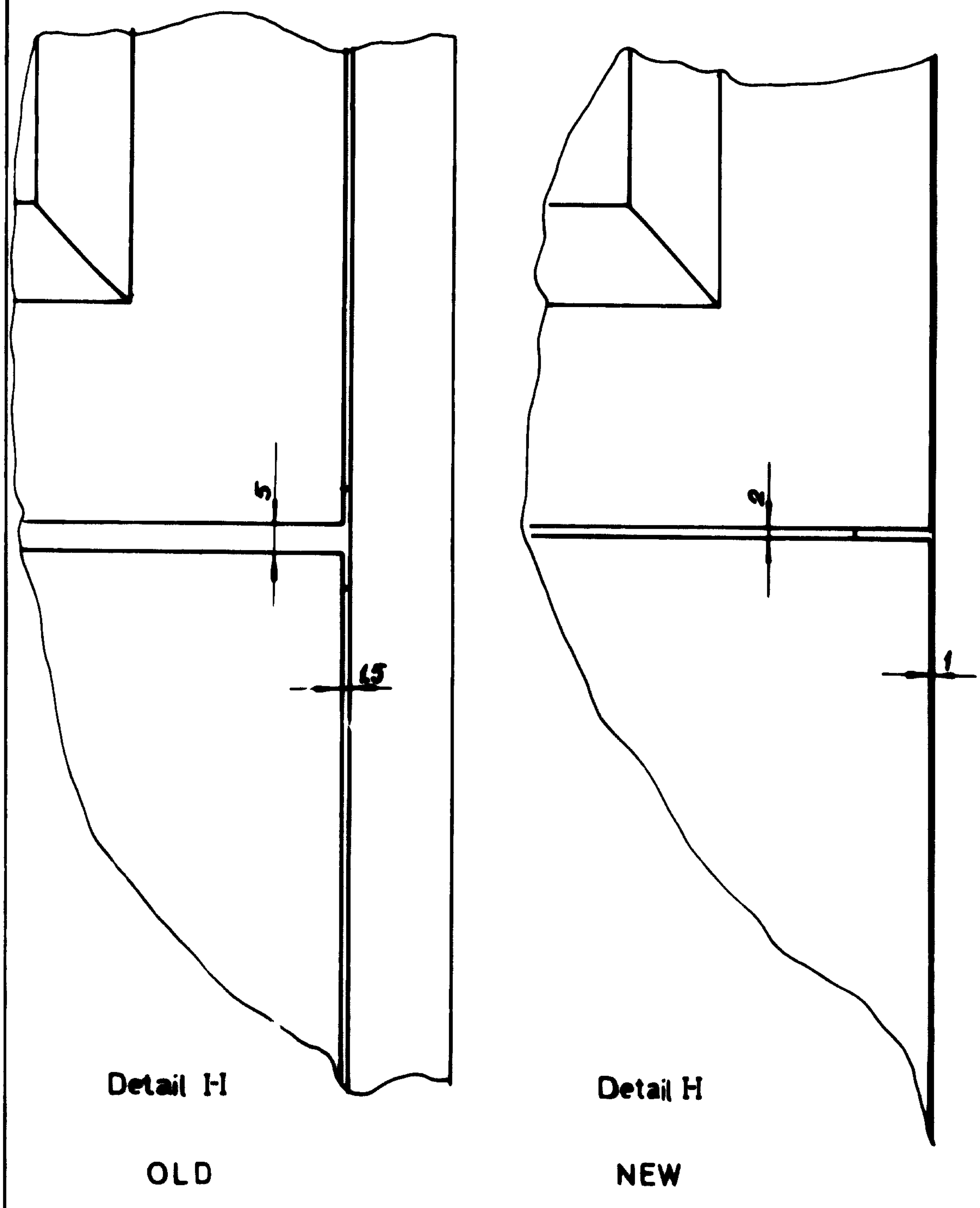

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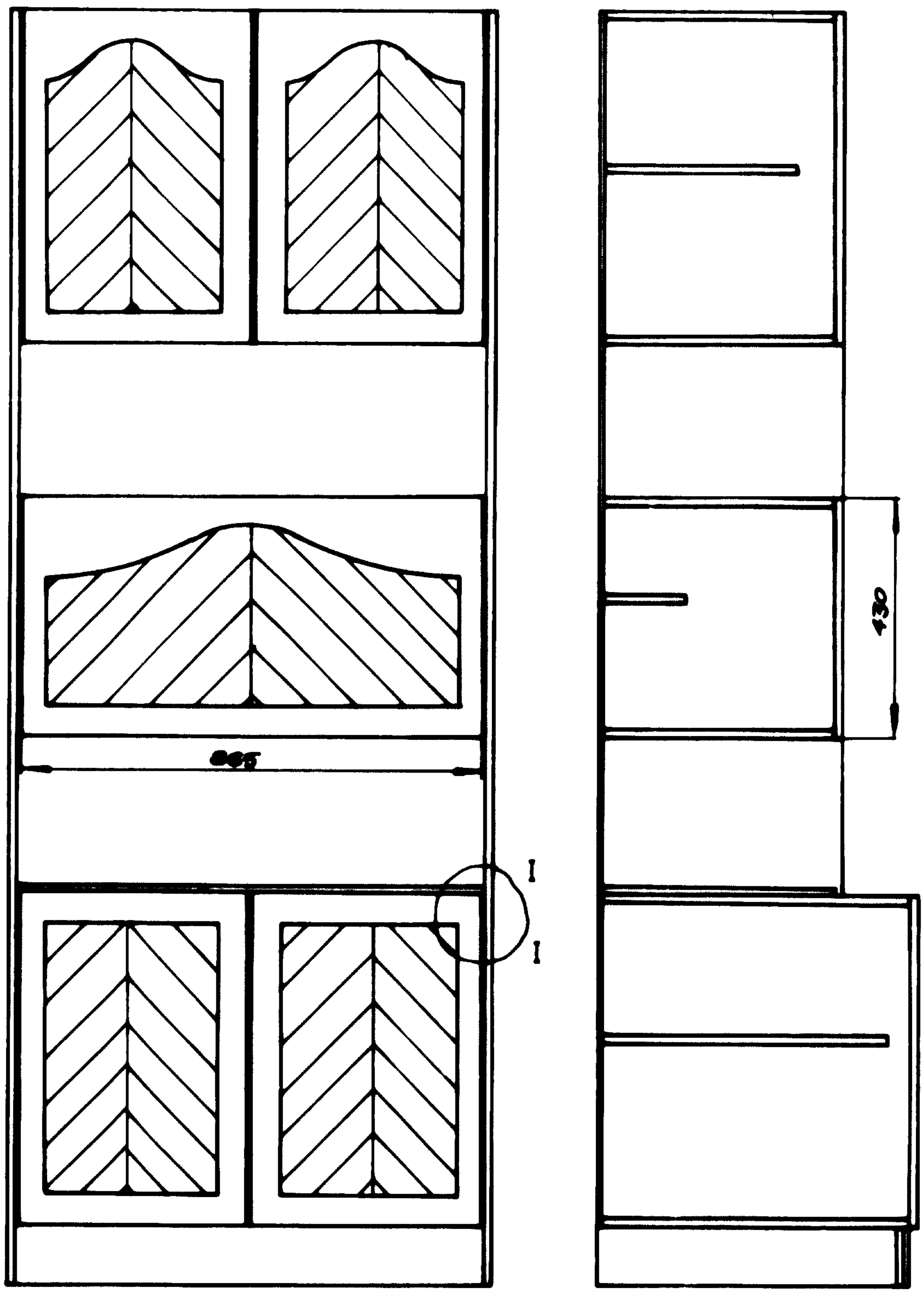

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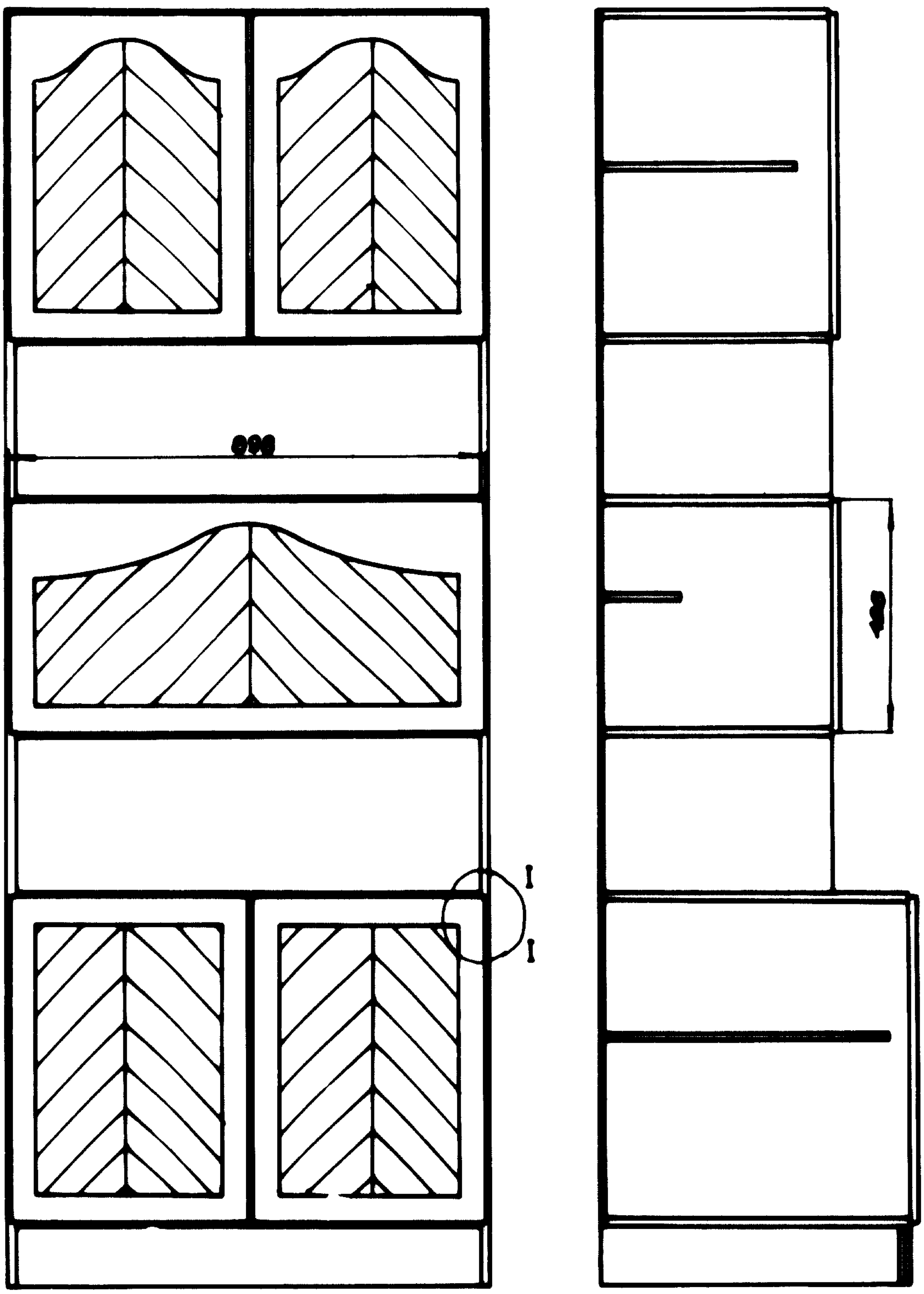

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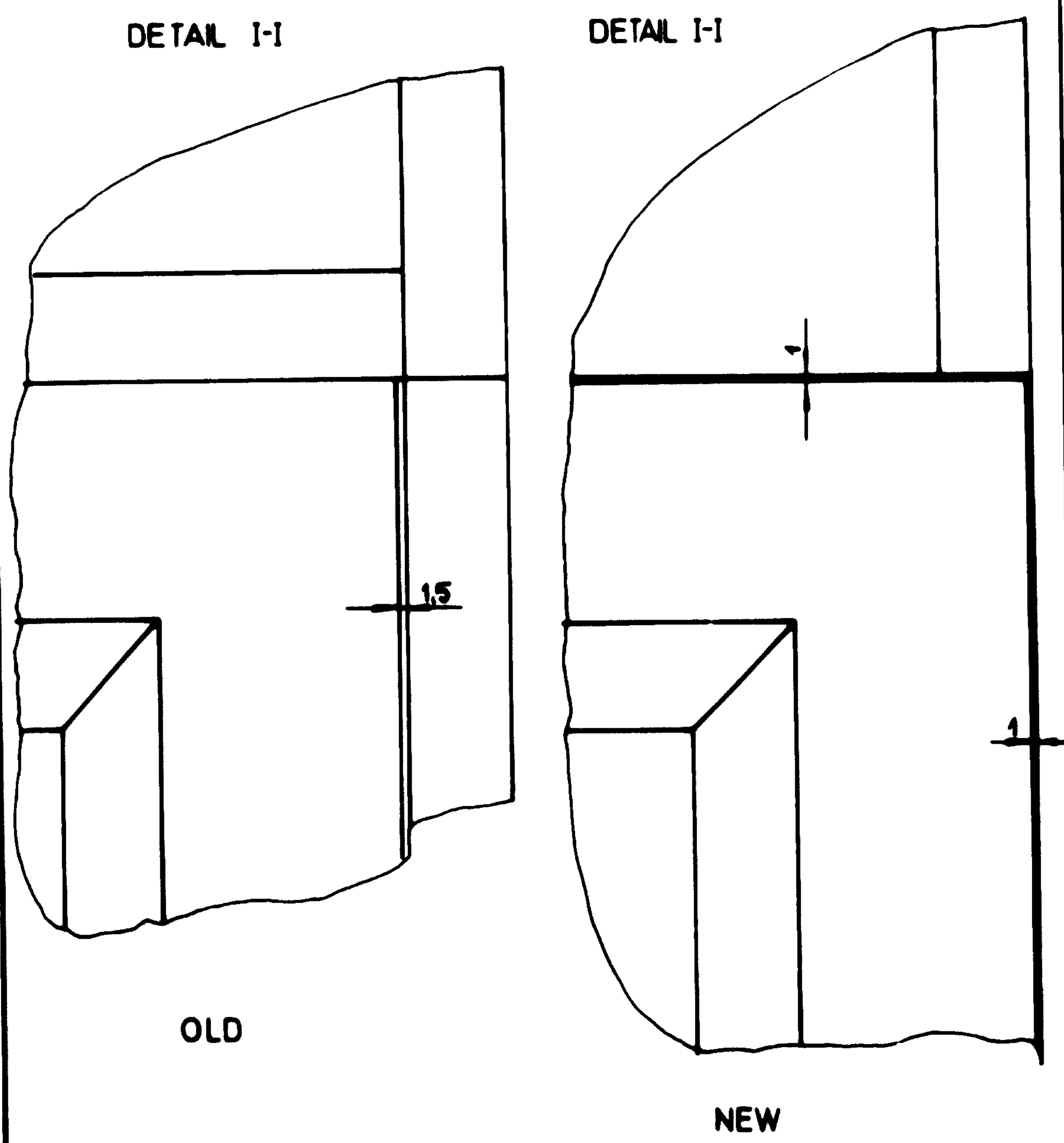


(I)

Table 1. **Materials savings resulting from redesigning of wall element**

	Solid wood (m^3)	Hardboard (m^2)	Particle board (m^3)	Face veneer (m^2)	Balancing veneer (m^2)
18mm	0,053847	16,75285	0,911789	64,5556	45,717
16mm	0,037737	16,7209	0,767753	57,5596	41,001
Total saving	0,016110	0,03195	0,144036	6,9960	4,716
Percentage saving	29,9%	0,19%	15,8%	10,8%	10,32%

Annex VI

ORGANIZATIONS AND FACTORIES CO-OPERATING WITH THE EXPERT

Organizations

Š IPAD Kombinat (Co-ordinating Unit)

Šumaprojekt, Sarajevo

Design Centre, Sarajevo

Wood Technology Institute, Sarajevo

Computer Centre, Sarajevo

Factories

"Romanija", Sokolac

"Standard", Sarajevo

"Konjuh", Živinice

"Radnik", Bosanska Gradiška

"Una", Bosanska Krupa

"Vrbas", Banja Luka

"Namještaj", Gradačac

"Srebrenik", Srebrenik

"Brčko", Brčko

"Bosna", Brčko

Annex VII

GRADED PERFORMANCE TESTS FOR EASY CHAIRS AND SETTEES

Performance tests are graded into three categories of severity of use. The same methods of test for seat, back and arms and for the drop test are used in each grade; but the magnitudes are increased from grade to grade, i.e. for the static and impact tests the weight of the load, the drop heights in the drop tests, and the number of applications of a fixed load in the fatigue tests.

The separate static load tests for seat and back (tests 1 and 4) may be combined to give a representative cycle of seat load on, back load on, back load off and seat load off under static conditions. Tests 2 and 5 (for the fatigue loadings on seat and back) may be similarly combined to give a representative cycle of seat and back load under fatigue conditions.

The article to be tested is submitted in turn to each of the 14 tests described below. The force and number of applications, appropriate to the grade for which it is being tested are shown in table 2 or table 3 (pp. 86 and 87).

Moisture content and temperature of the article during testing

If the article contains items made of materials whose properties depend significantly on moisture content and it is suspected that the moisture content is unduly high, it is conditioned before testing in an atmosphere at 20°C (±2°C) and 65% (±5%) relative humidity. Since the properties of some plastics are strongly dependent on temperature, a record of the variations in temperature and relative humidity should, if possible, be taken in the long-term fatigue tests on plastic articles. The moisture content and temperature during the other tests are recorded at the time of test.

Initial inspection

Immediately before testing, each article is thoroughly inspected. In the case of upholstered articles, as much of the cover on the bottom is removed as is necessary to allow a thorough inspection of joints etc. Any apparent defect is noted, so that it will not be attributed to the test loadings.

Tests for chairs and easy chairs

Test 1 - Seat static load test

A downwards force is repeatedly applied 10 times at a rate not exceeding 40 times a minute by means of a 200-mm diameter loading pad, faced with a 25 mm thick layer of hard polyether foam, at right angles to the surface of the seat to any position along the fore and rear centre line of the seat likely to cause failure.

As it may not be clear which position is most likely to cause failure, several positions, up to a maximum of three, may be loaded 10 times.

The magnitudes of the load to be applied are those specified for test 1 in table 2.

Test 2 - Seat fatigue test

The test is carried out as test 1, except that the magnitude of the seat fatigue load and the number of applications are those specified for test 2 in table 2 and the centre of the seat loading pad is 175 mm forward of the intersection point of the centre lines of the seat and back surfaces.

Test 3 - Seat impact test

The seat impact load is applied by allowing a seat impact pad, weighing 25 kg and having a 200-mm diameter striking surface of leather or similar material filled with fine, dried sand, to fall freely through the heights and for the number of times specified for test 3 in table 2. The impact load is applied anywhere a person is likely to sit, at the position most likely to cause a failure up to a maximum of three positions.

Test 4 - Back static load test

The load, a rectangular loading pad of 200 mm height, 250 mm width and faced with a 25-mm layer of hard polyether foam is repeatedly applied 10 times at a rate not exceeding 40 times a minute, at right angles to the surface of the back. The centre of the pad is at a distance above the intersection point of the centre lines of the seat and back surface equal to 230 mm for soft seats; 265 mm for medium seats; 300 mm for hard seats; or 100 mm below the top of the back, whichever is the lower, except for back rests less than 200 mm in height, when the centre of the load pad is at the centre of such back rests. The article is prevented from moving rearwards by stops placed behind the rear feet or castors. During this test the seat is loaded by a constant force specified for test 1 in table 2 by means of a 200-mm diameter loading pad applied at right angles to the seat surface anywhere along the centre line of the seat but not more than 250 mm forward of the intersection of the centre lines.

The test is performed by the repeated application of the back load of the force specified in table 2 for test 4 with the seat load in the position that just allows the front feet to lift away from the floor except at the rear of the base. If the article tends to overbalance with the seat load in its most forward position, the back load is reduced to such a magnitude as just prevents rearwards overbalancing, and the actual force is noted. The back load is not to be less than 620 N and the seat load, in its most forward position, is to be increased above the value specified in table 2 for test 1 if necessary to prevent overbalancing, and the actual force used is noted.

Test 5 - Back fatigue test

The back load in this test is applied as for test 4, except that the magnitude and number of applications of the back load are those specified for test 5 in table 2. The article is prevented from rearwards movement by floor stops behind the rear feet or castors, and overbalancing is prevented by a constant seat force of 1,000 N with the centre of the seat loading pad at 175 mm forward of the intersection point of the centre lines of the seat back surfaces. If the article tends to overbalance, the back load is reduced to such a magnitude as just prevents rearwards overbalancing, and the actual force is noted. When the article is fitted with a spring rocking action base having a tension adjustment, the tension is reduced, so that the maximum possible rocking movement is obtained without causing impacts on the rocker stops. When the test is applied to a stool without a back rest or with a very low one, the backwards force is applied horisontally to the front edge of the seat.

Test 6 - Back impact test

The article is placed in its normal position with its front feet prevented from moving forwards by means of stops. A weight of 6.5 kg is allowed to strike the centre of the top of the outside of the back in a forward direction. The weight has a striking surface of 100 mm diameter, is suitably padded so as not to damage the surface, and strikes the article horizontally at the speed specified for test 6 in table 2. The article is allowed to rotate freely forwards about the front feet. This is carried out 10 times at a rate of 10 times a minute.

If the article has wings, the test is repeated with the mass striking the outside of the top of the wing at right angles to its surface and in a position most likely to cause failure. If the article has a swivel base, then the direction of the impact force must pass through the vertical axis of the swivel. To prevent movement of the article across the floor, the stops may be moved to the side feet.

Test 7 - Sideways arm static load test

A pair of horizontal outward loads, of the magnitude given in table 3 for the appropriate grade, is applied repeatedly 10 times by means of 100-mm diameter load pads to any position along the insides of the uppermost part of the arms most likely to cause failure. Since it may not be clear which of several positions is most likely to cause failure, each of the positions up to a maximum of three may be loaded 10 times.

Test 8 - Sideways arm fatigue test

The test is carried out as test 7, except that the magnitude of the load is 110 N and the number of applications is as specified in table 2 for test 8. The point of application of the load is 50 mm behind the front edge of the arm. The direction of the pair of loads is inwards if the inside arms are 655 mm or less apart, but is outwards if the inside arms are further apart.

Test 9 - Sideways arm impact test

The test is carried out as test 6, except that the impact blow is applied in an inwards direction to the outside face of the arm at any position most likely to cause a failure, 10 times in each position up to a maximum of three. The article is placed in its normal position with a pair of side feet prevented from moving sideways by means of stops. If the article has a swivel base, then the direction of the impact force must pass through the vertical axis of the swivel.

Test 10 - Downwards arm static load test

A vertical, downwards force of the magnitude specified for test 10 in table 2 is applied repeatedly at a rate not exceeding 40 times a minute, 10 times to the upper surface of one arm by means of a 100 mm-diameter pad to any point along the arm most likely to cause a failure. A counterbalancing vertical force of 750 N is applied to the seat, if necessary, to prevent overbalancing.

Test 11 - Downwards arm fatigue test

A vertical downwards force of 340 N is applied simultaneously to each arm by means of a 100-mm diameter pad, at a rate not exceeding 40 times a minute, for the number of applications specified in table 2 for test 11. The point of application is 50 mm behind the front edge of the arm.

Tests for settees and similar articles

For articles intended to seat more than two persons, tests 1 to 6 inclusive are applied to seat units selected by the test operator in accordance with the following: if the number of seating units is not obvious from inspection, the article is to be regarded as consisting of a number of equal units, each being not more than 560 mm in width at the front and not less that 380 mm at the rear of the seat.

Tests on seating units of settees

Static loading

The load is applied, in turn, to one end position and to a central position, while each of the other seating units supports a constant vertical force of 750 N, except for a two-seat settee, when the central loading is not accompanied by any additional load.

Fatigue loading

Half the specified number of applications are made first to a central position and the remainder of the specified number of applications to an end position.

Impact loading

The loading is applied to an end position and to a central position.

Tests on backs

Static loading

A double back static load is applied by means of a pair of back loading pads situated with their centres 500 mm apart with a corresponding pair of constant seat forces. For two-seat settees the double back static load is applied to positions equidistant from the centre of width. For settees with three or more positions the double back static load is applied to two adjacent positions at one end and then to two positions equidistant from the centre of width.

Fatigue loading

Half the specified number of applications are made to a central position, the remainder to one end position.

Impact loading

The load is applied to an end position and to a central position and also to a wing if one exists.

Other tests

The other tests applied to arms and bases are performed as described for chairs.

Tests for chairs and settees

Test 12 - Drop test

For chairs: The chair is supported so that the impact is on one foot and the line joining that foot to the diagonally opposite foot is inclined at 10^{o} to the horisontal, whilst the line joining the remaining feet is horisontal. The chair is lifted up and allowed to fall freely on a concrete floor. The height of fall is that specified for test 12 in table 3 appropriate to the grade. The chair is dropped in this way 10 times onto a front leg and 10 times onto a rear leg.

For settees: The settee is lifted up at one end and allowed to fall freely so that the impacting feet or castors strike a concrete floor at the same level as the non-lifted feet or castors. The heights of fall are those specified for test 12 in table 3. The settee is dropped in this way 10 times.

Test 13 - Diagonal base load test

Two opposing forces of the magnitude specified for test 12 in table 3 are applied simultaneously to diagonally opposite legs or corners of the article, as near as possible to the lowest point. Application of these forces is made in an inwards direction 10 times at a rate of about 20 times per minute.

Test 14 - Swivelling test

For an article with a swivel action, a vertical downwards force of 1,000 N is applied to the seat by means of a 200-mm diameter pad with its centre 175 mm forward of the intersection point of the centre lines of the seat and back surfaces. The seat of the article is to be rotated 45° relative to the base at 30 ± 10 cycles a minute for the number of cycles specified for test 14 in table 3.

Conditions for acceptance

As a consequence of the test the article shall not develop any of the following defects:

(a) Fracture of any member or joint;

(b) Fracture or extensive cracking through the thickness of any part of a structural shell;

(c) Loosening, which can be detected by hand pressure applied to members or joints intended to be rigid;

(d) Loosening of the underframe or base inserts moulded into a structural shell relative to the shell surface, detectable by hand pressure applied to the underframe or base.

Any free movement in the back, arms or legs of the article found in the final inspection shall not be noticeably greater than initially.

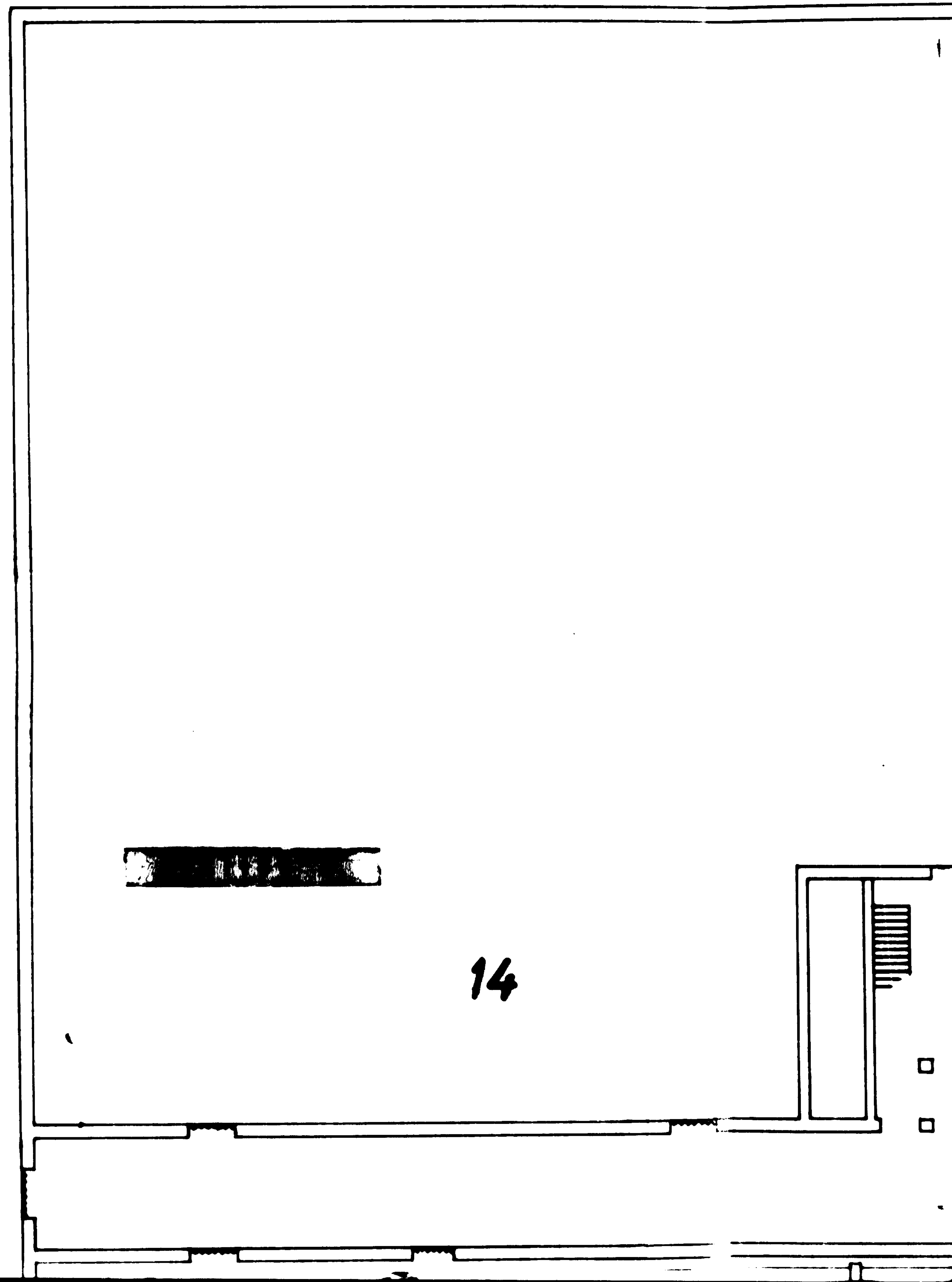
No part of the article shall develop any deformation that will adversely affect its function, nor shall any cracks develop that will spoil its appearance.

Table 2. Seat, back and arm tests for easy chairs and settees - number of applications and test loading

Test number	Test loading	Point of application	Grade of severity		
			Light duty	Medium duty	Heavy duty
	<u>Seat</u>				
1.	Static	Anywhere	10 x 780 N	10 x 1,000 N	10 x 1,250 N
2.	Fatigue	Standard	25,000 x 1,000 N	50,000 x 1,000 N	100,000 x 1,000 N
3.	Impact	Anywhere	10 x 25 kg x 90 mm	10 x 25 kg x 200 mm	10 x 25 kg x 300 mm
	<u>Back</u>				
4.	Static	Standard	10 x 620 N	10 x 780 N	10 x 1,000 N
5.	Fatigue	Standard	25,000 x 400 N	50,000 x 400 N	100,000 x 400 N
6.	Impact	Top of back	10 x 6.5 kg at 0.75 m/sec	10 x 6.5 kg at 1.5 m/sec	10 x 6.5 kg at 3.0 m/sec
	<u>Arm sideways</u>				
	Simultaneously to each arm				
7.	Static (outwards)	Anywhere	10 x 300 N	10 x 420 N	10 x 600 N
8.	Fatigue (inwards) if inside arms 655 mm or less apart, otherwise outwards	Standard	25,000 x 110 N	50,000 x 110 N	100,000 x 110 N
9.	Impact	Anywhere	10 x 6.5 kg at 0.75 m/sec	10 x 6.5 kg at 1.5 m/sec	10 x 6.5 kg at 3.0 m/sec
	<u>Arm downwards</u>				
10.	Static, to one arm	Anywhere	10 x 710 N	10 x 1,000 N	10 x 1,250 N
11.	Fatigue, to both arms	Standard	25,000 x 340 N	50,000 x 340 N	100,000 x 340 N

Table 3. Drop and diagonal base load tests for easy chairs and settees - number of applications and test loading

Test number	Test Loading	Grade of severity		
		Light duty	Medium duty	Heavy duty
	Drop test			
12.	Rear foot	10 x 75 mm	10 x 100 mm	10 x 150 mm
	Front foot	10 x 75 mm	10 x 100 mm	10 x 150 mm
	Diagonal base load			
13.	Static	10 x 250 N	10 x 375 N	10 x 500 N
	Swivelling test			
14.	1,000 N downwards seat force and rotate $\pm 45^{\circ}$	25,000 times	50,000 times	100,000 times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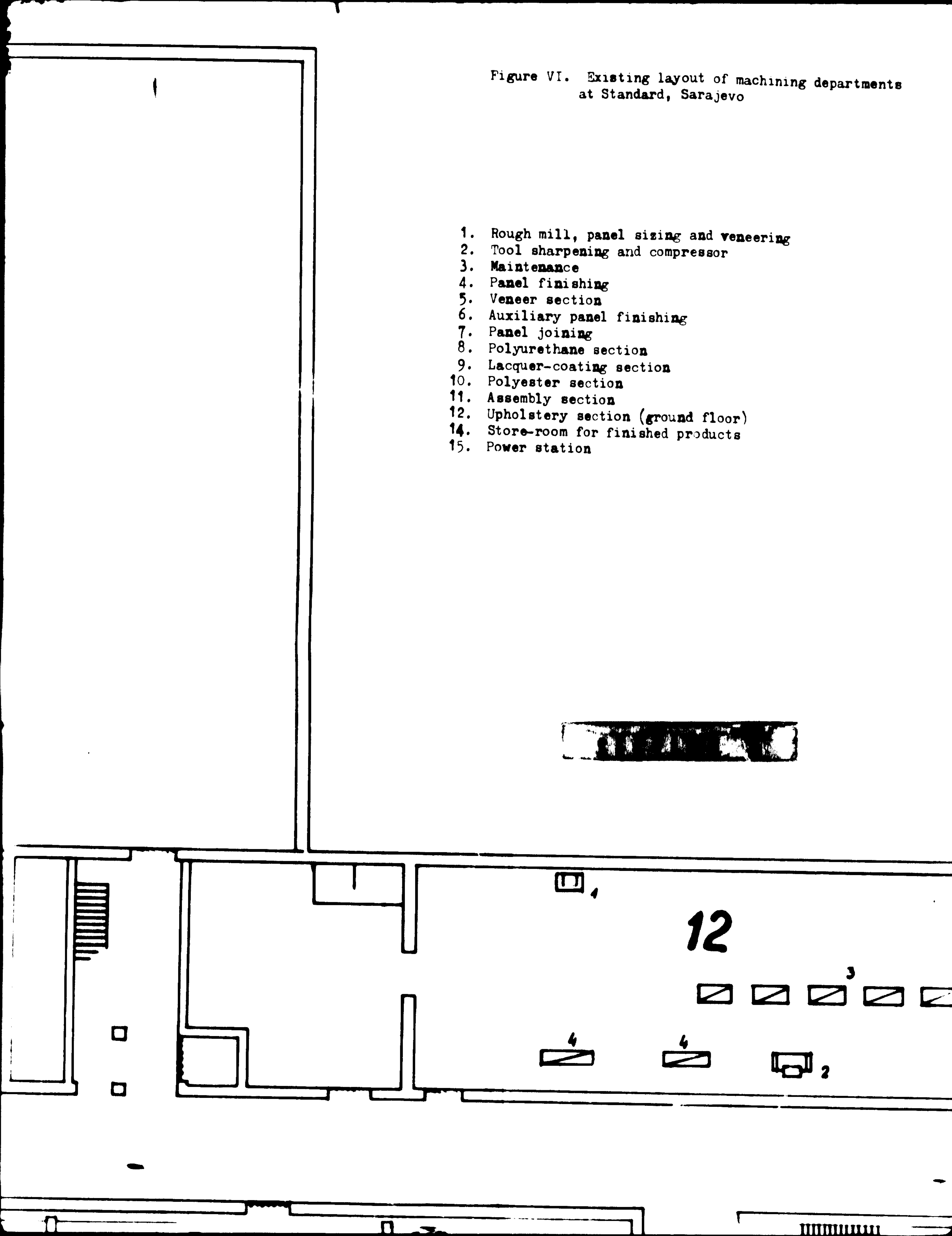
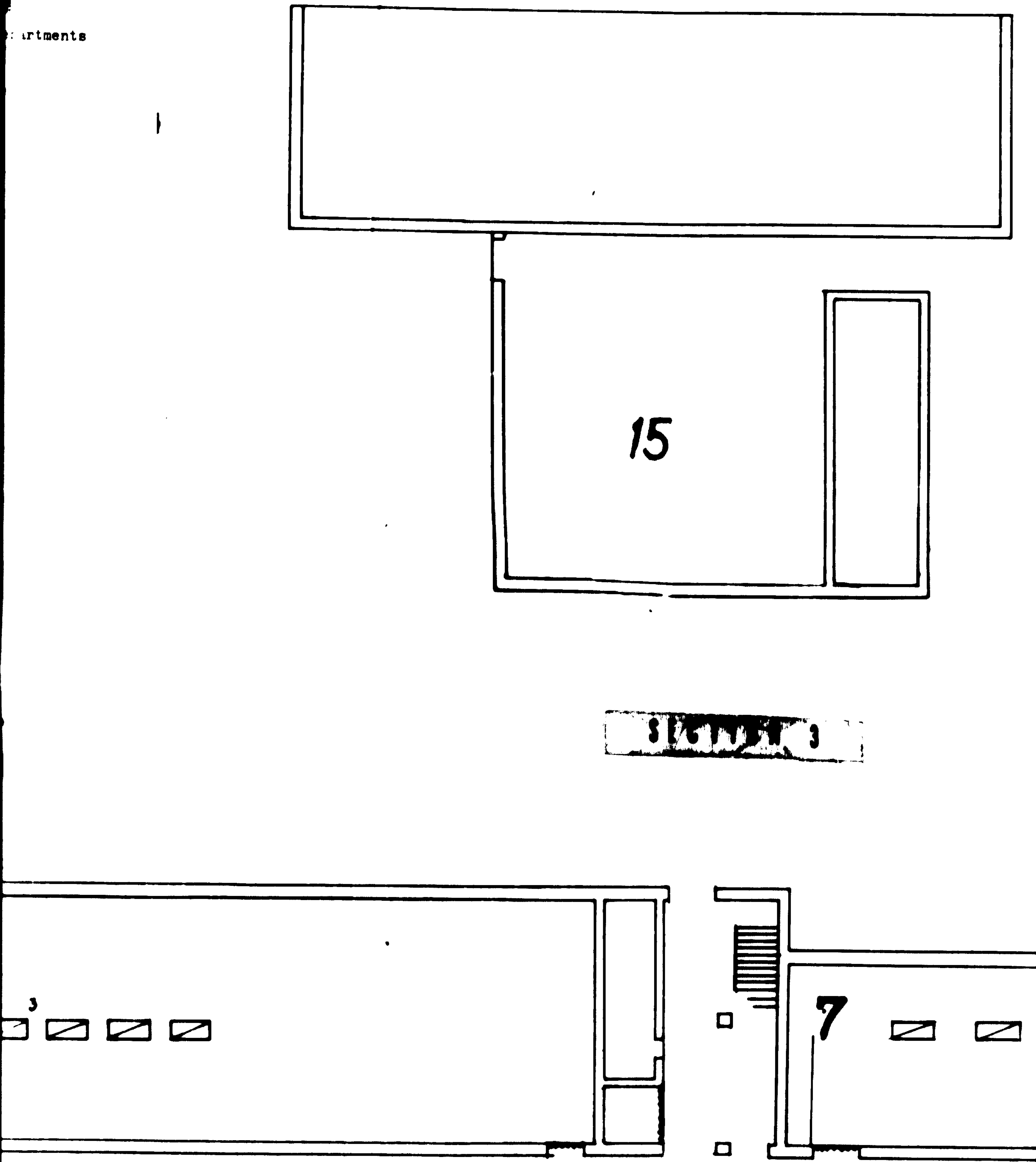
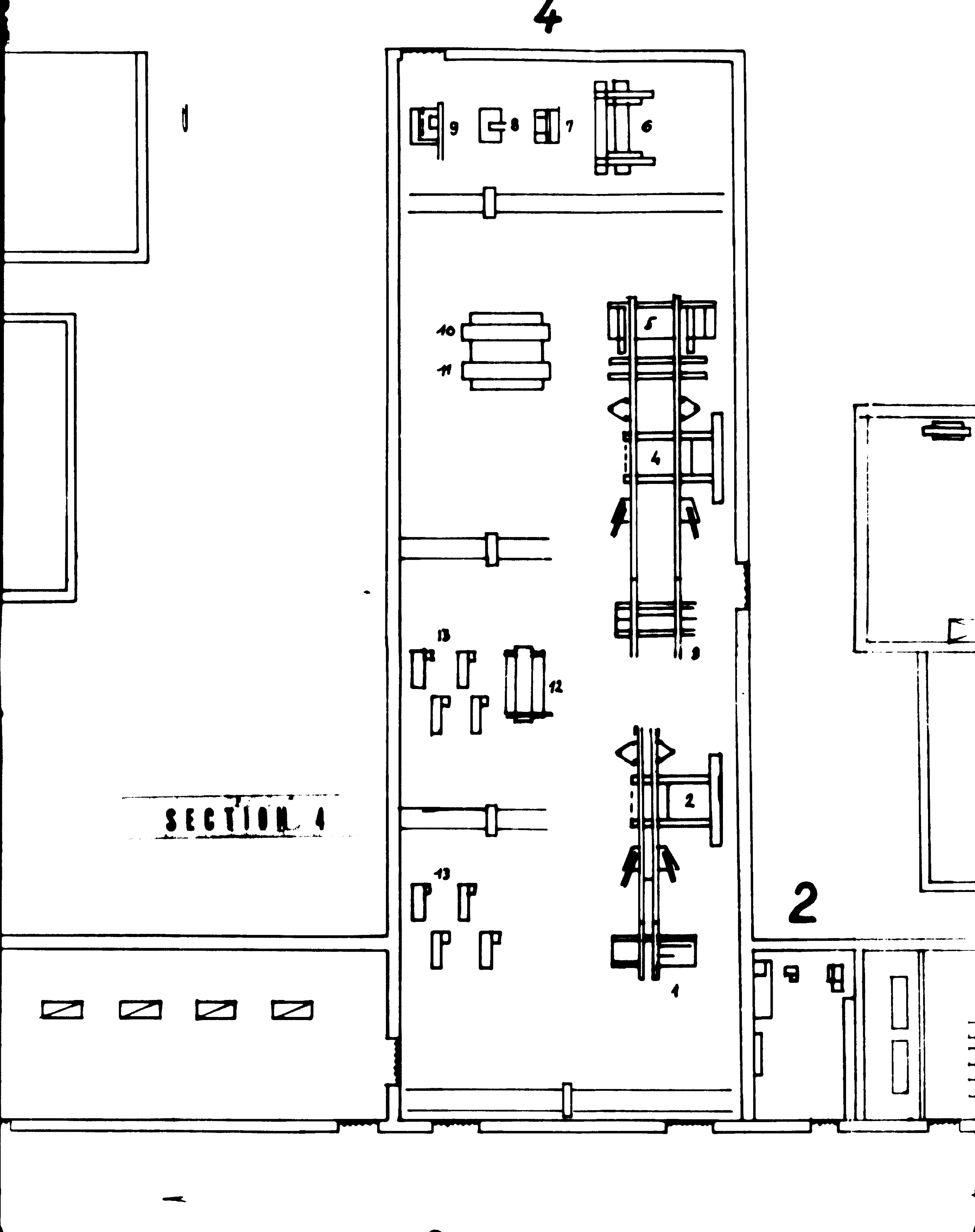


Figure VI. Existing layout of machining departments at Standard, Sarajevo

1. Rough mill, panel sizing and veneering
2. Tool sharpening and compressor
3. Maintenance
4. Panel finishing
5. Veneer section
6. Auxiliary panel finishing
7. Panel joining
8. Polyurethane section
9. Lacquer-coating section
10. Polyester section
11. Assembly section
12. Upholstery section (ground floor)
14. Store-room for finished products
15. Power station

artments

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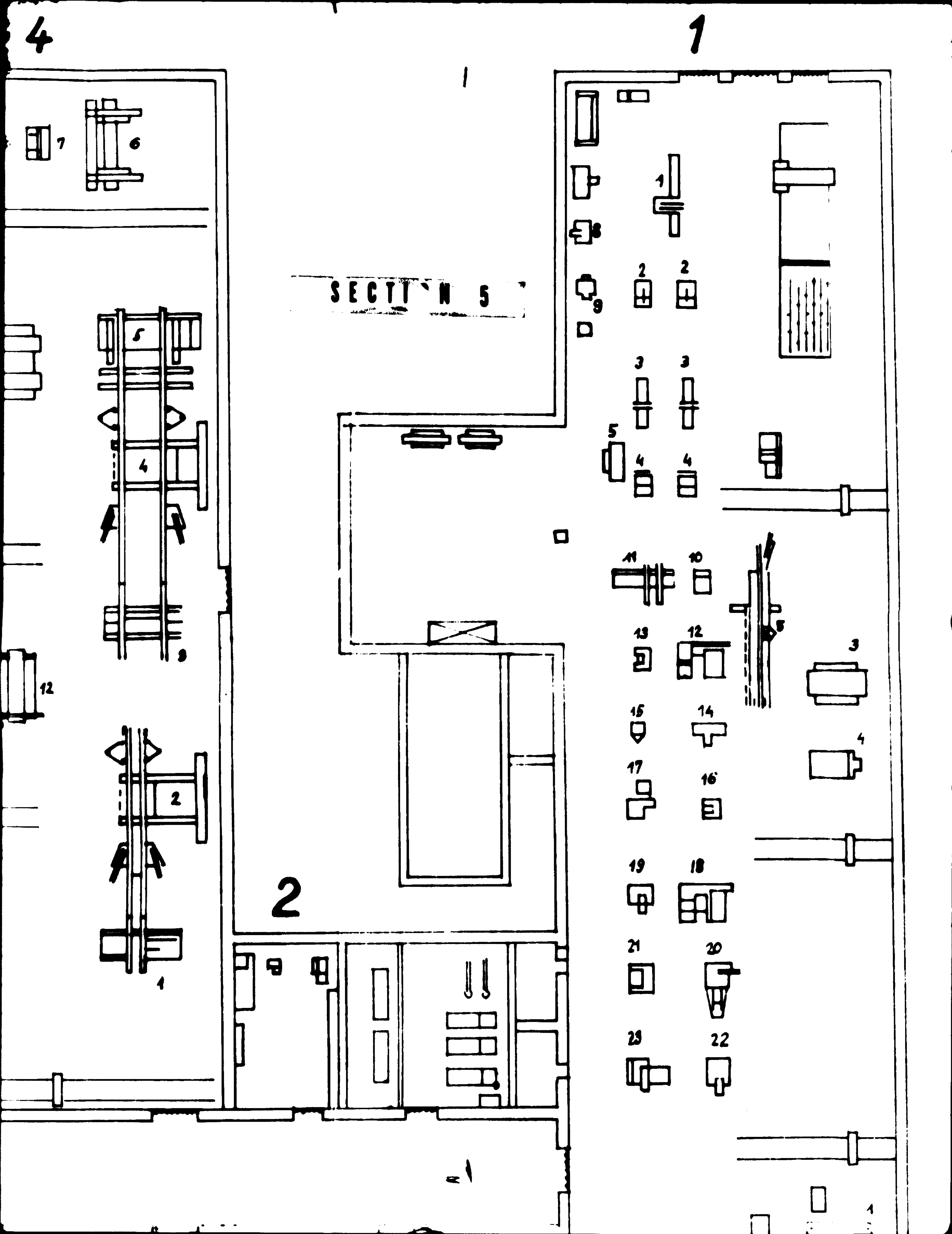
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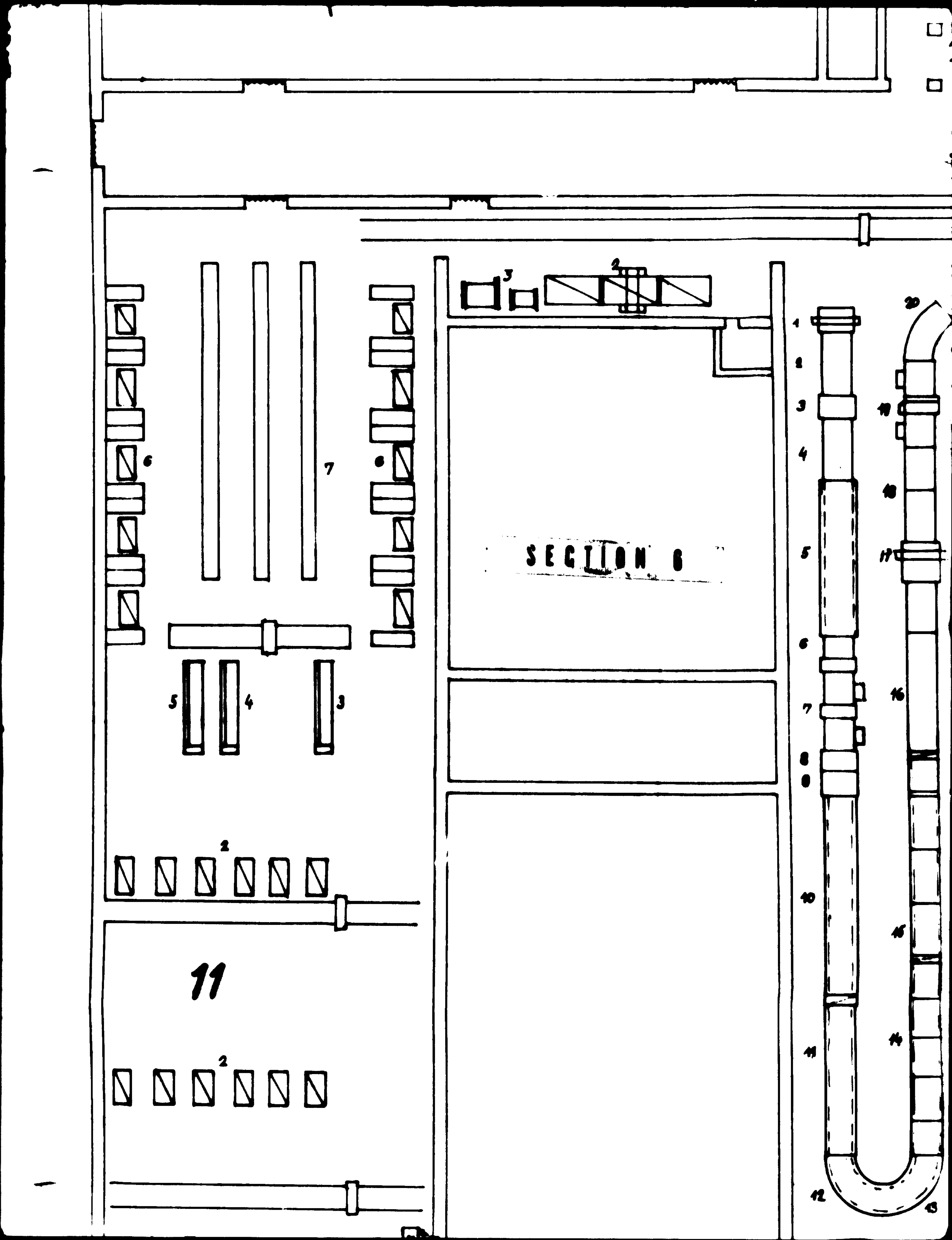
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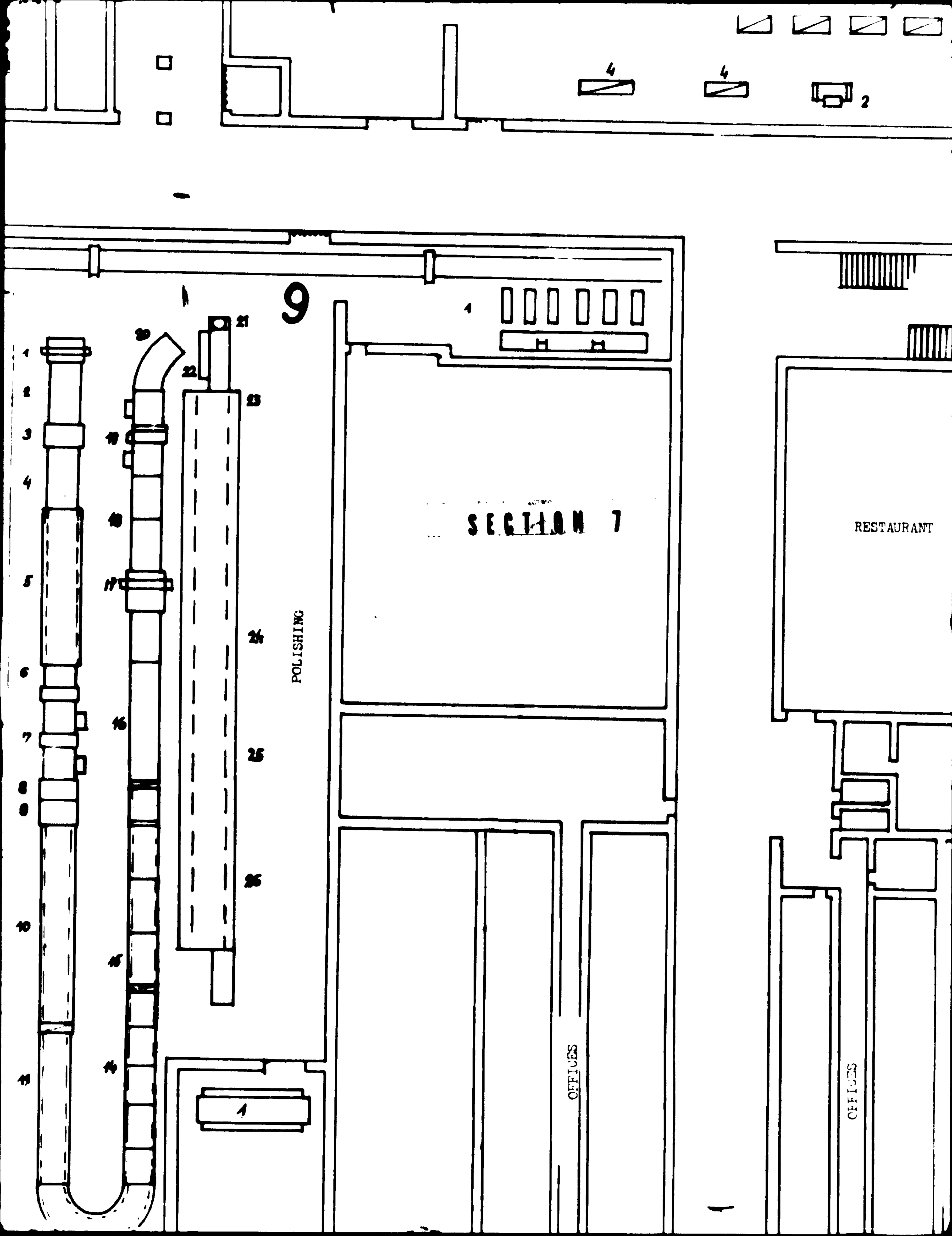
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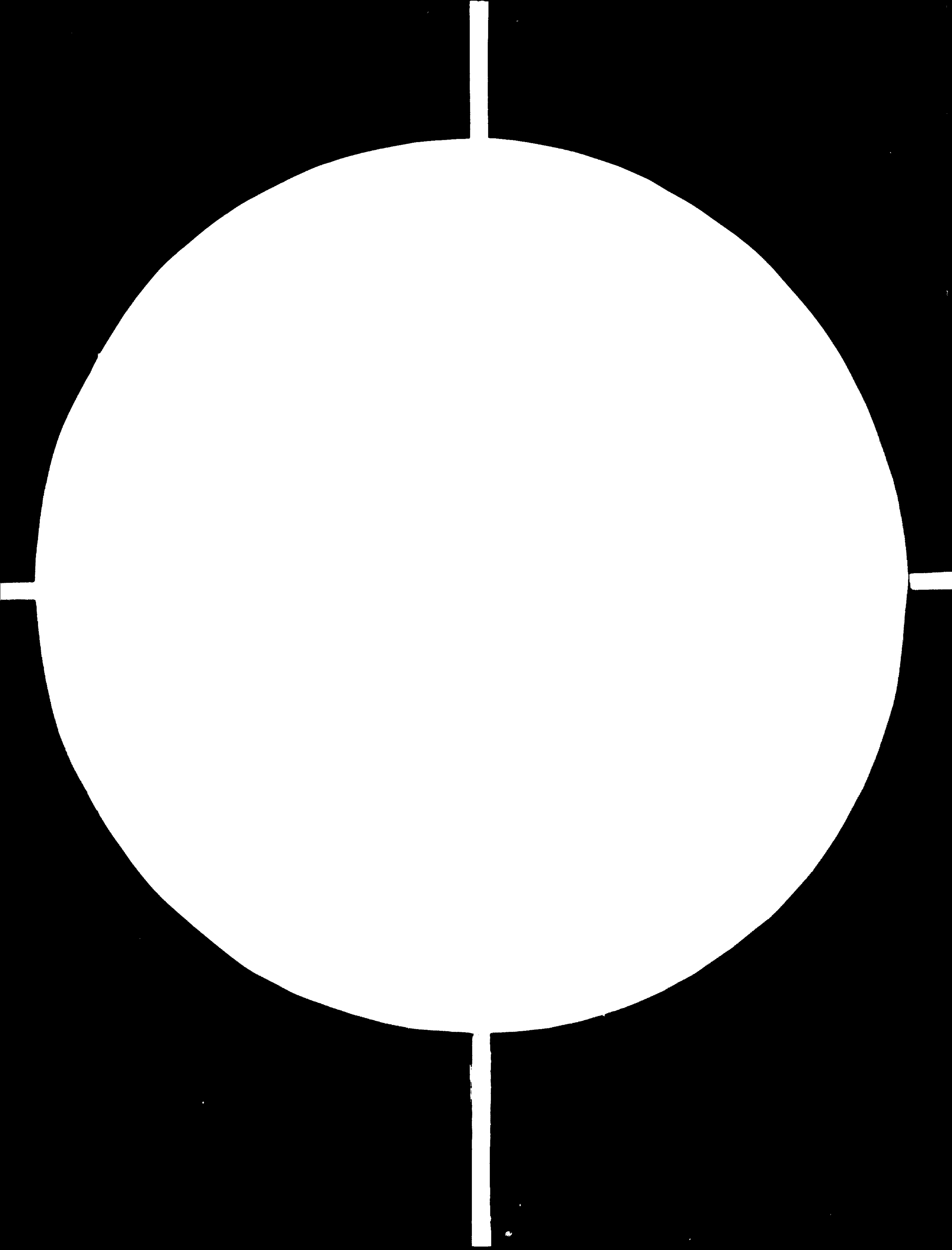

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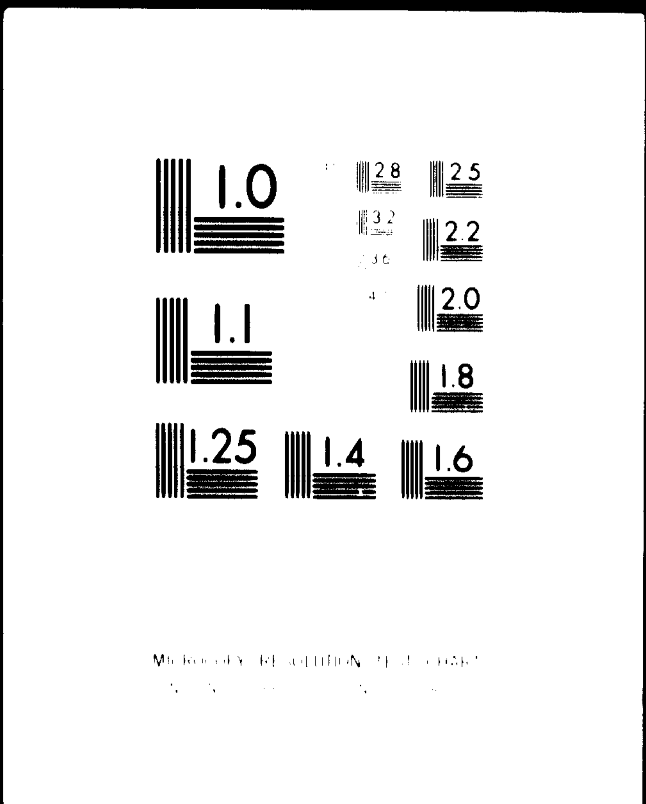

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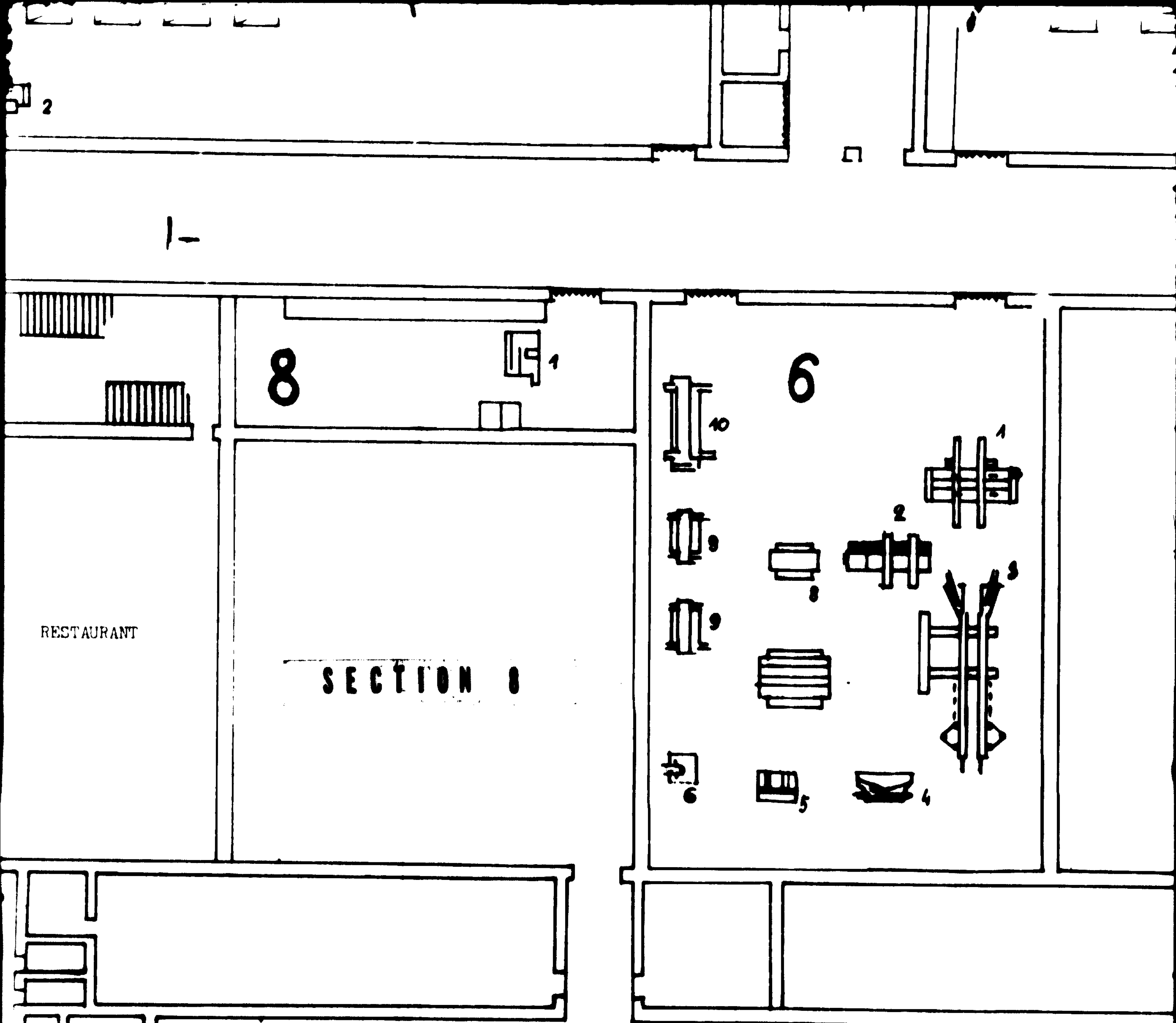


Panel sizing

1. Panel-sizing machine
2. Panel-sizing machine
3. Calibrating machine
4. Calibrating machine
5. Single-end edge bander

Panel veneering

1. Glue spreader
2. Single daylight press
3. Glue mixer
4. Glue spreader
5. Multiple daylight press

Rough mill

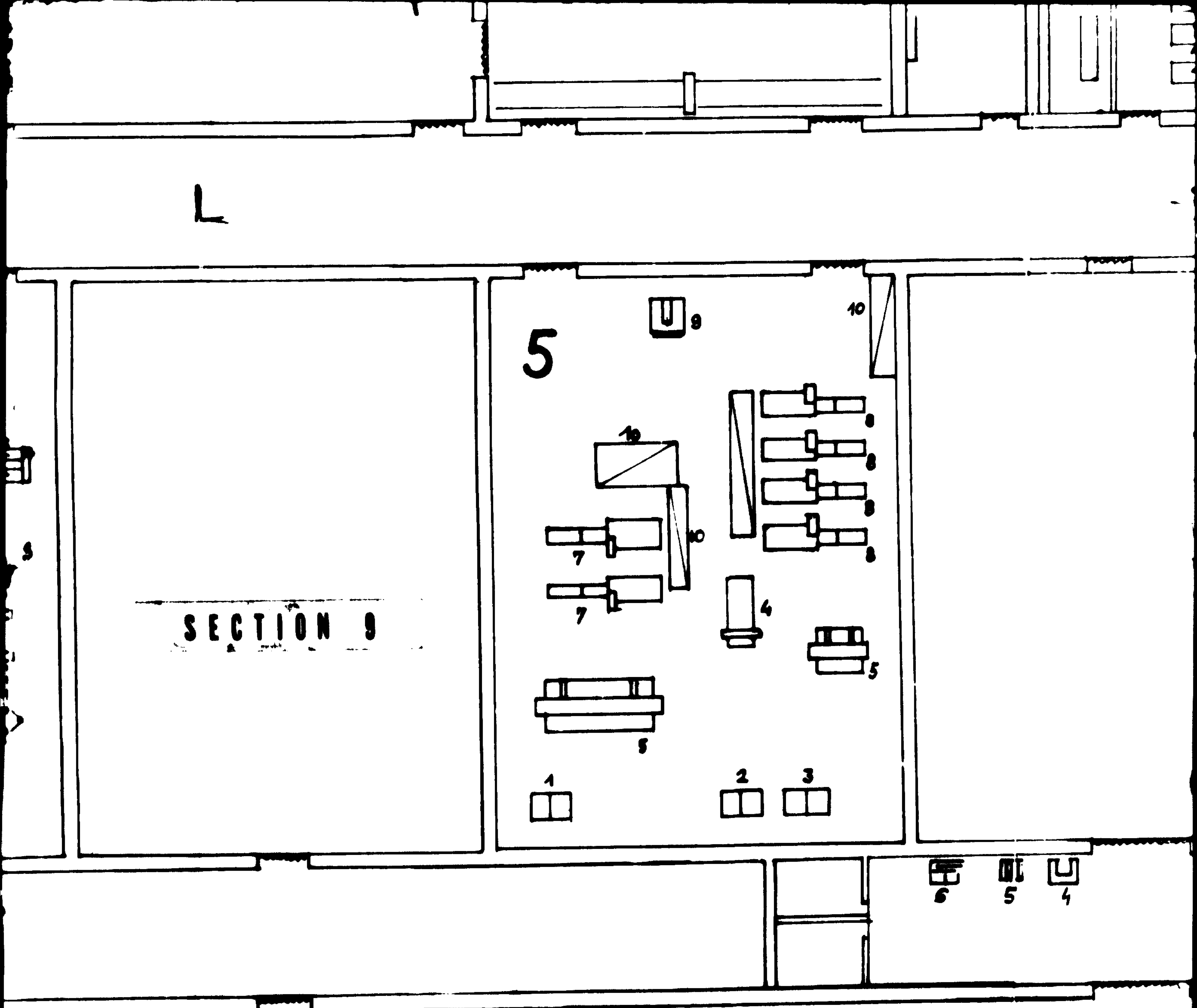
1. Cut-off machine
2. Rip-saw
3. Jointer
4. Thicknesser
5. Multiple rip-saw
6. Copying machine
7. Lathe

Panel finishing

1. Double-end tenoner
2. Two-sided edge bander
3. Double-end tenoner
4. Two-sided edge bander
5. Dowel-hole boring machine
6. Dowel-hole boring machine
7. Spindle moulder
8. Router
9. Hardware recessing machine
10. Wide belt-sander
11. Wide belt-sander
12. Semiautomatic belt-sander
13. Table

Veneer section

1. Cutting table
2. Cutting table
3. Cutting table
4. Veneer cross-cutter
5. Veneer pack-jointer
6. [illegible]



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Auxiliary panel finishing

1. Double-end tenoner
2. Double circular saw
3. Two-sided edge bander
4. Edge sander
5. Spindle moulder
6. Router
7. Dowel-hole boring machine
8. Wide belt-sander
9. Belt-sander
10. Semiautomatic belt-sander

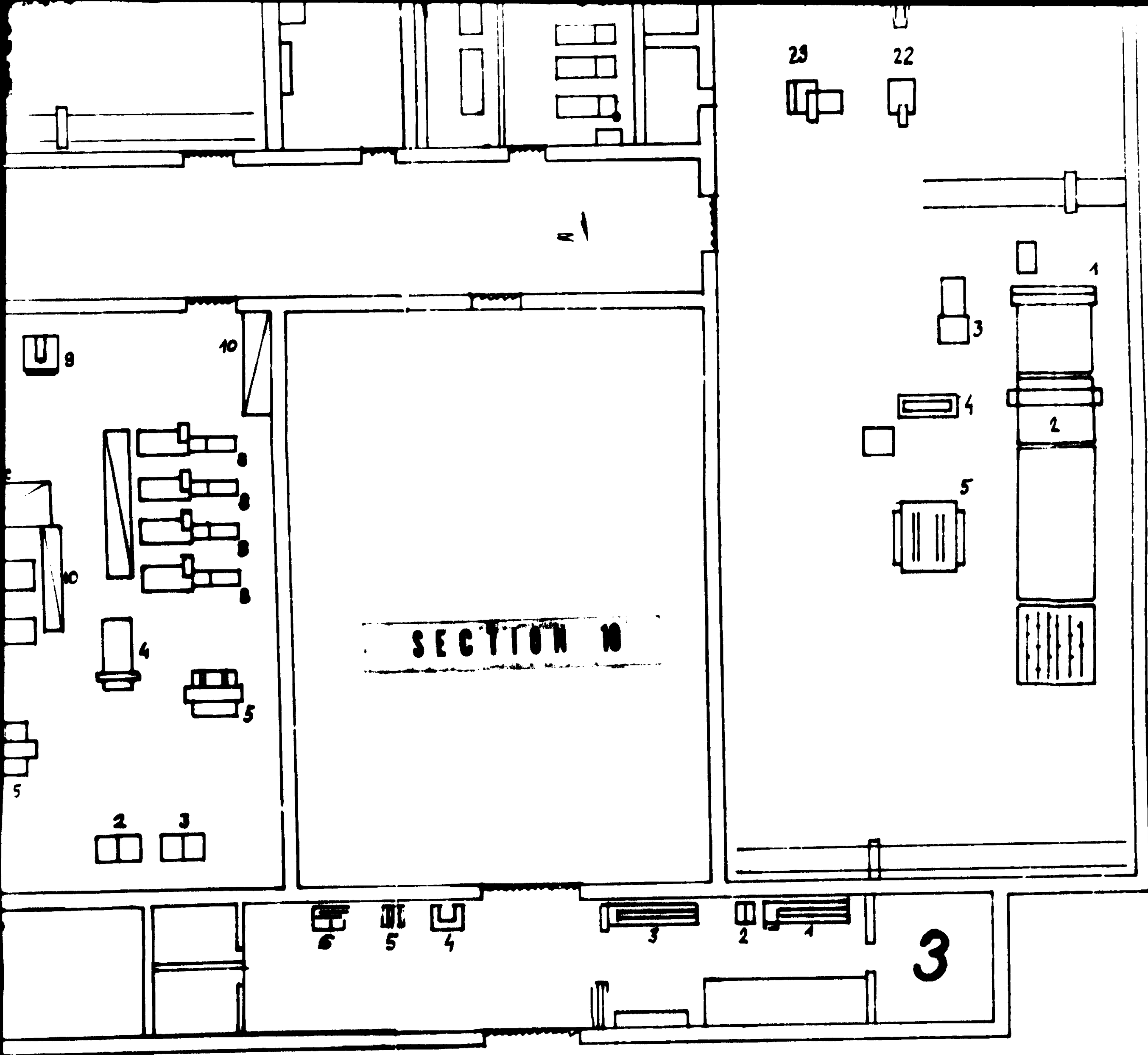
Assembly section

1. Core-glueing machine
2. Preparation of corpus parts
3. Assembling/clamping
4. Assembling/clamping
5. Assembling/clamping
6. Preparation of face elements
7. Assembly of corpus and face elements

Polyester section

Lacquer-coating section

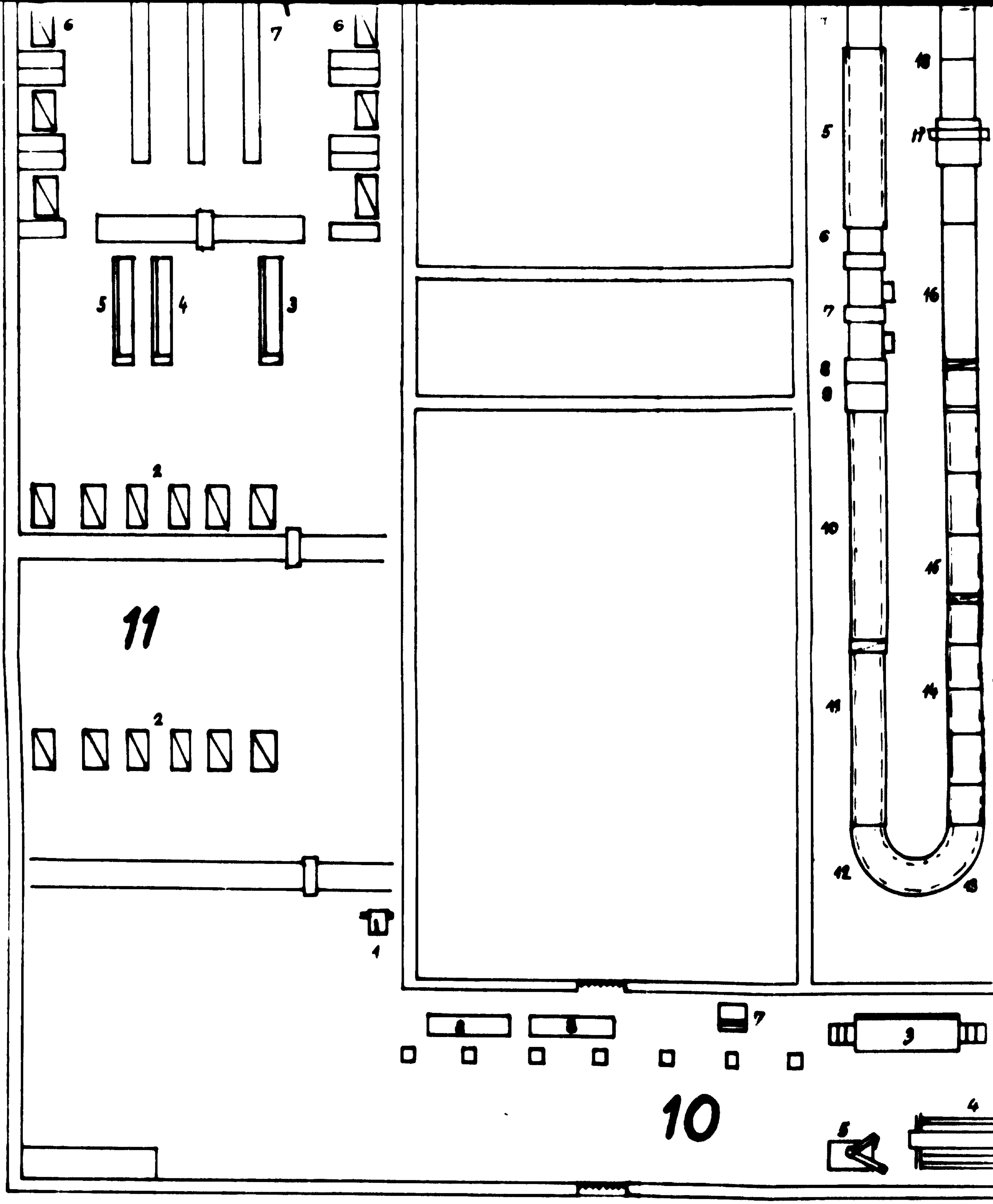
1. Intermediate lacquer-coat san
2. Belt conveyer
3. Stain roller-coater
4. Belt conveyer
5. Drying channel
6. Accelerating conveyer
7. Curtain coater
8. Belt conveyer
9. Drying chamber
10. Low channel
11. Low channel
12. Return conveyer
13. Return conveyer
14. Low channel
15. Low channel
16. Cooling zone
17. Intermediate lacquer-coat san
18. Belt conveyer
19. Curtain coater
20. Exit conveyer
21. Chain conveyer
22. Rack trolley
23. Drying channel



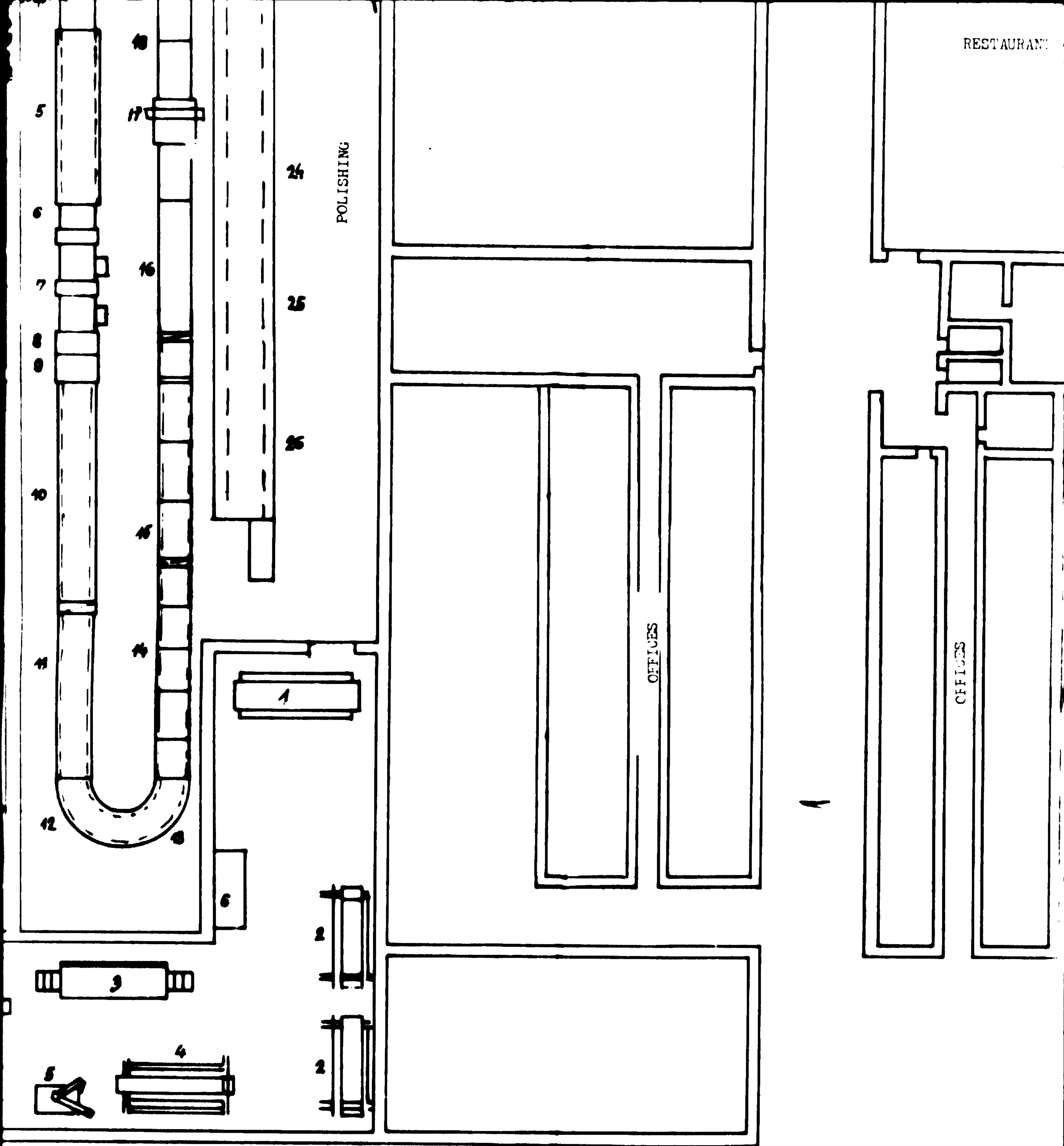
Lacquer-coating section

1. Intermediate lacquer-coat sander
2. Belt conveyer
3. Stain roller-coater
4. Belt conveyer
5. Drying channel
6. Accelerating conveyer
7. Curtain coater
8. Belt conveyer
9. Drying chamber
10. Low channel
11. Low channel
12. Return conveyer
13. Return conveyer
14. Low channel
15. Low channel
16. Cooling zone
17. Intermediate lacquer-coat sander
18. Belt conveyer
19. Curtain coater
20. Exit conveyer
21. Chain conveyer

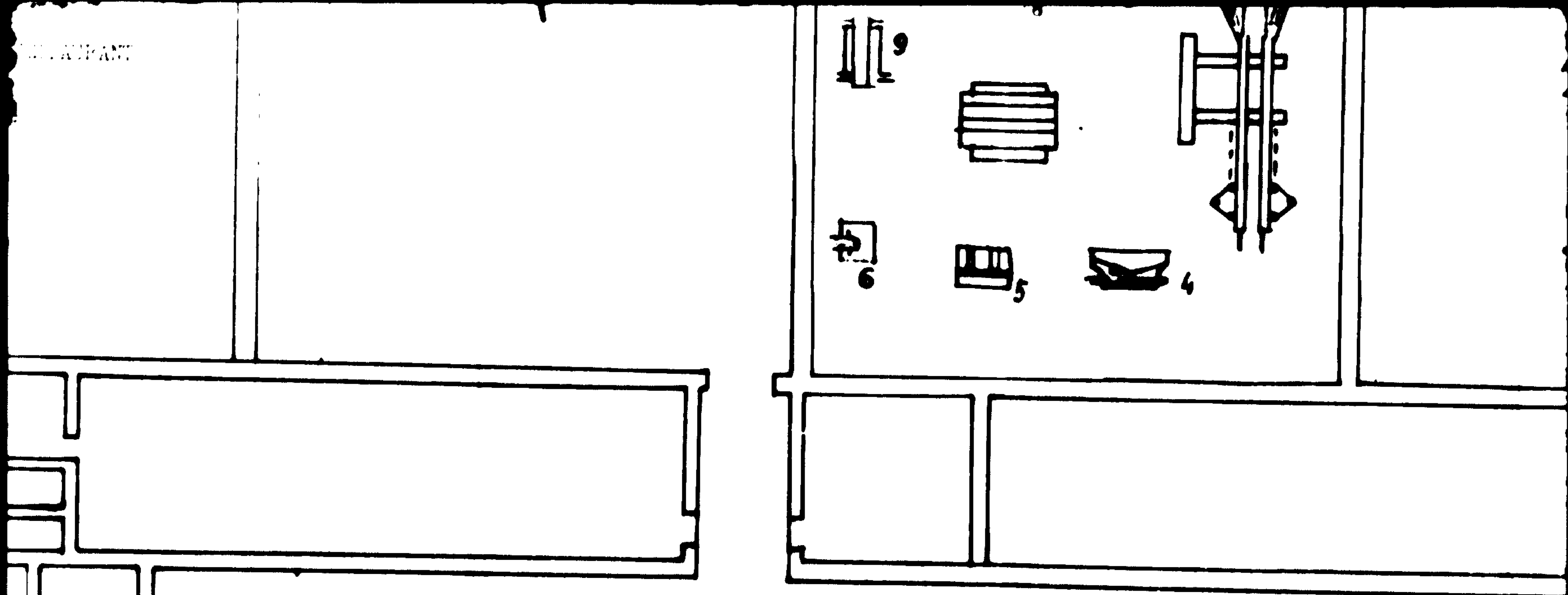
lements



SECTION 11



SECTION 12



Panel sizing

1. Panel-sizing machine
2. Panel-sizing machine
3. Calibrating machine
4. Calibrating machine
5. Single-end edge bander

Panel veneering

1. Glue spreader
2. Single daylight press
3. Glue mixer
4. Glue spreader
5. Multiple daylight press

Rough mill

1. Cut-off machine
2. Rip-saw
3. Jointer
4. Thicknesser
5. Multiple rip-saw
6. Copying machine
7. Lathe
8. Band-saw
9. Core production
10. Spindle moulder
11. Double circular saw
12. Frame clamp
13. Router
14. Two-sided boring machine
15. Horizontal boring machine
16. Spindle moulder
17. Dowel-glueing machine
18. Frame clamp
19. Band-saw
20. Dowel-hole boring machine
21. Precision circular saw
22. Router

Panel finishing

1. Double-end tenoner
2. Two-sided edge bander
3. Double-end tenoner
4. Two-sided edge bander
5. Dowel-hole boring machine
6. Dowel-hole boring machine
7. Spindle moulder
8. Router
9. Hardware recessing machine
10. Wide belt-sander
11. Wide belt-sander
12. Semiautomatic belt-sander
13. Table

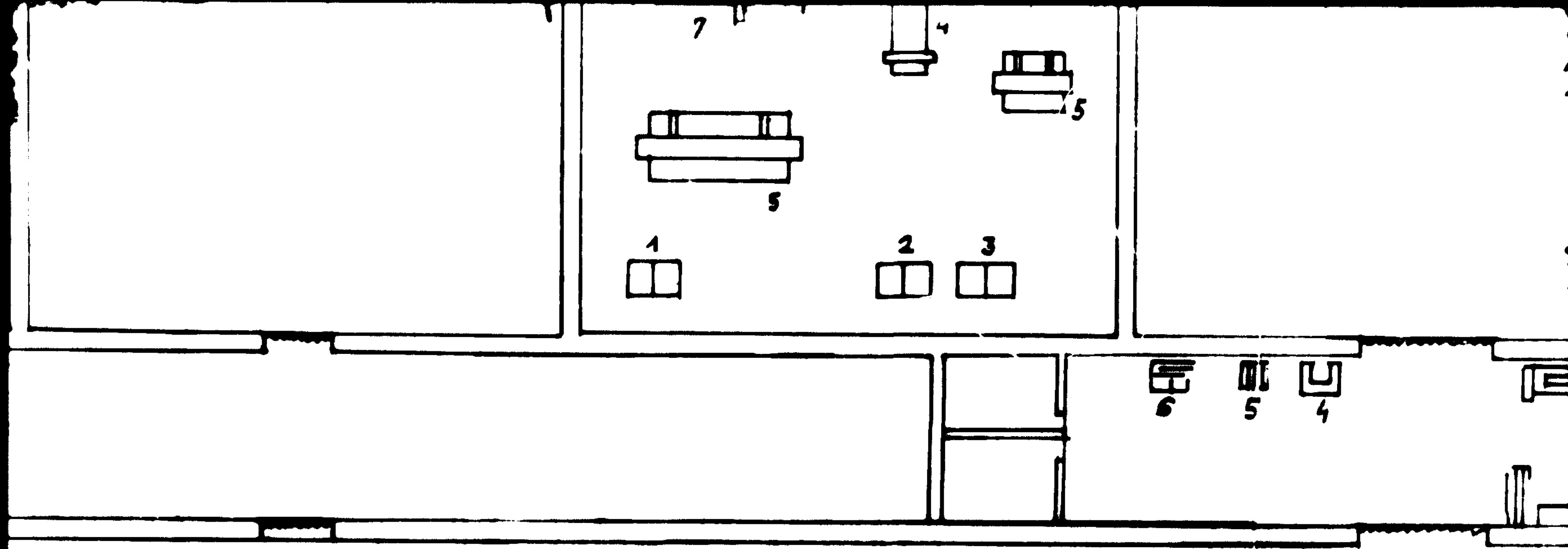
Veneer section

1. Cutting table
2. Cutting table
3. Cutting table
4. Veneer cross-cutter
5. Veneer pack-jointer
6. Veneer pack-jointer
7. Splicer
8. Splicer
9. Veneer jointer and glue spreader
10. Checking table

Upholstery section (ground floor)

1. Press for arm chairs
2. Press for settees
3. Production of armchairs and settees
4. Assembly of armchairs and settees

SECTION 13



Auxiliary panel finishing

1. Double-end tenoner
2. Double circular saw
3. Two-sided edge bander
4. Edge sander
5. Spindle moulder
6. Router
7. Dowel-hole boring machine
8. Wide belt-sander
9. Belt-sander
10. Semiautomatic belt-sander

Assembly section

1. Core-glueing machine
2. Preparation of corpus parts
3. Assembling/clamping
4. Assembling/clamping
5. Assembling/clamping
6. Preparation of face elements
7. Assembly of corpus and face elements

Polyester section

1. Automatic sander
2. Semiautomatic sander
3. Buffing machine
4. Edge sander
5. Buffing machine
6. Checking table
7. Router
8. Checking table

Lacquer-coating section

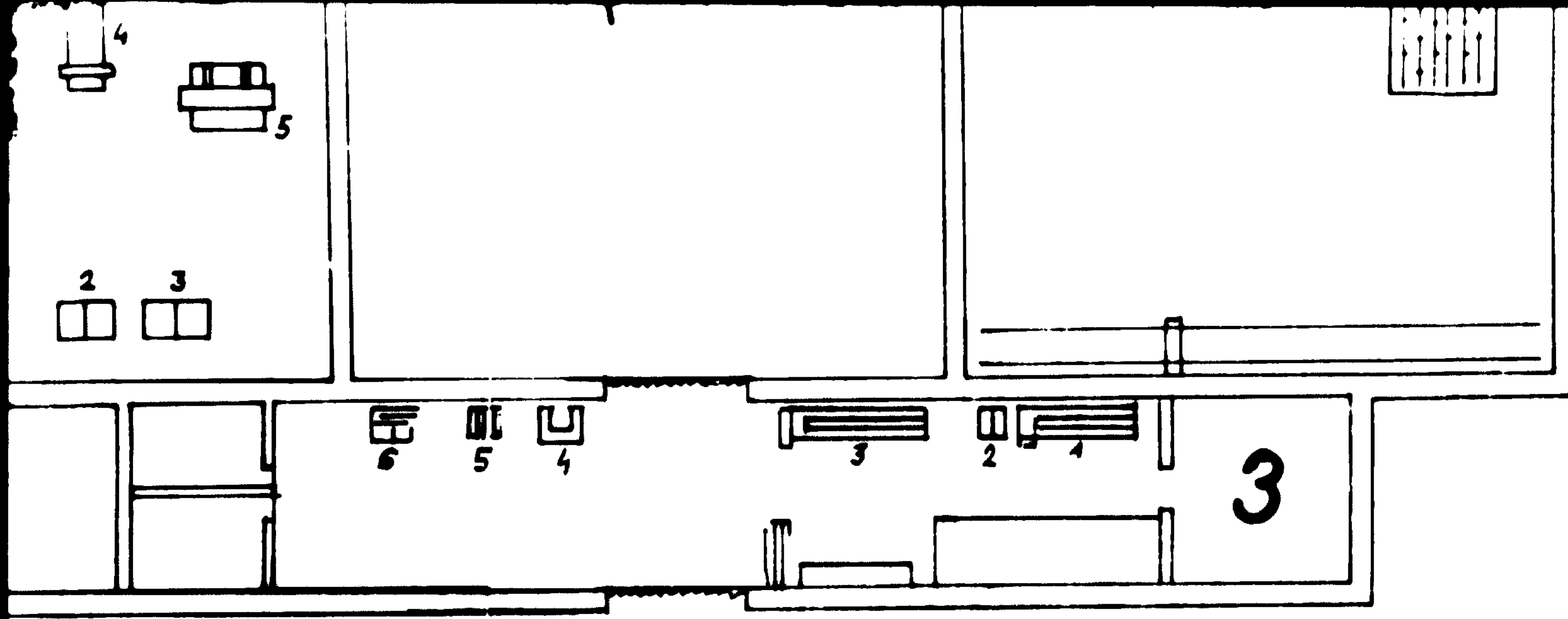
1. Intermediate lacquer-coat sander
2. Belt conveyer
3. Stain roller-coater
4. Belt conveyer
5. Drying channel
6. Accelerating conveyer
7. Curtain coater
8. Belt conveyer
9. Drying chamber
10. Low channel
11. Low channel
12. Return conveyer
13. Return conveyer
14. Low channel
15. Low channel
16. Cooling zone
17. Intermediate lacquer-coat sander
18. Belt conveyer
19. Curtain coater
20. Exit conveyer
21. Chain conveyer
22. Rack trolley
23. Drying channel
24. Drying channel
25. Drying channel
26. Drying channel

1. Spraying booth
2. Curtain coater
3. Drying racks

reader

settees
ttees

SECTION 14



Lacquer-coating section

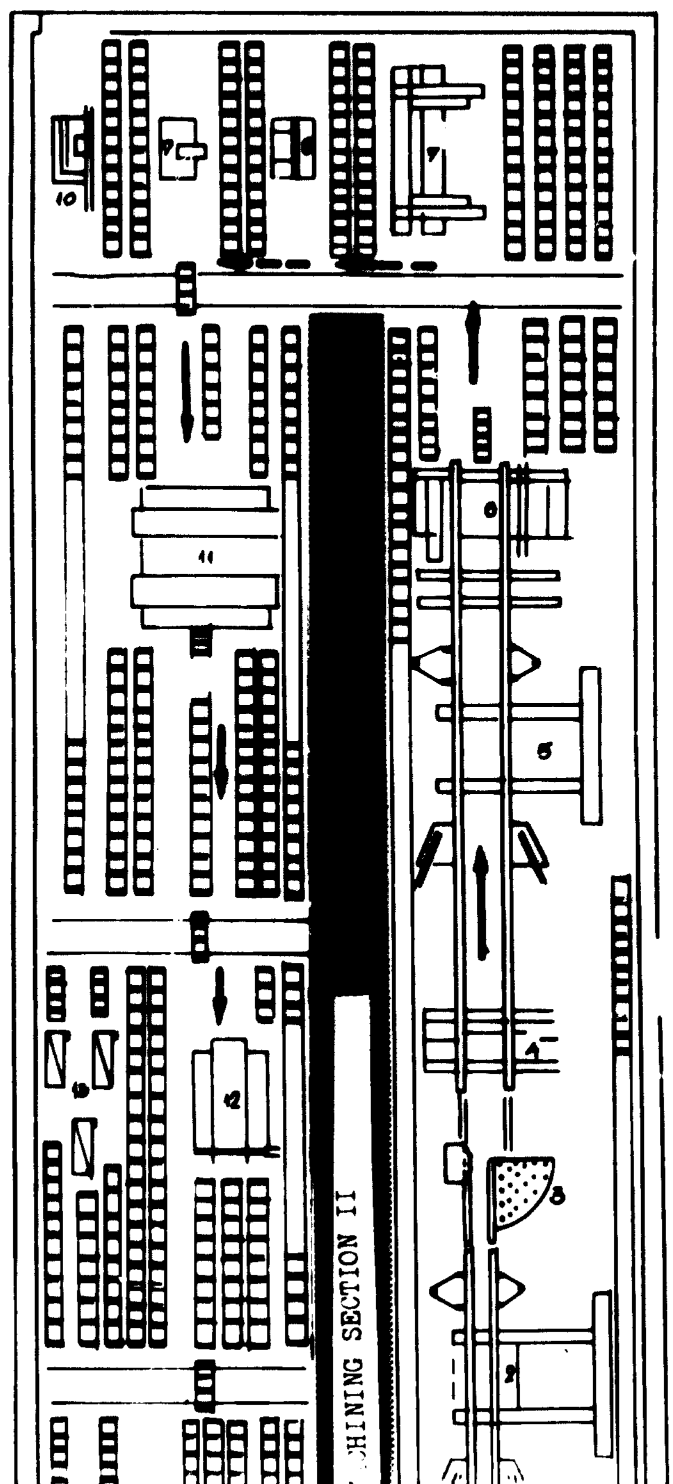
1. Intermediate lacquer-coat sander
2. Belt conveyer
3. Stain roller-coater
4. Belt conveyer
5. Drying channel
6. Accelerating conveyer
7. Curtain coater
8. Belt conveyer
9. Drying chamber
10. Low channel
11. Low channel
12. Return conveyer
13. Return conveyer
14. Low channel
15. Low channel
16. Cooling zone
17. Intermediate lacquer-coat sander
18. Belt conveyer
19. Curtain coater
20. Exit conveyer
21. Chain conveyer
22. Rack trolley
23. Drying channel
24. Drying channel
25. Drying channel
26. Drying channel

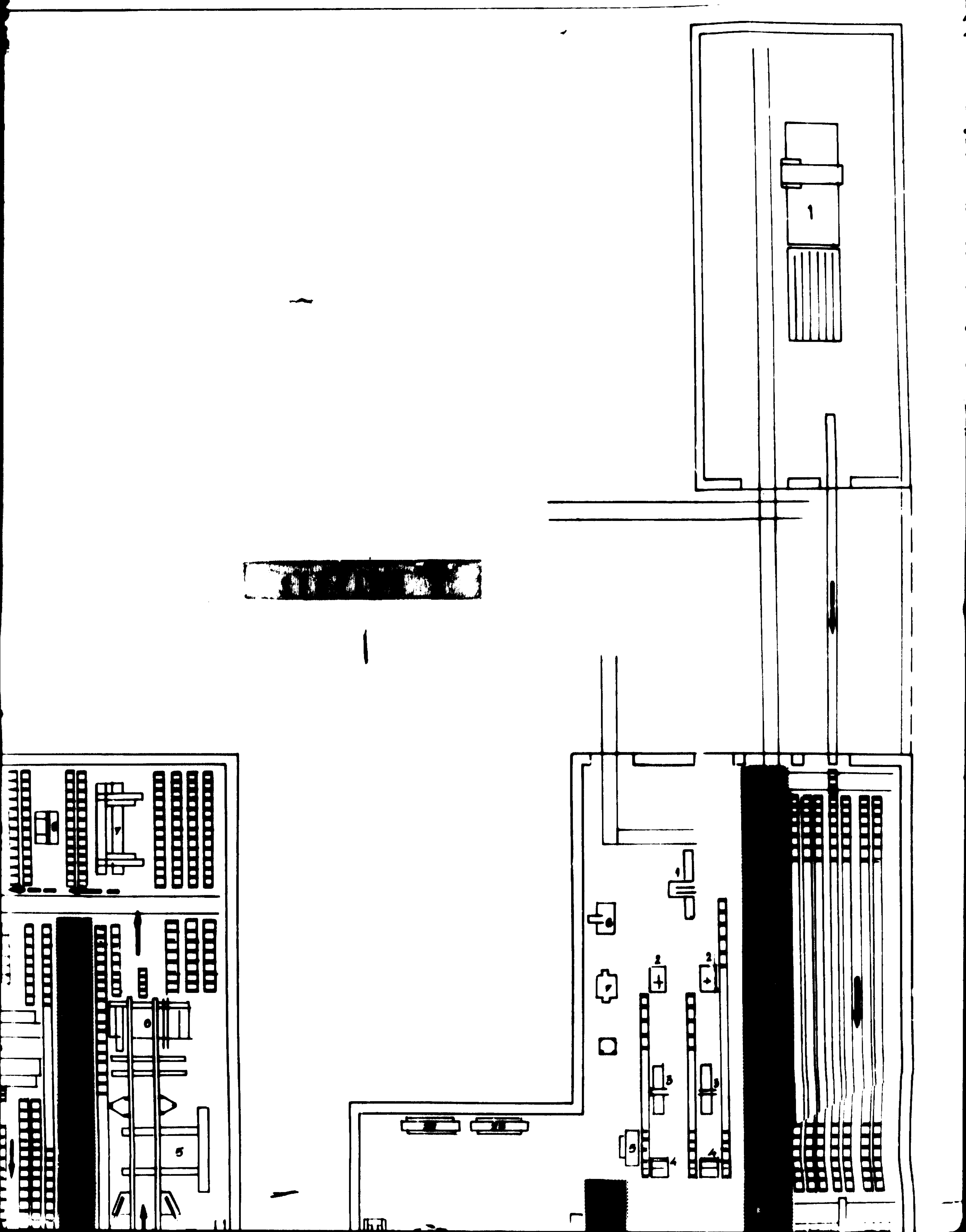
1. Spraying booth
2. Curtain coater
3. Drying racks

SECTION 15

Figure VII. Proposed layout of machining departments at Standard, Sarajevo

[redacted]




1
2
2
3
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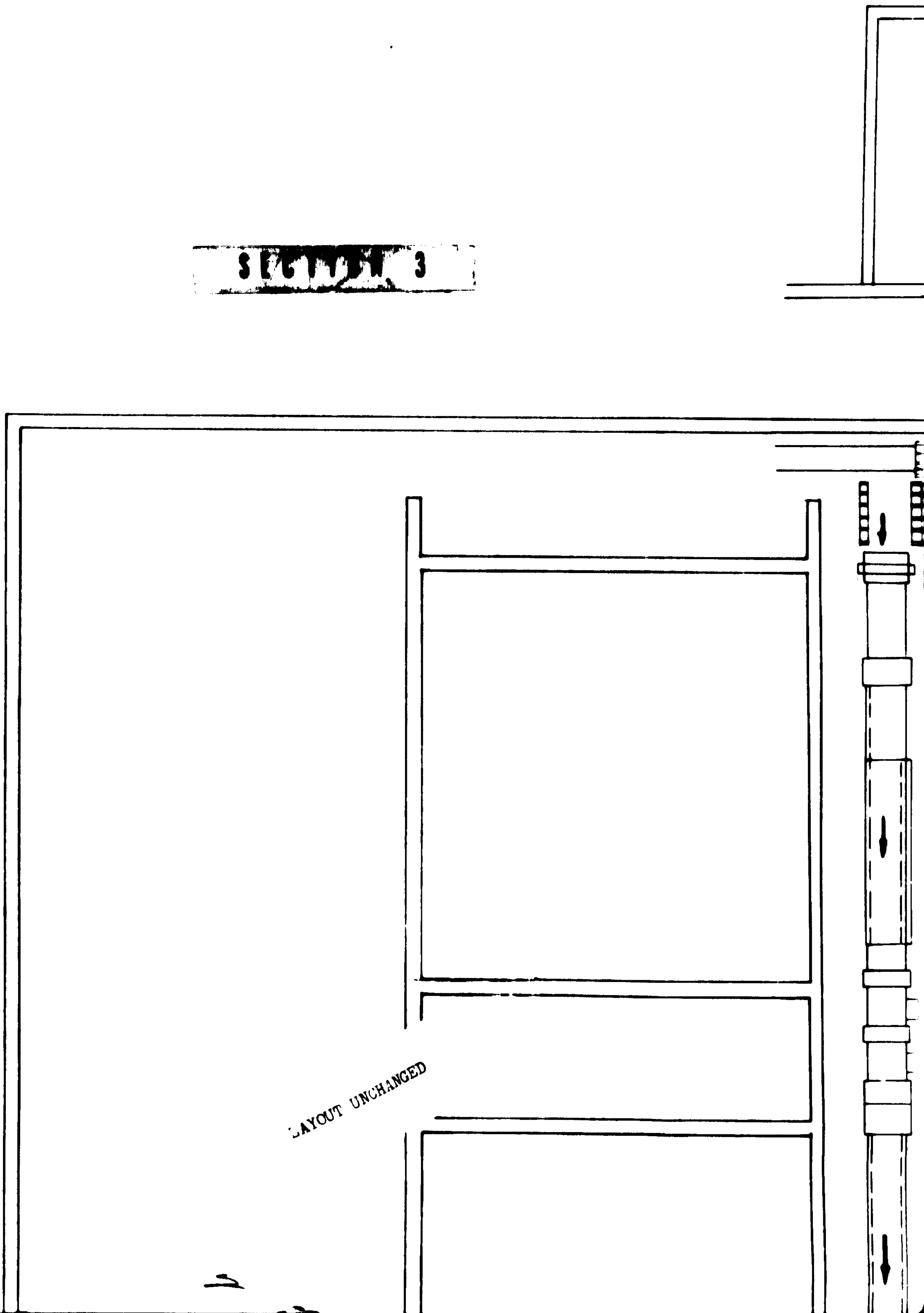
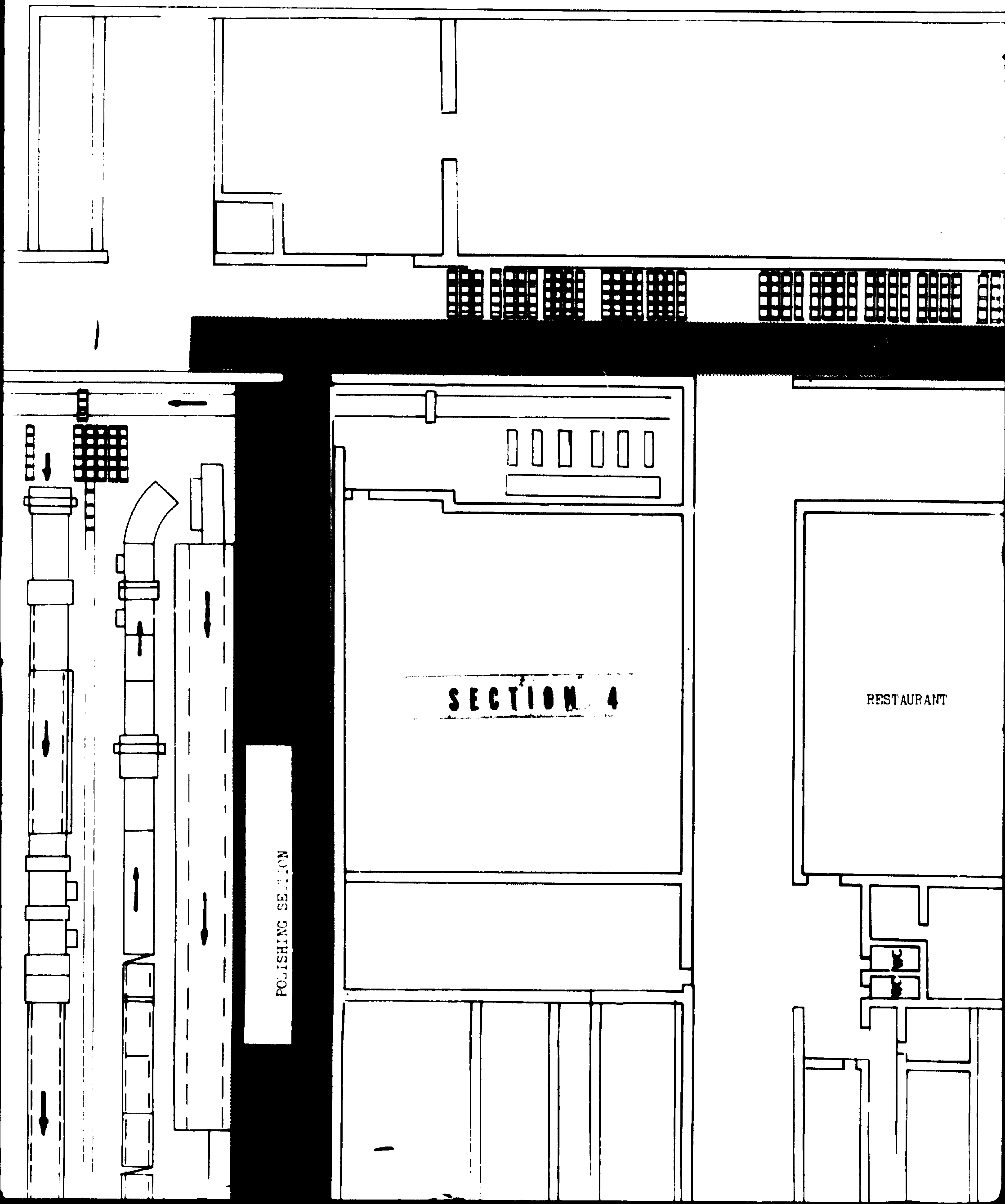
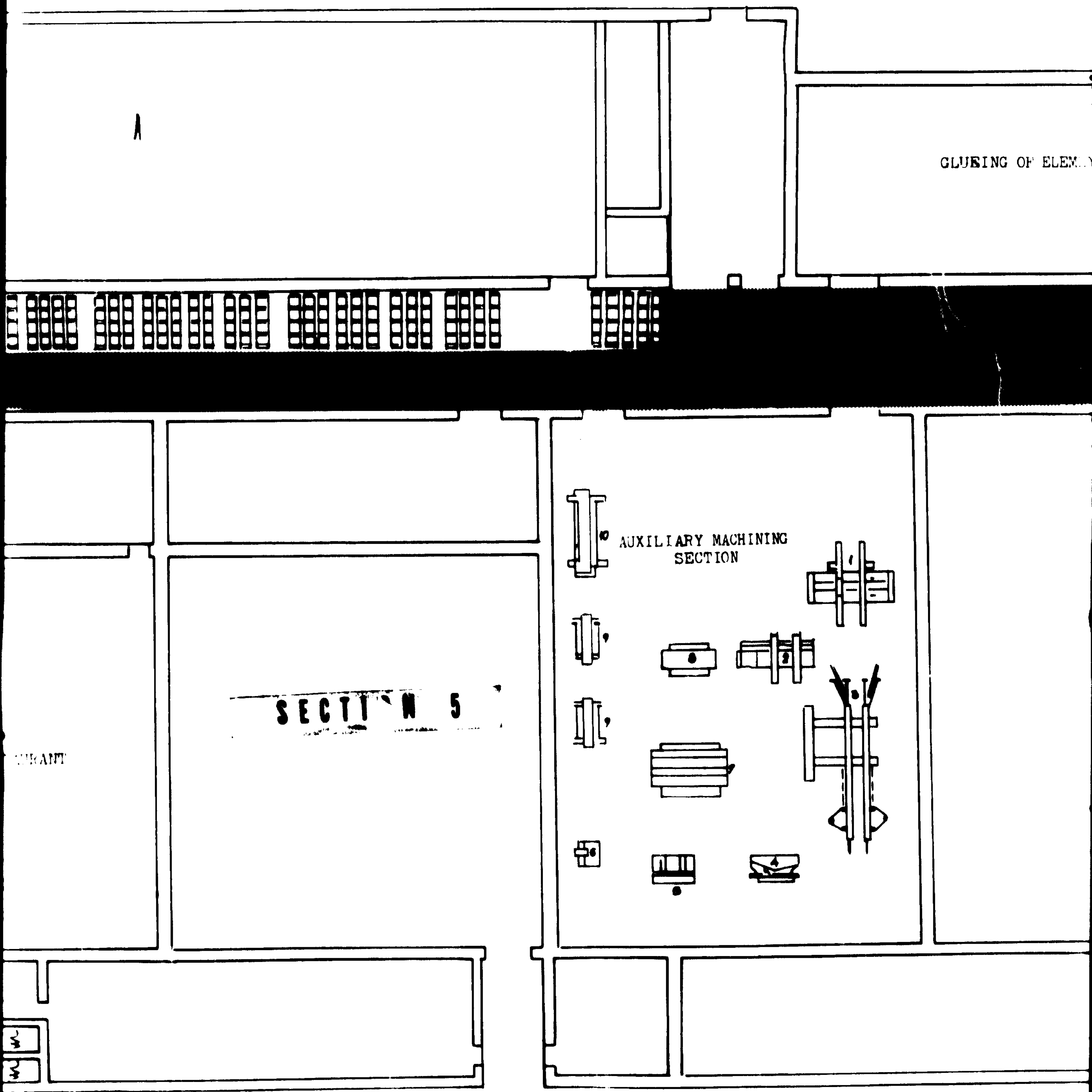
SECTION 3

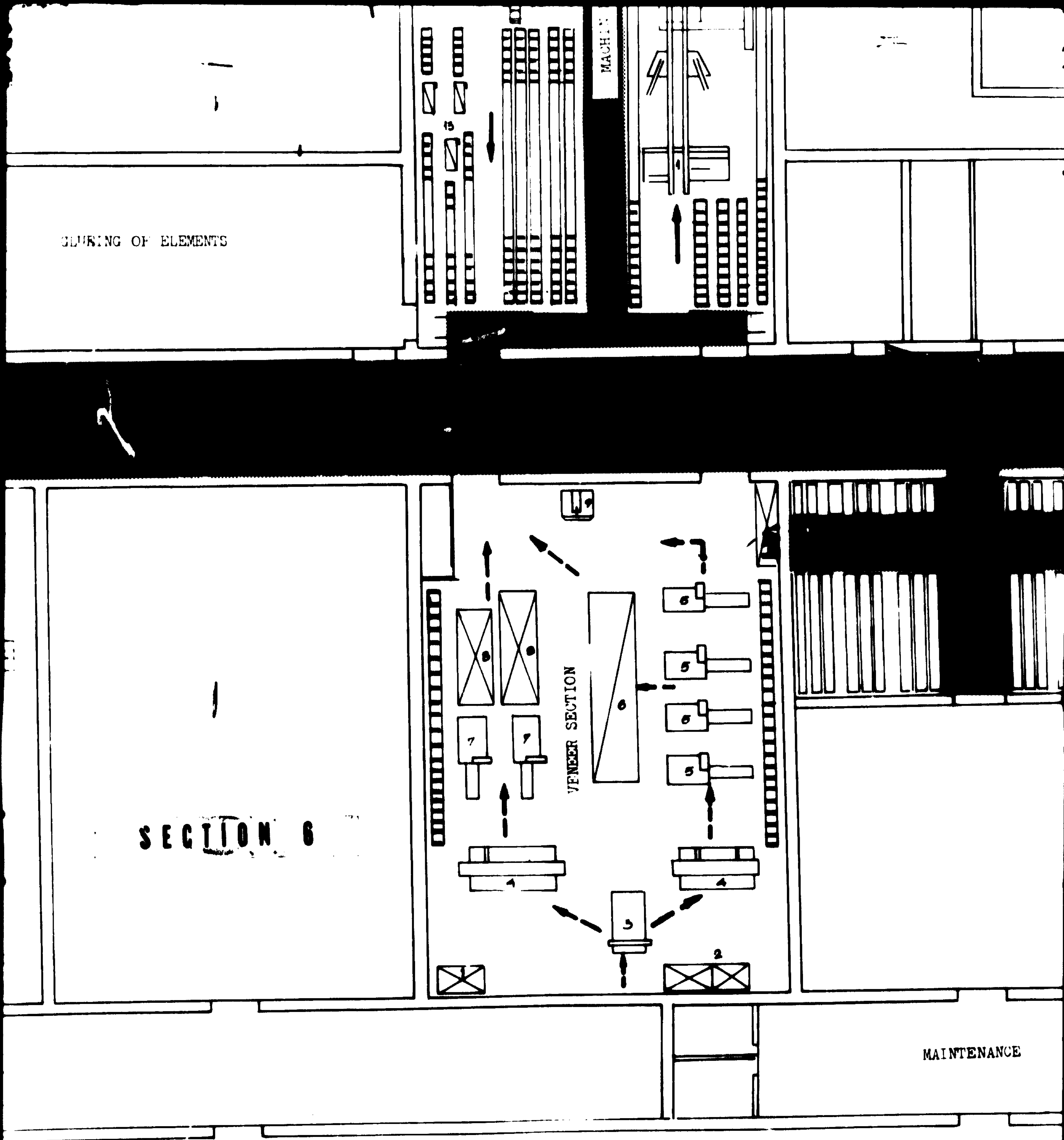



SECTION 4
RESTAURANT
POLISHING



AUXILIARY MACHINING SECTION

1. Double-end tenoner
2. Double circular saw
3. Edge bander
4. Edge sander
5. Spindle moulder
6. Router
7. Dowel-hole boring machine



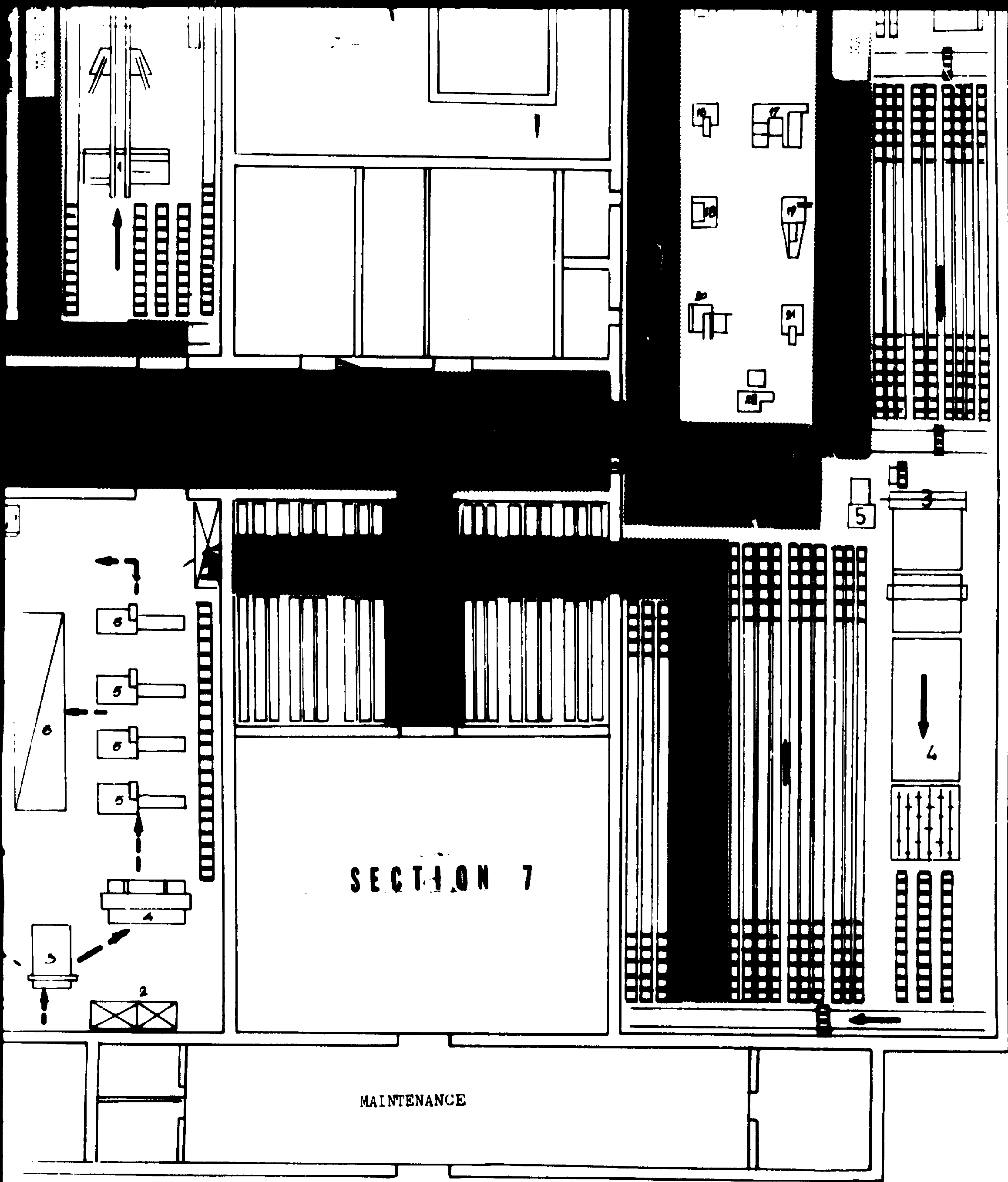
VENEER SECTION

1. Table
2. Tables
3. Veneer cross-cutter
4. Veneer pack-jointer
5. Splicer
6. Checking table
7. Splicer

MACHINING SECTION I

Rough mill

1. Cut-off machine
2. Rip-saw
3. Jointer
4. Thicknesser
5. Multiple rip-saw
6. Band-saw
7. [illegible]



MACHINING SECTION I

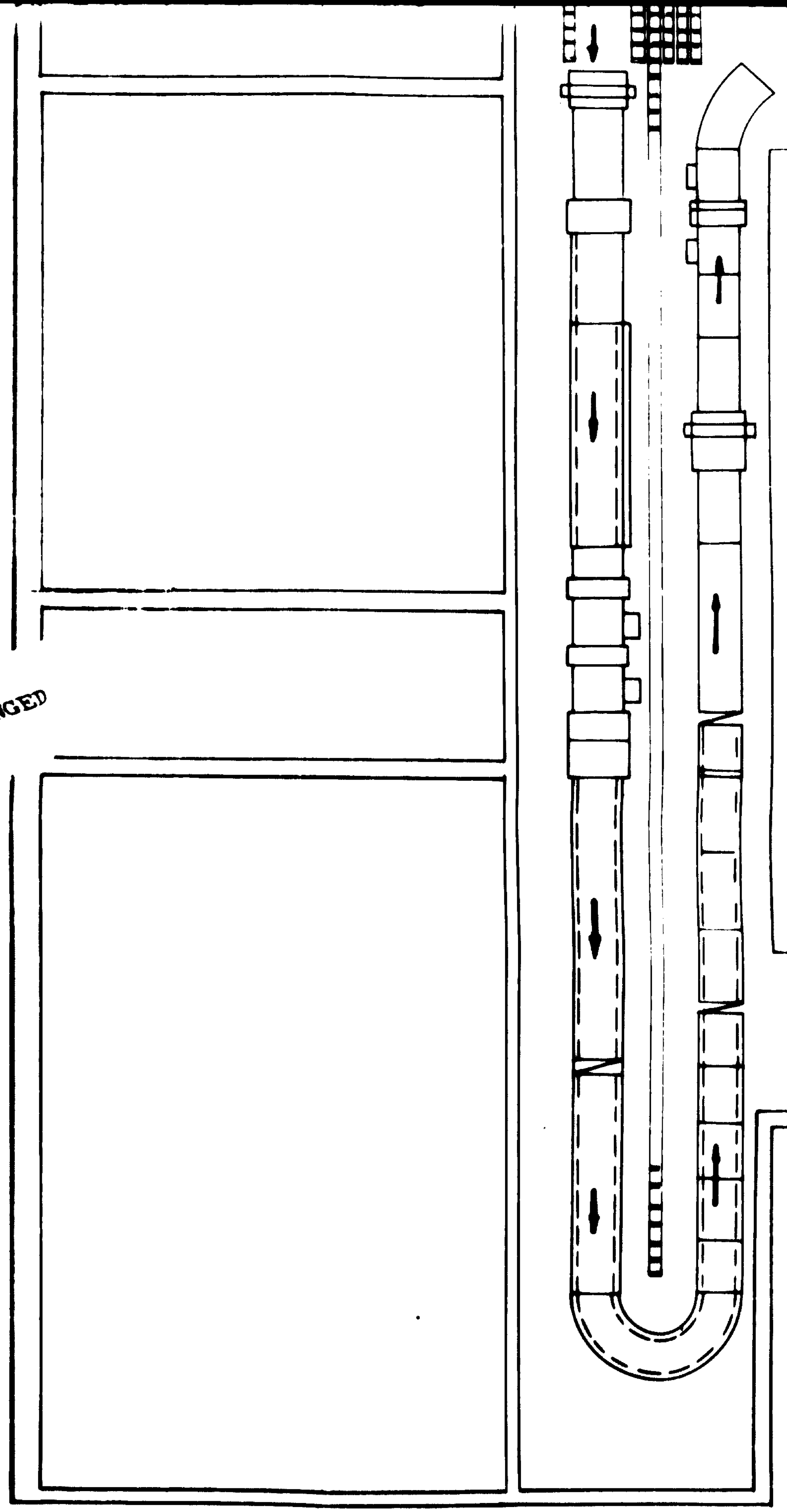
<u>Rough mill</u>

1. Cut-off machine
2. Rip-saw
3. Jointer
4. Thicknesser
5. Multiple rip-saw
6. Band-saw

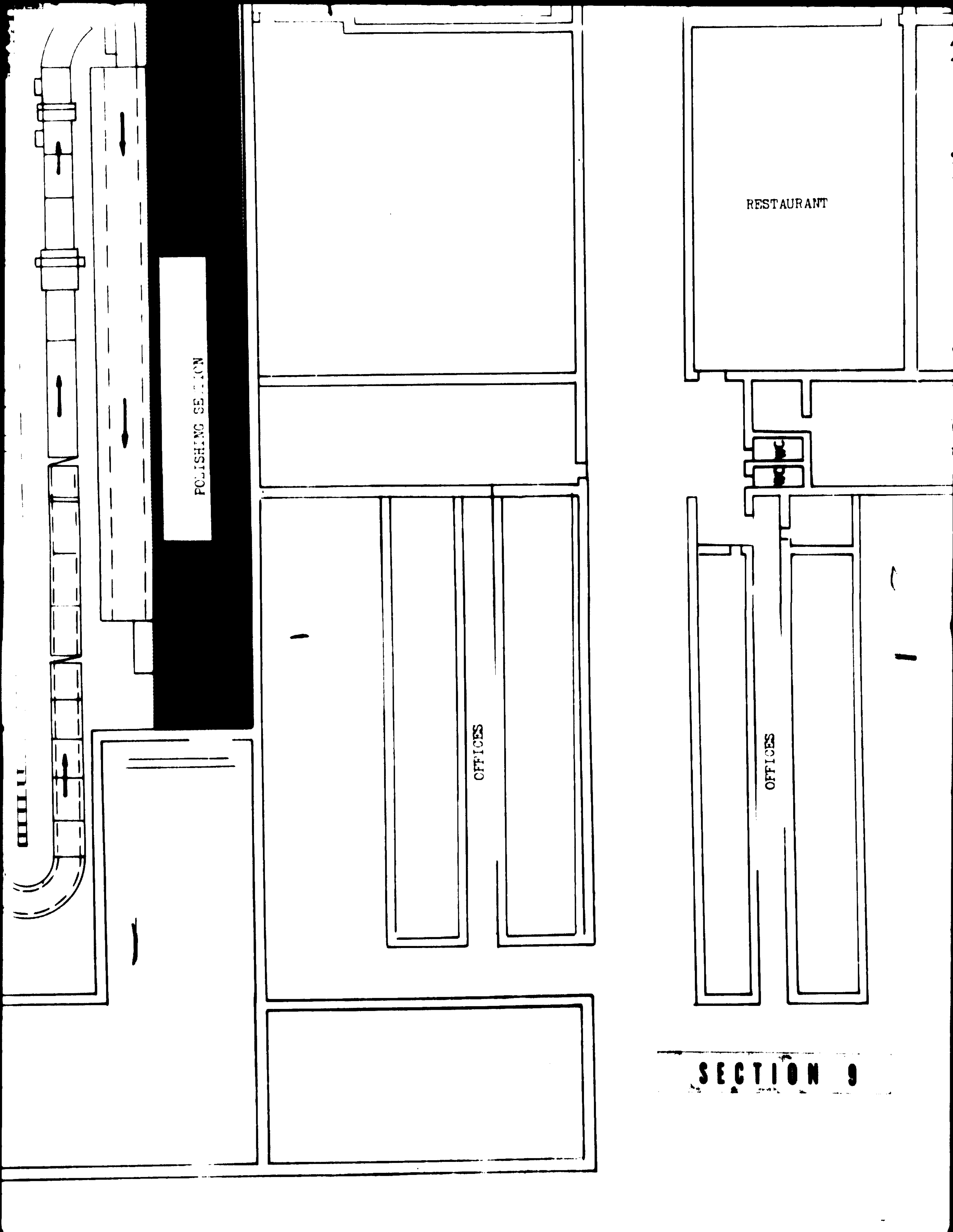
<u>Panel sizing</u>

1. Panel-sizing machine
2. Calibrating machine
3. Glue spreader
4. Press
5. Glue mixer

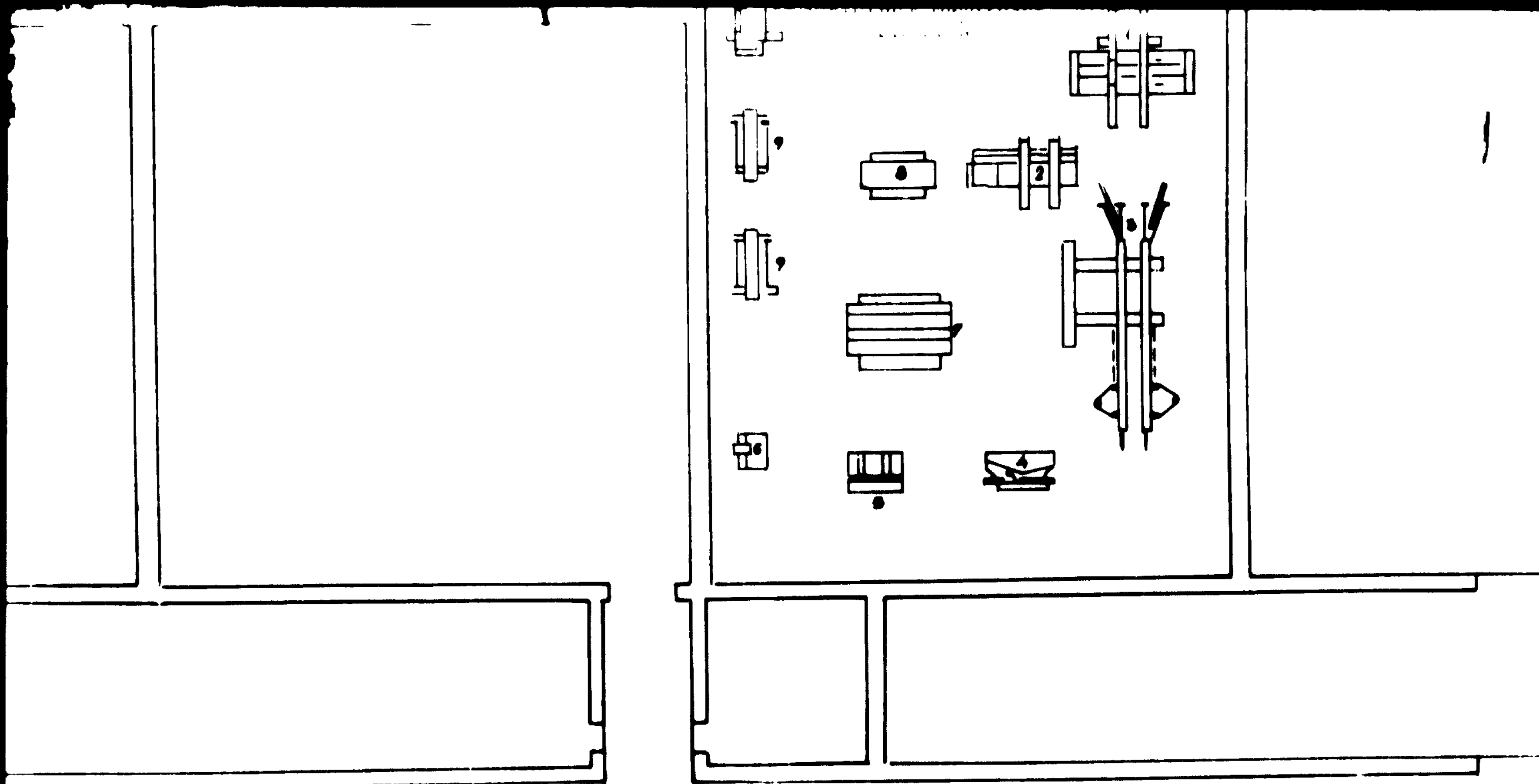
LAYOUT UNCHANGED



SECTION 8



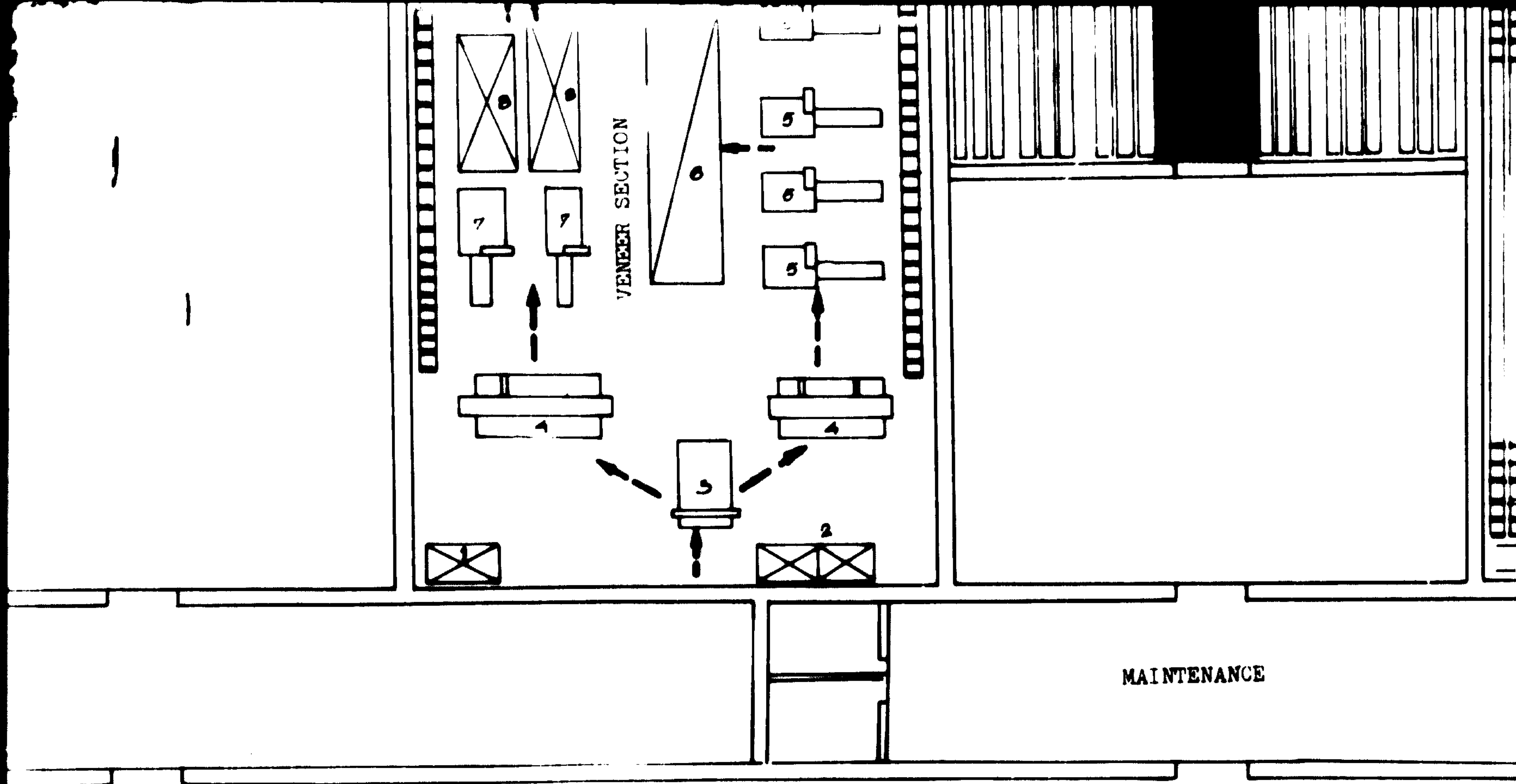
SECTION 9



AUXILIARY MACHINING SECTION

1. Double-end tenoner
2. Double circular saw
3. Edge bander
4. Edge sander
5. Spindle moulder
6. Router
7. Dowel-hole boring machine
8. Wide belt-sander
9. Belt-sander
10. Semiautomatic belt-sander

SECTION 10



VENEER SECTION

1. Table
2. Tables
3. Veneer cross-cutter
4. Veneer pack-jointer
5. Splicer
6. Checking table
7. Splicer
8. Checking table
9. Veneer jointer and glue spreader

MACHINING SECTION II

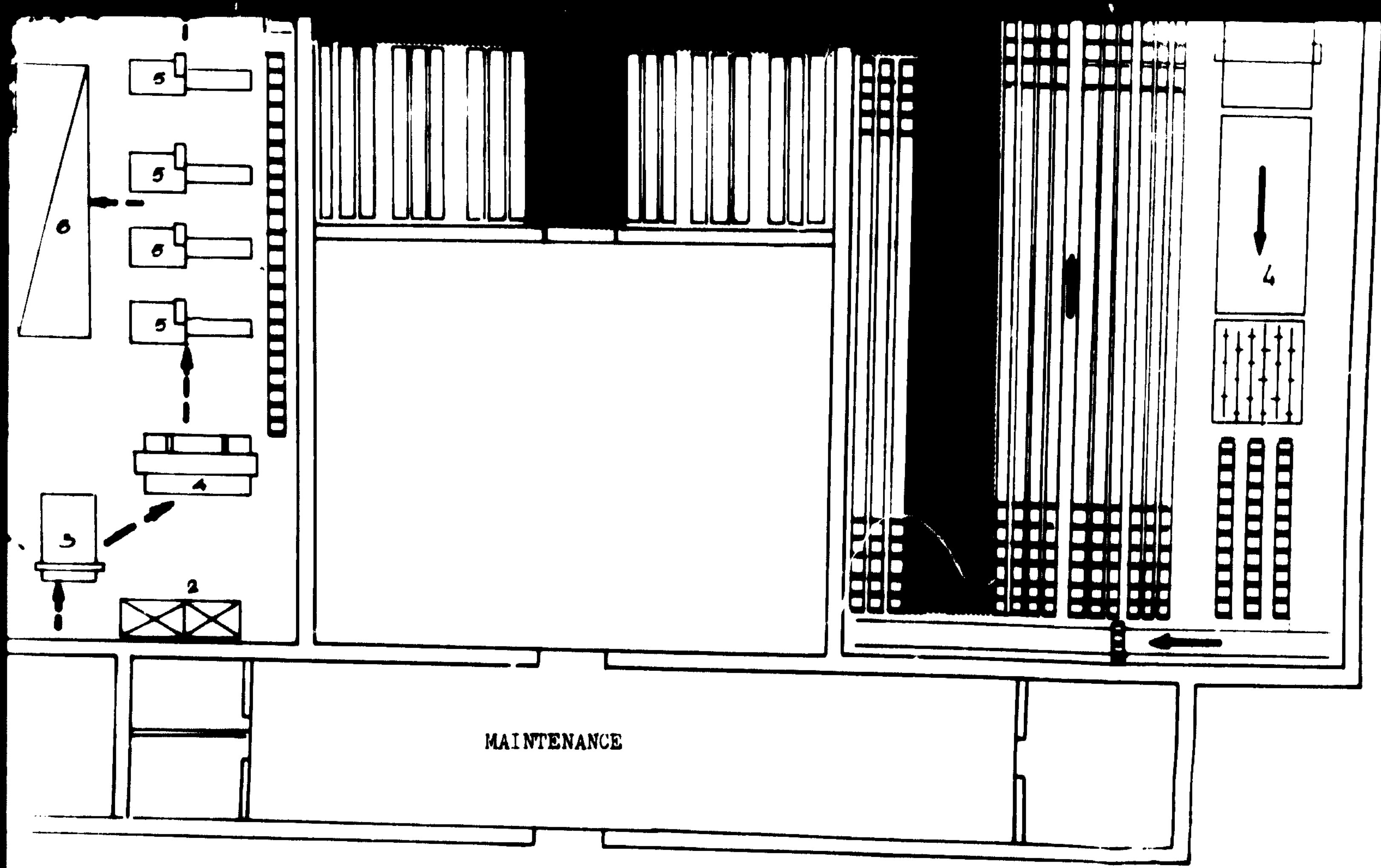
1. Double-end tenoner
2. Edge bander
3. Board turner
4. Double-end tenoner
5. Edge bander
6. Dowel-hole boring machine
7. Dowel-hole boring machine
8. Spindle moulder
9. Router
10. Hardware recessing machine
11. Wide belt-sander
12. Semiautomatic belt-sander
13. Table

MACHINING SECTION I

Rough mill

1. Cut-off machine
2. Rip-saw
3. Jointer
4. Thicknesser
5. Multiple rip-saw
6. Band-saw
7. Core production
8. Double circular saw
9. Horizontal boring machine
10. Router
11. Frame clamp
12. Spindle moulder
13. Two-sided boring machine
14. Spindle moulder
15. Spindle moulder
16. Band-saw
17. Frame clamp
18. Precision circular saw
19. Dowel-hole boring machine
20. Single-end tenoner
21. Router
22. Dowel-glueing machine
23. Lathe
24. Copying machine
25. Belt-sander
26. Drawer sander

SECTION 11



MACHINING SECTION I

Rough mill

1. Cut-off machine
2. Rip-saw
3. Jointer
4. Thicknesser
5. Multiple rip-saw
6. Band-saw
7. Core production
8. Double circular saw
9. Horizontal boring machine
10. Router
11. Frame clamp
12. Spindle moulder
13. Two-sided boring machine
14. Spindle moulder
15. Spindle moulder
16. Band-saw
17. Frame clamp
18. Precision circular saw
19. Dowel-hole boring machine
20. Single-end tenoner
21. Router
22. Dowel-glueing machine
23. Lathe
24. Copying machine
25. Belt-sander
26. Drawer sander

Panel sizing

1. Panel-sizing machine
2. Calibrating machine
3. Glue spreader
4. Press
5. Glue mixer

SECTION 12

B-14

79. 11.15